

**NETGEAR®**

# Software Administration Manual

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## M4300 Intelligent Edge Series Fully Managed Stackable Switches

Software Version 12.0.8

M4300 Series Switches  
M4300-96X Modular Switch

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### Revision History

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## Chapter 1 Documentation Resources

## Chapter 2 LAGs

|  |    |
|--|----|
| Link Aggregation Concepts .....                  | 21 |
| Add Ports to LAGs. ....                          | 22 |
| CLI: Add Ports to the LAGs. ....                 | 22 |
| Local Browser Interface: Add Ports to LAGs ..... | 22 |

## Chapter 3 VLANs

|   |    |
|---|----|
| VLAN Concepts .....   | 25 |
| Create Two VLANs .....  | 26 |
| CLI: Create Two VLANs. ....   | 26 |
| Local Browser Interface: Create Two VLANs .....                                     | 26 |
| Assign Ports to VLAN 2. ....  | 27 |
| CLI: Assign Ports to VLAN 2 .....   | 27 |
| Local Browser Interface: Assign Ports to VLAN 2 .....                               | 28 |
| Create Three VLANs .....  | 29 |
| CLI: Create Three VLANs .....   | 29 |
| Local Browser Interface: Create Three VLANs .....                                   | 29 |
| Assign Ports to VLAN 3. ....  | 31 |
| CLI: Assign Ports to VLAN 3 .....   | 31 |
| Local Browser Interface: Assign Ports to VLAN 3 .....                               | 31 |
| Assign VLAN 3 as the Default VLAN for Port 1/0/2 .....                              | 32 |
| CLI: Assign VLAN 3 as the Default VLAN for Port 1/0/2 .....                         | 32 |
| Local Browser Interface: Assign VLAN 3 as the Default<br>VLAN for Port 1/0/2 .....  | 33 |
| Create a MAC-Based VLAN. ....   | 33 |
| CLI: Create a MAC-Based VLAN .....  | 34 |
| Local Browser Interface: Assign a MAC-Based VLAN .....                              | 35 |
| Create a Protocol-Based VLAN. ....  | 37 |
| CLI: Create a Protocol-Based VLAN .....   | 37 |
| Local Browser Interface: Create a Protocol-Based VLAN .....                         | 38 |
| Virtual VLANs: Create an IP Subnet-Based VLAN .....                                 | 41 |
| CLI: Create an IP Subnet-Based VLAN. ....   | 42 |
| Local Browser Interface: Create an IP Subnet-Based VLAN .....                       | 43 |
| Voice VLANs. ....   | 44 |
| Voice VLAN Interoperation with Auto-VoIP .....                                      | 46 |
| CLI: Configure Voice VLAN and Prioritize Voice Traffic .....                        | 48 |
| Local Browser Interface: Configure Voice VLAN and<br>Prioritize Voice Traffic ..... | 50 |
| Configure GARP VLAN Registration Protocol .....                                     | 56 |
| CLI: Enable GVRP .....  | 56 |
| Local Browser Interface: Configure GVRP on switch A .....                           | 58 |
| Local Browser Interface: Configure GVRP on Switch B .....                           | 60 |
| Private VLANs. ....   | 61 |
| Assign Private-VLAN Types (Primary, Isolated, Community) .....                      | 63 |
| CLI: Assign Private-VLAN Type (Primary, Isolated, Community). ....                  | 63 |

|   |    |
|---|----|
| Local Browser Interface: Assign Private-VLAN Type<br>(Primary, Isolated, Community) . . . . . | 63 |
| Configure Private-VLAN Association . . . . .  | 65 |
| CLI: Configure Private-VLAN Association . . . . .   | 65 |
| Local Browser Interface: Configure Private-VLAN Association. . . . .                          | 65 |
| Configure Private-VLAN Port Mode (Promiscuous, Host). . . . .                                 | 66 |
| CLI: Configure Private-VLAN Port Mode (Promiscuous, Host) . . . . .                           | 66 |
| Local Browser Interface: Configure Private-VLAN Port<br>Mode (Promiscuous, Host). . . . .     | 66 |
| Configure Private-VLAN Host Ports . . . . .   | 68 |
| CLI: Configure Private-VLAN Host Ports. . . . .   | 68 |
| Local Browser Interface: Assign Private-VLAN Port Host Ports . . . . .                        | 68 |
| Map Private-VLAN Promiscuous Port . . . . .   | 69 |
| CLI: Map Private-VLAN Promiscuous Port . . . . .  | 69 |
| Local Browser Interface: Map Private-VLAN Promiscuous Port . . . . .                          | 70 |
| VLAN Access Ports and Trunk Ports . . . . .   | 70 |
| CLI: Configure a VLAN Trunk. . . . .  | 72 |
| Local Browser Interface: Configure a VLAN Trunk. . . . .                                      | 73 |

## Chapter 4 Port Routing

|   |    |
|---|----|
| Port Routing Concepts . . . . .   | 78 |
| Port Routing Configuration . . . . .                                      | 78 |
| Enable Routing for the Switch . . . . .                                   | 79 |
| CLI: Enable Routing for the Switch . . . . .                              | 79 |
| Local Browser Interface: Enable Routing for the Switch . . . . .          | 80 |
| Enable Routing for Ports on the Switch. . . . .                           | 80 |
| CLI: Enable Routing for Ports on the Switch . . . . .                     | 81 |
| Local Browser Interface: Enable Routing for Ports on the Switch . . . . . | 81 |
| Add a Default Route. . . . .  | 83 |
| CLI: Add a Default Route . . . . .  | 84 |
| Local Browser Interface: Add a Default Route . . . . .                    | 84 |
| Add a Static Route . . . . .  | 85 |
| CLI: Show Routing Information . . . . .                                   | 85 |
| Local Browser Interface: Add a Static Route . . . . .                     | 85 |

## Chapter 5 VLAN Routing

|   |    |
|---|----|
| VLAN Routing Concepts. . . . .  | 88 |
| Create Two VLANs . . . . .  | 88 |
| CLI: Create Two VLANs. . . . .  | 89 |
| Local Browser Interface: Create Two VLANs . . . . .                                   | 90 |
| Set Up VLAN Routing for the VLANs and the Switch . . . . .                            | 93 |
| CLI: Set Up VLAN Routing for the VLANs and the Switch. . . . .                        | 93 |
| Local Browser Interface: Set Up VLAN Routing for the<br>VLANs and the Switch. . . . . | 94 |



## Chapter 6 RIP

|  |     |
|--|-----|
| Routing Information Protocol Concepts.....                                       | 96  |
| Enable Routing for the Switch.....   | 97  |
| CLI: Enable Routing for the Switch.....  | 97  |
| Local Browser Interface: Enable Routing for the Switch.....                      | 97  |
| Enable Routing for Ports.....  | 98  |
| CLI: Enable Routing and Assigning IP Addresses for Ports<br>1/0/2 and 1/0/3..... | 98  |
| Local Browser Interface: Enable Routing for the Ports.....                       | 98  |
| Enable RIP on the Switch.....  | 100 |
| CLI: Enable RIP on the Switch.....   | 100 |
| Local Browser Interface: Enable RIP on the Switch.....                           | 100 |
| Enable RIP for Ports 1/0/2 and 1/0/3.....  | 101 |
| CLI: Enable RIP for Ports 1/0/2 and 1/0/3.....                                   | 101 |
| Local Browser Interface: Enable RIP for Ports 1/0/2 and 1/0/3.....               | 101 |
| Configure VLAN Routing with RIP Support.....                                     | 102 |
| CLI: Configure VLAN Routing with RIP Support.....                                | 103 |
| Local Browser Interface: Configure VLAN Routing with RIP Support.....            | 104 |

## Chapter 7 OSPF

|  |     |
|--|-----|
| Open Shortest Path First Concepts.....                               | 108 |
| Inter-area Router.....   | 108 |
| CLI: Configure an Inter-area Router.....                             | 109 |
| Local Browser Interface: Configure an Inter-area Router.....         | 111 |
| OSPF on a Border Router.....   | 115 |
| CLI: Configure OSPF on a Border Router.....                          | 115 |
| Local Browser Interface: Configure OSPF on a Border Router.....      | 116 |
| Stub Areas.....  | 121 |
| CLI: Configure Area 1 as a Stub Area on A1.....                      | 122 |
| Local Browser Interface: Configure Area 1 as a Stub Area on A1.....  | 123 |
| CLI: Configure Area 1 as a Stub Area on A2.....                      | 127 |
| Local Browser Interface: Configure Area 1 as a Stub Area on A2.....  | 128 |
| NSSA Areas.....  | 131 |
| CLI: Configure Area 1 as an NSSA Area.....                           | 131 |
| Local Browser Interface: Configure Area 1 as an NSSA Area on A1..... | 133 |
| CLI: Configure Area 1 as an NSSA Area on A2.....                     | 137 |
| Local Browser Interface: Configure Area 1 as an NSSA Area on A2..... | 139 |
| VLAN Routing OSPF.....   | 143 |
| CLI: Configure VLAN Routing OSPF.....                                | 144 |
| Local Browser Interface: Configure VLAN Routing OSPF.....            | 145 |
| OSPFv3.....  | 148 |
| CLI: Configure OSPFv3.....   | 149 |
| Local Browser Interface: Configure OSPFv3.....                       | 151 |

## Chapter 8 PBR

|                                    |     |
|------------------------------------|-----|
| Policy-Based Routing Concepts..... | 155 |
|------------------------------------|-----|

|                            |     |
|----------------------------|-----|
| Route-Map Statements ..... | 155 |
| PBR Processing Logic ..... | 156 |
| PBR Configurations .....   | 158 |
| PBR Example .....          | 158 |

## Chapter 9 ARP

|  |     |
|--|-----|
| Proxy ARP Concepts .....                                     | 162 |
| Proxy ARP Examples .....                                     | 162 |
| CLI: show ip interface .....                                 | 162 |
| CLI: ip proxy-arp .....                                      | 163 |
| Local Browser Interface: Configure Proxy ARP on a Port. .... | 163 |

## Chapter 10 VRRP

|  |     |
|--|-----|
| Virtual Router Redundancy Protocol Concepts .....                | 165 |
| VRRP on a Master Router .....                                    | 166 |
| CLI: Configure VRRP on a Master Router .....                     | 166 |
| Local Browser Interface: Configure VRRP on a Master Router ..... | 167 |
| VRRP on a Backup Router .....                                    | 168 |
| CLI: Configure VRRP on a Backup Router .....                     | 168 |
| Local Browser Interface: Configure VRRP on a Backup Router ..... | 169 |

## Chapter 11 ACLs

|   |     |
|---|-----|
| Access Control List Concepts .....  | 172 |
| MAC ACLs .....  | 172 |
| IP ACLs .....   | 173 |
| ACL Configuration .....   | 173 |
| Set Up an IP ACL with Two Rules .....   | 173 |
| CLI: Set Up an IP ACL with Two Rules .....  | 174 |
| Local Browser Interface: Set Up an IP ACL with Two Rules .....                        | 175 |
| One-Way Access Using a TCP Flag in an ACL .....                                       | 178 |
| CLI: Configure One-Way Access Using a TCP Flag in an ACL .....                        | 179 |
| Local Browser Interface: Configure One-Way Access Using<br>a TCP Flag in an ACL ..... | 182 |
| Use ACLs to Configure Isolated VLANs on a Layer 3 Switch .....                        | 193 |
| CLI: Configure One-Way Access Using a TCP Flag in ACL<br>Commands .....               | 194 |
| Local Browser Interface: Configure One-Way Access Using<br>a TCP Flag in an ACL ..... | 196 |
| Set up a MAC ACL with Two Rules .....   | 204 |
| CLI: Set up a MAC ACL with Two Rules .....  | 204 |
| Local Browser Interface: Set up a MAC ACL with Two Rules .....                        | 205 |
| Configure ACL Mirroring .....   | 207 |
| CLI: Configure ACL Mirroring .....  | 208 |
| Local Browser Interface: Configure ACL Mirroring .....                                | 210 |
| Configure ACL Redirection .....   | 213 |
| CLI: Redirect a Traffic Stream .....  | 214 |

|  |     |
|--|-----|
| Local Browser Interface: Redirect a Traffic Stream .....                         | 215 |
| Add ACL Remarks .....  | 218 |
| Change the Sequence of an ACL Rule .....   | 219 |
| Configure a Management ACL .....   | 221 |
| Example 1: Permit Any Host to Access the Switch Through<br>Telnet or HTTP: ..... | 222 |
| Example 2: Permit a Specific Host to Access the Switch<br>Through SSH Only ..... | 222 |
| Configure IPv6 ACLs .....  | 222 |
| CLI: Configure an IPv6 ACL .....   | 224 |
| Local Browser Interface: Configure an IPv6 ACL .....                             | 226 |

## Chapter 12 CoS Queuing

|  |     |
|--|-----|
| CoS Queuing Concepts .....   | 232 |
| CoS Queue Mapping .....  | 232 |
| Trusted Ports .....  | 232 |
| Untrusted Ports .....  | 233 |
| CoS Queue Configuration .....  | 233 |
| Show the Trust Mode for a Class of Service .....   | 234 |
| CLI: Show the Trust Mode for a Class of Service .....  | 234 |
| Local Browser Interface: Show the Trust Mode for a Class<br>of Service .....                           | 234 |
| Set the Trust Mode for a Class of Service .....  | 235 |
| CLI: Set the Trust Mode for a Class of Service .....   | 235 |
| Local Browser Interface: Set the Trust Mode for a Class of<br>Service .....                            | 235 |
| Configure Cos-queue Min-bandwidth and<br>Strict Priority Scheduler Mode .....                          | 236 |
| CLI: Configure Cos-queue Min-bandwidth and Strict<br>Priority Scheduler Mode .....                     | 236 |
| Local Browser Interface: Configure CoS-queue<br>Min-bandwidth and Strict Priority Scheduler Mode ..... | 236 |
| Set the CoS Trust Mode for an Interface .....  | 238 |
| CLI: Set the CoS Trust Mode for an Interface .....   | 238 |
| Local Browser Interface: Set the CoS Trust Mode for an<br>Interface .....                              | 238 |
| Configure Traffic Shaping .....  | 239 |
| CLI: Configure Traffic Shaping .....   | 239 |
| Local Browser Interface: Configure Traffic Shaping .....   | 239 |

## Chapter 13 DiffServ

|   |     |
|---|-----|
| Differentiated Services Concepts .....            | 242 |
| DiffServ .....                                    | 243 |
| CLI: Configure DiffServ .....                     | 243 |
| Local Browser Interface: Configure DiffServ ..... | 246 |
| DiffServ for VoIP .....                           | 258 |
| CLI: Configure DiffServ for VoIP .....            | 259 |

|   |     |
|---|-----|
| Local Browser Interface: Diffserv for VoIP .....                | 261 |
| Auto VoIP .....   | 266 |
| Protocol-Based Auto VoIP .....                                  | 266 |
| OUI-Based Auto VoIP .....                                       | 267 |
| Example 1: Enable Protocol-Based Auto VoIP .....                | 268 |
| Example 2: Change the Queue of Protocol-Based Auto VoIP .....   | 269 |
| Example 3: Create an Auto VoIP VLAN .....                       | 270 |
| DiffServ for IPv6 .....   | 273 |
| CLI: Configure DiffServ for IPv6 .....                          | 273 |
| Local Browser Interface: Configure DiffServ for IPv6 .....      | 274 |
| Color Conform Policy .....                                      | 280 |
| CLI: Configure a Color Conform Policy .....                     | 281 |
| Local Browser Interface: Configure a Color Conform Policy ..... | 282 |
| WRED Explicit Congestion Notification .....                     | 287 |

## Chapter 14 IGMP Snooping and Querier

|   |     |
|---|-----|
| Internet Group Management Protocol Concepts .....   | 291 |
| IGMP Snooping .....   | 291 |
| CLI: Enable IGMP Snooping .....   | 291 |
| Local Browser Interface: Enable IGMP Snooping .....                                       | 292 |
| Show igmpsnooping .....   | 292 |
| CLI: Show igmpsnooping .....  | 292 |
| Local Browser Interface: Show igmpsnooping .....  | 293 |
| Show mac-address-table igmpsnooping .....   | 293 |
| CLI for IGMPv1 and IGMPv2: Show mac-address-table<br>igmpsnooping .....                   | 293 |
| CLI for IGMPv3: show igmpsnooping ssm entries .....                                       | 294 |
| Local Browser Interface: Show mac-address-table igmpsnooping ..                           | 294 |
| External Multicast Router .....   | 294 |
| CLI: Configure the Switch with an External Multicast Router .....                         | 294 |
| Local Browser Interface: Configure the Switch with an<br>External Multicast Router .....  | 295 |
| Multicast Router Using VLAN .....   | 295 |
| CLI: Configure the Switch with a Multicast Router Using VLAN .....                        | 295 |
| Local Browser Interface: Configure the Switch with a<br>Multicast Router Using VLAN ..... | 296 |
| IGMP Querier Concepts .....   | 296 |
| Enable IGMP Querier .....   | 297 |
| CLI: Enable IGMP Querier .....  | 297 |
| Local Browser Interface: Enable IGMP Querier .....  | 298 |
| Show IGMP Querier Status .....  | 300 |
| CLI: Show IGMP Querier Status .....   | 300 |
| Local Browser Interface: Show IGMP Querier Status .....                                   | 300 |

## Chapter 15 MVR

|  |     |
|--|-----|
| Multicast VLAN Registration .....      | 302 |
| Configure MVR in Compatible Mode ..... | 303 |

|  |     |
|--|-----|
| CLI: Configure MVR in Compatible Mode.....                     | 304 |
| Local Browser Interface: Configure MVR in Compatible Mode..... | 306 |
| Configure MVR in Dynamic Mode.....                             | 309 |
| CLI: Configure MVR in Dynamic Mode.....                        | 309 |
| Local Browser Interface: Configure MVR in Dynamic Mode.....    | 312 |

## Chapter 16 Security Management

|   |     |
|---|-----|
| Port Security Concepts.....   | 317 |
| Set the Dynamic and Static Limit on Port 1/0/1.....   | 318 |
| CLI: Set the Dynamic and Static Limit on Port 1/0/1.....  | 318 |
| Local Browser Interface: Set the Dynamic and Static Limit<br>on Port 1/0/1.....                       | 318 |
| Convert the Dynamic Address Learned<br>from 1/0/1 to a Static Address.....                            | 320 |
| CLI: Convert the Dynamic Address Learned from 1/0/1 to<br>the Static Address.....                     | 320 |
| Local Browser Interface: Convert the Dynamic Address<br>Learned from 1/0/1 to the Static Address..... | 320 |
| Create a Static Address.....  | 321 |
| CLI: Create a Static Address.....   | 321 |
| Local Browser Interface: Create a Static Address.....   | 321 |
| Protected Ports.....  | 321 |
| CLI: Configure a Protected Port to Isolate Ports on the Switch.....                                   | 322 |
| Local Browser Interface: Configure a Protected Port to<br>Isolate Ports on the Switch.....            | 324 |
| 802.1x Port Security.....   | 327 |
| CLI: Authenticating dot1x Users by a RADIUS Server.....   | 328 |
| Local Browser Interface: Authenticating dot1x Users by a<br>RADIUS Server.....                        | 329 |
| Create a Guest VLAN.....  | 333 |
| CLI: Create a Guest VLAN.....   | 334 |
| Local Browser Interface: Create a Guest VLAN.....   | 335 |
| Assign VLANs Using RADIUS.....  | 338 |
| CLI: Assign VLANs Using RADIUS.....   | 339 |
| Local Browser Interface: Assign VLANs Using RADIUS.....   | 342 |
| Dynamic ARP Inspection.....   | 345 |
| CLI: Configure Dynamic ARP Inspection.....  | 346 |
| Local Browser Interface: Configure Dynamic ARP Inspection.....  | 347 |
| Static Mapping.....   | 350 |
| CLI: Configure Static Mapping.....  | 350 |
| Local Browser Interface: Configure Static Mapping.....  | 351 |
| DHCP Snooping.....  | 352 |
| CLI: Configure DHCP Snooping.....   | 353 |
| Local Browser Interface: Configure DHCP Snooping.....   | 354 |
| Find a Rogue DHCP Server.....   | 356 |
| CLI: Find a Rogue DHCP server.....  | 356 |
| Local Browser Interface: Find a Rogue DHCP server.....  | 357 |
| Enter Static Binding into the Binding Database.....   | 359 |

|   |     |
|---|-----|
| CLI: Enter Static Binding into the Binding Database .....   | 359 |
| Local Browser Interface: Enter Static Binding into the Binding Database .....                     | 359 |
| Maximum Rate of DHCP Messages .....   | 360 |
| CLI: Configure the Maximum Rate of DHCP Messages .....  | 360 |
| Local Browser Interface: Configure the Maximum Rate of DHCP Messages .....                        | 361 |
| IP Source Guard .....   | 361 |
| CLI: Configure Dynamic ARP Inspection .....   | 362 |
| Local Browser Interface: Configure Dynamic ARP Inspection .....                                   | 364 |
| Command Authorization .....   | 367 |
| CLI Example 1: Configure Command Authorization by a TACACS+ Server .....                          | 367 |
| CLI Example 2: Configure Command Authorization by a RADIUS Server .....                           | 370 |
| Privileged Exec Command Mode Authorization .....  | 373 |
| CLI Example 1: Configure EXEC Authorization by a TACACS+ Server .....                             | 373 |
| CLI Example 2: Configure EXEC Authorization by a RADIUS Server .....                              | 376 |
| Accounting .....  | 378 |
| CLI: Configure Telnet Command Accounting by a TACACS+ Server .....                                | 378 |
| Configure Telnet EXEC Accounting by RADIUS Server .....   | 379 |
| Use the Authentication Manager to Set Up an Authentication Method List .....                      | 380 |
| Configure a Dot1x-MAB Authentication Method List with Dot1x-MAB Priority .....                    | 381 |
| Configure a Dot1x-MAB Authentication Method List with MAB-Dot1x Priority .....                    | 382 |
| Configure a Dot1x, MAB, and Captive Portal Authentication Method List with Default Priority ..... | 382 |
| RADIUS Change of Authorization .....  | 384 |
| IPv6 Stateless RA Guard .....   | 386 |
| Changing the SSH/Telnet Login Method to Radius .....  | 387 |
| CLI: Change the SSH/Telnet Login Method to Radius .....   | 387 |
| GUI: Change the SSH/Telnet Login Method to Radius .....   | 388 |

## Chapter 17 MAB

|   |     |
|---|-----|
| MAC Authentication Bypass Concepts .....  | 391 |
| Configure MAC Authentication Bypass on a Switch .....   | 393 |
| Configure a Network Policy Server on a Microsoft Windows Server 2008 R2 or Later Server ..... | 397 |
| Configure an Active Directory on a Microsoft Windows Server 2008 R2 or Later Server .....     | 405 |
| Reduce the MAB Authentication Time .....  | 407 |
| CLI: Reduce the Authentication Time for MAB .....   | 407 |
| Local Browser Interface: Reduce the Authentication Time for MAB .....                         | 407 |

## Chapter 18 SNTP

|  |     |
|--|-----|
| Simple Network Time Protocol Concepts .....              | 409 |
| Show SNTP (CLI Only) .....                               | 409 |
| show sntp .....  | 409 |
| show sntp client .....                                   | 409 |
| show sntp server .....                                   | 410 |
| Configure SNTP .....                                     | 410 |
| CLI: Configure SNTP .....                                | 410 |
| Local Browser Interface: Configure SNTP .....            | 412 |
| Set the Time Zone (CLI Only) .....                       | 413 |
| Set the Named SNTP Server .....                          | 413 |
| CLI: Set the Named SNTP Server .....                     | 413 |
| Local Browser Interface: Set the Named SNTP Server ..... | 414 |

## Chapter 19 Tools

|  |     |
|--|-----|
| Traceroute .....   | 417 |
| CLI: Traceroute .....  | 417 |
| Local Browser Interface: Traceroute .....  | 418 |
| Configuration Scripting .....  | 418 |
| script Command .....   | 419 |
| script list Command and script delete Command .....  | 419 |
| script apply running-config.scr Command .....  | 420 |
| Create a Configuration Script .....  | 420 |
| Upload a Configuration Script .....  | 420 |
| Pre-Login Banner .....   | 421 |
| Create a Pre-Login Banner .....  | 421 |
| Port Mirroring .....   | 422 |
| CLI: Specify the Source (Mirrored) Ports and Destination (Probe) ...                       | 422 |
| Local Browser Interface: Specify the Source (Mirrored) Ports and Destination (Probe) ..... | 423 |
| Remote SPAN .....  | 423 |
| CLI: Enable RSPAN on a Switch .....  | 424 |
| Dual Image .....   | 426 |
| CLI: Download a Backup Image and Make It Active .....                                      | 427 |
| Local Browser Interface: Download a Backup Image and Make It Active .....                  | 428 |
| Outbound Telnet .....  | 429 |
| CLI: show network .....  | 430 |
| CLI: show telnet .....   | 430 |
| CLI: transport output telnet .....   | 431 |
| Local Browser Interface: Configure Telnet .....  | 432 |
| CLI: Configure the Session Limit and Session Time-out .....                                | 432 |
| Local Browser Interface: Configure the Session Time-out .....                              | 433 |
| Error Disablement and Automatic Error Recovery .....                                       | 433 |
| Loop Protection .....  | 435 |
| Nondisruptive Configuration Management .....   | 437 |
| Full Memory Dump .....   | 438 |

## Chapter 20 Syslog

|   |     |
|---|-----|
| Syslog Concepts .....   | 440 |
| Show Logging .....  | 440 |
| CLI: Show Logging .....   | 440 |
| Local Browser Interface: Show Logging .....                                       | 441 |
| Show Logging Buffered .....   | 443 |
| CLI: Show Logging Buffered .....  | 443 |
| Local Browser Interface: Show Logging Buffered .....                              | 444 |
| Show Logging Traplogs .....   | 444 |
| CLI: Show Logging Traplogs .....  | 444 |
| Local Browser Interface: Show Logging Trap Logs .....                             | 445 |
| Show Logging Hosts .....  | 445 |
| CLI: Show Logging Hosts .....   | 445 |
| Local Browser Interface: Show Logging Hosts .....                                 | 446 |
| Configure Logging for a Port .....  | 446 |
| CLI: Configure Logging for the Port .....   | 446 |
| Local Browser Interface: Configure Logging for the Port .....                     | 447 |
| Email Alerting .....  | 448 |
| CLI: Send Log Messages to admin@switch.com Using<br>Account aaa@netgear.com ..... | 449 |

## Chapter 21 Switch Stacks

|   |     |
|---|-----|
| Switch Stack Management and Connectivity .....                                  | 451 |
| Stack Master and Stack Members .....  | 451 |
| Stack Master .....  | 452 |
| Stack Members .....   | 453 |
| Stack Member Numbers .....  | 453 |
| Stack Member Priority Values .....  | 453 |
| Install and Power-up a Stack .....  | 453 |
| Compatible Switch Models .....  | 454 |
| Install a Switch Stack .....  | 454 |
| Switch Firmware and Firmware Mismatch .....                                     | 455 |
| Upgrade the Firmware .....  | 455 |
| Migrate Configuration with a Firmware Upgrade .....                             | 456 |
| Local Browser Interface: Copy Master Firmware to a Stack Member .....           | 457 |
| Stack Switches Using a 10G Copper Port .....                                    | 457 |
| CLI: Configure the 10G Copper Ports as Stack Ports .....                        | 458 |
| Local Browser Interface: Configure the 10G Copper Ports<br>as Stack Ports ..... | 460 |
| Add, Remove, or Replace a Stack Member .....                                    | 461 |
| Add Switches to an Operating Stack .....  | 461 |
| Remove a Switch from a Stack .....  | 462 |
| Replace a Stack Member .....  | 463 |
| Switch Stack Configuration Files .....  | 464 |
| Preconfigure a Switch .....   | 465 |
| Renumber Stack Members .....  | 466 |
| CLI: Renumber Stack Members .....   | 466 |



|   |     |
|---|-----|
| Local Browser Interface: Renumber Stack Members .....                 | 467 |
| Move the Stack Master to a Different Unit .....                       | 468 |
| CLI: Move the Stack Master to a Different Unit .....                  | 468 |
| Local Browser Interface: Move the Stack Master to a Different Unit .. | 468 |

## Chapter 22 SNMP

|  |     |
|--|-----|
| Add a New Community .....  | 471 |
| CLI: Add a New Community .....   | 471 |
| Local Browser Interface: Add a New Community .....                                       | 471 |
| Enable SNMP Trap .....   | 472 |
| CLI: Enable SNMP Trap .....  | 472 |
| Local Browser Interface: Enable SNMP Trap .....  | 472 |
| SNMP Version 3 .....   | 473 |
| CLI: Configure SNMPv3 .....  | 473 |
| Local Browser Interface: Configure SNMPv3 .....  | 474 |
| sFlow .....  | 475 |
| CLI: Configure Statistical Packet-Based Sampling of Packet<br>Flows with sFlow .....     | 476 |
| Local Browser Interface: Configure Statistical<br>Packet-based Sampling with sFlow ..... | 477 |
| Time-Based Sampling of Counters with sFlow .....   | 478 |
| CLI: Configure Time-Based Sampling of Counters with sFlow .....                          | 478 |
| Local Browser Interface: Configure Time-Based Sampling<br>of Counters with sFlow .....   | 479 |

## Chapter 23 DNS

|  |     |
|--|-----|
| Domain Name System Concepts .....  | 481 |
| Specify Two DNS Servers .....  | 481 |
| CLI: Specify Two DNS Servers .....   | 481 |
| Local Browser Interface: Specify Two DNS Servers .....                       | 482 |
| Manually Add a Host Name and an IP Address .....                             | 482 |
| CLI: Manually Add a Host Name and an IP Address .....                        | 482 |
| Local Browser Interface: Manually Add a Host Name and<br>an IP Address ..... | 483 |

## Chapter 24 DHCP Server

|   |     |
|---|-----|
| Dynamic Host Configuration Protocol Concepts .....  | 485 |
| Configure a DHCP Server in Dynamic Mode .....   | 485 |
| CLI: Configure a DHCP Server in Dynamic Mode .....  | 485 |
| Local Browser Interface: Configure a DHCP Server in<br>Dynamic Mode .....                 | 486 |
| Configure a DHCP Server that Assigns a Fixed IP Address .....                             | 488 |
| CLI: Configure a DHCP Server that Assigns a Fixed IP Address .....                        | 488 |
| Local Browser Interface: Configure a DHCP Server that<br>Assigns a Fixed IP Address ..... | 489 |

## Chapter 25 DHCPv6 Server

|   |     |
|---|-----|
| Dynamic Host Configuration Protocol                               |     |
| Version 6 Concepts .....  | 492 |
| CLI: Configure DHCPv6 Prefix Delegation .....                     | 493 |
| Local Browser Interface: Configure DHCPv6 Prefix Delegation ..... | 494 |
| Configure a Stateless DHCPv6 Server .....                         | 498 |
| CLI: Configure a Stateless DHCPv6 Server .....                    | 498 |
| Local Browser Interface: Configure a Stateless DHCPv6 Server .... | 499 |
| Configure a Stateful DHCPv6 Server .....                          | 502 |
| CLI: Configure a Stateful DHCPv6 Server .....                     | 502 |
| Local Browser Interface: Configure a Stateful DHCPv6 Server ....  | 503 |
| CLI: Set Up a Configuration With a DHCPv6 Server and DHCPv6 Relay | 507 |
| Configure the DHCPv6 Server .....                                 | 507 |
| Configure the DHCPv6 Relay .....                                  | 508 |

## Chapter 26 DVLANS and Private VLANs

|  |     |
|--|-----|
| Double VLANs .....   | 511 |
| CLI: Enable a Double VLAN .....                            | 512 |
| Local Browser Interface: Enable a Double VLAN .....        | 512 |
| Private VLAN Groups .....                                  | 515 |
| CLI: Create a Private VLAN Group .....                     | 516 |
| Local Browser Interface: Create a Private VLAN Group ..... | 517 |

## Chapter 27 STP

|  |     |
|--|-----|
| Spanning Tree Protocol Concepts .....                          | 522 |
| Configure Classic STP (802.1d) .....                           | 522 |
| CLI: Configure Classic STP (802.1d) .....                      | 522 |
| Local Browser Interface: Configure Classic STP (802.1d) .....  | 522 |
| Configure Rapid STP (802.1w) .....                             | 523 |
| CLI: Configure Rapid STP (802.1w) .....                        | 523 |
| Local Browser Interface: Configure Rapid STP (802.1w) .....    | 524 |
| Configure Multiple STP (802.1s) .....                          | 525 |
| CLI: Configure Multiple STP (802.1s) .....                     | 525 |
| Local Browser Interface: Configure Multiple STP (802.1s) ..... | 526 |
| Configure PVSTP and PVRSTP .....                               | 527 |
| CLI: Configure PVSTP .....                                     | 529 |
| Local Browser Interface: Configure PVSTP .....                 | 531 |

## Chapter 28 Tunnels for IPv6

|   |     |
|---|-----|
| Tunnel Concepts .....                               | 537 |
| Create a 6in4 Tunnel .....                          | 537 |
| CLI: Create a 6in4 Tunnel .....                     | 538 |
| Local Browser Interface: Create a 6in4 Tunnel ..... | 539 |
| Create a 6to4 Tunnel .....                          | 543 |

|   |     |
|---|-----|
| CLI: Create a 6to4 Tunnel .....                     | 544 |
| Local Browser Interface: Create a 6to4 Tunnel ..... | 549 |

## Chapter 29 IPv6 Interface Configuration

|   |     |
|---|-----|
| Create an IPv6 Routing Interface .....                                    | 563 |
| CLI: Create an IPv6 Routing Interface .....                               | 563 |
| Local Browser Interface: Create an IPv6 Routing Interface .....           | 564 |
| Create an IPv6 Routing VLAN .....   | 566 |
| CLI: Create an IPv6 Routing VLAN .....                                    | 566 |
| Local Browser Interface: Create an IPv6 VLAN Routing Interface ...        | 568 |
| Configure DHCPv6 Mode on the Routing Interface .....                      | 570 |
| CLI: Configure DHCPv6 mode on routing interface .....                     | 571 |
| Local Browser Interface: Configure DHCPv6 mode on routing interface ..... | 572 |

## Chapter 30 PIM

|   |     |
|---|-----|
| Protocol Independent Multicast Concepts .....   | 575 |
| PIM-DM .....                                    | 575 |
| CLI: Configure PIM-DM .....                     | 577 |
| Local Browser Interface: Configure PIM-DM ..... | 581 |
| PIM-SM .....                                    | 598 |
| CLI: Configure PIM-SM .....                     | 599 |
| Local Browser Interface: Configure PIM-SM ..... | 604 |

## Chapter 31 DHCP L2 Relay and L3 Relay

|   |     |
|---|-----|
| DHCP L2 Relay .....   | 625 |
| CLI: Enable DHCP L2 Relay .....   | 625 |
| Local Browser Interface: Enable DHCP L2 Relay .....                     | 627 |
| DHCP L3 Relay .....   | 630 |
| Configure the DHCP L3 Server in a Windows Server Operating System ..... | 630 |
| Configure a DHCP L3 Switch .....  | 638 |

## Chapter 32 MLD

|   |     |
|---|-----|
| Multicast Listener Discovery Concepts .....           | 644 |
| Configure MLD .....                                   | 644 |
| CLI: Configure MLD .....                              | 645 |
| Local Browser Interface: Configure MLD .....          | 647 |
| MLD Snooping .....                                    | 657 |
| CLI: Configure MLD Snooping .....                     | 657 |
| Local Browser Interface: Configure MLD Snooping ..... | 658 |

## Chapter 33 DVMRP

|   |     |
|---|-----|
| Distance Vector Multicast Routing Protocol Concepts ..... | 662 |
| CLI: Configure DVMRP .....                                | 663 |

|  |     |
|--|-----|
| Local Browser Interface: Configure DVMRP ..... | 669 |
|--|-----|

## Chapter 34 PTP End-to-End Transparent Clock

|  |     |
|--|-----|
| PTP Concepts .....   | 680 |
| PTP Time Stamp Operation .....                                     | 680 |
| PTP Transparent Clocks .....                                       | 681 |
| Manage the PTP End-to-End Transparent Clock .....                  | 682 |
| CLI: Globally Disable PTP End-to-End Transparent Clock .....       | 682 |
| CLI: Disable PTP End-to-End Transparent Clock for an Interface ... | 682 |
| CLI: Globally Reenable PTP End-to-End Transparent Clock .....      | 682 |
| CLI: Reenable PTP End-to-End Transparent Clock for an Interface..  | 683 |
| CLI: Display the PTP End-to-End Transparent Clock Status .....     | 683 |

## Chapter 35 Link Dependency

|  |     |
|--|-----|
| Link Dependency Concepts .....                           | 685 |
| CLI: Create a Link State Group .....                     | 686 |
| Local Browser Interface: Create a Link State Group ..... | 687 |

## Chapter 36 Captive Portals

|   |     |
|---|-----|
| Captive Portal Concepts .....   | 690 |
| Captive Portal Configuration Concepts .....                                 | 691 |
| Enable a Captive Portal .....   | 691 |
| CLI: Enable a Captive Portal .....  | 691 |
| Local Browser Interface: Enable a Captive Portal .....                      | 692 |
| Client Access, Authentication, and Control .....                            | 693 |
| Block a Captive Portal Instance .....                                       | 693 |
| CLI: Block a Captive Portal Instance .....                                  | 693 |
| Local Browser Interface: Block a Captive Portal Instance .....              | 694 |
| Local Authorization, Create Users and Groups .....                          | 694 |
| CLI: Create Users and Groups .....  | 694 |
| Local Browser Interface: Create Users and Groups .....                      | 695 |
| Remote Authorization (RADIUS) User Configuration .....                      | 696 |
| CLI: Configure RADIUS as the Verification Mode .....                        | 697 |
| Local Browser Interface: Configure RADIUS as the<br>Verification Mode ..... | 698 |
| SSL Certificates .....  | 698 |

## Chapter 37 iSCSI

|   |     |
|---|-----|
| iSCSI Concepts .....  | 700 |
| Enable iSCSI Awareness with VLAN Priority Tag .....                             | 701 |
| CLI: Enable iSCSI Awareness with VLAN Priority Tag .....                        | 701 |
| Local Browser Interface: Enable iSCSI Awareness with<br>VLAN Priority Tag ..... | 701 |
| Enable iSCSI Awareness with DSCP .....  | 702 |
| CLI: Enable iSCSI Awareness with DSCP .....                                     | 702 |

|   |     |
|---|-----|
| Local Browser Interface: Enable iSCSI Awareness with DSCP ..... | 702 |
| Set the iSCSI Target Port .....                                 | 703 |
| CLI: Set iSCSI Target Port .....                                | 703 |
| Local Browser Interface: Set iSCSI Target Port .....            | 703 |
| Show iSCSI Sessions .....                                       | 704 |
| CLI: Show iSCSI Sessions .....                                  | 704 |
| Local Browser Interface: Show iSCSI Sessions .....              | 705 |

## Chapter 38 Override Factory Defaults

|  |     |
|--|-----|
| Override the Factory Default Configuration File .....          | 707 |
| CLI: Install Another Factory Defaults Configuration File ..... | 707 |
| CLI: Erase the Old Factory Default Configuration File .....    | 708 |

## Chapter 39 NETGEAR SFP

|  |     |
|--|-----|
| Connect with a NETGEAR AGM731F SFP ..... | 710 |
|--|-----|

## Chapter 40 Expandable Ports Configuration

|  |     |
|--|-----|
| Expand a 40G Port on an APM402XL Port Card to Four 10G Ports ....  | 712 |
| CLI: Expand a 40G Port to Four 10G Ports .....                     | 712 |
| Local Browser Interface: Expand a 40G Port to Four 10G Ports ..... | 712 |

## Index

# 1

## Documentation Resources

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Before installation, read the release notes for your switch. The release notes detail the platform-specific functionality of the switching, routing, SNMP, configuration, management, and other packages.

You can also download the following publications by visiting [netgear.com/support/download/](http://netgear.com/support/download/):

- The installation guide for your switch and for the components:
  - *Installation Guide M4300 Intelligent Edge Series Fully Managed Stackable Switches*
  - *Installation Guide Fully Managed Switches Model M4300-96X*
  - *Installation Guide Fully Managed Switch Port Cards APM408C, APM408P, APM408F, and APM402XL*
  - *Installation Guide NETGEAR Power Supplies Units for Managed Switches, APS150W, APS250W, APS299W, APS550W, APS1000W, APS600W, and APS1200W*
- The hardware installation guide for your switch:
  - *M4300 Intelligent Edge Series Fully Managed Stackable Switches*
  - *Fully Managed Stackable Switch M4300-96X*
- The software manuals for the M4300 series switches, including modular model M4300-96X:
  - *M4300 Intelligent Edge Series Fully Managed Stackable Switches Software Administration Manual (this manual)*
  - *M4300 Intelligent Edge Series Fully Managed Stackable Switches CLI Command Reference Manual*
  - *M4300 Intelligent Edge Series Fully Managed Stackable Switches User Manual*
  - *M4300 Intelligent Edge Series Fully Managed Stackable Switches Software Setup Manual*

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**Note:** For more information about the topics covered in this manual, visit the support website at [netgear.com/support](http://netgear.com/support).

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**Note:** Firmware updates with new features and bug fixes are made available from time to time at [netgear.com/support/download/](http://netgear.com/support/download/). Some products can regularly check the site and download new firmware, or you can check for and download new firmware manually. If the features or behavior of your product does not match what is described in this guide, you might need to update your firmware.

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# 2

## LAGs

---

### Link Aggregation Groups

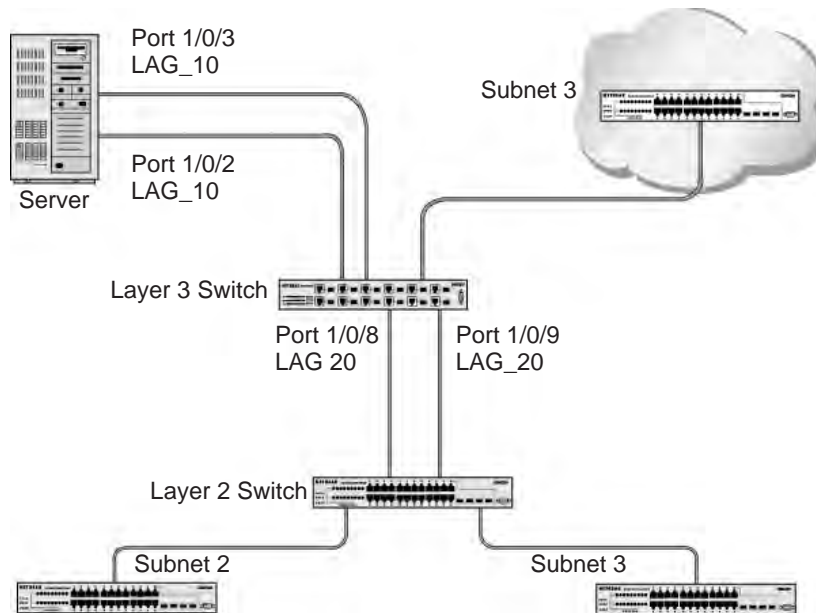
This chapter includes the following sections:

- [Link Aggregation Concepts](#)
- [Add Ports to LAGs](#)



# Link Aggregation Concepts

Link aggregation allows the switch to treat multiple physical links between two endpoints as a single logical link. All the physical links in a given LAG must operate in full-duplex mode at the same speed. LAGs can be used to directly connect two switches when the traffic between them requires high bandwidth and reliability, or to provide a higher-bandwidth connection to a public network. Management functions treat a LAG as if it is a single physical port. You can include a LAG in a VLAN. You can configure more than one LAG for a given switch.



**Figure 1. Example network with two LAGs**

LAGs offer the following benefits:

- Increased reliability and availability. If one of the physical links in the LAG goes down, traffic is dynamically and transparently reassigned to one of the other physical links.
- Better use of physical resources. Traffic can be load-balanced across the physical links.
- Increased bandwidth. The aggregated physical links deliver higher bandwidth than each individual link.
- Incremental increase in bandwidth. A physical upgrade could produce a tenfold increase in bandwidth; LAG produces a twofold or fivefold increase, which is useful if only a small increase is needed.

# Add Ports to LAGs

The example is shown as CLI commands and as a local browser interface procedure.

## CLI: Add Ports to the LAGs

```
(Netgear Switch) #config
(Netgear Switch) (Config)#interface 0/2
(Netgear Switch) (Interface 0/2)#addport 1/1
(Netgear Switch) (Interface 0/2)#exit
(Netgear Switch) (Config)#interface 0/3
(Netgear Switch) (Interface 0/3)#addport 1/1
(Netgear Switch) (Interface 0/3)#exit
(Netgear Switch) (Config)#interface 0/8
(Netgear Switch) (Interface 0/8)#addport 1/2
(Netgear Switch) (Interface 0/8)#exit
(Netgear Switch) (Config)#interface 0/9
(Netgear Switch) (Interface 0/9)#addport 1/2
(Netgear Switch) (Interface 0/9)#exit
(Netgear Switch) (Config)#exit
```

## Local Browser Interface: Add Ports to LAGs

1. Add ports to lag\_10.
  - a. Select **Switching > LAG > LAG Membership**.

A screen similar to the following displays.

- b. In the **LAG ID** list, select **LAG 1**.
  - c. Click **Unit 1**. The ports display.

- d. Click the gray boxes under port **2** and **3**.  
Two check marks display in the box.
  - e. Click the **Apply** button to save the settings.
2. Add ports to lag\_20.
- a. Select **Switching > LAG > LAG Membership**.

A screen similar to the following displays.

The screenshot shows the 'LAG Membership' configuration page. The left sidebar has 'LAG' selected, with 'LAG Membership' highlighted. The main area contains configuration fields for LAG ID (set to 'Lag 2'), LAG Name (set to 'ch2'), LAG Description, Admin Mode (set to 'Enable'), Link Trap (set to 'Disable'), STP Mode (set to 'Enable'), Static Mode (set to 'Disable'), and Hash Mode (set to 'Src/Dest MAC, VLAN, EType, incoming port'). Below these fields is a section for 'Unit 1' showing a grid of 24 ports. Ports 8 and 9 are highlighted with checkmarks, indicating they are selected for the LAG.

- b. Under LAG Membership, in the **LAG ID** list, select **LAG 2**.
- c. Click **Unit 1**. The ports display.
- d. Click the gray boxes under ports **8** and **9**.  
Two check marks display in the boxes.
- e. Click **Apply** to save the settings.

# 3

## VLANs

---

### Virtual LANs

This chapter includes the following sections:

- [VLAN Concepts](#)
- [Create Two VLANs](#)
- [Assign Ports to VLAN 2](#)
- [Create Three VLANs](#)
- [Assign Ports to VLAN 3](#)
- [Assign VLAN 3 as the Default VLAN for Port 1/0/2](#)
- [Create a MAC-Based VLAN](#)
- [Create a Protocol-Based VLAN](#)
- [Virtual VLANs: Create an IP Subnet-Based VLAN](#)
- [Voice VLANs](#)
- [Configure GARP VLAN Registration Protocol](#)
- [Private VLANs](#)
- [Assign Private-VLAN Types \(Primary, Isolated, Community\)](#)
- [Configure Private-VLAN Association](#)
- [Configure Private-VLAN Port Mode \(Promiscuous, Host\)](#)
- [Configure Private-VLAN Host Ports](#)
- [Map Private-VLAN Promiscuous Port](#)
- [VLAN Access Ports and Trunk Ports](#)

# VLAN Concepts

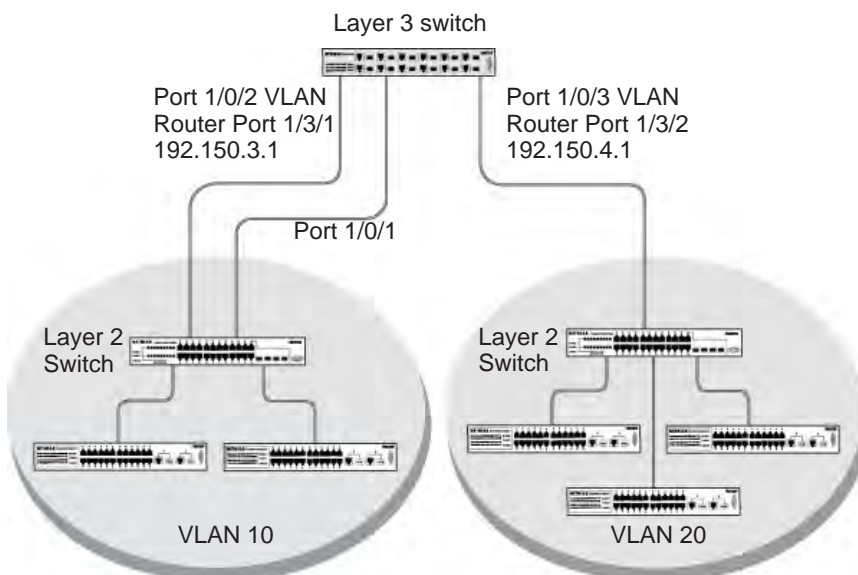
Adding virtual LAN (VLAN) support to a Layer 2 switch offers some of the benefits of both bridging and routing. Like a bridge, a VLAN switch forwards traffic based on the Layer 2 header, which is fast. Like a router, it partitions the network into logical segments, which provides better administration, security, and management of multicast traffic.

A VLAN is a set of end stations and the switch ports that connect them. You can have different reasons for the logical division, such as department or project membership. The only physical requirement is that the end station and the port to which it is connected both belong to the same VLAN.

Each VLAN in a network has an associated VLAN ID, which appears in the IEEE 802.1Q tag in the Layer 2 header of packets transmitted on a VLAN. An end station might omit the tag, or the VLAN portion of the tag, in which case the first switch port to receive the packet can either reject it or insert a tag using its default VLAN ID. A given port can handle traffic for more than one VLAN, but it can support only one default VLAN ID.

The Private Edge VLAN feature lets you set protection between ports located on the switch. This means that a protected port cannot forward traffic to another protected port on the same switch. The feature does not provide protection between ports located on different switches.

The diagram in this section shows a switch with four ports configured to handle the traffic for two VLANs. Port 1/0/2 handles traffic for both VLANs, while port 1/0/1 is a member of VLAN 2 only, and ports 1/0/3 and 1/0/4 are members of VLAN 3 only. The script following the diagram shows the commands you would use to configure the switch as shown in the diagram.



**Figure 2. Switch with 4 ports configured for traffic from 2 VLANs**

The following examples show how to create VLANs, assign ports to the VLANs, and assign a VLAN as the default VLAN to a port.

## Create Two VLANs

The example is shown as CLI commands and as a local browser interface procedure.

### CLI: Create Two VLANs

Use the following commands to create two VLANs and to assign the VLAN IDs while leaving the names blank.

```
(Netgear Switch) #vlan database
(Netgear Switch) (Vlan)#vlan 2
(Netgear Switch) (Vlan)#vlan 3
(Netgear Switch) (Vlan)#exit
```

### Local Browser Interface: Create Two VLANs

1. Create VLAN2.
  - a. Select **Switching > VLAN > Basic > VLAN Configuration**.

A screen similar to the following displays.

| VLAN ID | VLAN Name | VLAN Type | Make Static |
|---------|-----------|-----------|-------------|
| 2       | VLAN2     | Static    | Disable     |
| 1       | default   | Default   | Disable     |

- b. Enter the following information:
    - In the **VLAN ID** field, enter **2**.
    - In the **VLAN Name** field, enter **VLAN2**.
    - In the **VLAN Type** list, select **Static**.
  - c. Click **Add**.

## 2. Create VLAN3.

### a. Select **Switching > VLAN > Basic > VLAN Configuration**.

A screen similar to the following displays.

| VLAN ID | VLAN Name | VLAN Type | Make Static |
|---------|-----------|-----------|-------------|
| 3       | VLAN3     | Static    | Disable     |
| 1       | default   | Default   | Disable     |
| 2       | VLAN2     | Static    | Disable     |

### b. Enter the following information:

- In the **VLAN ID** field, enter **3**.
- In the **VLAN Name** field, enter **VLAN3**.
- In the **VLAN Type** list, select **Static**.

### c. Click **Add**.

## Assign Ports to VLAN 2

This sequence shows how to assign ports to VLAN2, and to specify that frames will always be transmitted tagged from all member ports and that untagged frames will be rejected on receipt.

## CLI: Assign Ports to VLAN 2

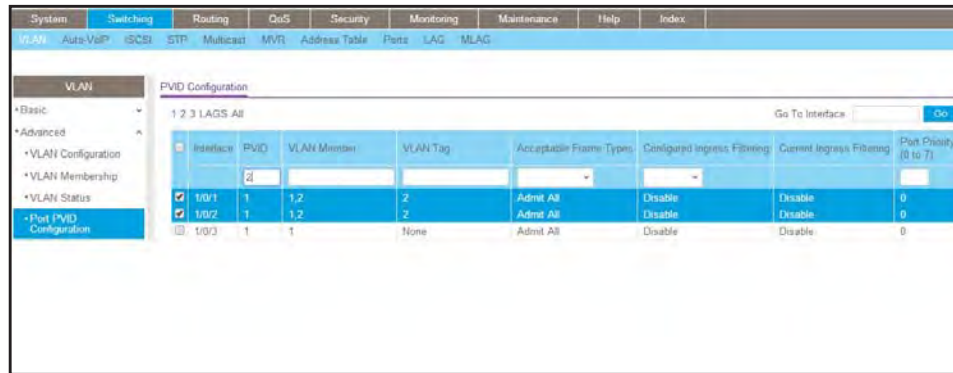
```
(Netgear Switch) #config
(Netgear Switch) (Config)#interface range 1/0/1-1/0/2
(Netgear Switch) (conf-if-range-1/0/1-1/0/2)#vlan participation include 2
(Netgear Switch) (conf-if-range-1/0/1-1/0/2)#vlan acceptframe vlanonly
(Netgear Switch) (conf-if-range-1/0/1-1/0/2)#vlan pvid 2
(Netgear Switch) (conf-if-range-1/0/1-1/0/2)#exit
(Netgear Switch) (Config)#vlan port tagging all 2
(Netgear Switch) (Config)#
```

## Local Browser Interface: Assign Ports to VLAN 2

### 1. Assign ports to VLAN2.

#### a. Select **Switching > VLAN > Advanced > VLAN Membership**.

A screen similar to the following displays.



#### b. In the **VLAN ID** list, select **2**.

#### c. Click **Unit 1**. The ports display.

#### d. Click the gray boxes under ports **1** and **2** until **T** displays.

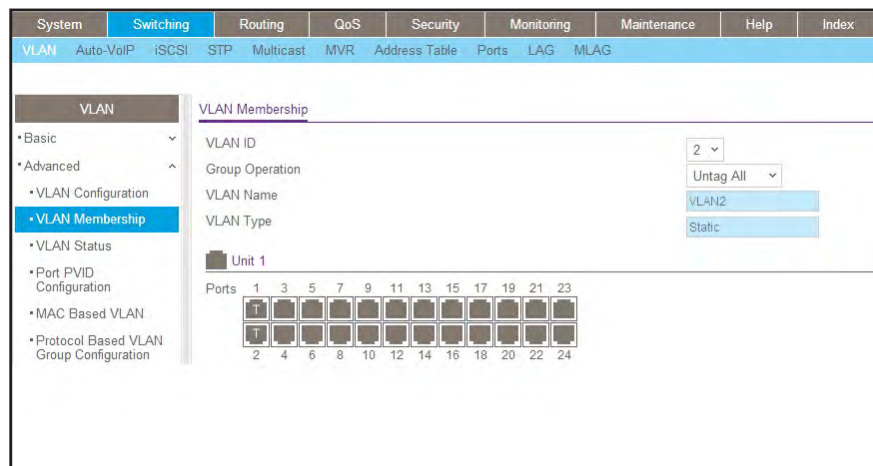
The T specifies that the egress packet is tagged for the ports.

#### e. Click **Apply** to save the settings.

### 2. Specify that only tagged frames will be accepted on ports 1/0/1 and 1/0/2.

#### a. Select **Switching > VLAN > Advanced > Port PVID Configuration**.

A screen similar to the following displays.



#### b. Under PVID Configuration, scroll down and select the check box for Interface **1/0/1**.

Then scroll down and select the Interface **1/0/2** check box.



- c. Enter the following information:
  - In the **Acceptable Frame Type polyhedron** list, select **VLAN Only**.
  - In the **PVID (1 to 4093)** field, enter **2**.
- d. Click **Apply** to save the settings.

## Create Three VLANs

The example is shown as CLI commands and as a local browser interface procedure.

### CLI: Create Three VLANs

Use the following commands to create three VLANs and to assign the VLAN IDs while leaving the names blank.

```
(Netgear Switch) #vlan database
(Netgear Switch) (Vlan)#vlan 100
(Netgear Switch) (Vlan)#vlan 101
(Netgear Switch) (Vlan)#vlan 102
(Netgear Switch) (Vlan)#exit
```

### Local Browser Interface: Create Three VLANs

1. Create VLAN100.
  - a. Select **Switching > VLAN > Basic > VLAN Configuration**.

A screen similar to the following displays.

| VLAN ID | VLAN Name | VLAN Type | Make Static |
|---------|-----------|-----------|-------------|
| 100     | VLAN100   | Disable   | Disable     |
| 1       | default   | Default   | Disable     |

- b. Enter the following information:
  - In the **VLAN ID** field, enter **100**.

- In the **VLAN Name** field, enter **VLAN100**.
  - c. Click **Add**.
2. Create VLAN101.
- a. Select **Switching > VLAN > Basic > VLAN Configuration**.

A screen similar to the following displays.

The screenshot shows the 'VLAN Configuration' page in the switch's web interface. The left sidebar has a tree view with 'VLAN Configuration' selected. The main area is divided into sections: 'Reset' (with a 'Reset Configuration' button), 'Internal VLAN Configuration' (with 'Internal VLAN Allocation Base' set to 4093 and 'Internal VLAN Allocation Policy' set to 'Ascending'), and 'VLAN Configuration' (a table listing VLANs).

| VLAN ID | VLAN Name | VLAN Type | Make Static |
|---------|-----------|-----------|-------------|
| 101     | VLAN101   |           | Disable     |
| 1       | default   | Default   | Disable     |
| 100     | VLAN100   | Static    | Disable     |

- b. Enter the following information:
    - In the **VLAN ID** field, enter **101**.
    - In the **VLAN Name** field, enter **VLAN101**.
  - c. Click **Add**.
3. Create VLAN102.
- a. Select **Switching > VLAN > Basic > VLAN Configuration**.

A screen similar to the following displays.

The screenshot shows the 'VLAN Configuration' page with VLAN 102 added. The 'VLAN Configuration' table now includes VLAN 102.

| VLAN ID | VLAN Name | VLAN Type | Make Static |
|---------|-----------|-----------|-------------|
| 102     | VLAN102   |           | Disable     |
| 1       | default   | Default   | Disable     |
| 100     | VLAN100   | Static    | Disable     |
| 101     | VLAN101   | Static    | Disable     |

- b. Enter the following information:
  - In the **VLAN ID** field, enter **102**.

- In the **VLAN Name** field, enter **VLAN102**.
- c. Click **Add**.

## Assign Ports to VLAN 3

This example shows how to assign the ports that will belong to VLAN 3, and to specify that untagged frames will be accepted on port 1/0/4. Note that port 1/0/2 belongs to both VLANs and that port 1/0/1 can never belong to VLAN 3.

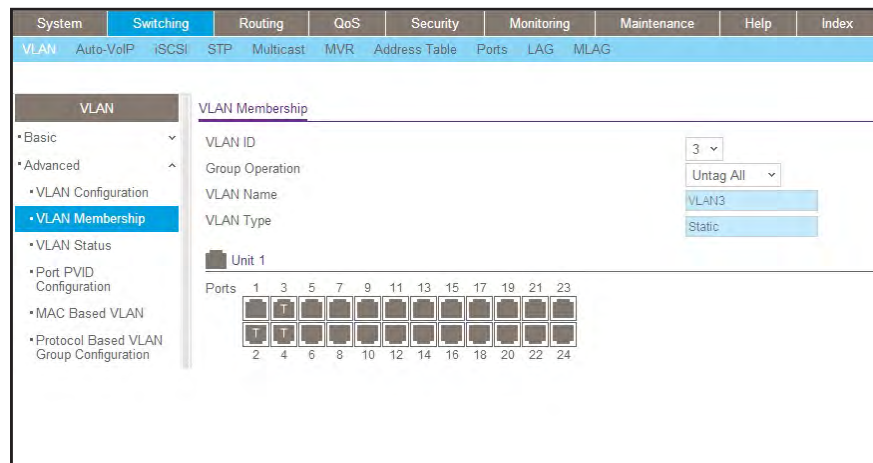
### CLI: Assign Ports to VLAN 3

```
(Netgear Switch) (Config)#interface range 1/0/2-1/0/4
(Netgear Switch) (conf-if-range-1/0/2-1/0/4)#vlan participation include 3
(Netgear Switch) (conf-if-range-1/0/2-1/0/4)#exit
(Netgear Switch) (Config)#interface 1/0/4
(Netgear Switch) (Interface 1/0/4)#vlan acceptframe all
(Netgear Switch) (Interface 1/0/4)#exit
(Netgear Switch) (Config)#exit
```

### Local Browser Interface: Assign Ports to VLAN 3

1. Assign ports to VLAN3.
  - a. Select **Switching > VLAN > Advanced > VLAN Membership**.

A screen similar to the following displays.



- b. In the **VLAN ID** list, select **3**.
- c. Click **Unit 1**. The ports display.
- d. Click the gray boxes under ports 2, 3, and 4 until T displays.

The T specifies that the egress packet is tagged for the ports.

- e. Click **Apply** to save the settings.
2. Specify that untagged frames will be accepted on port 1/0/4.
  - a. Select **Switching > VLAN > Advanced > Port PVID Configuration**.

A screen similar to the following displays.

| Interface | PVID | VLAN Member | VLAN Tag | Acceptable Frame Types | Configured ingress Filtering | Current ingress Filtering | Port Priority (0 to 7) |
|-----------|------|-------------|----------|------------------------|------------------------------|---------------------------|------------------------|
| 1/0/4     | 1    | 1           | None     | Admit All              | Disable                      | Disable                   | 0                      |
| 1/0/1     | 1    | 1           | None     | Admit All              | Disable                      | Disable                   | 0                      |
| 1/0/2     | 1    | 1           | None     | Admit All              | Disable                      | Disable                   | 0                      |
| 1/0/3     | 1    | 1           | None     | Admit All              | Disable                      | Disable                   | 0                      |
| 1/0/4     | 1    | 1           | None     | Admit All              | Disable                      | Disable                   | 0                      |
| 1/0/5     | 1    | 1           | None     | Admit All              | Disable                      | Disable                   | 0                      |
| 1/0/6     | 1    | 1           | None     | Admit All              | Disable                      | Disable                   | 0                      |
| 1/0/7     | 1    | 1           | None     | Admit All              | Disable                      | Disable                   | 0                      |
| 1/0/8     | 1    | 1           | None     | Admit All              | Disable                      | Disable                   | 0                      |
| 1/0/9     | 1    | 1           | None     | Admit All              | Disable                      | Disable                   | 0                      |
| 1/0/10    | 1    | 1           | None     | Admit All              | Disable                      | Disable                   | 0                      |

- b. Scroll down and select the Interface **1/0/4** check box.
- Now 1/0/4 appears in the Interface field at the top.
- c. In the **Acceptable Frame Types** list, select **Admit All**.
  - d. Click **Apply** to save the settings.

## Assign VLAN 3 as the Default VLAN for Port 1/0/2

This example shows how to assign VLAN 3 as the default VLAN for port 1/0/2.

### CLI: Assign VLAN 3 as the Default VLAN for Port 1/0/2

```
(Netgear Switch) #config
(Netgear Switch) (Config)#interface 1/0/2
(Netgear Switch) (Interface 1/0/2)#vlan pvid 3
(Netgear Switch) (Interface 1/0/2)#exit
(Netgear Switch) (Config)#exit
```

## Local Browser Interface: Assign VLAN 3 as the Default VLAN for Port 1/0/2

1. Select **Switching > VLAN > Advanced > Port PVID Configuration**.

A screen similar to the following displays.

| Interface                                 | PVID | VLAN Member | VLAN's Tag | Acceptable Frame Types | Configured Ingress Filtering | Current Ingress Filtering | Port Priority (0 to 7) |
|---|------|-------------|------------|------------------------|------------------------------|---------------------------|------------------------|
| <input checked="" type="checkbox"/> 1/0/2 | 3    | 1           | None       | Admit All              | Disable                      | Disable                   | 0                      |
| <input type="checkbox"/> 1/0/3            | 1    | 1           | None       | Admit All              | Disable                      | Disable                   | 0                      |
| <input type="checkbox"/> 1/0/4            | 1    | 1           | None       | Admit All              | Disable                      | Disable                   | 0                      |
| <input type="checkbox"/> 1/0/5            | 1    | 1           | None       | Admit All              | Disable                      | Disable                   | 0                      |
| <input type="checkbox"/> 1/0/6            | 1    | 1           | None       | Admit All              | Disable                      | Disable                   | 0                      |
| <input type="checkbox"/> 1/0/7            | 1    | 1           | None       | Admit All              | Disable                      | Disable                   | 0                      |
| <input type="checkbox"/> 1/0/8            | 1    | 1           | None       | Admit All              | Disable                      | Disable                   | 0                      |
| <input type="checkbox"/> 1/0/9            | 1    | 1           | None       | Admit All              | Disable                      | Disable                   | 0                      |
| <input type="checkbox"/> 1/0/10           | 1    | 1           | None       | Admit All              | Disable                      | Disable                   | 0                      |

2. Under PVID Configuration, scroll down and select the Interface **1/0/2** check box. Now 1/0/2 appears in the Interface field at the top.
3. In the **PVID (1 to 4093)** field, enter **3**.
4. Click **Apply** to save the settings.

## Create a MAC-Based VLAN

The MAC-based VLAN feature allows incoming untagged packets to be assigned to a VLAN and thus classify traffic based on the source MAC address of the packet.

You define a MAC to VLAN mapping by configuring an entry in the MAC to VLAN table. An entry is specified using a source MAC address and the appropriate VLAN ID. The MAC to VLAN configurations are shared across all ports of the device (i.e., there is a system-wide table that has MAC address to VLAN ID mappings).

When untagged or priority tagged packets arrive at the switch and entries exist in the MAC to VLAN table, the source MAC address of the packet is looked up. If an entry is found, the corresponding VLAN ID is assigned to the packet. If the packet is already priority tagged it will maintain this value; otherwise, the priority will be set to 0 (zero). The assigned VLAN ID is verified against the VLAN table. If the VLAN is valid, ingress processing on the packet continues; otherwise, the packet is dropped. This implies that you can configure a MAC address mapping to a VLAN that has not been created on the system.

## CLI: Create a MAC-Based VLAN

### 1. Create VLAN3.

```
(Netgear Switch)#vlan database
(Netgear Switch)(Vlan)#vlan 3
(Netgear Switch)(Vlan)#exit
```

### 2. Add port 1/0/23 to VLAN3.

```
(Netgear Switch)#config
(Netgear Switch)(Config)#interface 1/0/23
(Netgear Switch)(Interface 1/0/23)#vlan participation include 3
(Netgear Switch)(Interface 1/0/23)#vlan pvid 3
(Netgear Switch)(Interface 1/0/23)#exit
```

### 3. Map MAC 00:00:0A:00:00:02 to VLAN3.

```
(Netgear Switch)(Config)#exit
(Netgear Switch)#vlan data
(Netgear Switch)(Vlan)#vlan association mac 00:00:00A:00:00:02 3
(Netgear Switch)(Vlan)#exit
```

### 4. Add all the ports to VLAN3.

```
(Netgear Switch)#config
(Netgear Switch)(Config)#interface range 1/0/1-1/0/28
(Netgear Switch)(conf-if-range-1/0/1-1/0/28)#vlan participation include 3
(Netgear Switch)(conf-if-range-1/0/1-1/0/28)#exit
(Netgear Switch)(Config)#exit
```

# Local Browser Interface: Assign a MAC-Based VLAN

1. Create VLAN3.
  - a. Select **Switching > VLAN > Basic > VLAN Configuration**.

A screen similar to the following displays.

| VLAN ID | VLAN Name | VLAN Type | Make Static |
|---------|-----------|-----------|-------------|
| 3       | VLAN3     | Static    | Disable     |

- b. Enter the following information:
      - In the **VLAN ID** field, enter **3**.
      - In the **VLAN Name** field, enter **VLAN3**.
      - In the **VLAN Type** list, select **Static**.
    - c. Click **Add**.
2. Assign ports to VLAN3.
  - a. Select **Switching > VLAN > Advanced > VLAN Membership**.

A screen similar to the following displays.

Unit 1

| Ports | 1                                   | 3                                   | 5                                   | 7                                   | 9                                   | 11                                  | 13                                  | 15                                  | 17                                  | 19                                  | 21                                  | 23                                  |
|-------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|
| 1     | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| 2     | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            |
| 3     | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| 4     | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            |
| 5     | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| 6     | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            |
| 7     | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| 8     | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            |
| 9     | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| 10    | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            |
| 11    | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| 12    | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            |
| 13    | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| 14    | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            |
| 15    | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| 16    | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            |
| 17    | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| 18    | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            |
| 19    | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| 20    | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            |
| 21    | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| 22    | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            |
| 23    | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| 24    | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            |

- b. In the **VLAN ID** list, select **3**.
      - c. Click **Unit 1**. The ports display.



- d. Click the gray box before Unit 1 until **U** displays.
  - e. Click **Apply**.
3. Assign VPID3 to port 1/0/23.
    - a. Select **Switching > VLAN > Advanced > Port PVID Configuration**.

A screen similar to the following displays.

| Interface | PVID | VLAN Member | VLAN Tag | Acceptable Frame Types | Configured Ingress Filtering | Current Ingress Filtering | Port Priority (0 to 7) |
|-----------|------|-------------|----------|------------------------|------------------------------|---------------------------|------------------------|
| 1/0/23    | 1    | 1.3         | None     | Admit All              | Disable                      | Disable                   | 0                      |
| 1/0/1     | 1    | 1.3         | None     | Admit All              | Disable                      | Disable                   | 0                      |
| 1/0/2     | 1    | 1.3         | None     | Admit All              | Disable                      | Disable                   | 0                      |
| 1/0/3     | 1    | 1.3         | None     | Admit All              | Disable                      | Disable                   | 0                      |
| 1/0/4     | 1    | 1.3         | None     | Admit All              | Disable                      | Disable                   | 0                      |
| 1/0/5     | 1    | 1.3         | None     | Admit All              | Disable                      | Disable                   | 0                      |
| 1/0/6     | 1    | 1.3         | None     | Admit All              | Disable                      | Disable                   | 0                      |
| 1/0/7     | 1    | 1.3         | None     | Admit All              | Disable                      | Disable                   | 0                      |
| 1/0/8     | 1    | 1.3         | None     | Admit All              | Disable                      | Disable                   | 0                      |

- b. Scroll down and select the **1/0/23** check box.
  - c. In the **PVID (1 to 4093)** field, enter **3**.
  - d. Click **Apply** to save the settings.
4. Map the specific MAC to VLAN3.
    - a. Select **Switching > VLAN > Advanced > MAC based VLAN**.

A screen similar to the following displays.

| MAC Address       | VLAN ID |
|-------------------|---------|
| 00:00:0A:00:00:02 | 3       |

- b. Enter the following information:
  - In the **MAC Address** field, enter **00:00:0A:00:00:02**.
  - In the **PVID (1 to 4093)** field, enter **3**.
- c. Click **Add**.



# Create a Protocol-Based VLAN

Create two protocol VLAN groups. One is for IPX and the other is for IP/ARP. The untagged IPX packets are assigned to VLAN 4, and the untagged IP/ARP packets are assigned to VLAN 5.

## CLI: Create a Protocol-Based VLAN

1. Create a VLAN protocol group `vlan_ipx` based on IPX protocol.

```
(Netgear Switch)#config
(Netgear Switch)(Config)#vlan protocol group 1
(Netgear Switch)(Config)#vlan protocol group name 1 "vlan_ipx"
(Netgear Switch)(Config)#vlan protocol group add protocol 1 ethertype ipx
```

2. Create a VLAN protocol group `vlan_ip` based on IP/ARP protocol.

```
(Netgear Switch)(Config)#vlan protocol group 2
(Netgear Switch)(Config)#vlan protocol group name 2 "vlan_ip"
(Netgear Switch)(Config)#vlan protocol group add protocol 2 ethertype ip
(Netgear Switch)(Config)#vlan protocol group add protocol 2 ethertype arp
(Netgear Switch)(Config)#exit
```

3. Assign VLAN protocol group 1 to VLAN 4.

```
(Netgear Switch)#vlan database
(Netgear Switch)(Vlan)#vlan 4
(Netgear Switch)(Vlan)#vlan 5
(Netgear Switch)(Vlan)#protocol group 1 4
```

4. Assign VLAN protocol group 2 to VLAN 5.

```
(Netgear Switch)(Vlan)#protocol group 2 5
```

## 5. Enable protocol VLAN group 1 and 2 on the interface.

```
(Netgear Switch)(Vlan)#exit
(Netgear Switch)#config
(Netgear Switch)(Config)#interface 1/0/11
(Netgear Switch)(Interface 1/0/11)#protocol vlan group 1
(Netgear Switch)(Interface 1/0/11)#protocol vlan group 2
(Netgear Switch)(Interface 1/0/11)#exit
```

# Local Browser Interface: Create a Protocol-Based VLAN

## 1. Create VLAN4 and VLAN5.

Create VLAN4.

### a. Select **Switching > VLAN > Basic > VLAN Configuration**.

A screen similar to the following displays.

| VLAN ID | VLAN Name | VLAN Type | Make Static |
|---------|-----------|-----------|-------------|
| 4       | VLAN4     | Static    | Disable     |
| 1       | default   | Default   | Disable     |

### b. Enter the following information:

In the **VLAN ID** field, enter **4**.

In the **VLAN Name** field, enter **VLAN4**.

In the **VLAN Type** list, select **Static**.

### c. Click **Add**.

Create VLAN5.

### a. Select **Switching > VLAN > Basic > VLAN Configuration**.

A screen similar to the following displays.

| VLAN ID | VLAN Name | VLAN Type | Make Static |
|---------|-----------|-----------|-------------|
| 5       | VLAN5     | Static    | Disable     |
| 1       | default   | Default   | Disable     |
| 4       | VLAN4     | Static    | Disable     |

b. Enter the following information:

In the **VLAN ID** field, enter **5**.

In the **VLAN Name** field, enter **VLAN5**.

In the **VLAN Type** list, select **Static**.

c. Click **Add**.

2. Create the protocol-based VLAN group `vlan_ipx`.

a. Select **Switching > VLAN > Advanced > Protocol Based VLAN Group Configuration**.

A screen similar to the following displays.

| Group ID | Group Name | Protocol | VLAN ID | Ports |
|----------|------------|----------|---------|-------|
| 1        | vlan_ipx   | ipx      | 4       |       |

Enter the following information:

- In the **Group ID** field, enter **1**.
- In the **Group Name** field, enter **vlan\_ipx**.
- In the **Protocol** list, enter **ipx**.

- In the **VLAN ID** field, enter **4**.
  - b. Click **Add**.
3. Create the protocol-based VLAN group `vlan_ip`.
- a. Select **Switching > VLAN > Advanced > Protocol Based VLAN Group Configuration**.

A screen similar to the following displays.

| Group ID | Group Name | Protocol | VLAN ID | Ports |
|----------|------------|----------|---------|-------|
| 2        | vlan_ip    | ip,arp   | 5       |       |
| 1        | vlan_ipx   | IPX      | 4       |       |

- b. Enter the following information:
    - In the **Group ID** field, enter **2**.
    - In the **Group Name** field, enter **vlan\_ip**.
    - In the **Protocol** list, select **IP** and **ARP** while holding down the **Ctrl** key.
    - In the **VLAN** field, enter **5**.
  - c. Click **Add**.
4. Add port 11 to the group `vlan_ipx`.
- a. Select **Switching > VLAN > Advanced > Protocol Based VLAN Group Membership**.

A screen similar to the following displays.

Group ID: 1  
Group Name: vlan\_ipx

Unit 1

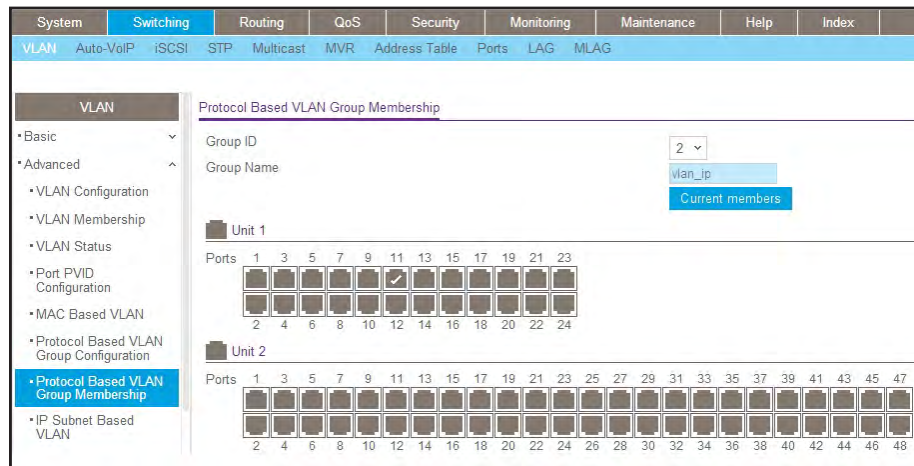
|   |   |   |   |    |    |    |    |    |    |    |    |
|---|---|---|---|----|----|----|----|----|----|----|----|
| 1 | 3 | 5 | 7 | 9  | 11 | 13 | 15 | 17 | 19 | 21 | 23 |
| 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 |

Unit 2

|   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| 1 | 3 | 5 | 7 | 9  | 11 | 13 | 15 | 17 | 19 | 21 | 23 | 25 | 27 | 29 | 31 | 33 | 35 | 37 | 39 | 41 | 43 | 45 | 47 |
| 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 | 26 | 28 | 30 | 32 | 34 | 36 | 38 | 40 | 42 | 44 | 46 | 48 |

- b. In the **Group ID** list, select **1**.
  - c. Click the gray box under port **11**. A check mark displays in the box.
  - d. Click the **Apply** button.
5. Add port 11 to the group vlan\_ip.
  - a. Select **Switching > VLAN > Advanced > Protocol Based VLAN Group Membership**.

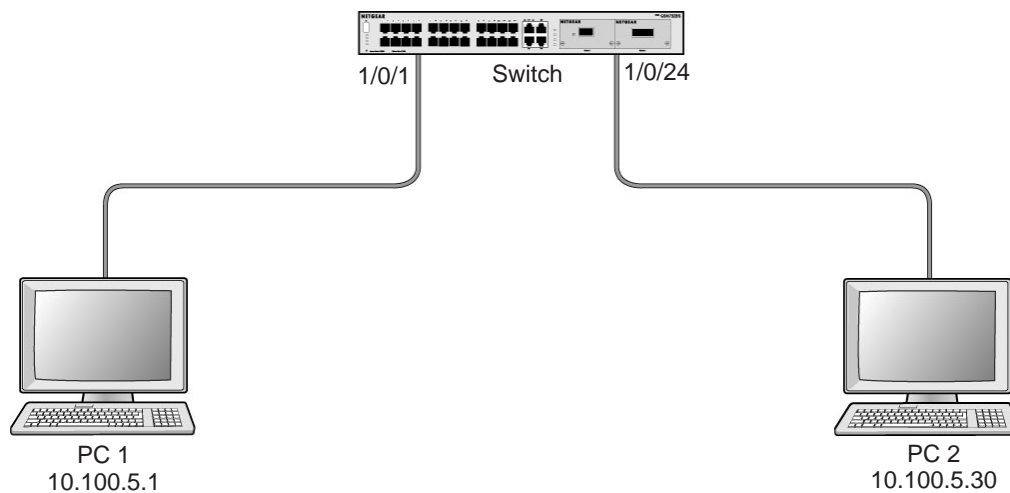
A screen similar to the following displays.



- b. In the **Group ID** list, select **2**.
  - c. Click the gray box under port **11**. A check mark displays in the box.
  - d. Click **Apply**.

## Virtual VLANs: Create an IP Subnet-Based VLAN

In an IP subnet-based VLAN, all the end workstations in an IP subnet are assigned to the same VLAN. In this VLAN, users can move their workstations without reconfiguring their network addresses. IP subnet VLANs are based on Layer 3 information from packet headers. The switch makes use of the network-layer address (for example, the subnet address for TCP/IP networks) in determining VLAN membership. If a packet is untagged or priority tagged, the switch associates the packet with any matching IP subnet classification. If no IP subnet classification can be made, the packet is subjected to the normal VLAN classification rules of the switch. This IP subnet capability does not imply a *routing* function or that the VLAN is routed. The IP subnet classification feature affects only the VLAN assignment of a packet. Appropriate 802.1Q VLAN configuration must exist in order for the packet to be switched.



**Figure 3. IP subnet-based VLAN**

## CLI: Create an IP Subnet-Based VLAN

```
(Netgear Switch) #vlan database
(Netgear Switch) (Vlan)#vlan 2000
(Netgear Switch) (Vlan)#vlan association subnet 10.100.0.0 255.255.0.0 2000
(Netgear Switch) (Vlan)#exit
```

Create an IP subnet-based VLAN 2000.

```
(Netgear Switch) #config
(Netgear Switch) (Config)#interface range 1/0/1-1/0/24
(Netgear Switch) (conf-if-range-1/0/1-1/0/24)# vlan participation include 2000
(Netgear Switch) (conf-if-range-1/0/1-1/0/24)#exit
(Netgear Switch) (Config)#
```

Assign all the ports to VLAN 2000.

```
(Netgear Switch) #show mac-addr-table vlan 2000
MAC Address      Interface      Status
-----
00:00:24:58:F5:56 1/0/1         Learned
00:00:24:59:00:62 1/0/24         Learned
```

# Local Browser Interface: Create an IP Subnet-Based VLAN

## 1. Create VLAN 2000.

### a. Select **Switching > VLAN > Basic > VLAN Configuration**.

A screen similar to the following displays.

| VLAN ID | VLAN Name | VLAN Type | Make Static |
|---------|-----------|-----------|-------------|
| 2000    | default   | Static    | Disable     |

### b. Enter the following information:

- In the **VLAN ID** field, enter **2000**.
- In the **VLAN Type** list, select **Static**.

### c. Click **Add**.

## 2. Assign all the ports to VLAN 2000.

### a. Select **Switching > VLAN > Advanced > VLAN Membership**.

A screen similar to the following displays.

| Unit   | Port | Configuration |
|--------|------|---------------|
| Unit 1 | 1    | U             |
|        | 2    | U             |
|        | 3    | U             |
|        | 4    | U             |
|        | 5    | U             |
|        | 6    | U             |
|        | 7    | U             |
|        | 8    | U             |
|        | 9    | U             |
|        | 10   | U             |
|        | 11   | U             |
|        | 12   | U             |
|        | 13   | U             |
|        | 14   | U             |
|        | 15   | U             |
|        | 16   | U             |
|        | 17   | U             |
|        | 18   | U             |
|        | 19   | U             |
|        | 20   | U             |
|        | 21   | U             |
|        | 22   | U             |
|        | 23   | U             |
|        | 24   | U             |

### b. In the **VLAN ID** list, select **2000**.

### c. Click **Unit 1**. The ports display.

### d. Click the gray box before Unit 1 until **U** displays.



- e. Click **Apply**.
3. Associate the IP subnet with VLAN 2000.
  - a. Select **Switching > VLAN > Advanced > IP Subnet Based VLAN**.

A screen similar to the following displays.

| System | Switching | Routing | QoS | Security  | Monitoring | Maintenance   | Help  | Index |      |
|--------|-----------|---------|-----|-----------|------------|---------------|-------|-------|------|
| VLAN   | Auto-VoIP | iSCSI   | STP | Multicast | MVR        | Address Table | Ports | LAG   | MLAG |

| IP Subnet Based VLAN Configuration |             |         |
|------------------------------------|-------------|---------|
| IP Address                         | Subnet Mask | VLAN ID |
| 10.100.0.0                         | 255.255.0.0 | 2000    |

- b. Enter the following information:
  - In the **IP Address** field, enter **10.100.0.0**.
  - In the **Subnet Mask** field, enter **255.255.0.0**.
  - In the **VLAN (1 to 4093)** field, enter **2000**.
- c. Click **Add**.

## Voice VLANs

The voice VLAN feature enables switch ports to carry voice traffic with defined priority to enable separation of voice and data traffic coming onto port. Voice VLAN ensures that the sound quality of an IP phone does not deteriorate when the data traffic on the port is high. Also, the inherent isolation provided by VLANs ensures that inter-VLAN traffic is under management control and that clients attached to the network cannot initiate a direct attack on voice components.

The switch can be configured to support voice VLAN on a port connecting to a VoIP phone. When a VLAN is associated with the voice VLAN port, then the VLAN ID info is passed onto the VoIP phone using the LLDP-MED mechanism. The voice data coming from the VoIP phone is tagged with the exchanged VLAN ID; thus, regular data arriving on the switch is given the default PVID of the port, and the voice traffic is received on a predefined VLAN. The two types of traffic are therefore segregated so that better service can be provided to the voice traffic.

When a dot1p priority is associated with the voice VLAN port instead of VLAN ID, then the priority info is passed onto the VoIP phone using the LLDP-MED mechanism. Thus, the voice data coming from the VoIP phone is tagged with VLAN 0 and with the exchanged priority.



Regular data arriving on the switch is given the default priority of the port (default 0), and the voice traffic is received with higher priority. This segregates both the traffic to provide better service to the voice traffic.

The switch can be configured to override the data traffic CoS. This feature enables overriding the 802.1P priority of the data traffic packets arriving at the port enabled for voice VLAN. Thus, a rogue client that is also connected to the voice VLAN port does not deteriorate the voice traffic.

The table below describes how does PVID and tagging are handled by voice VLAN in the four modes.

**Table 1. PVID and Tagging**

| Configure Voice VLAN = 4088, Data = 4000  | Ingress VLAN Tag          | Egress VLAN Tag           | PVID | Comments   |
|---|---------------------------|---------------------------|------|--|
| <b>Disable</b> - Default value  | No                        | No                        | 1    | No voice VLAN  |
| <b>None</b> - Allow the IP phone to use its own configuration to send untagged voice traffic  | No                        | No                        | 1    | No special priority for voice, but user must configure data VLAN if it is not using default VLAN.  |
| <b>VLAN ID</b> - Enter the Voice VLAN ID in the Value field.  | Yes<br>(VLAN=4088, PRI=1) | Yes<br>(VLAN=4088, PRI=1) | 4000 | <ul style="list-style-type: none"> <li>Voice VLAN automatically becomes part of tagged set for the port. VoIP traffic are expected to be received with this VLAN tag</li> <li>Voice VLAN sets egress tagging for voice VLAN (4088) automatically</li> <li>No priority is assigned by voice VLAN automatically. If the user want higher priority for voice traffic, user needs to manually configure it. This priority (dot1p) is conveyed from the Voice device as part of VLAN tag in the VoIP traffic. The user is not expected to configure any CoS on the port.</li> </ul> |
| <b>dot1p</b> - Configure Voice VLAN 802.1p priority tagging for voice traffic. When this is selected, enter the dot1p value in the Value field. | Yes<br>(VLAN=0, PRI=5)    | Yes<br>(VLAN=0, PRI=5)    | 4000 | <ul style="list-style-type: none"> <li>The user needs to configure dot1p priority value (e.g. 5). This value will be communicated to the VoIP device over LLDP.</li> <li>Priority advertised is 0 by default</li> </ul>  |
| <b>Untagged</b> - Configure the phone to send untagged voice traffic  | No                        | No                        | 4088 | <ul style="list-style-type: none"> <li>No need to set PVID for voice but may needed for data VLAN 4000. VLAN Id 0 will be communicated to the VoIP device.</li> </ul>  |

---

**Note:** For Voice VLAN feature, CoS override can be enabled for 8 ports only.

---

## Voice VLAN Interoperation with Auto-VoIP

This section describes a situation in which both the voice VLAN and Auto-VoIP are enabled on a port.

A voice VLAN configures the ingress port as tagged (in VLAN-ID mode) only if the switch can exchange LLDP-MED packets with the VoIP device. If the VoIP device is not LLDP-capable or LLDP is disabled on the switch port, the voice VLAN does not add the VLAN as tagged or untagged on the ingress port. That is, the voice VLAN does not really work if the LLDP-MED exchange does not occur.

Auto-VoIP requires a VLAN (the Auto-VoIP VLAN) to be configured on the switch. If you enable Auto-VoIP on a port, the switch automatically adds that port as an untagged port of the Auto-VoIP VLAN. This occurs because the switch expects to receive the voice packets as untagged packets. You also must configure the egress port as a member of the VLAN (untagged is fine). The switch forwards all untagged voice traffic from the VoIP device through the egress port as tagged packets with the Auto-VoIP VLAN (even if the Auto-VoIP VLAN is untagged on the port) and with the VLAN priority set to 7 (for a nonstacking switch) or 6 (for a stacking switch). This occurs to enable the next hop to prioritize the traffic.

The following figure shows egress packets.

| Packet | Packet Length | Source MAC        | Dest MAC          | Source IP      | Dest IP        | Protocol |
|--------|---------------|-------------------|-------------------|----------------|----------------|----------|
| 0386   | 222 bytes     | 00:08:30:8A:1E:D0 | DC:7B:94:D6:2A:E4 | 10.130.181.145 | 10.130.64.133  | UDP      |
| 0388   | 222 bytes     | 00:08:30:8A:1E:D0 | DC:7B:94:D6:2A:E4 | 10.130.181.145 | 10.130.64.133  | UDP      |
| 0389   | 114 bytes     | DC:7B:94:D6:2A:E4 | 00:08:30:8A:1E:D0 | 10.130.64.133  | 10.130.181.145 | UDP      |
| 0390   | 222 bytes     | 00:08:30:8A:1E:D0 | DC:7B:94:D6:2A:E4 | 10.130.181.145 | 10.130.64.133  | UDP      |
| 0391   | 78 bytes      | DC:7B:94:D6:2A:E4 | 00:08:30:8A:1E:D0 | 10.130.64.133  | 10.130.181.145 | UDP      |
| 0393   | 218 bytes     | DC:7B:94:D6:2A:E4 | 00:08:30:8A:1E:D0 | 10.130.64.133  | 10.130.181.145 | UDP      |
| 0394   | 222 bytes     | 00:08:30:8A:1E:D0 | DC:7B:94:D6:2A:E4 | 10.130.181.145 | 10.130.64.133  | UDP      |
| 0395   | 218 bytes     | DC:7B:94:D6:2A:E4 | 00:08:30:8A:1E:D0 | 10.130.64.133  | 10.130.181.145 | UDP      |
| 0396   | 222 bytes     | 00:08:30:8A:1E:D0 | DC:7B:94:D6:2A:E4 | 10.130.181.145 | 10.130.64.133  | UDP      |
| 0397   | 218 bytes     | DC:7B:94:D6:2A:E4 | 00:08:30:8A:1E:D0 | 10.130.64.133  | 10.130.181.145 | UDP      |
| 0399   | 78 bytes      | DC:7B:94:D6:2A:E4 | 00:08:30:8A:1E:D0 | 10.130.64.133  | 10.130.181.145 | UDP      |
| 0399   | 222 bytes     | 00:08:30:8A:1E:D0 | DC:7B:94:D6:2A:E4 | 10.130.181.145 | 10.130.64.133  | UDP      |

| Frame 386 (222 bytes on wire (222 bytes captured))   |
|--|
| Ethernet II, Src: 00:08:30:8A:1E:D0 (00:08:30:8A:1E:D0), Dst: dc:7b:94:d6:2a:e4 (dc:7b:94:d6:2a:e4)                            |
| 802.1Q Virtual LAN   |
| <ul style="list-style-type: none"> <li>111 ..... = Priority: 7</li> <li>0 = CFI: 0</li> <li>0000 0000 1010 = ID: 10</li> </ul> |
| Type: IP (0x0800)  |
| Trailer: 154487B4  |
| Internet Protocol, Src: 10.130.181.145 (10.130.181.145), Dst: 10.130.64.133 (10.130.64.133)                                    |
| User Datagram Protocol, Src Port: 24868 (24868), Dst Port: 24140 (24140)   |
| Data (172 bytes)   |

**Figure 4. Egress packets**

These packets were sent untagged from the VoIP device to the Auto-VoIP-enabled port. (The voice VLAN is also enabled on that port, but LLDP is disabled). Because the LLDP exchange did not occur, the voice VLAN is passive and the Auto-VoIP is active.

However, if you configure a port for both the voice VLAN and Auto-VoIP with same VLAN ID for both VLANs, and LLDP-MED functions between the switch and VoIP device, the voice VLAN receives priority over Auto-VoIP. In that situation, the VoIP device sends tagged VoIP packets to the switch.

If you need a data VLAN, you need to configure it separately because the voice VLAN and Auto-VoIP do not automatically create data a VLAN.

If you use a separate data VLAN, the voice VLAN supports segregation and separation of voice traffic from data traffic. The priority that is set in the VLAN header of the tagged VoIP traffic depends on the VoIP device.

The following figure shows the ingress port (voice VLAN ID 10) with traffic received from the VoIP device.

| Packet | Packet Length | Source MAC        | Dest MAC          | Source IP      | Dest IP       | Protocol |
|--------|---------------|-------------------|-------------------|----------------|---------------|----------|
| 0001   | 222 bytes     | 00:08:30:8A:1E:D0 | DC:7B:94:D6:2A:E4 | 10.130.181.145 | 10.130.64.133 | UDP      |
| 0002   | 222 bytes     | 00:08:30:8A:1E:D0 | DC:7B:94:D6:2A:E4 | 10.130.181.145 | 10.130.64.133 | UDP      |
| 0003   | 222 bytes     | 00:08:30:8A:1E:D0 | DC:7B:94:D6:2A:E4 | 10.130.181.145 | 10.130.64.133 | UDP      |
| 0004   | 222 bytes     | 00:08:30:8A:1E:D0 | DC:7B:94:D6:2A:E4 | 10.130.181.145 | 10.130.64.133 | UDP      |
| 0005   | 222 bytes     | 00:08:30:8A:1E:D0 | DC:7B:94:D6:2A:E4 | 10.130.181.145 | 10.130.64.133 | UDP      |
| 0006   | 222 bytes     | 00:08:30:8A:1E:D0 | DC:7B:94:D6:2A:E4 | 10.130.181.145 | 10.130.64.133 | UDP      |
| 0007   | 222 bytes     | 00:08:30:8A:1E:D0 | DC:7B:94:D6:2A:E4 | 10.130.181.145 | 10.130.64.133 | UDP      |
| 0008   | 222 bytes     | 00:08:30:8A:1E:D0 | DC:7B:94:D6:2A:E4 | 10.130.181.145 | 10.130.64.133 | UDP      |
| 0009   | 222 bytes     | 00:08:30:8A:1E:D0 | DC:7B:94:D6:2A:E4 | 10.130.181.145 | 10.130.64.133 | UDP      |
| 0010   | 222 bytes     | 00:08:30:8A:1E:D0 | DC:7B:94:D6:2A:E4 | 10.130.181.145 | 10.130.64.133 | UDP      |
| 0011   | 222 bytes     | 00:08:30:8A:1E:D0 | DC:7B:94:D6:2A:E4 | 10.130.181.145 | 10.130.64.133 | UDP      |
| 0012   | 222 bytes     | 00:08:30:8A:1E:D0 | DC:7B:94:D6:2A:E4 | 10.130.181.145 | 10.130.64.133 | UDP      |

| 802.1Q Virtual LAN |    |
|--------------------|----|
| Priority           | 5  |
| CFI                | 0  |
| ID                 | 10 |

**Figure 5. Ingress packets**

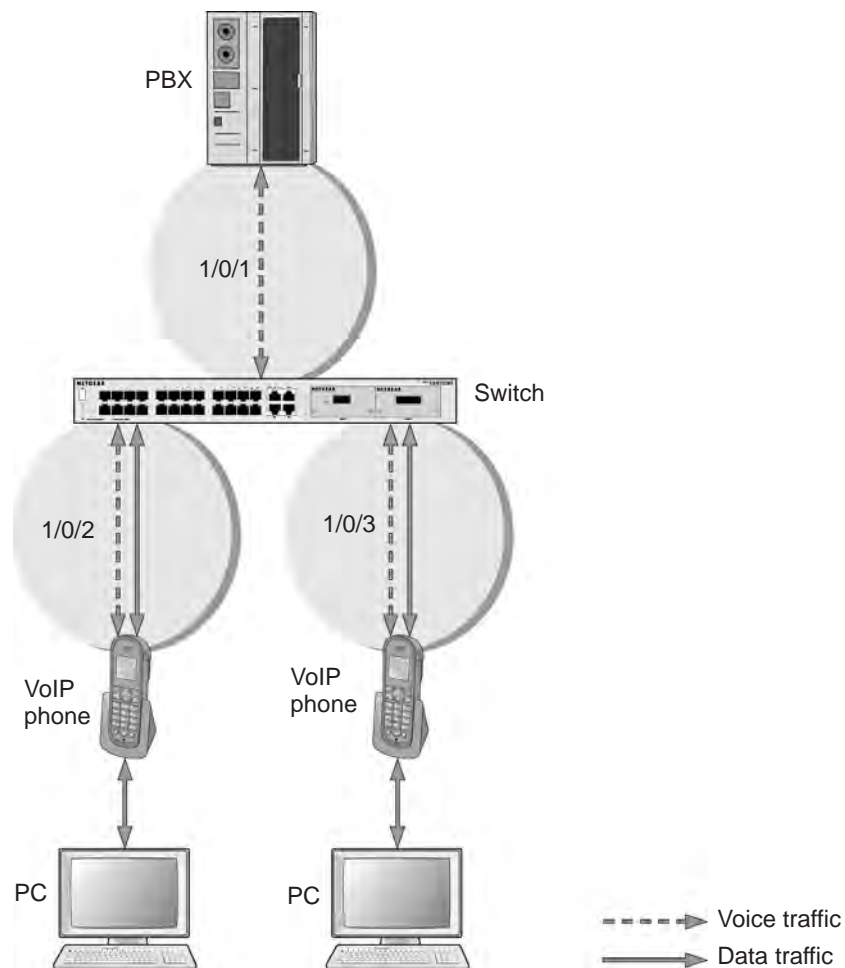
You can use the CoS override aspect of the voice VLAN (that is, you can use the **vlan priority** command) to lower the dot1p priority of the ingress port so that untagged data traffic is assigned a lower CoS queue.

You must configure the egress port with the voice VLAN as its member (untagged is fine) so that the traffic is forwarded with the voice VLAN tag and with the same priority as the incoming packet from VoIP device (in this case, 5). This enables the next hop to prioritize the VoIP traffic.

---

**Note:** For more information about voice VLANs, see [Auto VoIP on page 266](#).

---



**Figure 6. Voice VLAN**

The script in this section shows how to configure Voice VLAN and prioritize the voice traffic. Here the Voice VLAN mode is in VLAN ID 10.

## CLI: Configure Voice VLAN and Prioritize Voice Traffic

### 1. Create VLAN 10.

```
(Netgear Switch) #vlan database
(Netgear Switch) (Vlan)#vlan 10
(Netgear Switch) (Vlan)#exit
```

**2. Include the ports 1/0/1 and 1/0/2 in VLAN 10.**

```
(Netgear Switch) (Config)#interface range 1/0/1-1/0/2
(Netgear Switch) (conf-if-range-1/0/1-1/0/2)#vlan participation include 10
(Netgear Switch) (conf-if-range-1/0/1-1/0/2)#vlan tagging 10
(Netgear Switch) (conf-if-range-1/0/1-1/0/2)#exit
```

**3. Configure Voice VLAN globally.**

```
(Netgear Switch) (Config)# voice vlan
```

**4. Configure Voice VLAN mode in the interface 1/0/2.**

```
(Netgear Switch) (Config)#interface 1/0/2
(Netgear Switch) (Interface 1/0/2)#voice vlan 10
(Netgear Switch) (Interface 1/0/2)#exit
```

---

**Note:** Steps 5 through 9 are optional. These steps assign the packets with the VLAN ID 10 to a high priority queue.

---

**5. Create the DiffServ class ClassVoiceVLAN.**

```
(Netgear Switch) (Config)#class-map match-all ClassVoiceVLAN
```

**6. Configure VLAN 10 as the matching criteria for the class.**

```
(Netgear Switch) (Config-classmap)#match vlan 10
```

**7. Create the DiffServ policy PolicyVoiceVLAN.**

```
(Netgear Switch) (Config)#policy-map PolicyVoiceVLAN in
```

**8. Map the policy and class and assign them to the higher-priority queue.**

```
(Netgear Switch) (Config-policy-map)#class ClassVoiceVLAN
(Netgear Switch) (Config-policy-classmap)#assign-queue 3
(Netgear Switch) (Config-policy-classmap)#exit
```

9. Assign it to interfaces 1/0/1 and 1/0/2.

```
(Netgear Switch) (Config)#interface range 1/0/1-1/0/2
(Netgear Switch) (conf-if-range-1/0/1-1/0/2)# service-policy in PolicyVoiceVLAN
```

## Local Browser Interface: Configure Voice VLAN and Prioritize Voice Traffic

1. Create VLAN 10.
  - a. Select **Switching > VLAN > Basic > VLAN Configuration**.

A screen similar to the following displays.

| VLAN ID | VLAN Name  | VLAN Type | Make Static |
|---------|------------|-----------|-------------|
| 10      | Voice VLAN |           | Disable     |
| 1       | default    | Default   | Disable     |

- b. In the VLAN ID field, enter 10.
  - c. In the **VLAN Name** field, enter **Voice VLAN**.
  - d. Click **Add**.
2. Include the ports 1/0/1 and 1/0/2 in VLAN 10.
  - a. Select **Switching > VLAN > Advanced > VLAN Membership**.



A screen similar to the following displays.

**VLAN Membership**

VLAN ID: 10

Group Operation: Untag All

VLAN Name: Voice VLAN

VLAN Type: Static

Unit 1

|   |   |   |   |    |    |    |    |    |    |    |    |
|---|---|---|---|----|----|----|----|----|----|----|----|
| 1 | 3 | 5 | 7 | 9  | 11 | 13 | 15 | 17 | 19 | 21 | 23 |
| 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 |

- b. In the VLAN Membership table, in the **VLAN ID** list, select **10**.
  - c. Select Port 1 and Port 2 as tagged.
  - d. Click **Apply**.
3. Configure Voice VLAN globally.
    - a. Select **Switching > VLAN > Advanced > Voice VLAN Configuration**.

A screen similar to the following displays.

**Voice VLAN Global Admin**

Admin Mode: ☐ Disable ☒ Enable

**Voice VLAN Configuration**

1 2 3 All Go To Interface  Go

| Interface                      | Interface Mode | Value | CoS Override Mode | Operational State | Authentication Mode | DSCP Value |
|--------------------------------|----------------|-------|-------------------|-------------------|---------------------|------------|
| <input type="checkbox"/> 1/0/1 | Disable        | 0     | Disable           | Disable           | Enable              | 0          |
| <input type="checkbox"/> 1/0/2 | Disable        | 0     | Disable           | Disable           | Enable              | 0          |
| <input type="checkbox"/> 1/0/3 | Disable        | 0     | Disable           | Disable           | Enable              | 0          |
| <input type="checkbox"/> 1/0/4 | Disable        | 0     | Disable           | Disable           | Enable              | 0          |
| <input type="checkbox"/> 1/0/5 | Disable        | 0     | Disable           | Disable           | Enable              | 0          |
| <input type="checkbox"/> 1/0/6 | Disable        | 0     | Disable           | Disable           | Enable              | 0          |
| <input type="checkbox"/> 1/0/7 | Disable        | 0     | Disable           | Disable           | Enable              | 0          |

- b. For Admin Mode, select the **Enable** radio button.
  - c. Click **Apply**.
4. Configure Voice VLAN mode in the interface 1/0/2.
    - a. Select **Switching > VLAN > Advanced > Voice VLAN Configuration**.
    - b. Select the **1/0/2** check box.
    - c. In the **Interface Mode** list, select **VLAN ID**.
    - d. In the **Value** field, enter **10**.

A screen similar to the following displays.

The screenshot shows the 'Voice VLAN Global Admin' and 'Voice VLAN Configuration' sections. The 'Admin Mode' is set to 'Enable'. The 'Voice VLAN Configuration' table lists interfaces and their configurations.

| Interface                                 | Interface Mode | Value | CoS Override Mode | Operational State | Authentication Mode | DSCP Value |
|---|----------------|-------|-------------------|-------------------|---------------------|------------|
| <input checked="" type="checkbox"/> 1/0/1 | Disable        | 0     | Disable           | Disable           | Enable              | 0          |
| <input checked="" type="checkbox"/> 1/0/2 | Disable        | 0     | Disable           | Disable           | Enable              | 0          |
| <input type="checkbox"/> 1/0/3            | Disable        | 0     | Disable           | Disable           | Enable              | 0          |
| <input type="checkbox"/> 1/0/4            | Disable        | 0     | Disable           | Disable           | Enable              | 0          |
| <input type="checkbox"/> 1/0/5            | Disable        | 0     | Disable           | Disable           | Enable              | 0          |
| <input type="checkbox"/> 1/0/6            | Disable        | 0     | Disable           | Disable           | Enable              | 0          |
| <input type="checkbox"/> 1/0/7            | Disable        | 0     | Disable           | Disable           | Enable              | 0          |

e. Click **Apply**.

**Note:** The following steps are optional. These steps assign the packets with VLAN ID 10 to a high priority queue.

5. Create the DiffServ class ClassVoiceVLAN.

a. Select **QoS > Advanced > DiffServ > Class Configuration**.

A screen similar to the following displays.

The screenshot shows the 'DiffServ' configuration page. The 'Class Name' field is set to 'ClassVoiceVLAN' and the 'Class Type' is set to 'All'.

| Class Name     | Class Type |
|----------------|------------|
| ClassVoiceVLAN | All        |

b. In the **Class Name** field, enter **ClassVoiceVLAN**.

c. In the **Class Type** list, select **All**.

d. Click **Add**. The Class Name screen displays, as shown in the next step in this procedure.

6. Configure matching criteria for the class as **VLAN 10**.

a. Select **QoS > DiffServ > Advanced > Class Configuration**.



A screen similar to the following displays.

| Class Name     | Class Type |
|----------------|------------|
| ClassVoiceVLAN | All        |

- b. Click the class **ClassVoiceVLAN**.
- c. In the DiffServ Class Configuration table, select **VLAN**.
- d. In the VLAN ID field, enter 10.

A screen similar to the following displays.

| DiffServ Class Configuration                     |                |
|--|----------------|
| <input type="radio"/> Match Every                | Any            |
| <input type="radio"/> Reference Class            | class1         |
| <input type="radio"/> Class Of Service           | 0              |
| <input checked="" type="radio"/> VLAN            | 10 (1 to 4093) |
| <input type="radio"/> Secondary Class of Service | 0              |
| <input type="radio"/> Secondary VLAN             | (1 to 4093)    |
| <input type="radio"/> Ethernet Type              | Appletalk      |
| <input type="radio"/> Source MAC                 | Address        |

- e. Click **Apply**.
7. Create the DiffServ policy PolicyVoiceVLAN.
  - a. Select **QoS > DiffServ > Advanced > Policy Configuration**.

A screen similar to the following displays.

| System  | Switching   | Routing        | QoS | Security | Monitoring | Maintenance | Help | Index |             |             |              |                 |    |                |
|---|-------------|----------------|-----|----------|------------|-------------|------|-------|-------------|-------------|--------------|-----------------|----|----------------|
| CoS DiffServ  |             |                |     |          |            |             |      |       |             |             |              |                 |    |                |
| DiffServ  |             |                |     |          |            |             |      |       |             |             |              |                 |    |                |
| Policy Configuration  |             |                |     |          |            |             |      |       |             |             |              |                 |    |                |
| <div> <div> <ul style="list-style-type: none"> <li>DiffServ Wizard</li> <li>Basic</li> <li>Advanced <ul style="list-style-type: none"> <li>DiffServ Configuration</li> <li>Class Configuration</li> <li>IPv6 Class Configuration</li> <li>Policy Configuration</li> <li>Service Interface Configuration</li> <li>Service Statistics</li> </ul> </li> </ul> </div> <div> <table> <tr> <th>Policy Name</th> <th>Policy Type</th> <th>Member Class</th> </tr> <tr> <td>PolicyVoiceVlan</td> <td>In</td> <td>ClassVoiceVLAN</td> </tr> </table> </div> </div> |             |                |     |          |            |             |      |       | Policy Name | Policy Type | Member Class | PolicyVoiceVlan | In | ClassVoiceVLAN |
| Policy Name   | Policy Type | Member Class   |     |          |            |             |      |       |             |             |              |                 |    |                |
| PolicyVoiceVlan   | In          | ClassVoiceVLAN |     |          |            |             |      |       |             |             |              |                 |    |                |

- b. In the **Policy Name** field, enter **PolicyVoiceVLAN**.
- c. In the **Policy Type** list, select **In**.
- d. In the **Member Class** list, select **ClassVoiceVLAN**.
- e. Click **Add**.

The Policy Configuration screen displays, as shown in the next step in this procedure.

8. Map the policy and class and assign them to the higher-priority queue.
  - a. Select **QoS > DiffServ > Advanced > Policy Configuration**.

A screen similar to the following displays.

| System  | Switching   | Routing        | QoS | Security | Monitoring | Maintenance | Help | Index |             |             |              |                 |    |                |
|---|-------------|----------------|-----|----------|------------|-------------|------|-------|-------------|-------------|--------------|-----------------|----|----------------|
| CoS DiffServ  |             |                |     |          |            |             |      |       |             |             |              |                 |    |                |
| DiffServ  |             |                |     |          |            |             |      |       |             |             |              |                 |    |                |
| Policy Configuration  |             |                |     |          |            |             |      |       |             |             |              |                 |    |                |
| <div> <div> <ul style="list-style-type: none"> <li>DiffServ Wizard</li> <li>Basic</li> <li>Advanced <ul style="list-style-type: none"> <li>DiffServ Configuration</li> <li>Class Configuration</li> <li>IPv6 Class Configuration</li> <li>Policy Configuration</li> <li>Service Interface Configuration</li> <li>Service Statistics</li> </ul> </li> </ul> </div> <div> <table> <tr> <th>Policy Name</th> <th>Policy Type</th> <th>Member Class</th> </tr> <tr> <td>PolicyVoiceVlan</td> <td>In</td> <td>ClassVoiceVLAN</td> </tr> </table> </div> </div> |             |                |     |          |            |             |      |       | Policy Name | Policy Type | Member Class | PolicyVoiceVlan | In | ClassVoiceVLAN |
| Policy Name   | Policy Type | Member Class   |     |          |            |             |      |       |             |             |              |                 |    |                |
| PolicyVoiceVlan   | In          | ClassVoiceVLAN |     |          |            |             |      |       |             |             |              |                 |    |                |

- b. Click the **Policy PolicyVoiceVLAN**.

A screen similar to the following displays.

| System  | Switching | Routing | QoS | Security | Monitoring | Maintenance | Help | Index |
|---|-----------|---------|-----|----------|------------|-------------|------|-------|
| CoS DiffServ  |           |         |     |          |            |             |      |       |
| DiffServ  |           |         |     |          |            |             |      |       |
| <div> <div> <ul style="list-style-type: none"> <li>DiffServ Wizard</li> <li>Basic</li> <li>Advanced <ul style="list-style-type: none"> <li>DiffServ Configuration</li> <li>Class Configuration</li> <li>IPv6 Class Configuration</li> <li><b>Policy Configuration</b></li> <li>Service Interface Configuration</li> <li>Service Statistics</li> </ul> </li> </ul> </div> <div> <div>Class Information</div> <div> Policy Name: PolicyVoiceVlan<br/> Policy Type: In<br/> Member Class Name: ClassVoiceVLAN </div> </div> <div> <div>Policy Attribute</div> <div> Policy Attribute: <input checked="" type="radio"/> Assign Queue (3) <input type="radio"/> Drop <input type="radio"/> Mark VLAN CoS (0) <input type="radio"/> Mark CoS As Secondary CoS (0) <input type="radio"/> Mark IP Precedence (0) </div> </div> </div> |           |         |     |          |            |             |      |       |

- c. In the field next to the **Assign Queue** radio button, select **3**.
  - d. Click **Apply**.
9. Assign it to interfaces 1/0/1 and 1/0/2.
- a. Select **QoS > DiffServ > Advanced > Service Interface Configuration**.

A screen similar to the following displays.

| System   | Switching       | Routing         | QoS       | Security           | Monitoring | Maintenance | Help | Index |           |                |                 |           |                    |   |                 |  |  |  |   |  |  |  |  |                                |  |  |  |  |                                |  |  |  |  |                                |  |  |  |  |                                |  |  |  |  |                                |  |  |  |  |
|--|-----------------|-----------------|-----------|--------------------|------------|-------------|------|-------|-----------|----------------|-----------------|-----------|--------------------|---|-----------------|--|--|--|---|--|--|--|--|--------------------------------|--|--|--|--|--------------------------------|--|--|--|--|--------------------------------|--|--|--|--|--------------------------------|--|--|--|--|--------------------------------|--|--|--|--|
| CoS DiffServ   |                 |                 |           |                    |            |             |      |       |           |                |                 |           |                    |   |                 |  |  |  |   |  |  |  |  |                                |  |  |  |  |                                |  |  |  |  |                                |  |  |  |  |                                |  |  |  |  |                                |  |  |  |  |
| DiffServ   |                 |                 |           |                    |            |             |      |       |           |                |                 |           |                    |   |                 |  |  |  |   |  |  |  |  |                                |  |  |  |  |                                |  |  |  |  |                                |  |  |  |  |                                |  |  |  |  |                                |  |  |  |  |
| <div> <div> <ul style="list-style-type: none"> <li>DiffServ Wizard</li> <li>Basic</li> <li>Advanced <ul style="list-style-type: none"> <li>DiffServ Configuration</li> <li>Class Configuration</li> <li>IPv6 Class Configuration</li> <li>Policy Configuration</li> <li><b>Service Interface Configuration</b></li> <li>Service Statistics</li> </ul> </li> </ul> </div> <div> <div>Service Interface Configuration</div> <div> 1 2 3 LAGS All Go To Interface: <input type="text"/> <input type="button" value="Go"/> </div> <table> <thead> <tr> <th>Interface</th> <th>Policy In Name</th> <th>Policy Out Name</th> <th>Direction</th> <th>Operational Status</th> </tr> </thead> <tbody> <tr> <td><input checked="" type="checkbox"/> 1/0/1</td> <td>PolicyVoiceVlan</td> <td></td> <td></td> <td></td> </tr> <tr> <td><input checked="" type="checkbox"/> 1/0/2</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td><input type="checkbox"/> 1/0/3</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td><input type="checkbox"/> 1/0/4</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td><input type="checkbox"/> 1/0/5</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td><input type="checkbox"/> 1/0/6</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td><input type="checkbox"/> 1/0/7</td> <td></td> <td></td> <td></td> <td></td> </tr> </tbody> </table> </div> </div> |                 |                 |           |                    |            |             |      |       | Interface | Policy In Name | Policy Out Name | Direction | Operational Status | <input checked="" type="checkbox"/> 1/0/1 | PolicyVoiceVlan |  |  |  | <input checked="" type="checkbox"/> 1/0/2 |  |  |  |  | <input type="checkbox"/> 1/0/3 |  |  |  |  | <input type="checkbox"/> 1/0/4 |  |  |  |  | <input type="checkbox"/> 1/0/5 |  |  |  |  | <input type="checkbox"/> 1/0/6 |  |  |  |  | <input type="checkbox"/> 1/0/7 |  |  |  |  |
| Interface  | Policy In Name  | Policy Out Name | Direction | Operational Status |            |             |      |       |           |                |                 |           |                    |   |                 |  |  |  |   |  |  |  |  |                                |  |  |  |  |                                |  |  |  |  |                                |  |  |  |  |                                |  |  |  |  |                                |  |  |  |  |
| <input checked="" type="checkbox"/> 1/0/1  | PolicyVoiceVlan |                 |           |                    |            |             |      |       |           |                |                 |           |                    |   |                 |  |  |  |   |  |  |  |  |                                |  |  |  |  |                                |  |  |  |  |                                |  |  |  |  |                                |  |  |  |  |                                |  |  |  |  |
| <input checked="" type="checkbox"/> 1/0/2  |                 |                 |           |                    |            |             |      |       |           |                |                 |           |                    |   |                 |  |  |  |   |  |  |  |  |                                |  |  |  |  |                                |  |  |  |  |                                |  |  |  |  |                                |  |  |  |  |                                |  |  |  |  |
| <input type="checkbox"/> 1/0/3   |                 |                 |           |                    |            |             |      |       |           |                |                 |           |                    |   |                 |  |  |  |   |  |  |  |  |                                |  |  |  |  |                                |  |  |  |  |                                |  |  |  |  |                                |  |  |  |  |                                |  |  |  |  |
| <input type="checkbox"/> 1/0/4   |                 |                 |           |                    |            |             |      |       |           |                |                 |           |                    |   |                 |  |  |  |   |  |  |  |  |                                |  |  |  |  |                                |  |  |  |  |                                |  |  |  |  |                                |  |  |  |  |                                |  |  |  |  |
| <input type="checkbox"/> 1/0/5   |                 |                 |           |                    |            |             |      |       |           |                |                 |           |                    |   |                 |  |  |  |   |  |  |  |  |                                |  |  |  |  |                                |  |  |  |  |                                |  |  |  |  |                                |  |  |  |  |                                |  |  |  |  |
| <input type="checkbox"/> 1/0/6   |                 |                 |           |                    |            |             |      |       |           |                |                 |           |                    |   |                 |  |  |  |   |  |  |  |  |                                |  |  |  |  |                                |  |  |  |  |                                |  |  |  |  |                                |  |  |  |  |                                |  |  |  |  |
| <input type="checkbox"/> 1/0/7   |                 |                 |           |                    |            |             |      |       |           |                |                 |           |                    |   |                 |  |  |  |   |  |  |  |  |                                |  |  |  |  |                                |  |  |  |  |                                |  |  |  |  |                                |  |  |  |  |                                |  |  |  |  |

- b. Select the check boxes for Interfaces **1/0/1** and **1/0/2**.
- c. Set the **Policy Name** field as **PolicyVoiceVLAN**.
- d. Click **Apply**.

# Configure GARP VLAN Registration Protocol

Generic Attribute Registration Protocol (GARP) VLAN Registration Protocol (GVRP) provides IEEE 802.1Q-compliant VLAN pruning and dynamic VLAN creation on 802.1Q-tagged ports. With GVRP, a switch can exchange VLAN configuration information with other GVRP switches, prune unnecessary broadcast and unknown unicast traffic, and create and manage VLANs dynamically on switches that are connected through 802.1Q-tagged ports.



**Figure 7. GVRP configuration**

## CLI: Enable GVRP

1. On Switch A, create VLANs 1000, 2000, and 3000, and add port 1/0/24 as a tagged port to VLANs 1000, 2000, and 3000.

```
(Netgear Switch) #vlan database
(Netgear Switch) (Vlan)#vlan 1000,2000,3000
(Netgear Switch) (Vlan)#exit
(Netgear Switch) #config
(Netgear Switch) (Config)#interface 1/0/24
(Netgear Switch) (Interface 1/0/24)#vlan participation include 1000
(Netgear Switch) (Interface 1/0/24)#vlan participation include 2000
(Netgear Switch) (Interface 1/0/24)#vlan participation include 3000
(Netgear Switch) (Interface 1/0/24)#vlan tagging 1000,2000,3000
```

2. On Switch A, enable GVRP.

```
(Netgear Switch) #set gvrp adminmode
(Netgear Switch) #config
(Netgear Switch) (Config)#interface 1/0/24
(Netgear Switch) (Interface 1/0/24)#set gvrp interfacemode
```

**3. On Switch B, enable GVRP.**

```
(Netgear Switch) #set gvrp adminmode
(Netgear Switch) #config
(Netgear Switch) (Config)#interface 1/0/11
(Netgear Switch) (Interface 1/0/11)#set gvrp interfacemode
```

**4. On Switch B, verify that VLANs 1000, 2000, and 3000 were created.**

```
(Netgear Switch) #show vlan

Maximum VLAN Entries..... 1024
VLAN Entries Currently in Use..... 5

VLAN ID  VLAN Name                VLAN Type
-----
1         default                    Default
2         Auto VoIP                AUTO VoIP
1000      Dynamic (GVRP)
2000      Dynamic (GVRP)
3000      Dynamic (GVRP)

(Netgear Switch) #show vlan 1000

VLAN ID: 1000
VLAN Name:
VLAN Type: Dynamic (GVRP)
Interface  Current  Configured  Tagging
-----
1/0/1      Exclude  Autodetect  Untagged
1/0/2      Exclude  Autodetect  Untagged
1/0/3      Exclude  Autodetect  Untagged
1/0/4      Exclude  Autodetect  Untagged
1/0/5      Exclude  Autodetect  Untagged
1/0/6      Exclude  Autodetect  Untagged
1/0/7      Exclude  Autodetect  Untagged
1/0/8      Exclude  Autodetect  Untagged
1/0/9      Exclude  Autodetect  Untagged
1/0/10     Exclude  Autodetect  Untagged
1/0/11     Include  Autodetect  Tagged
1/0/12     Exclude  Autodetect  Untagged
1/0/13     Exclude  Autodetect  Untagged
1/0/14     Exclude  Autodetect  Untagged
1/0/15     Exclude  Autodetect  Untagged
1/0/16     Exclude  Autodetect  Untagged
```

## Local Browser Interface: Configure GVRP on switch A

1. On Switch A, create VLANs 1000, 2000, and 3000:
  - a. Select **Switching > VLAN > Advanced > VLAN Configuration**.

A screen similar to the following displays.

The screenshot shows the 'VLAN Configuration' page. The left sidebar has a tree view with 'VLAN' expanded, showing 'Basic', 'VLAN Configuration', and 'Advanced'. 'VLAN Configuration' is selected. The main area has a 'Reset' button and a 'Reset Configuration' checkbox. Below is the 'Internal VLAN Configuration' section with 'Internal VLAN Allocation Base' set to 4093 and 'Internal VLAN Allocation Policy' set to 'Descending'. At the bottom is the 'VLAN Configuration' table:

| VLAN ID | VLAN Name | VLAN Type | Make Static |
|---------|-----------|-----------|-------------|
| 1000    |           |           | Disable     |
| 1       | default   | Default   | Disable     |

- b. In the VLAN ID field, enter **1000**.
  - c. Click **Add**.
  - d. Repeat Step a through Step c to create VLANs 2000 and 3000.
2. Add port 1/0/24 as a tagged port to VLANs 1000, 2000, and 3000:
  - a. Select **Switching > VLAN > Advanced > VLAN Membership**.

A screen similar to the following displays.

The screenshot shows the 'VLAN Membership' page. The left sidebar has 'VLAN Membership' selected under 'VLAN'. The main area shows 'VLAN ID' set to 1000, 'Group Operation' set to 'Untag All', 'VLAN Name' set to 'VLAN1000', and 'VLAN Type' set to 'Static'. Below is a port selection grid for 'Unit 1' showing ports 1 through 24. Port 24 is highlighted with a 'T' icon, indicating it is tagged.

- a. From the VLAN ID menu, select **1000**.
  - b. Click **Unit 1**.

The ports display.

  - c. Click the gray box under port **24** until **T** displays.

T specifies that the switch tags egress packets for port 24.

d. Click **Apply**.

3. Enable GVRP globally:

a. Select **Switching > VLAN > Advanced > GARP Switch Configuration**.

A screen similar to the following displays.

The screenshot shows the 'GARP Switch Configuration' page. The left sidebar lists various configuration options under 'Advanced', with 'GARP Switch Configuration' selected. The main content area shows two settings: 'GVRP Mode' and 'GMRP Mode'. Both are currently set to 'Disable' (radio button selected). The 'GVRP Mode' has a dropdown menu showing 'Disable' and 'Enable'. The 'GMRP Mode' has a dropdown menu showing 'Disable' and 'Enable'.

b. Next to GVRP Mode, select the **Enable** radio button.

c. Click **Apply**.

4. Enable GVRP on port 1/0/24.

a. Select **Switching > VLAN > Advanced > GARP Port Configuration**.

A screen similar to the following displays.

The screenshot shows the 'GARP Port Configuration' page. The left sidebar lists various configuration options under 'Advanced', with 'GARP Port Configuration' selected. The main content area shows a table with columns: Interface, Port GVRP Mode, Port GMRP Mode, Join Timer, Leave Timer, and Leave All Timer. The table lists interfaces from 1/0/1 to 1/0/15. The 'Port GVRP Mode' column shows 'Enable' for interface 1/0/24 and 'Disable' for all other interfaces. The 'Port GMRP Mode' column shows 'Disable' for all interfaces. The 'Join Timer' column shows '20' for all interfaces. The 'Leave Timer' column shows '60' for all interfaces. The 'Leave All Timer' column shows '1000' for all interfaces. There is a 'Go To Interface' field with a 'Go' button.

| Interface | Port GVRP Mode | Port GMRP Mode | Join Timer | Leave Timer | Leave All Timer |
|-----------|----------------|----------------|------------|-------------|-----------------|
| 1/0/24    | Enable         | Disable        | 20         | 60          | 1000            |
| 1/0/1     | Disable        | Disable        | 20         | 60          | 1000            |
| 1/0/2     | Disable        | Disable        | 20         | 60          | 1000            |
| 1/0/3     | Disable        | Disable        | 20         | 60          | 1000            |
| 1/0/4     | Disable        | Disable        | 20         | 60          | 1000            |
| 1/0/5     | Disable        | Disable        | 20         | 60          | 1000            |
| 1/0/6     | Disable        | Disable        | 20         | 60          | 1000            |
| 1/0/7     | Disable        | Disable        | 20         | 60          | 1000            |
| 1/0/8     | Disable        | Disable        | 20         | 60          | 1000            |
| 1/0/9     | Disable        | Disable        | 20         | 60          | 1000            |
| 1/0/10    | Disable        | Disable        | 20         | 60          | 1000            |
| 1/0/11    | Disable        | Disable        | 20         | 60          | 1000            |
| 1/0/12    | Disable        | Disable        | 20         | 60          | 1000            |
| 1/0/13    | Disable        | Disable        | 20         | 60          | 1000            |
| 1/0/14    | Disable        | Disable        | 20         | 60          | 1000            |
| 1/0/15    | Disable        | Disable        | 20         | 60          | 1000            |

b. Scroll down and select the check box that corresponds to interface 1/0/24.

The Interface field in the table heading displays 1/0/24.



- c. From the Port GVRP Mode menu, select **Enable**.
- d. Click **Apply**.

## Local Browser Interface: Configure GVRP on Switch B

1. Enable GVRP globally:
  - a. Select **Switching > VLAN > Advanced > GARP Switch Configuration**.

A screen similar to the following displays.

The screenshot shows the 'GARP Switch Configuration' page. The left sidebar lists various configuration options under 'Advanced', with 'GARP Switch Configuration' selected. The main content area shows the 'GARP Switch Configuration' section with two radio buttons: 'GVRP Mode' (Disable, Enable) and 'GMRP Mode' (Disable, Enable). The 'Enable' radio button for GVRP Mode is selected.

- b. Next to GVRP Mode, select the **Enable** radio button.
  - c. Click **Apply**.
2. Enable GVRP on port 1/0/11:
  - a. Select **Switching > VLAN > Advanced > GARP Port Configuration**.

A screen similar to the following displays.

The screenshot shows the 'GARP Port Configuration' page. The left sidebar lists various configuration options under 'Advanced', with 'GARP Port Configuration' selected. The main content area shows the 'GARP Port Configuration' section with a table of port configurations. The '1/0/11' port is selected, and its 'Port GVRP Mode' is set to 'Enable'.

| Interface | Port GVRP Mode | Port GMRP Mode | Join Timer | Leave Timer | Leave All Timer |
|-----------|----------------|----------------|------------|-------------|-----------------|
| 1/0/11    | Enable         | Disable        | 20         | 60          | 1000            |
| 1/0/1     | Disable        | Disable        | 20         | 60          | 1000            |
| 1/0/2     | Disable        | Disable        | 20         | 60          | 1000            |
| 1/0/3     | Disable        | Disable        | 20         | 60          | 1000            |
| 1/0/4     | Disable        | Disable        | 20         | 60          | 1000            |
| 1/0/5     | Disable        | Disable        | 20         | 60          | 1000            |
| 1/0/6     | Disable        | Disable        | 20         | 60          | 1000            |
| 1/0/7     | Disable        | Disable        | 20         | 60          | 1000            |
| 1/0/8     | Disable        | Disable        | 20         | 60          | 1000            |
| 1/0/9     | Disable        | Disable        | 20         | 60          | 1000            |
| 1/0/10    | Disable        | Disable        | 20         | 60          | 1000            |
| 1/0/12    | Disable        | Disable        | 20         | 60          | 1000            |
| 1/0/13    | Disable        | Disable        | 20         | 60          | 1000            |
| 1/0/14    | Disable        | Disable        | 20         | 60          | 1000            |
| 1/0/15    | Disable        | Disable        | 20         | 60          | 1000            |



- b. Scroll down and select the check box that corresponds to interface 1/0/11.  
The Interface field in the table heading displays 1/0/11.
- c. From the Port GVRP Mode menu, select **Enable**.
- d. Click **Apply**.

## Private VLANs

The Private VLANs feature separates a regular VLAN domain into two or more subdomains. Each subdomain is defined (represented) by a primary VLAN and a secondary VLAN. The primary VLAN ID is the same for all subdomains that belong to a private VLAN. The secondary VLAN ID differentiates subdomains from each other and provides Layer 2 isolation between ports of the same private VLAN.

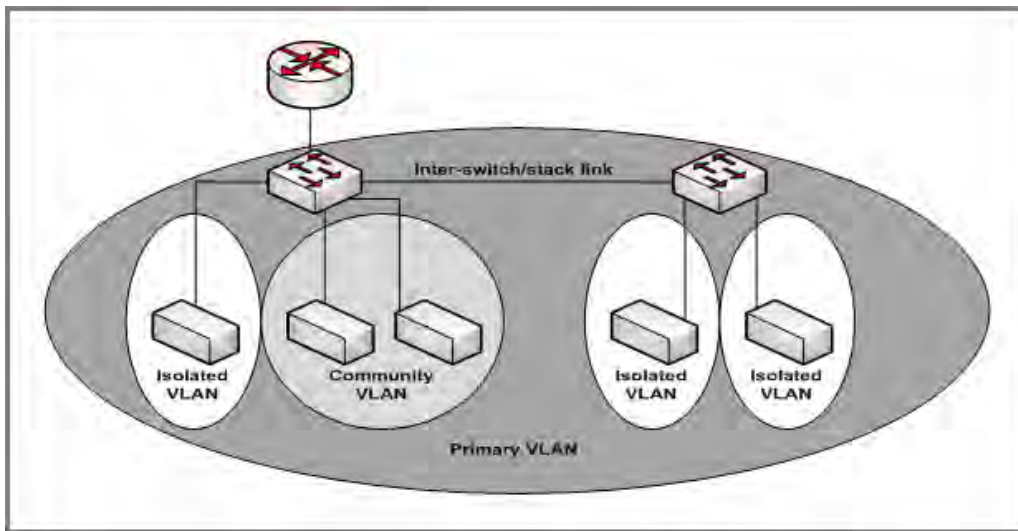
There are three types of VLAN within a private VLAN:

- **Primary VLAN.** it forwards the traffic from the promiscuous ports to isolated ports, community ports, and other promiscuous ports in the same private VLAN. Only one primary VLAN can be configured per private VLAN. All ports within a private VLAN share the same primary VLAN.
- **Community VLAN.** is a secondary VLAN. It forwards traffic between ports which belong to the same community and to the promiscuous ports. There can be multiple community VLANs per private VLAN.
- **Isolated VLAN.** is a secondary VLAN. It carries traffic from isolated ports to promiscuous ports. Only one isolated VLAN can be configured per private VLAN.

There are three types of port designation within a private VLAN:

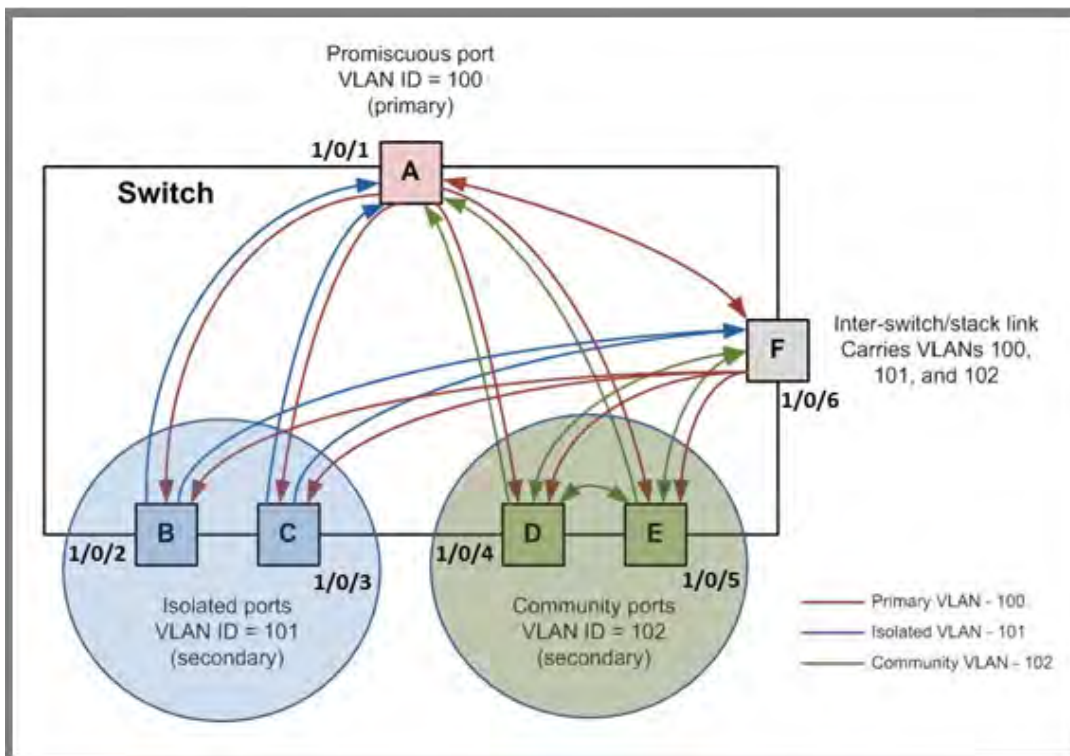
- **Promiscuous port.** belongs to a primary VLAN and can communicate with all interfaces in the private VLAN, including other promiscuous ports, community ports, and isolated ports.
- **Community ports.** These ports can communicate with other community ports and promiscuous ports.
- **Isolated ports.** These can ONLY communicate with promiscuous ports.

The following figure shows how private VLANs can be extended across multiple switches through inter-switch/stack links that transport primary, community, and isolated VLANs between devices.



**Figure 8. Private VLANs**

The following figure illustrates the private VLAN traffic flow. Five ports A, B, C, D, and E make up a private VLAN. Port A is a promiscuous port which is associated with the primary VLAN 100. Ports B and C are the host ports which belong to the isolated VLAN 101. Ports D and E are the community ports which are associated with community VLAN 102. Port F is the inter-switch/stack link. It is configured to transmit VLANs 100, 101 and 102. Colored arrows represent possible packet flow paths in the private VLAN domain.



**Figure 9. Packet flow within a Private VLAN domain**

# Assign Private-VLAN Types (Primary, Isolated, Community)

The example is shown as CLI commands and as a local browser interface procedure.

## CLI: Assign Private-VLAN Type (Primary, Isolated, Community)

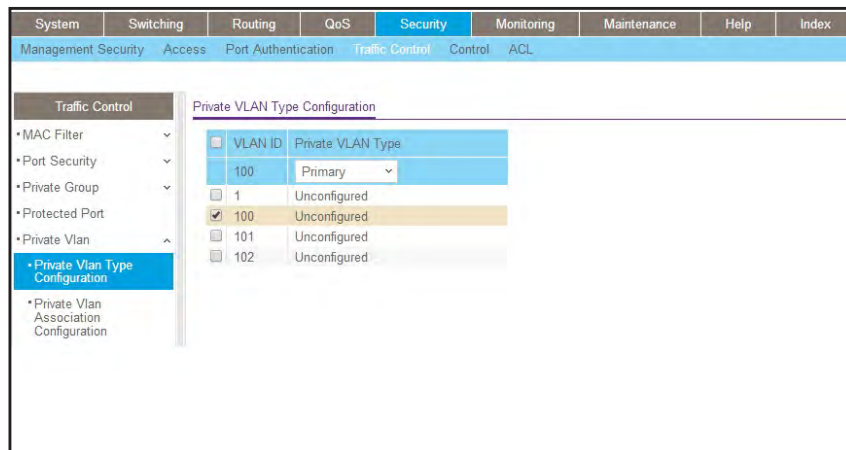
Use the following commands to assign VLAN 100 to primary VLAN, VLAN 101 to isolated VLAN, and VLAN 102 to community VLAN.

```
(Netgear Switch) #config
(Netgear Switch) (Config)#vlan 100
(Netgear Switch) (Config)(Vlan) #private-vlan primary
(Netgear Switch) (Config)(Vlan) #exit
(Netgear Switch) (Config)#vlan 101
(Netgear Switch) (Config)(Vlan) #private-vlan isolated
(Netgear Switch) (Config)(Vlan) #exit
(Netgear Switch) (Config)#vlan 102
(Netgear Switch) (Config)(Vlan) #private-vlan community
(Netgear Switch) (Config)(Vlan) #end
```

## Local Browser Interface: Assign Private-VLAN Type (Primary, Isolated, Community)

1. Create VLAN 10.
- a. Select **Security > Traffic Control > Private VLAN > Private VLAN Type Configuration**.

A screen similar to the following displays.



- b. Under **Private VLAN Type Configuration**, select the **VLAN ID 100** check box. Now 100 appears in the interface field at the top.
  - c. In the **Private VLAN Type** field, select **Primary** from the menu.
  - d. Click **Apply** to save the settings
2. Assign VLAN 101 as an isolated VLAN.
  - a. Select **Security > Traffic Control > Private VLAN > Private VLAN Type Configuration**.

A screen similar to the following displays.

The screenshot shows the 'Private VLAN Type Configuration' page. The left sidebar has 'Private Vlan Type Configuration' selected. The main area has a table with two columns: 'VLAN ID' and 'Private VLAN Type'. The table contains the following data:

| VLAN ID                                 | Private VLAN Type |
|---|-------------------|
| <input type="checkbox"/> 101            | Isolated          |
| <input type="checkbox"/> 1              | Unconfigured      |
| <input type="checkbox"/> 100            | Primary           |
| <input checked="" type="checkbox"/> 101 | Unconfigured      |
| <input type="checkbox"/> 102            | Unconfigured      |

- b. Under **Private VLAN Type Configuration**, select the **VLAN ID 101** check box. Now 101 appears in the interface field at the top.
  - c. In the **Private VLAN Type** field, select **Isolated** from the menu.
  - d. Click **Apply** to save the settings
3. Assign VLAN 102 to community VLAN.
  - a. Select **Security > Traffic Control > Private VLAN > Private VLAN Type Configuration**.

A screen similar to the following displays.

The screenshot shows the 'Private VLAN Type Configuration' page. The left sidebar has 'Private Vlan Type Configuration' selected. The main area has a table with two columns: 'VLAN ID' and 'Private VLAN Type'. The table contains the following data:

| VLAN ID                                 | Private VLAN Type |
|---|-------------------|
| <input type="checkbox"/> 102            | Community         |
| <input type="checkbox"/> 1              | Unconfigured      |
| <input type="checkbox"/> 100            | Primary           |
| <input type="checkbox"/> 101            | Isolated          |
| <input checked="" type="checkbox"/> 102 | Unconfigured      |

- b. Under **Private VLAN Type Configuration**, select the **VLAN ID 102** check box. Now 102 appears in the interface field at the top.
- c. In the **Private VLAN Type** field, select **Community** from the menu.
- d. Click **Apply** to save the settings.

## Configure Private-VLAN Association

The example is shown as CLI commands and as a local browser interface procedure.

### CLI: Configure Private-VLAN Association

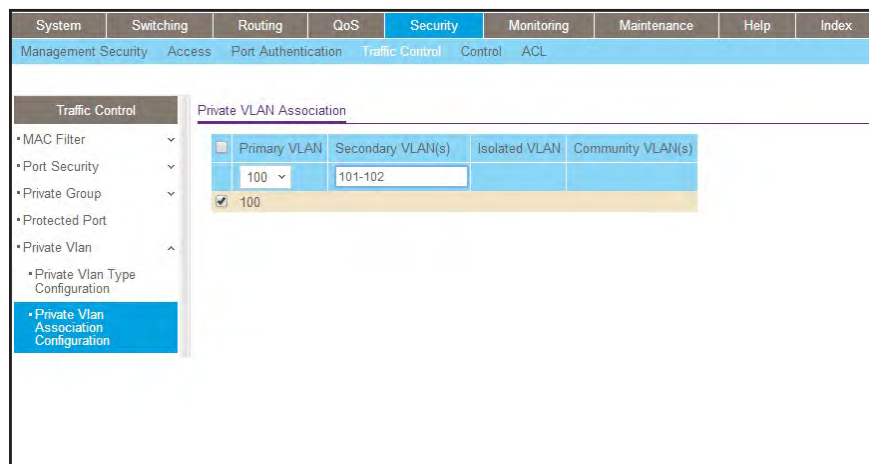
Use the following commands to associate VLAN 101-102 (secondary VLAN) to VLAN 100 (primary VLAN).

```
(Netgear Switch) #config
(Netgear Switch) (Config)#vlan 100
(Netgear Switch) (Config)(Vlan) #private-vlan association 101-102
(Netgear Switch) (Config)(Vlan) #end
```

### Local Browser Interface: Configure Private-VLAN Association

1. Associate VLAN 101-102 (secondary VLAN) to VLAN 100 (primary VLAN).
  - a. Select **Security > Traffic Control > Private VLAN > Private VLAN Association Configuration**.

A screen similar to the following displays.



- b. Under **Private VLAN Association Configuration**, select the VLAN ID 100.

- c. In the **Secondary VLAN(s)** field, type 101-102.
- d. Click **Apply** to save the settings.

## Configure Private-VLAN Port Mode (Promiscuous, Host)

The example is shown as CLI commands and as a local browser interface procedure.

### CLI: Configure Private-VLAN Port Mode (Promiscuous, Host)

Use the following commands to assign port 1/0/1 to promiscuous port mode and ports 1/0/2-1/0/5 to host port mode.

```
(Netgear Switch) #config
(Netgear Switch) (Config)#interface 1/0/1
(Netgear Switch) (Interface 1/0/1)#switchport mode private-vlan promiscuous
(Netgear Switch) (Interface 1/0/1)#exit
(Netgear Switch) (Config)#interface 1/0/2-1/0/5
(Netgear Switch) (Interface 1/0/2-1/0/5)#switchport mode private-vlan host
(Netgear Switch) (Interface 1/0/2-1/0/5)#end
```

### Local Browser Interface: Configure Private-VLAN Port Mode (Promiscuous, Host)

1. Configure port 1/0/1 to promiscuous port mode.
  - a. Select **Security > Traffic Control > Private VLAN > Private VLAN Port Mode Configuration**.



A screen similar to the following displays.

| Interface                                 | Port Vlan Mode |
|---|----------------|
| <input checked="" type="checkbox"/> 1/0/1 | Promiscuous    |
| <input type="checkbox"/> 1/0/2            | General        |
| <input type="checkbox"/> 1/0/3            | General        |
| <input type="checkbox"/> 1/0/4            | General        |
| <input type="checkbox"/> 1/0/5            | General        |
| <input type="checkbox"/> 1/0/6            | General        |
| <input type="checkbox"/> 1/0/7            | General        |
| <input type="checkbox"/> 1/0/8            | General        |
| <input type="checkbox"/> 1/0/9            | General        |
| <input type="checkbox"/> 1/0/10           | General        |
| <input type="checkbox"/> 1/0/11           | General        |
| <input type="checkbox"/> 1/0/12           | General        |
| <input type="checkbox"/> 1/0/13           | General        |

- b. Under **Private VLAN Port Mode Configuration**, select the 1/0/1 interface check box.

Now 1/0/1 appears in the **Interface** field at the top.

- c. In the **Port VLAN Mode** field, select **Promiscuous** from the menu.  
d. Click **Apply** to save the settings.

2. Configure ports 1/0/2-1/0/5 to host port mode.

- a. Select **Security > Traffic Control > Private VLAN > Private VLAN Port Mode Configuration**.

A screen similar to the following displays.

| Interface                                 | Port Vlan Mode |
|---|----------------|
| <input type="checkbox"/> 1/0/1            | Promiscuous    |
| <input checked="" type="checkbox"/> 1/0/2 | Host           |
| <input checked="" type="checkbox"/> 1/0/3 | General        |
| <input checked="" type="checkbox"/> 1/0/4 | General        |
| <input checked="" type="checkbox"/> 1/0/5 | General        |
| <input type="checkbox"/> 1/0/6            | General        |
| <input type="checkbox"/> 1/0/7            | General        |
| <input type="checkbox"/> 1/0/8            | General        |
| <input type="checkbox"/> 1/0/9            | General        |
| <input type="checkbox"/> 1/0/10           | General        |

- b. Under **Private VLAN Port Mode Configuration**, select the 1/0/2 to 1/0/5 interface check box.  
c. In the **Port VLAN Mode** field, select **Host** from the menu.  
d. Click **Apply** to save the settings.

# Configure Private-VLAN Host Ports

The example is shown as CLI commands and as a local browser interface procedure.

## CLI: Configure Private-VLAN Host Ports

Use the following commands to associate isolated ports 1/0/2-1/0/3 to a private-VLAN (primary=100, secondary=101). Community ports 1/0/4-1/0/5 to a private-VLAN (primary=100, secondary=102).

```
(Netgear Switch) #config
(Netgear Switch) (Config)#interface 1/0/2-1/0/3
(Netgear Switch) (Interface 1/0/2-1/0/3)#switchport private-vlan host-association
100 101
(Netgear Switch) (Interface 1/0/2-1/0/3)#exit
(Netgear Switch) (Config)#interface 1/0/4-1/0/5
(Netgear Switch) (Interface 1/0/4-1/0/5)#switchport private-vlan host-association
100 102
(Netgear Switch) (Interface 1/0/4-1/0/5)#end
```

## Local Browser Interface: Assign Private-VLAN Port Host Ports

1. Associate isolated ports 1/0/2-1/0/3 to a private-VLAN (primary=100, secondary=101).
  - a. Select **Security > Traffic Control > Private VLAN > Private VLAN Host Interface Configuration**.

A screen similar to the following displays.

| Interface                                 | Host Primary VLAN (2 to 4093) | Host Secondary VLAN (2 to 4093) | Operational VLAN(s) |
|---|-------------------------------|---------------------------------|---------------------|
| <input type="checkbox"/> 1/0/1            | 0                             | 0                               |                     |
| <input checked="" type="checkbox"/> 1/0/2 | 0                             | 0                               |                     |
| <input checked="" type="checkbox"/> 1/0/3 | 0                             | 0                               |                     |
| <input type="checkbox"/> 1/0/4            | 0                             | 0                               |                     |
| <input type="checkbox"/> 1/0/5            | 0                             | 0                               |                     |
| <input type="checkbox"/> 1/0/6            | 0                             | 0                               |                     |
| <input type="checkbox"/> 1/0/7            | 0                             | 0                               |                     |
| <input type="checkbox"/> 1/0/8            | 0                             | 0                               |                     |
| <input type="checkbox"/> 1/0/9            | 0                             | 0                               |                     |
| <input type="checkbox"/> 1/0/10           | 0                             | 0                               |                     |

- b. Under **Private VLAN Host Interface Configuration**, select the 1/0/2 and 1/0/3 interface check box.



- c. In the **Host Primary VLAN** field, enter 100.
  - d. In the **Host Secondary VLAN** field, enter 101.
  - e. Click **Apply** to save the settings.
2. Associate isolated ports 1/0/4-1/0/5 to a private-VLAN (primary=100, secondary=102).
  - a. Select **Security > Traffic Control > Private VLAN > Private VLAN Host Interface Configuration**.

A screen similar to the following displays.

| Interface                                 | Host Primary VLAN (2 to 4093) | Host Secondary VLAN (2 to 4093) | Operational VLAN(s) |
|---|-------------------------------|---------------------------------|---------------------|
| <input type="checkbox"/> 1/0/1            | 0                             | 0                               |                     |
| <input type="checkbox"/> 1/0/2            | 100                           | 101                             | 100-101             |
| <input type="checkbox"/> 1/0/3            | 100                           | 101                             | 100-101             |
| <input checked="" type="checkbox"/> 1/0/4 | 0                             | 0                               |                     |
| <input checked="" type="checkbox"/> 1/0/5 | 0                             | 0                               |                     |
| <input type="checkbox"/> 1/0/6            | 0                             | 0                               |                     |
| <input type="checkbox"/> 1/0/7            | 0                             | 0                               |                     |
| <input type="checkbox"/> 1/0/8            | 0                             | 0                               |                     |
| <input type="checkbox"/> 1/0/9            | 0                             | 0                               |                     |
| <input type="checkbox"/> 1/0/10           | 0                             | 0                               |                     |

- b. Under **Private VLAN Host Interface Configuration**, select the 1/0/4 and 1/0/5 interface check box.
  - c. In the **Host Primary VLAN** field, enter 100.
  - d. In the **Host Secondary VLAN** field, enter 102.
  - e. Click **Apply** to save the settings.

## Map Private-VLAN Promiscuous Port

The example is shown as CLI commands and as a local browser interface procedure.

### CLI: Map Private-VLAN Promiscuous Port

Use the following commands to map private-VLAN promiscuous port 1/0/1 to a primary VLAN (100) and to secondary VLANs (101-102).

```
(Netgear Switch) #config
(Netgear Switch) (Config)#interface 1/0/1
(Netgear Switch) (Interface 1/0/1)#switchport private-vlan mapping 100 101-102
(Netgear Switch) (Interface 1/0/1)#end
```

## Local Browser Interface: Map Private-VLAN Promiscuous Port

1. Map private-VLAN promiscuous port 1/0/1 to a primary VLAN (100) and to selected secondary VLANs (101-102).
  - a. Select **Security > Traffic Control > Private VLAN > Private VLAN Promiscuous Interface Configuration**.

A screen similar to the following displays.

The screenshot shows the 'Private VLAN Promiscuous Interface Configuration' page. On the left is a sidebar with a tree view containing categories like MAC Filter, Port Security, Private Group, Protected Port, Private Vlan, Private Vlan Type Configuration, Private Vlan Association Configuration, Private Vlan Port Mode Configuration, Private Vlan Host Interface Configuration, and 'Private Vlan Promiscuous Interface Configuration' (which is highlighted). The main area has a title bar with tabs for Management Security, Access, Port Authentication, Traffic Control (selected), Control, and ACL. Below the title bar is a 'Go To Interface' field with a 'Go' button. The main content is a table with columns: Interface, Promiscuous Primary VLAN (2 to 4093), Promiscuous Secondary VLAN(s) Range[2-4093], and Operational VLAN(s). The table lists interfaces 1/0/1 through 1/0/12. Interface 1/0/1 is checked in the 'Interface' column and has '100' in the 'Promiscuous Primary VLAN' column and '101-102' in the 'Promiscuous Secondary VLAN(s)' column. Other interfaces are unchecked and have '0' in the primary VLAN column.

| Interface                                 | Promiscuous Primary VLAN (2 to 4093) | Promiscuous Secondary VLAN(s) Range[2-4093] | Operational VLAN(s) |
|---|--------------------------------------|---|---------------------|
| <input checked="" type="checkbox"/> 1/0/1 | 100                                  | 101-102                                     |                     |
| <input type="checkbox"/> 1/0/2            | 0                                    |   | 100-101             |
| <input type="checkbox"/> 1/0/3            | 0                                    |   | 100-101             |
| <input type="checkbox"/> 1/0/4            | 0                                    |   | 100, 102            |
| <input type="checkbox"/> 1/0/5            | 0                                    |   | 100, 102            |
| <input type="checkbox"/> 1/0/6            | 0                                    |   |                     |
| <input type="checkbox"/> 1/0/7            | 0                                    |   |                     |
| <input type="checkbox"/> 1/0/8            | 0                                    |   |                     |
| <input type="checkbox"/> 1/0/9            | 0                                    |   |                     |
| <input type="checkbox"/> 1/0/10           | 0                                    |   |                     |
| <input type="checkbox"/> 1/0/11           | 0                                    |   |                     |
| <input type="checkbox"/> 1/0/12           | 0                                    |   |                     |

- b. Under **Private VLAN Promiscuous Interface Configuration**, select the 1/0/1 interface check box. Now 1/0/1 appears in the **Interface** field at the top.
  - c. In the **Promiscuous Primary VLAN** field, enter 100.
  - d. In the **Promiscuous Secondary VLAN** field, enter 101-102.
  - e. Click **Apply** to save the settings

## VLAN Access Ports and Trunk Ports

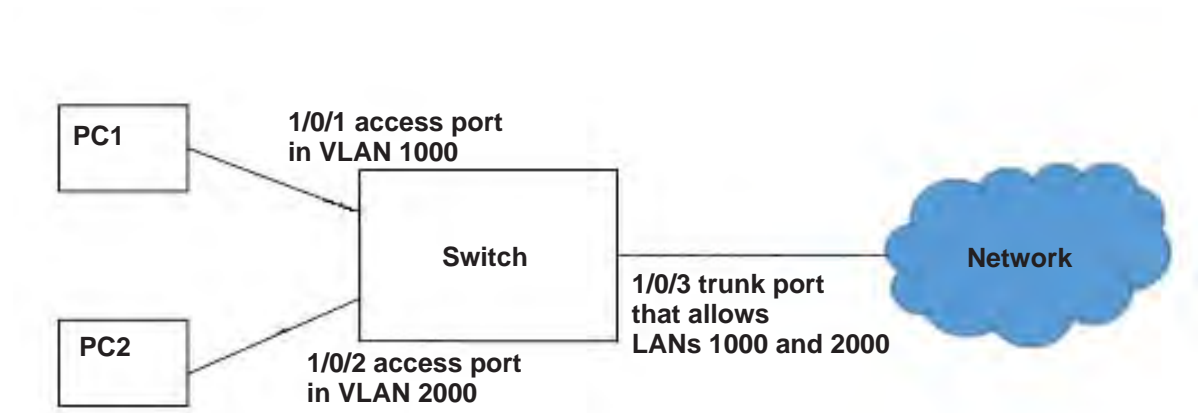
Using switch ports can minimize potential configuration errors. Switch ports also facilitate the configuration of a VLAN by reducing the number of commands that you must enter. To configure a port that is connected to an end user, use a switch port in access mode. To configure a port that is connected to another switch, use a switch port in trunk mode.

In addition, to access mode and trunk mode, you can configure switch ports in general mode, which is the default mode and does not restrict the configuration so you can configure the port as needed.

The switch supports the following switch port modes, each with its own VLAN membership rules:

- **Access mode.** In access mode, the following rules apply to switch ports:
  - Ports belong to a single VLAN, for which the VID is the configured PVID.
  - Ports are intended for end-point connections, which, in general, do not operate with LANs and operate with tagged traffic.
  - Ports accept both tagged and untagged traffic. (You cannot configure whether the ports accept tagged or untagged traffic.)
  - All egress traffic must be sent untagged.
  - Ingress filtering is always enabled.
  - Ports are intended for connecting end stations to the switch, especially when end stations are incapable of generating VLAN tags.
- **Trunk mode.** In trunk mode, the following rules apply to switch ports:
  - Ports can belong to as many VLANs as needed.
  - Ports accept both incoming tagged and untagged traffic.
  - All incoming untagged frames are tagged with the native VLAN as the VID.
  - Egress frames are sent tagged for all VLANs other than the native VLAN. Frames that belong to the native VLAN are sent without a VLAN tag.
  - Ingress filtering is always enabled. If incoming frames are tagged correctly (that is, tagged with a VID of one of the VLANs to which the port belongs), they are admitted.
  - Ports are intended for connections between switches, for which the traffic is generally tagged.
  - If you configure a list with allowed VLANs, a trunk port becomes a member of VLANs that are defined in the list with allowed VLANs.
- **General mode.** In general mode, the following rules apply to switch ports:
  - By default, all ports are designated as general mode ports and belong to the default VLAN.
  - Ports conform to NETGEAR legacy switch behavior for switch ports.
  - You configure various VLAN parameters such as membership, tagging, and PVID by using legacy commands.
  - You can enable or disable ingress filtering.

The following figure shows a configuration with access ports and a trunk port.



**Figure 10. Access and trunk ports**

## CLI: Configure a VLAN Trunk

1. Create VLAN 1000 and 2000.

```
(Netgear Switch) #vlan database
(Netgear Switch) (Vlan)#vlan 1000
(Netgear Switch) (Vlan)#vlan 2000
(Netgear Switch) (Vlan)#exit
```

2. Configure port 1/0/1 as an access port.

```
(Netgear Switch) #config
(Netgear Switch) (Config)#interface 1/0/1
(Netgear Switch) (Interface 1/0/1)#switchport mode access
(Netgear Switch) (Interface 1/0/1)#switchport access vlan 1000
(Netgear Switch) (Interface 1/0/1)#exit
(Netgear Switch) (Config)#
```

3. Configure port 1/0/2 as an access port.

```
(Netgear Switch) #config
(Netgear Switch) (Config)#interface 1/0/2
(Netgear Switch) (Interface 1/0/2)#switchport mode access
(Netgear Switch) (Interface 1/0/2)#switchport access vlan 2000
(Netgear Switch) (Interface 1/0/2)#exit
(Netgear Switch) (Config)#
```

#### 4. Configure port 1/0/3 as a trunk port.

```
(Netgear Switch) (Interface 1/0/3)#switchport mode trunk
(Netgear Switch) (Interface 1/0/3)#switchport trunk allowed vlan 1000,2000
```

#### 5. Configure all incoming untagged packets to be tagged with the native VLAN ID.

```
(Netgear Switch) (Interface 1/0/3)#switchport trunk native vlan 1000
```

## Local Browser Interface: Configure a VLAN Trunk

### 1. Create VLAN 1000

#### a. Select **Switching > VLAN > Advanced > VLAN Configuration**.

A screen similar to the following displays.

| VLAN ID | VLAN Name | VLAN Type | Make Static |
|---------|-----------|-----------|-------------|
| 1000    |           |           | Disable     |
| 1       | default   | Default   | Disable     |

#### b. In the **VLAN ID** field, enter **1000**.

#### c. Click **Add**.

A screen similar to the following displays.

**VLAN** Reset

• Basic ^

• **VLAN Configuration**

• Advanced ^

Internal VLAN Configuration

Internal VLAN Allocation Base: 4093

Internal VLAN Allocation Policy: ☐ Ascending ☒ Descending

VLAN Configuration

| <input type="checkbox"/> | VLAN ID | VLAN Name | VLAN Type | Make Static |
|--------------------------|---------|-----------|-----------|-------------|
| <input type="checkbox"/> | 2000    |           |           | Disable     |
| <input type="checkbox"/> | 1       | default   | Default   | Disable     |
| <input type="checkbox"/> | 1000    | VLAN1000  | Static    | Disable     |

- d. In the **VLAN ID** field, enter **2000**.
- e. Click **Add**.
2. Configure port 1/0/1 as an access port in VLAN 1000.
  - a. **Select Switching > VLAN > Advanced > VLAN Trunking Configuration.**

A screen similar to the following displays.

**VLAN** Switchport Configuration

• Basic ^

• Advanced ^

• VLAN Configuration

• **VLAN Trunking Configuration**

• VLAN Membership

• VLAN Status

• Port PVID Configuration

• MAC Based VLAN

• Protocol Based VLAN Group Configuration

• Protocol Based VLAN Group Membership

• IP Subnet Based VLAN

• Port DVLAN Configuration

• Voice VLAN Configuration

• GARP Switch Configuration

• GARP Port Configuration

1 2 3 LAG All Go To Interface  Go

| <input type="checkbox"/>            | Interface | Switchport Mode | Native VLAN Tagging | Access VLAN ID | Native VLAN ID | Trunk Allowed VLANs |
|-------------------------------------|-----------|-----------------|---------------------|----------------|----------------|---------------------|
| <input type="checkbox"/>            | 1/0/1     | Access          | Disable             | 1000           | 1              | 1-4093              |
| <input checked="" type="checkbox"/> | 1/0/1     | General         | Disable             | 1              | 1              | 1-4093              |
| <input type="checkbox"/>            | 1/0/2     | General         | Disable             | 1              | 1              | 1-4093              |
| <input type="checkbox"/>            | 1/0/3     | General         | Disable             | 1              | 1              | 1-4093              |
| <input type="checkbox"/>            | 1/0/4     | General         | Disable             | 1              | 1              | 1-4093              |
| <input type="checkbox"/>            | 1/0/5     | General         | Disable             | 1              | 1              | 1-4093              |
| <input type="checkbox"/>            | 1/0/6     | General         | Disable             | 1              | 1              | 1-4093              |
| <input type="checkbox"/>            | 1/0/7     | General         | Disable             | 1              | 1              | 1-4093              |
| <input type="checkbox"/>            | 1/0/8     | General         | Disable             | 1              | 1              | 1-4093              |
| <input type="checkbox"/>            | 1/0/9     | General         | Disable             | 1              | 1              | 1-4093              |
| <input type="checkbox"/>            | 1/0/10    | General         | Disable             | 1              | 1              | 1-4093              |
| <input type="checkbox"/>            | 1/0/11    | General         | Disable             | 1              | 1              | 1-4093              |
| <input type="checkbox"/>            | 1/0/12    | General         | Disable             | 1              | 1              | 1-4093              |
| <input type="checkbox"/>            | 1/0/13    | General         | Disable             | 1              | 1              | 1-4093              |
| <input type="checkbox"/>            | 1/0/14    | General         | Disable             | 1              | 1              | 1-4093              |
| <input type="checkbox"/>            | 1/0/15    | General         | Disable             | 1              | 1              | 1-4093              |
| <input type="checkbox"/>            | 1/0/16    | General         | Disable             | 1              | 1              | 1-4093              |
| <input type="checkbox"/>            | 1/0/17    | General         | Disable             | 1              | 1              | 1-4093              |
| <input type="checkbox"/>            | 1/0/18    | General         | Disable             | 1              | 1              | 1-4093              |
| <input type="checkbox"/>            | 1/0/19    | General         | Disable             | 1              | 1              | 1-4093              |
| <input type="checkbox"/>            | 1/0/20    | General         | Disable             | 1              | 1              | 1-4093              |

- b. Select the check box that corresponds to interface 1/0/1.



The **Interface** field in the table heading displays 1/0/1.

- c. In the **Switchport Mode** field, select **Access**.
  - d. In the **Access VLAN ID** field, select **1000**.
  - e. Click **Apply**.
3. Configure port 1/0/2 as an access port in VLAN 2000.
- a. **Select Switching > VLAN > Advanced > VLAN Trunking Configuration.**

A screen similar to the following displays.

| Interface | Switchport Mode | Native VLAN Tagging | Access VLAN ID | Native VLAN ID | Trunk Allowed VLANs |
|-----------|-----------------|---------------------|----------------|----------------|---------------------|
| 1/0/1     | Access          | Disable             | 1000           | 1              | 1-4093              |
| 1/0/2     | General         | Disable             | 1              | 1              | 1-4093              |
| 1/0/3     | General         | Disable             | 1              | 1              | 1-4093              |
| 1/0/4     | General         | Disable             | 1              | 1              | 1-4093              |
| 1/0/5     | General         | Disable             | 1              | 1              | 1-4093              |
| 1/0/6     | General         | Disable             | 1              | 1              | 1-4093              |
| 1/0/7     | General         | Disable             | 1              | 1              | 1-4093              |
| 1/0/8     | General         | Disable             | 1              | 1              | 1-4093              |
| 1/0/9     | General         | Disable             | 1              | 1              | 1-4093              |
| 1/0/10    | General         | Disable             | 1              | 1              | 1-4093              |
| 1/0/11    | General         | Disable             | 1              | 1              | 1-4093              |
| 1/0/12    | General         | Disable             | 1              | 1              | 1-4093              |
| 1/0/13    | General         | Disable             | 1              | 1              | 1-4093              |
| 1/0/14    | General         | Disable             | 1              | 1              | 1-4093              |
| 1/0/15    | General         | Disable             | 1              | 1              | 1-4093              |
| 1/0/16    | General         | Disable             | 1              | 1              | 1-4093              |
| 1/0/17    | General         | Disable             | 1              | 1              | 1-4093              |
| 1/0/18    | General         | Disable             | 1              | 1              | 1-4093              |
| 1/0/19    | General         | Disable             | 1              | 1              | 1-4093              |
| 1/0/20    | General         | Disable             | 1              | 1              | 1-4093              |
| 1/0/21    | General         | Disable             | 1              | 1              | 1-4093              |

- b. Select the check box that corresponds to interface 1/0/2.

The **Interface** field in the table heading displays 1/0/2.

- c. In the **Switchport Mode** field, select **Access**.
  - d. In the **Access VLAN ID** field, select **2000**.
  - e. Click **Apply**.
4. Configure port 1/0/3 as a trunk port that allows VLANs 1000 and 2000.
- a. **Select Switching > VLAN > Advanced > VLAN Trunking Configuration.**

A screen similar to the following displays.



| System   | Switching | Routing | QoS | Security  | Monitoring | Maintenance   | Help  | Index |
|----------|-----------|---------|-----|-----------|------------|---------------|-------|-------|
| VLAN     | Auto-VoIP | iSCSI   | STP | Multicast | MVR        | Address Table | Ports | LAG   |
| MLAG MRP |           |         |     |           |            |               |       |       |

| VLAN  | Switchport Configuration   |                          |                     |                 |                     |                     |                |                     |                          |       |       |         |   |      |           |                          |       |        |         |      |   |        |                          |       |        |         |      |   |        |                                     |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |
|---|--|--------------------------|---------------------|-----------------|---------------------|---------------------|----------------|---------------------|--------------------------|-------|-------|---------|---|------|-----------|--------------------------|-------|--------|---------|------|---|--------|--------------------------|-------|--------|---------|------|---|--------|-------------------------------------|-------|---------|---------|---|---|--------|--------------------------|-------|---------|---------|---|---|--------|--------------------------|-------|---------|---------|---|---|--------|--------------------------|-------|---------|---------|---|---|--------|--------------------------|-------|---------|---------|---|---|--------|--------------------------|-------|---------|---------|---|---|--------|--------------------------|-------|---------|---------|---|---|--------|--------------------------|--------|---------|---------|---|---|--------|--------------------------|--------|---------|---------|---|---|--------|--------------------------|--------|---------|---------|---|---|--------|--------------------------|--------|---------|---------|---|---|--------|--------------------------|--------|---------|---------|---|---|--------|--------------------------|--------|---------|---------|---|---|--------|--------------------------|--------|---------|---------|---|---|--------|--------------------------|--------|---------|---------|---|---|--------|--------------------------|--------|---------|---------|---|---|--------|--------------------------|--------|---------|---------|---|---|--------|--------------------------|--------|---------|---------|---|---|--------|--------------------------|--------|---------|---------|---|---|--------|
| <ul style="list-style-type: none"> <li>Basic</li> <li>Advanced</li> <li>VLAN Configuration</li> <li><b>VLAN Trunking Configuration</b></li> <li>VLAN Membership</li> <li>VLAN Status</li> <li>Port PVID Configuration</li> <li>MAC Based VLAN</li> <li>Protocol Based VLAN Group Configuration</li> <li>Protocol Based VLAN Group Membership</li> <li>IP Subnet Based VLAN</li> <li>Port DVLAN Configuration</li> <li>Voice VLAN Configuration</li> <li>GARP Switch Configuration</li> <li>GARP Port Configuration</li> </ul> | <div>1 2 3 LAG All</div> <div>Go To Interface <input type="text"/> <input type="button" value="Go"/></div> <table border="1"> <thead> <tr> <th><input type="checkbox"/></th> <th>Interface</th> <th>Switchport Mode</th> <th>Native VLAN Tagging</th> <th>Access VLAN ID</th> <th>Native VLAN ID</th> <th>Trunk Allowed VLANs</th> </tr> </thead> <tbody> <tr> <td><input type="checkbox"/></td> <td>1/0/3</td> <td>Trunk</td> <td>Disable</td> <td>1</td> <td>2000</td> <td>1000,2000</td> </tr> <tr> <td><input type="checkbox"/></td> <td>1/0/1</td> <td>Access</td> <td>Disable</td> <td>1000</td> <td>1</td> <td>1-4093</td> </tr> <tr> <td><input type="checkbox"/></td> <td>1/0/2</td> <td>Access</td> <td>Disable</td> <td>2000</td> <td>1</td> <td>1-4093</td> </tr> <tr> <td><input checked="" type="checkbox"/></td> <td>1/0/3</td> <td>General</td> <td>Disable</td> <td>1</td> <td>1</td> <td>1-4093</td> </tr> <tr> <td><input type="checkbox"/></td> <td>1/0/4</td> <td>General</td> <td>Disable</td> <td>1</td> <td>1</td> <td>1-4093</td> </tr> <tr> <td><input type="checkbox"/></td> <td>1/0/5</td> <td>General</td> <td>Disable</td> <td>1</td> <td>1</td> <td>1-4093</td> </tr> <tr> <td><input type="checkbox"/></td> <td>1/0/6</td> <td>General</td> <td>Disable</td> <td>1</td> <td>1</td> <td>1-4093</td> </tr> <tr> <td><input type="checkbox"/></td> <td>1/0/7</td> <td>General</td> <td>Disable</td> <td>1</td> <td>1</td> <td>1-4093</td> </tr> <tr> <td><input type="checkbox"/></td> <td>1/0/8</td> <td>General</td> <td>Disable</td> <td>1</td> <td>1</td> <td>1-4093</td> </tr> <tr> <td><input type="checkbox"/></td> <td>1/0/9</td> <td>General</td> <td>Disable</td> <td>1</td> <td>1</td> <td>1-4093</td> </tr> <tr> <td><input type="checkbox"/></td> <td>1/0/10</td> <td>General</td> <td>Disable</td> <td>1</td> <td>1</td> <td>1-4093</td> </tr> <tr> <td><input type="checkbox"/></td> <td>1/0/11</td> <td>General</td> <td>Disable</td> <td>1</td> <td>1</td> <td>1-4093</td> </tr> <tr> <td><input type="checkbox"/></td> <td>1/0/12</td> <td>General</td> <td>Disable</td> <td>1</td> <td>1</td> <td>1-4093</td> </tr> <tr> <td><input type="checkbox"/></td> <td>1/0/13</td> <td>General</td> <td>Disable</td> <td>1</td> <td>1</td> <td>1-4093</td> </tr> <tr> <td><input type="checkbox"/></td> <td>1/0/14</td> <td>General</td> <td>Disable</td> <td>1</td> <td>1</td> <td>1-4093</td> </tr> <tr> <td><input type="checkbox"/></td> <td>1/0/15</td> <td>General</td> <td>Disable</td> <td>1</td> <td>1</td> <td>1-4093</td> </tr> <tr> <td><input type="checkbox"/></td> <td>1/0/16</td> <td>General</td> <td>Disable</td> <td>1</td> <td>1</td> <td>1-4093</td> </tr> <tr> <td><input type="checkbox"/></td> <td>1/0/17</td> <td>General</td> <td>Disable</td> <td>1</td> <td>1</td> <td>1-4093</td> </tr> <tr> <td><input type="checkbox"/></td> <td>1/0/18</td> <td>General</td> <td>Disable</td> <td>1</td> <td>1</td> <td>1-4093</td> </tr> <tr> <td><input type="checkbox"/></td> <td>1/0/19</td> <td>General</td> <td>Disable</td> <td>1</td> <td>1</td> <td>1-4093</td> </tr> <tr> <td><input type="checkbox"/></td> <td>1/0/20</td> <td>General</td> <td>Disable</td> <td>1</td> <td>1</td> <td>1-4093</td> </tr> <tr> <td><input type="checkbox"/></td> <td>1/0/21</td> <td>General</td> <td>Disable</td> <td>1</td> <td>1</td> <td>1-4093</td> </tr> </tbody> </table> | <input type="checkbox"/> | Interface           | Switchport Mode | Native VLAN Tagging | Access VLAN ID      | Native VLAN ID | Trunk Allowed VLANs | <input type="checkbox"/> | 1/0/3 | Trunk | Disable | 1 | 2000 | 1000,2000 | <input type="checkbox"/> | 1/0/1 | Access | Disable | 1000 | 1 | 1-4093 | <input type="checkbox"/> | 1/0/2 | Access | Disable | 2000 | 1 | 1-4093 | <input checked="" type="checkbox"/> | 1/0/3 | General | Disable | 1 | 1 | 1-4093 | <input type="checkbox"/> | 1/0/4 | General | Disable | 1 | 1 | 1-4093 | <input type="checkbox"/> | 1/0/5 | General | Disable | 1 | 1 | 1-4093 | <input type="checkbox"/> | 1/0/6 | General | Disable | 1 | 1 | 1-4093 | <input type="checkbox"/> | 1/0/7 | General | Disable | 1 | 1 | 1-4093 | <input type="checkbox"/> | 1/0/8 | General | Disable | 1 | 1 | 1-4093 | <input type="checkbox"/> | 1/0/9 | General | Disable | 1 | 1 | 1-4093 | <input type="checkbox"/> | 1/0/10 | General | Disable | 1 | 1 | 1-4093 | <input type="checkbox"/> | 1/0/11 | General | Disable | 1 | 1 | 1-4093 | <input type="checkbox"/> | 1/0/12 | General | Disable | 1 | 1 | 1-4093 | <input type="checkbox"/> | 1/0/13 | General | Disable | 1 | 1 | 1-4093 | <input type="checkbox"/> | 1/0/14 | General | Disable | 1 | 1 | 1-4093 | <input type="checkbox"/> | 1/0/15 | General | Disable | 1 | 1 | 1-4093 | <input type="checkbox"/> | 1/0/16 | General | Disable | 1 | 1 | 1-4093 | <input type="checkbox"/> | 1/0/17 | General | Disable | 1 | 1 | 1-4093 | <input type="checkbox"/> | 1/0/18 | General | Disable | 1 | 1 | 1-4093 | <input type="checkbox"/> | 1/0/19 | General | Disable | 1 | 1 | 1-4093 | <input type="checkbox"/> | 1/0/20 | General | Disable | 1 | 1 | 1-4093 | <input type="checkbox"/> | 1/0/21 | General | Disable | 1 | 1 | 1-4093 |
| <input type="checkbox"/>  | Interface  | Switchport Mode          | Native VLAN Tagging | Access VLAN ID  | Native VLAN ID      | Trunk Allowed VLANs |                |                     |                          |       |       |         |   |      |           |                          |       |        |         |      |   |        |                          |       |        |         |      |   |        |                                     |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |
| <input type="checkbox"/>  | 1/0/3  | Trunk                    | Disable             | 1               | 2000                | 1000,2000           |                |                     |                          |       |       |         |   |      |           |                          |       |        |         |      |   |        |                          |       |        |         |      |   |        |                                     |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |
| <input type="checkbox"/>  | 1/0/1  | Access                   | Disable             | 1000            | 1                   | 1-4093              |                |                     |                          |       |       |         |   |      |           |                          |       |        |         |      |   |        |                          |       |        |         |      |   |        |                                     |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |
| <input type="checkbox"/>  | 1/0/2  | Access                   | Disable             | 2000            | 1                   | 1-4093              |                |                     |                          |       |       |         |   |      |           |                          |       |        |         |      |   |        |                          |       |        |         |      |   |        |                                     |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |
| <input checked="" type="checkbox"/>   | 1/0/3  | General                  | Disable             | 1               | 1                   | 1-4093              |                |                     |                          |       |       |         |   |      |           |                          |       |        |         |      |   |        |                          |       |        |         |      |   |        |                                     |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |
| <input type="checkbox"/>  | 1/0/4  | General                  | Disable             | 1               | 1                   | 1-4093              |                |                     |                          |       |       |         |   |      |           |                          |       |        |         |      |   |        |                          |       |        |         |      |   |        |                                     |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |
| <input type="checkbox"/>  | 1/0/5  | General                  | Disable             | 1               | 1                   | 1-4093              |                |                     |                          |       |       |         |   |      |           |                          |       |        |         |      |   |        |                          |       |        |         |      |   |        |                                     |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |
| <input type="checkbox"/>  | 1/0/6  | General                  | Disable             | 1               | 1                   | 1-4093              |                |                     |                          |       |       |         |   |      |           |                          |       |        |         |      |   |        |                          |       |        |         |      |   |        |                                     |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |
| <input type="checkbox"/>  | 1/0/7  | General                  | Disable             | 1               | 1                   | 1-4093              |                |                     |                          |       |       |         |   |      |           |                          |       |        |         |      |   |        |                          |       |        |         |      |   |        |                                     |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |
| <input type="checkbox"/>  | 1/0/8  | General                  | Disable             | 1               | 1                   | 1-4093              |                |                     |                          |       |       |         |   |      |           |                          |       |        |         |      |   |        |                          |       |        |         |      |   |        |                                     |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |
| <input type="checkbox"/>  | 1/0/9  | General                  | Disable             | 1               | 1                   | 1-4093              |                |                     |                          |       |       |         |   |      |           |                          |       |        |         |      |   |        |                          |       |        |         |      |   |        |                                     |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |
| <input type="checkbox"/>  | 1/0/10   | General                  | Disable             | 1               | 1                   | 1-4093              |                |                     |                          |       |       |         |   |      |           |                          |       |        |         |      |   |        |                          |       |        |         |      |   |        |                                     |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |
| <input type="checkbox"/>  | 1/0/11   | General                  | Disable             | 1               | 1                   | 1-4093              |                |                     |                          |       |       |         |   |      |           |                          |       |        |         |      |   |        |                          |       |        |         |      |   |        |                                     |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |
| <input type="checkbox"/>  | 1/0/12   | General                  | Disable             | 1               | 1                   | 1-4093              |                |                     |                          |       |       |         |   |      |           |                          |       |        |         |      |   |        |                          |       |        |         |      |   |        |                                     |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |
| <input type="checkbox"/>  | 1/0/13   | General                  | Disable             | 1               | 1                   | 1-4093              |                |                     |                          |       |       |         |   |      |           |                          |       |        |         |      |   |        |                          |       |        |         |      |   |        |                                     |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |
| <input type="checkbox"/>  | 1/0/14   | General                  | Disable             | 1               | 1                   | 1-4093              |                |                     |                          |       |       |         |   |      |           |                          |       |        |         |      |   |        |                          |       |        |         |      |   |        |                                     |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |
| <input type="checkbox"/>  | 1/0/15   | General                  | Disable             | 1               | 1                   | 1-4093              |                |                     |                          |       |       |         |   |      |           |                          |       |        |         |      |   |        |                          |       |        |         |      |   |        |                                     |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |
| <input type="checkbox"/>  | 1/0/16   | General                  | Disable             | 1               | 1                   | 1-4093              |                |                     |                          |       |       |         |   |      |           |                          |       |        |         |      |   |        |                          |       |        |         |      |   |        |                                     |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |
| <input type="checkbox"/>  | 1/0/17   | General                  | Disable             | 1               | 1                   | 1-4093              |                |                     |                          |       |       |         |   |      |           |                          |       |        |         |      |   |        |                          |       |        |         |      |   |        |                                     |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |
| <input type="checkbox"/>  | 1/0/18   | General                  | Disable             | 1               | 1                   | 1-4093              |                |                     |                          |       |       |         |   |      |           |                          |       |        |         |      |   |        |                          |       |        |         |      |   |        |                                     |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |
| <input type="checkbox"/>  | 1/0/19   | General                  | Disable             | 1               | 1                   | 1-4093              |                |                     |                          |       |       |         |   |      |           |                          |       |        |         |      |   |        |                          |       |        |         |      |   |        |                                     |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |
| <input type="checkbox"/>  | 1/0/20   | General                  | Disable             | 1               | 1                   | 1-4093              |                |                     |                          |       |       |         |   |      |           |                          |       |        |         |      |   |        |                          |       |        |         |      |   |        |                                     |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |
| <input type="checkbox"/>  | 1/0/21   | General                  | Disable             | 1               | 1                   | 1-4093              |                |                     |                          |       |       |         |   |      |           |                          |       |        |         |      |   |        |                          |       |        |         |      |   |        |                                     |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |       |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |                          |        |         |         |   |   |        |

b. Select the check box that corresponds to interface 1/0/3.

The **Interface** field in the table heading displays 1/0/3.

c. In the **Switchport Mode** field, select **Trunk**.

d. In the **Native VLAN ID** field, select **2000**.

**Note:** In this step, you configure incoming untagged packets to be tagged with VLAN ID 2000. If you want the switch to drop untagged packets, ignore this step.

e. In the **Trunk Allowed VLANs** field, enter **1000,2000**.

f. Click **Apply**.

# 4

## Port Routing

---

Port routing, default routes, and static routes

This chapter includes the following sections:

- [Port Routing Concepts](#)
- [Port Routing Configuration](#)
- [Enable Routing for the Switch](#)
- [Enable Routing for Ports on the Switch](#)
- [Add a Default Route](#)
- [Add a Static Route](#)

# Port Routing Concepts

The first networks were small enough for the end stations to communicate directly. As networks grew, Layer 2 bridging was used to segregate traffic, a technology that worked well for unicast traffic, but had problems coping with large quantities of multicast packets. The next major development was routing, where packets were examined and redirected at Layer 3. End stations needed to know how to reach their nearest router, and the routers had to interpret the network topology so that they could forward traffic. Although bridges tended to be faster than routers, using routers allowed the network to be partitioned into logical subnetworks, which restricted multicast traffic and also facilitated the development of security mechanisms.

An end station specifies the destination station's Layer 3 address in the packet's IP header, but sends the packet to the MAC address of a router. When the Layer 3 router receives the packet, it will minimally:

- Look up the Layer 3 address in its address table to determine the outbound port.
- Update the Layer 3 header.
- Re-create the Layer 2 header.

The router's IP address is often statically configured in the end station, although the switch supports protocols such as DHCP that allow the address to be assigned dynamically. Likewise, you can assign some of the entries in the routing tables used by the router statically, but protocols such as RIP and OSPF allow the tables to be created and updated dynamically as the network configuration changes.

# Port Routing Configuration

The switch always supports Layer 2 bridging, but Layer 3 routing must be explicitly enabled, first for the switch as a whole, and then for each port that is to be part of the routed network.

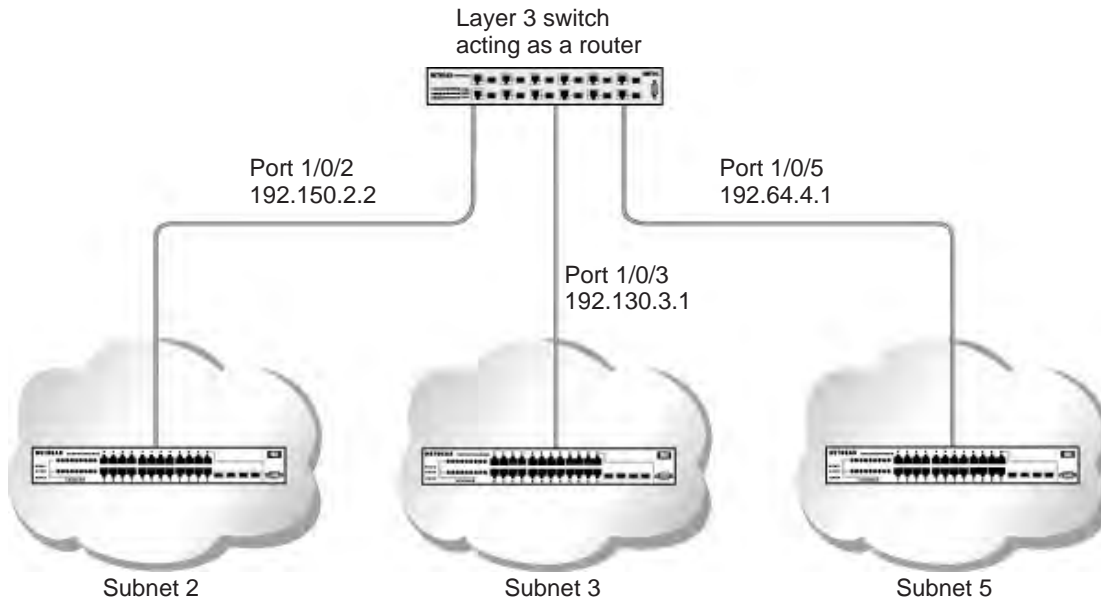
The configuration commands used in the example in this section enable IP routing on ports 1/0/2, 1/0/3, and 1/0/5. The router ID will be set to the switch's management IP address, or to that of any active router interface if the management address is not configured.

After the routing configuration commands have been issued, the following functions will be active:

- IP forwarding, responsible for forwarding received IP packets.
- ARP mapping, responsible for maintaining the ARP Table used to correlate IP and MAC addresses. The table contains both static entries and entries dynamically updated based on information in received ARP frames.
- Routing Table Object, responsible for maintaining the common routing table used by all registered routing protocols.

You can then activate RIP or OSPF, used by routers to exchange route information, on top of IP Routing. RIP is more often used in smaller networks, while OSPF was designed for larger and more complex topologies.

The following figure shows a Layer 3 switch configured for port routing. It connects three different subnets, each connected to a different port.



**Figure 11. Layer 3 switch configured for port routing**

## Enable Routing for the Switch

The example is shown as CLI commands and as a local browser interface procedure.

### CLI: Enable Routing for the Switch

The following script shows the commands that you use to configure the switch to provide the port routing support shown in [Figure 11, Layer 3 switch configured for port routing on page 79](#).

Use the following command to enable routing for the switch. Execution of the command enables IP forwarding by default.

```
(Netgear Switch) #config
(Netgear Switch) (Config)#ip routing
(Netgear Switch) (Config)#exit
```

## Local Browser Interface: Enable Routing for the Switch

1. Select **Routing > IP > Basic > IP Configuration**.

A screen similar to the following displays.

2. For Routing Mode, select the **Enable** radio button.
3. Click **Apply** to save the settings.

## Enable Routing for Ports on the Switch

Use the following commands or the local browser interface to enable routing for ports on the switch. The default link-level encapsulation format is Ethernet. Configure the IP addresses and subnet masks for the ports. Network-directed broadcast frames will be dropped. The maximum transmission unit (MTU) size is 1500 bytes.

## CLI: Enable Routing for Ports on the Switch

```
(Netgear Switch) #config
(Netgear Switch) (Config)#interface 1/0/2
(Netgear Switch) (Interface 1/0/2)#routing
(Netgear Switch) (Interface 1/0/2)#ip address 192.150.2.1 255.255.255.0
(Netgear Switch) (Interface 1/0/2)#exit

(Netgear Switch) (Config)#interface 1/0/3
(Netgear Switch) (Interface 1/0/3)#routing
(Netgear Switch) (Interface 1/0/3)#ip address 192.150.3.1 255.255.255.0
(Netgear Switch) (Interface 1/0/3)#exit

(Netgear Switch) (Config)#interface 1/0/5
(Netgear Switch) (Interface 1/0/5)#routing
(Netgear Switch) (Interface 1/0/5)#ip address 192.150.5.1 255.255.255.0
(Netgear Switch) (Interface 1/0/5)#exit
(Netgear Switch) (Config)#exit
```

## Local Browser Interface: Enable Routing for Ports on the Switch

1. Assign IP address 192.150.2.1/24 to interface 1/0/2.
  - a. Select **Routing > IP > Advanced > IP Interface Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

IP

• Basic

• Advanced

• IP Configuration

• Statistics

• IP Interface Configuration

• Secondary IP

IP Interface Configuration

1 2 3 VLANs All

| Port                                      | Description | VLAN ID | IP Address Configuration Method | IP Address  | Subnet Mask   | Routing Mode | Administrative Mode |
|---|-------------|---------|---------------------------------|-------------|---------------|--------------|---------------------|
| <input type="checkbox"/> 1/0/1            |             |         | Manual                          | 192.150.2.1 | 255.255.255.0 | Enable       | Enable              |
| <input checked="" type="checkbox"/> 1/0/2 |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 1/0/3            |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 1/0/4            |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 1/0/5            |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |

- b. Scroll down and select the interface **1/0/2** check box.  
Now 1/0/2 appears in the Interface field at the top.
  - c. Under the IP Interface Configuration, enter the following information:
    - In the **IP Address** field, enter **192.150.2.1**.

- In the **Subnet Mask** field, enter **255.255.255.0**.
  - In the **Routing Mode** field, select **Enable**.
  - d. Click **Apply** to save the settings.
2. Assign IP address 192.150.3.1/24 to interface 1/0/3.
- a. Select **Routing > IP > Advanced > IP Interface Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

| IP                           |   | IP Interface Configuration |  |  |  |  |  |  |  |
|------------------------------|---|----------------------------|--|--|--|--|--|--|--|
| • Basic                      | ▼ | 1 2 3 VLANs All            |  |  |  |  |  |  |  |
| • Advanced                   | ▲ |                            |  |  |  |  |  |  |  |
| • IP Configuration           |   |                            |  |  |  |  |  |  |  |
| • Statistics                 |   |                            |  |  |  |  |  |  |  |
| • IP Interface Configuration |   |                            |  |  |  |  |  |  |  |
| • Secondary IP               |   |                            |  |  |  |  |  |  |  |

| Port                           | Description | VLAN ID | IP Address Configuration Method | IP Address  | Subnet Mask   | Routing Mode | Administrative Mode |
|--------------------------------|-------------|---------|---------------------------------|-------------|---------------|--------------|---------------------|
| <input type="checkbox"/> 1/0/1 |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 1/0/2 |             |         | Manual                          | 192.150.2.1 | 255.255.255.0 | Enable       | Enable              |
| <input type="checkbox"/> 1/0/3 |             |         | Manual                          | 192.150.3.1 | 255.255.255.0 | Enable       | Enable              |
| <input type="checkbox"/> 1/0/4 |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 1/0/5 |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |

- b. Scroll down and select the interface **1/0/3** check box.
- Now 1/0/3 appears in the Interface field at the top.
- c. Enter the following information:
- In the **IP Address** field, enter **192.150.3.1**.
  - In the **Subnet Mask** field, enter **255.255.255.0**.
  - In the **Routing Mode** field, select **Enable**.
- d. Click **Apply** to save the settings.
3. Assign IP address 192.150.5.1/24 to interface 1/0/5.
- a. Select **Routing > IP > Advanced > IP Interface Configuration**.



A screen similar to the following displays.

| Port                                      | Description | VLAN ID | IP Address Configuration Method | IP Address  | Subnet Mask   | Routing Mode | Administrative Mode |
|---|-------------|---------|---------------------------------|-------------|---------------|--------------|---------------------|
| <input checked="" type="checkbox"/> 1/0/5 |             |         | Manual                          | 192.150.5.1 | 255.255.255.0 | Enable       | Enable              |
| <input type="checkbox"/> 1/0/1            |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 1/0/2            |             |         | Manual                          | 192.150.2.1 | 255.255.255.0 | Enable       | Enable              |
| <input type="checkbox"/> 1/0/3            |             |         | Manual                          | 192.150.3.1 | 255.255.255.0 | Enable       | Enable              |
| <input type="checkbox"/> 1/0/4            |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |

- b. Scroll down and select the interface **1/0/5** check box.  
Now 1/0/5 appears in the Interface field at the top.
- c. Enter the following information:
  - In the **IP Address** field, enter **192.150.5.1**.
  - In the **Subnet Mask** field, enter **255.255.255.0**.
  - In the **Routing Mode** field, select **Enable**.
- d. Click **Apply** to save the settings.

## Add a Default Route

When IP routing takes place on a switch, a routing table is needed for the switch to forward the packet based on the destination IP address. The route entry in the routing table can either be created dynamically through routing protocols like RIP and OSPF, or be manually created by the network administrator. The route created manually is called the static or default route.

A default route is used for forwarding the packet when the switch cannot find a match in the routing table for an IP packet. The following example shows how to create a default route.

## CLI: Add a Default Route

```
(FSM7338S) (Config) #ip route default?
<nexthopip> Enter the IP Address of the next router.
(FSM7328S) (Config)#ip route default 10.10.10.2
```

---

**Note:** IP subnet 10.10.10.0 should be configured using either port routing (Enable Routing for Ports on the Switch on page 80) or VLAN routing (see Set Up VLAN Routing for the VLANs and the Switch on page 93).

---

## Local Browser Interface: Add a Default Route

1. Select **Routing > Routing Table > Basic > Route Configuration**.

A screen similar to the following displays.

2. In the **Route Type** list, select **DefaultRoute**.
3. In the **Next Hop IP Address** field, enter one of the routing interface's IP addresses.
  - The **Network Address** and **Subnet Mask** fields will not accept input as they are not needed.
  - The **Preference** field is optional. A value of 1 (highest) will be assigned by default if not specified.
4. Click the **Add** button on the bottom of the screen.

This creates the default route entry in the routing table.

# Add a Static Route

When the switch performs IP routing, it forwards the packet to the default route for a destination that is not in the same subnet as the source address. However, you can set a path (static route) that is different than the default route if you prefer. The following procedure shows how to add a static route to the switch routing table.

## CLI: Show Routing Information

The following commands assume that the switch already has a defined a routing interface with a network address of 10.10.10.0, and is configured so that all packets destined for network 10.10.100.0 take the path of routing port.

```
(FSM7328S) #show ip route

Total Number of Routes.....1

Network      Subnet      Next Hop      Next Hop
Address      Mask        Protocol      Intf         IP Address
-----
10.10.10.0   255.255.255.0 Local         1/0/3        10.10.10.1
```

To delete the static route, simply add the **no** keyword in the front of the **ip route** command.

## Local Browser Interface: Add a Static Route

1. Select **Routing > Routing Table > Basic > Route Configuration**.

A screen similar to the following displays.

| Route Type | Network Address | Subnet Mask   | Next Hop IP Address | Preference | Description |
|------------|-----------------|---------------|---------------------|------------|-------------|
| Static     | 10.10.20.0      | 255.255.255.0 | 192.168.1.1         | 1          |             |
| Default    | 0.0.0.0         | 0.0.0.0       | 10.10.10.2          | 1          |             |

2. In the **Route Type** list, select **Static**.
3. Fill in the **Network Address** field.

Note that this field should have a network IP address, not a host IP address. Do not enter something like *10.100.100.1*. The last number should always be 0 (zero).

4. In the **Subnet Mask** field, enter a value that matches the subnet range that you want to use.
5. The **Preference** field is optional. A value of 1 is entered by default if you do not enter a number.
6. Click the **Add** button on the bottom of the screen. The screen is updated with the static route shown in the routing table.
7. To remove a route entry, either static or default, select the check box to the left of the entry, and click the **Delete** button on the bottom of the screen.

# 5

## VLAN Routing

---

VLAN routing for a VLAN and for the switch

This chapter includes the following sections:

- [VLAN Routing Concepts](#)
- [Create Two VLANs](#)
- [Set Up VLAN Routing for the VLANs and the Switch](#)

# VLAN Routing Concepts

You can configure the switch with some ports supporting VLANs and some supporting routing. You can also configure it to allow traffic on a VLAN to be treated as if the VLAN were a router port.

When a port is enabled for bridging (the default) rather than routing, all normal bridge processing is performed for an inbound packet, which is then associated with a VLAN. Its MAC destination address (DA) and VLAN ID are used to search the MAC address table. If routing is enabled for the VLAN and the MAC DA of an inbound unicast packet is that of the internal bridge-router interface, the packet is routed. An inbound multicast packet is forwarded to all ports in the VLAN, and also to the internal bridge-router interface if it was received on a routed VLAN.

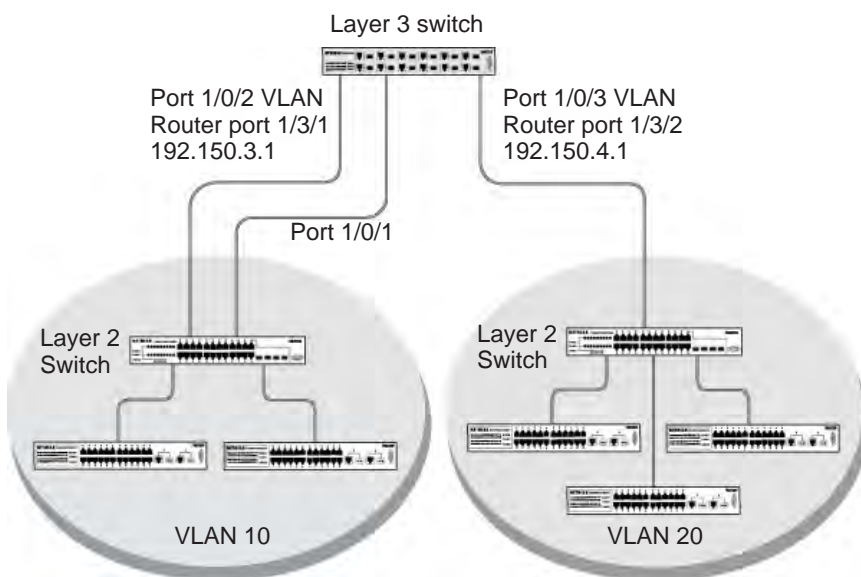
Since a port can be configured to belong to more than one VLAN, VLAN routing might be enabled for all of the VLANs on the port, or for a subset. VLAN routing can be used to allow more than one physical port to reside on the same subnet. It could also be used when a VLAN spans multiple physical networks, or when more segmentation or security is required.

The next section shows you how to configure the switch to support VLAN routing and how to use RIP and OSPF. A port can be either a VLAN port or a router port, but not both. However, a VLAN port can be part of a VLAN that is itself a router port.

## Create Two VLANs

This section provides an example of how to configure the switch to support VLAN routing. The configuration of the VLAN router port is similar to that of a physical port. The main difference is that, after the VLAN has been created, you must use the **show ip vlan** command to determine the VLAN's interface ID so that you can use it in the router configuration commands.

The diagram in this section shows a Layer 3 switch configured for port routing. It connects two VLANs, with two ports participating in one VLAN, and one port in the other. The script shows the commands that you use to configure the switch to provide the VLAN routing support shown in the diagram.



**Figure 12. Layer 3 switch configured for port routing**

## CLI: Create Two VLANs

The following code sequence shows an example of creating two VLANs with egress frame tagging enabled.

```
(Netgear Switch) #vlan data
(Netgear Switch) (Vlan)#vlan 10
(Netgear Switch) (Vlan)#vlan 20
(Netgear Switch) (Vlan)#exit
(Netgear Switch) #conf
(Netgear Switch) (Config)#interface range 1/0/1-1/0/2
(Netgear Switch) (conf-if-range-1/0/1-1/0/2)#vlan participation include 10
(Netgear Switch) (conf-if-range-1/0/1-1/0/2)#vlan pvid 10
(Netgear Switch) (conf-if-range-1/0/1-1/0/2)#exit
(Netgear Switch) (Config)#interface 1/0/3
(Netgear Switch) (Interface 1/0/3)#vlan participation include 20
(Netgear Switch) (Interface 1/0/3)#vlan pvid 20
(Netgear Switch) (Interface 1/0/3)#exit
(Netgear Switch) (Config)#exit
```



## Local Browser Interface: Create Two VLANs

### 1. Create VLAN 10 and VLAN20.

#### a. Select **Switching > VLAN > Advanced > VLAN Configuration**.

A screen similar to the following displays.

| System   | Switching | Routing   | QoS         | Security  | Monitoring | Maintenance   | Help  | Index |         |           |           |             |    |        |        |         |   |         |         |         |
|--|-----------|-----------|-------------|-----------|------------|---------------|-------|-------|---------|-----------|-----------|-------------|----|--------|--------|---------|---|---------|---------|---------|
| VLAN   | Auto-VoIP | iSCSI     | STP         | Multicast | MVR        | Address Table | Ports | LAG   | MLAG    |           |           |             |    |        |        |         |   |         |         |         |
| <div>VLAN</div> <div>Reset</div> <div>Basic</div> <div>VLAN Configuration</div> <div>Advanced</div> <div>Internal VLAN Configuration</div> <div>Internal VLAN Allocation Base: 4093</div> <div>Internal VLAN Allocation Policy: Ascending Descending</div> <div>VLAN Configuration</div> <table border="1"> <thead> <tr> <th>VLAN ID</th> <th>VLAN Name</th> <th>VLAN Type</th> <th>Make Static</th> </tr> </thead> <tbody> <tr> <td>10</td> <td>VLAN10</td> <td>Static</td> <td>Disable</td> </tr> <tr> <td>1</td> <td>default</td> <td>Default</td> <td>Disable</td> </tr> </tbody> </table> |           |           |             |           |            |               |       |       | VLAN ID | VLAN Name | VLAN Type | Make Static | 10 | VLAN10 | Static | Disable | 1 | default | Default | Disable |
| VLAN ID  | VLAN Name | VLAN Type | Make Static |           |            |               |       |       |         |           |           |             |    |        |        |         |   |         |         |         |
| 10   | VLAN10    | Static    | Disable     |           |            |               |       |       |         |           |           |             |    |        |        |         |   |         |         |         |
| 1  | default   | Default   | Disable     |           |            |               |       |       |         |           |           |             |    |        |        |         |   |         |         |         |

#### b. In the **VLAN ID** field, enter **10**.

#### c. In the **VLAN Name** field, enter **VLAN10**.

#### d. In the **VLAN Type** list, select **Static**.

#### e. Click **Add**.

#### f. Select **Switching > VLAN > Advanced > VLAN Configuration**.

A screen similar to the following displays.

| System   | Switching | Routing   | QoS         | Security  | Monitoring | Maintenance   | Help  | Index |         |           |           |             |    |        |        |         |   |         |         |         |    |        |        |         |
|--|-----------|-----------|-------------|-----------|------------|---------------|-------|-------|---------|-----------|-----------|-------------|----|--------|--------|---------|---|---------|---------|---------|----|--------|--------|---------|
| VLAN   | Auto-VoIP | iSCSI     | STP         | Multicast | MVR        | Address Table | Ports | LAG   | MLAG    |           |           |             |    |        |        |         |   |         |         |         |    |        |        |         |
| <div>VLAN</div> <div>Reset</div> <div>Basic</div> <div>VLAN Configuration</div> <div>Advanced</div> <div>Internal VLAN Configuration</div> <div>Internal VLAN Allocation Base: 4093</div> <div>Internal VLAN Allocation Policy: Ascending Descending</div> <div>VLAN Configuration</div> <table border="1"> <thead> <tr> <th>VLAN ID</th> <th>VLAN Name</th> <th>VLAN Type</th> <th>Make Static</th> </tr> </thead> <tbody> <tr> <td>20</td> <td>VLAN20</td> <td>Static</td> <td>Disable</td> </tr> <tr> <td>1</td> <td>default</td> <td>Default</td> <td>Disable</td> </tr> <tr> <td>10</td> <td>VLAN10</td> <td>Static</td> <td>Disable</td> </tr> </tbody> </table> |           |           |             |           |            |               |       |       | VLAN ID | VLAN Name | VLAN Type | Make Static | 20 | VLAN20 | Static | Disable | 1 | default | Default | Disable | 10 | VLAN10 | Static | Disable |
| VLAN ID  | VLAN Name | VLAN Type | Make Static |           |            |               |       |       |         |           |           |             |    |        |        |         |   |         |         |         |    |        |        |         |
| 20   | VLAN20    | Static    | Disable     |           |            |               |       |       |         |           |           |             |    |        |        |         |   |         |         |         |    |        |        |         |
| 1  | default   | Default   | Disable     |           |            |               |       |       |         |           |           |             |    |        |        |         |   |         |         |         |    |        |        |         |
| 10   | VLAN10    | Static    | Disable     |           |            |               |       |       |         |           |           |             |    |        |        |         |   |         |         |         |    |        |        |         |

#### g. In the **VLAN ID** field, enter **20**.

#### h. In the **VLAN Name** field, enter **VLAN20**.

#### i. In the **VLAN Type** list, select **Static**.

#### j. Click **Add**.

2. Add ports to the VLAN10 and VLAN20.

a. Select **Switching > VLAN > Advanced > VLAN Membership**.

A screen similar to the following displays.

The screenshot shows the 'VLAN Membership' configuration page. The left sidebar has a tree view with 'VLAN' expanded, showing 'Basic', 'Advanced', 'VLAN Configuration', 'VLAN Membership' (selected), 'VLAN Status', 'Port PVID Configuration', 'MAC Based VLAN', and 'Protocol Based VLAN Group Configuration'. The main area has tabs for 'VLAN', 'Auto-VoIP', 'iSCSI', 'STP', 'Multicast', 'MVR', 'Address Table', 'Ports', 'LAG', and 'MLAG'. The 'VLAN' tab is active, showing 'VLAN ID' as 10, 'Group Operation' as 'Untag All', 'VLAN Name' as 'VLAN10', and 'VLAN Type' as 'Static'. Below this is a section for 'Unit 1' with a grid of 24 ports. Ports 1 and 2 are highlighted with a 'T' in a gray box, indicating they are tagged.

b. In the **VLAN ID** field, select **10**.

c. Click the **Unit 1**. The ports display.

d. Click the gray boxes under ports **1** and **2** until **T** displays.

The T specifies that the egress packet is tagged for the port.

e. Click **Apply**.

f. Select **Switching > VLAN > Advanced > VLAN Membership**.

A screen similar to the following displays.

The screenshot shows the 'VLAN Membership' configuration page for VLAN 20. The left sidebar is the same as in the previous screenshot. The main area shows 'VLAN ID' as 20, 'Group Operation' as 'Untag All', 'VLAN Name' as 'VLAN20', and 'VLAN Type' as 'Static'. Below this is a section for 'Unit 1' with a grid of 24 ports. Port 3 is highlighted with a 'T' in a gray box, indicating it is tagged.

g. In the **VLAN ID** list, select **20**.

h. Click **Unit 1**. The ports display.

i. Click the gray box under port **3** until **T** displays.

The T specifies that the egress packet is tagged for the port.

j. Click **Apply**.

### 3. Assign PVID to VLAN10 and VLAN20.

#### a. Select **Switching > VLAN > Advanced > Port PVID Configuration**.

A screen similar to the following displays.

| Interface | PVID | VLAN Member | VLAN Tag | Acceptable Frame Types | Configured Ingress Filtering | Current Ingress Filtering | Port Priority (0 to 7) |
|-----------|------|-------------|----------|------------------------|------------------------------|---------------------------|------------------------|
| 1/0/1     | 10   | 1           | 10       | Admit All              | Disable                      | Disable                   | 0                      |
| 1/0/2     | 10   | 1           | 10       | Admit All              | Disable                      | Disable                   | 0                      |
| 1/0/3     | 10   | 1           | 20       | Admit All              | Disable                      | Disable                   | 0                      |
| 1/0/4     | 10   | 1           | None     | Admit All              | Disable                      | Disable                   | 0                      |

#### b. Scroll down and select **1/0/1** and **1/0/2** check boxes.

#### c. In the **PVID (1 to 4093)** field, enter **10**.

#### d. Click **Apply** to save the settings.

#### e. Select **Switching > VLAN > Advanced > Port PVID Configuration**.

A screen similar to the following displays.

| Interface | PVID | VLAN Member | VLAN Tag | Acceptable Frame Types | Configured Ingress Filtering | Current Ingress Filtering | Port Priority (0 to 7) |
|-----------|------|-------------|----------|------------------------|------------------------------|---------------------------|------------------------|
| 1/0/1     | 20   | 1           | 20       | Admit All              | Disable                      | Disable                   | 0                      |
| 1/0/2     | 20   | 1           | 10       | Admit All              | Disable                      | Disable                   | 0                      |
| 1/0/3     | 10   | 1           | 20       | Admit All              | Disable                      | Disable                   | 0                      |
| 1/0/4     | 10   | 1           | None     | Admit All              | Disable                      | Disable                   | 0                      |

#### f. Scroll down and select the **1/0/3** check box.

#### g. In the **PVID (1 to 4093)** field, enter **20**.

#### h. Click **Apply** to save the settings.

# Set Up VLAN Routing for the VLANs and the Switch

The example is shown as CLI commands and as a local browser interface procedure.

## CLI: Set Up VLAN Routing for the VLANs and the Switch

1. The following code sequence shows how to enable routing for the VLANs:

```
(Netgear Switch) #vlan data
(Netgear Switch) (Vlan)#vlan routing 10
(Netgear Switch) (Vlan)#vlan routing 20
(Netgear Switch) (Vlan)#exit
```

This returns the logical interface IDs that will be used instead of the slot/port in subsequent routing commands. Assume that VLAN 10 is assigned the ID 3/1, and VLAN 20 is assigned the ID 3/2.

2. Enable routing for the switch.

```
(Netgear Switch) #config
(Netgear Switch) (Config)#ip routing
(Netgear Switch) (Config)#exit
```

3. The next sequence shows an example of configuring the IP addresses and subnet masks for the virtual router ports.

```
(Netgear Switch) (Config)#interface vlan 10
(Netgear Switch) (Interface-vlan 10)#ip address 192.150.3.1 255.255.255.0
(Netgear Switch) (Interface-vlan 10)#exit
(Netgear Switch) (Config)#interface vlan 20
(Netgear Switch) (Interface-vlan 20)#ip address 192.150.4.1 255.255.255.0
(Netgear Switch) (Interface-vlan 20)#exit
(Netgear Switch) (Config)#exit
```

# Local Browser Interface: Set Up VLAN Routing for the VLANs and the Switch

## 1. Select **Routing > VLAN > VLAN Routing**.

A screen similar to the following displays.

| VLAN ID | Port | MAC Address | IP Address  | Subnet Mask   |
|---------|------|-------------|-------------|---------------|
| 10      |      |             | 192.150.3.1 | 255.255.255.0 |

## 2. Enter the following information:

- In the **VLAN ID (1 to 4093)** list, select **10**.
- In the **IP Address** field, enter **192.150.3.1**.
- In the **Subnet Mask** field, enter **255.255.255.0**.

## 3. Click **Add** to save the settings.

## 4. Select **Routing > VLAN > VLAN Routing**.

A screen similar to the following displays.

| VLAN ID | Port  | MAC Address       | IP Address  | Subnet Mask   |
|---------|-------|-------------------|-------------|---------------|
| 20      |       |                   | 192.150.4.1 | 255.255.255.0 |
| 10      | 0/4/1 | 20:0C:C8:4D:95:99 | 192.150.3.1 | 255.255.255.0 |

## 5. Enter the following information:

- Select **10** in the **VLAN ID (1 to 4093)** field.
- In the **IP Address** field, enter **192.150.4.1**.
- In the **Subnet Mask** field, enter **255.255.255.0**.

## 6. Click **Add** to save the settings.

# 6

## RIP

---

### Routing Information Protocol

This chapter includes the following sections:

- [Routing Information Protocol Concepts](#)
- [Enable Routing for the Switch](#)
- [Enable Routing for Ports](#)
- [Enable RIP on the Switch](#)
- [Enable RIP for Ports 1/0/2 and 1/0/3](#)
- [Configure VLAN Routing with RIP Support](#)

# Routing Information Protocol Concepts

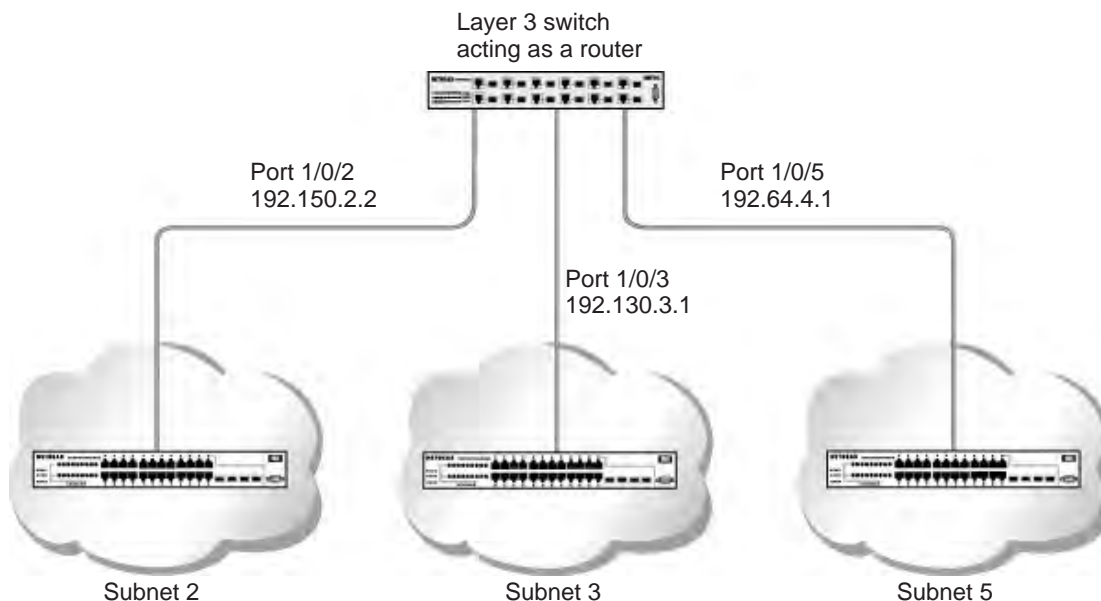
Routing Information Protocol (RIP) is a protocol that routers can use to exchange network topology information. It is characterized as an interior gateway protocol, and is typically used in small to medium-sized networks. A router running RIP sends the contents of its routing table to each of its adjacent routers every 30 seconds. When a route is removed from the routing table, it is flagged as unusable by the receiving routers after 180 seconds, and removed from their tables after an additional 120 seconds.

There are two versions of RIP (the switch supports both):

- RIPv1 defined in RFC 1058.
  - Routes are specified by IP destination network and hop count.
  - The routing table is broadcast to all stations on the attached network.
- RIPv2 defined in RFC 1723.
  - Route specification also includes subnet mask and gateway.
  - The routing table is sent to a multicast address, reducing network traffic.
  - Authentication is used for security.

You can configure a given port to do the following:

- Receive packets in either or both formats.
- Send packets formatted for RIPv1 or RIPv2, or send RIPv2 packets to the RIPv1 broadcast address.
- Prevent any RIP packets from being received.
- Prevent any RIP packets from being sent.



**Figure 13. Network with RIP on ports 1/0/2 and 1/0/3**



# Enable Routing for the Switch

The example is shown as CLI commands and as a local browser interface procedure.

## CLI: Enable Routing for the Switch

```
(Netgear Switch) #config
(Netgear Switch) (Config)#ip routing
(Netgear Switch) (Config)#exit
```

## Local Browser Interface: Enable Routing for the Switch

1. Select **Routing > IP > Basic > IP Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

IP

- Basic
- IP Configuration**
- Statistics
- Advanced

IP Configuration

Default Time to Live: 64

Routing Mode: ☒ Enable ☐ Disable

ICMP Echo Replies: ☒ Enable ☐ Disable

ICMP Redirects: ☐ Enable ☒ Disable

ICMP Rate Limit Interval: 1000 (0 to 2147483647 ms)

ICMP Rate Limit Burst Size: 100 (1 to 200)

Maximum Next Hops: 16

Maximum Routes: 12288

Select to configure Global Default Gateway: ☐

Global Default Gateway: 0.0.0.0

2. For Routing Mode, select the **Enable** radio button.
3. Click **Apply** to save the settings.

# Enable Routing for Ports

The example is shown as CLI commands and as a local browser interface procedure.

## CLI: Enable Routing and Assigning IP Addresses for Ports 1/0/2 and 1/0/3

```
(Netgear Switch) #config
(Netgear Switch) (Config)#interface 1/0/2
(Netgear Switch) (Interface 1/0/2)#routing
(Netgear Switch) (Interface 1/0/2)#ip address 192.150.2.1 255.255.255.0
(Netgear Switch) (Interface 1/0/2)#exit
(Netgear Switch) (Config)#interface 1/0/3
(Netgear Switch) (Interface 1/0/3)#routing
(Netgear Switch) (Interface 1/0/3)#ip address 192.150.3.1 255.255.255.0
(Netgear Switch) (Interface 1/0/3)#exit
(Netgear Switch) (Config)#exit
```

## Local Browser Interface: Enable Routing for the Ports

1. Assign IP address 192.150.2.1/24 to interface 1/0/2.
  - a. Select **Routing > Advanced > IP Interface Configuration**.

A screen similar to the following displays.

| System        | Switching |      |      | Routing |     | QoS  | Security | Monitoring       | Maintenance | Help      | Index          |
|---------------|-----------|------|------|---------|-----|------|----------|------------------|-------------|-----------|----------------|
| Routing Table | IP        | IPv6 | VLAN | ARP     | RIP | OSPF | OSPFv3   | Router Discovery | VRRP        | Multicast | IPv6 Multicast |

IP

IP Interface Configuration

• Basic

• Advanced

• IP Configuration

• Statistics

• IP Interface Configuration

• Secondary IP

1 2 VLANs All

| Port                                      | Description | VLAN ID | IP Address Configuration Method | IP Address  | Subnet Mask   | Routing Mode | Administrative Mode |
|---|-------------|---------|---------------------------------|-------------|---------------|--------------|---------------------|
| <input type="checkbox"/> 1/0/2            |             |         | Manual                          | 192.150.2.1 | 255.255.255.0 | Enable       | Enable              |
| <input type="checkbox"/> 1/0/1            |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |
| <input checked="" type="checkbox"/> 1/0/2 |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 1/0/3            |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 1/0/4            |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 1/0/5            |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |

- b. Scroll down and select the Interface **1/0/2** check box. Now 1/0/2 appears in the Interface field at the top.
  - c. Enter the following information:
    - In the **IP Address Configuration Method** field, select **Manual**.

- In the **IP Address** field, enter **192.150.2.1**.
  - In the **Subnet Mask** field, enter **255.255.255.0**.
  - In the **Routing Mode** field, select **Enable**.
- d. Click **Apply** to save the settings.
2. Assign IP address 192.150.3.1/24 to interface 1/0/3.
- a. Select **Routing > Advanced > IP Interface Configuration**.

A screen similar to the following displays.

System

Switching

Routing

QoS

Security

Monitoring

Maintenance

Help

Index

Routing Table

IP

IPv6

VLAN

ARP

RIP

OSPF

OSPFv3

Router Discovery

VRRP

Multicast

IPv6 Multicast

IP

IP Interface Configuration

• Basic

• Advanced

• IP Configuration

• Statistics

• IP Interface Configuration

• Secondary IP

1

2

All

| Port                                      | Description | VLAN ID | IP Address Configuration Method | IP Address  | Subnet Mask   | Routing Mode | Administrative Mode |
|---|-------------|---------|---------------------------------|-------------|---------------|--------------|---------------------|
| <input type="checkbox"/> 1/0/3            |             |         | Manual                          | 192.150.3.1 | 255.255.255.0 | Enable       | Enable              |
| <input type="checkbox"/> 1/0/1            |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 1/0/2            |             |         | Manual                          | 192.150.2.1 | 255.255.255.0 | Enable       | Enable              |
| <input checked="" type="checkbox"/> 1/0/3 |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 1/0/4            |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 1/0/5            |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |

- b. Scroll down and select the interface **1/0/3** check box.
- Now 1/0/3 appears in the Interface field at the top.
- c. Enter the following information:
- In the **IP Address Configuration Method** field, select **Manual**.
- In the **IP Address** field, enter **192.150.3.1**.
  - In the **Subnet Mask** field, enter **255.255.255.0**.
  - In the **Routing Mode** field, select **Enable**.
- d. Click **Apply** to save the settings.

# Enable RIP on the Switch

---

**Note:** Unless you have previously disabled RIP, you can skip this step since RIP is enabled by default.

---

## CLI: Enable RIP on the Switch

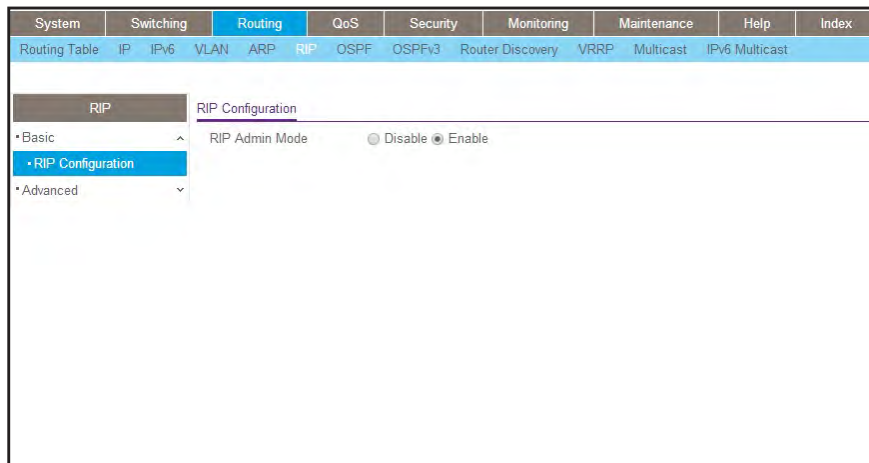
This sequence enables RIP for the switch. The route preference defaults to 15.

```
(Netgear Switch) #config
(Netgear Switch) (Config)#router rip
(Netgear Switch) (Config router)#enable
(Netgear Switch) (Config router)#exit
(Netgear Switch) (Config)#exit
```

## Local Browser Interface: Enable RIP on the Switch

1. Select **Routing > RIP > Basic > RIP Configuration**.

A screen similar to the following displays.



2. For RIP Admin Mode, select **Enable** radio button.
3. Click **Apply** to save the setting.

# Enable RIP for Ports 1/0/2 and 1/0/3

The example is shown as CLI commands and as a local browser interface procedure.

## CLI: Enable RIP for Ports 1/0/2 and 1/0/3

This command sequence enables RIP for ports 1/0/2 and 1/0/3. Authentication defaults to none, and no default route entry is created. The commands specify that both ports receive both RIPv1 and RIPv2 frames, but send only RIPv2-formatted frames.

```
(Netgear Switch) #config
(Netgear Switch) (Config)#interface 1/0/2
(Netgear Switch) (Interface 1/0/2)#ip rip
(Netgear Switch) (Interface 1/0/2)#ip rip receive version both
(Netgear Switch) (Interface 1/0/2)#ip rip send version rip2
(Netgear Switch) (Interface 1/0/2)#exit
(Netgear Switch) (Config)#interface 1/0/3
(Netgear Switch) (Interface 1/0/3)#ip rip
(Netgear Switch) (Interface 1/0/3)#ip rip receive version both
(Netgear Switch) (Interface 1/0/3)#ip rip send version rip2
(Netgear Switch) (Interface 1/0/3)#exit
(Netgear Switch) (Config)#exit
```

## Local Browser Interface: Enable RIP for Ports 1/0/2 and 1/0/3

1. Select **Routing > RIP > Advanced > RIP Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

RIP

• Basic

• Advanced

• RIP Configuration

• Interface Configuration

• Route Redistribution

RIP Interface Configuration

12All

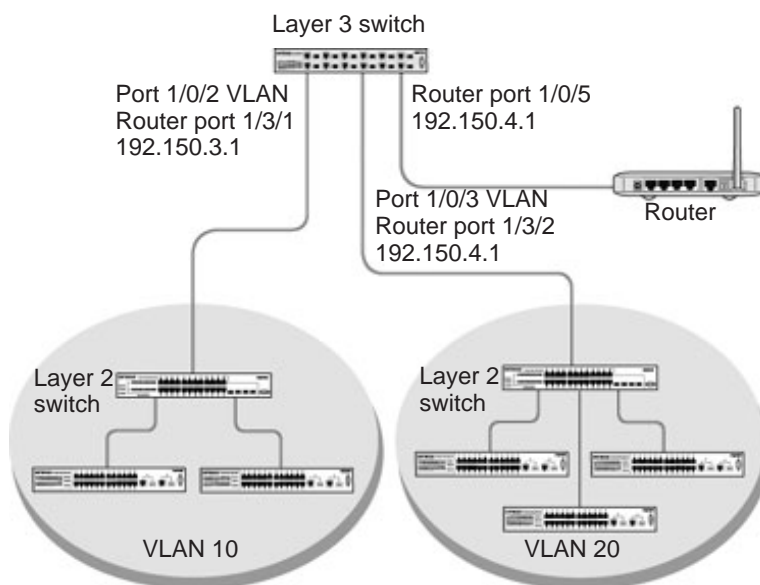
| <input type="checkbox"/>            | Interface | Send Version | Receive Version | RIP Mode          | Authentication Type | Authentication Key | Authentication Key ID |
|-------------------------------------|-----------|--------------|-----------------|-------------------|---------------------|--------------------|-----------------------|
| <input type="checkbox"/>            |           | <div></div>  | <div></div>     | <div>Enable</div> | <div></div>         |                    |                       |
| <input type="checkbox"/>            | 1/0/1     | RIP-2        | Both            | Disable           | None                |                    | 0                     |
| <input checked="" type="checkbox"/> | 1/0/2     | RIP-2        | Both            | Disable           | None                |                    | 0                     |
| <input checked="" type="checkbox"/> | 1/0/3     | RIP-2        | Both            | Disable           | None                |                    | 0                     |

2. Scroll down and select the **Interface 1/0/2 and 1/0/3** check box.

3. Enter the following information:
  - For RIP Admin Mode, select the **Enable** radio button.
  - In the **Send Version** field, select **RIP-2**.
4. Click **Apply** to save the settings.

## Configure VLAN Routing with RIP Support

Routing Information Protocol (RIP) is one of the protocols that routers can use to exchange network topology information. It is characterized as an interior gateway protocol, and is typically used in small to medium-sized networks.



**Figure 14. VLAN routing RIP configuration example**

This example adds support for RIPv2 to the configuration created in the base VLAN routing example. A second router, using port routing rather than VLAN routing, has been added to the network.

## CLI: Configure VLAN Routing with RIP Support

### 1. Configure VLAN routing with RIP support on the switch.

```
(Netgear Switch) #vlan data
(Netgear Switch) (Vlan)#vlan 10
(Netgear Switch) (Vlan)#vlan 20
(Netgear Switch) (Vlan)#vlan routing 10
(Netgear Switch) (Vlan)#vlan routing 20
(Netgear Switch) (Vlan)#exit
(Netgear Switch) #conf
```

```
(Netgear Switch) (Config)#ip routing
(Netgear Switch) (Config)#vlan port tagging all 10
(Netgear Switch) (Config)#vlan port tagging all 20
(Netgear Switch) (Config)#interface 1/0/2
(Netgear Switch) (Interface 1/0/2)#vlan participation include 10
(Netgear Switch) (Interface 1/0/2)#vlan pvid 10
(Netgear Switch) (Interface 1/0/2)#exit
(Netgear Switch) (Config)#interface 1/0/3
(Netgear Switch) (Interface 1/0/3)#vlan participation include 20
(Netgear Switch) (Interface 1/0/3)#vlan pvid 20
(Netgear Switch) (Interface 1/0/3)#exit
(Netgear Switch) #config
(Netgear Switch) (Config)#interface vlan 10
(Netgear Switch) (Interface vlan 10)#ip address 192.150.3.1 255.255.255.0
(Netgear Switch) (Interface vlan 10)#exit
(Netgear Switch) (Config)#interface vlan 20
(Netgear Switch) (Interface vlan 20)#ip address 192.150.4.1 255.255.255.0
(Netgear Switch) (Interface vlan 20)#exit
```

### 2. Enable RIP for the switch.

The route preference defaults to 15.

```
(Netgear Switch) (Config)#router rip
(Netgear Switch) (Config router)#enable
(Netgear Switch) (Config router)#exit
```

### 3. Configure the IP address and subnet mask for a nonvirtual router port.

```
(Netgear Switch) (Config)#interface 1/0/5
(Netgear Switch) (Interface 1/0/5)#ip address 192.150.5.1 255.255.255.0
(Netgear Switch) (Interface 1/0/5)#exit
```



#### 4. Enable RIP for the VLAN router ports.

Authentication defaults to none, and no default route entry is created.

```
(Netgear Switch) (Config)#interface vlan 10
(Netgear Switch) (Interface vlan 10)#ip rip
(Netgear Switch) (Interface vlan 10)#exit
(Netgear Switch) (Config)#interface vlan 20
(Netgear Switch) (Interface vlan 20)#ip rip
(Netgear Switch) (Interface vlan 20)#exit
(Netgear Switch) (Config)#exit
```

## Local Browser Interface: Configure VLAN Routing with RIP Support

### 1. Configure a VLAN and include ports 1/0/2 in the VLAN:

#### a. Select **Routing > VLAN > VLAN Routing Wizard**.

A screen similar to the following displays.

The screenshot shows the Netgear Local Browser Interface with the 'Routing' tab selected. Under 'Routing', 'VLAN' is selected, and the 'VLAN Routing Wizard' is active. The configuration fields are as follows:

- Vlan ID:** 10
- IP Address:** 192.150.3.1
- Network Mask:** 255.255.255.0
- Unit 1:** Selected
- Ports:** A grid of 48 ports (2 rows of 24) is shown. Port 2 in the first row is highlighted with a 'T' in a gray box, indicating it is tagged for egress.

#### b. Enter the following information:

- In the **VLAN ID** field, enter 10.
- In the **IP Address** field, enter **192.150.3.1**.
- In the **Network Mask** field, enter **255.255.255.0**.

#### c. Click **Unit 1**. The ports display:

#### d. Click the gray box under port **2** until **T** displays.

The T specifies that the egress packet is tagged for the port.

#### e. Click **Apply** to save the VLAN that includes ports 2.

### 2. Configure a VLAN, and include port 1/0/3 in the VLAN:

#### a. Select **Routing > VLAN > VLAN Routing Wizard**.

A screen similar to the following displays.

- b. Enter the following information:
  - In the **Vlan ID** field, enter **20**.
  - In the **IP Address** field, enter **192.150.4.1**.
  - In the **Network Mask** field, enter **255.255.255.0**.
- c. Click **Unit 1**. The ports display.
- d. Click the gray box under port **3** until **T** displays.  
The T specifies that the egress packet is tagged for the port.
- e. Click **Apply** to save the VLAN that includes port 3.
3. Enable RIP on the switch (you can skip this step since the RIP is enabled by default).
  - a. Select **Routing > RIP > Basic > RIP Configuration**.

A screen similar to the following displays.

- b. For RIP Admin Mode, select the **Enable** radio button.
- c. Click **Apply** to save the setting.
4. Enable RIP on VLANs 10 and 20.

- a. Select **Routing > RIP > Advanced > RIP Configuration**.

A screen similar to the following displays.

| Interface                                   | Send Version | Receive Version | RIP Mode | Authentication Type | Authentication Key | Authentication Key ID | Bad Packets Received | Bad Routes Received | Update |
|---|--------------|-----------------|----------|---------------------|--------------------|-----------------------|----------------------|---------------------|--------|
| <input checked="" type="checkbox"/> vlan 20 | RIP-2        | Both            | Enable   | None                |                    | 0                     |                      |                     |        |
| <input checked="" type="checkbox"/> vlan 10 | RIP-2        | Both            | Enable   | None                |                    | 0                     |                      |                     |        |

- b. Click the **VLANS** on the top of table.
- c. Scroll down and select the interface **vlan10** and **vlan 20** check boxes.
- d. Enter the following information:  
For RIP Mode, select the **Enable** radio button.
- e. Click **Apply** to save the settings.

# 7

## OSPF

---

### Open Shortest Path First

This chapter includes the following sections:

- [Open Shortest Path First Concepts](#)
- [Inter-area Router](#)
- [OSPF on a Border Router](#)
- [Stub Areas](#)
- [NSSA Areas](#)
- [VLAN Routing OSPF](#)
- [OSPFv3](#)

# Open Shortest Path First Concepts

For larger networks, Open Shortest Path First (OSPF) is generally used in preference to RIP. OSPF offers several benefits to the administrator of a large or complex network:

- Less network traffic:
  - Routing table updates are sent only when a change has occurred.
  - Only the part of the table which has changed is sent.
  - Updates are sent to a multicast, not a broadcast, address.
- Hierarchical management, allowing the network to be subdivided.

The top level of the hierarchy of an OSPF network is known as an autonomous system (AS) or routing domain, and is a collection of networks with a common administration and routing strategy. The AS is divided into areas: Intra-area routing is used when a source and destination address are in the same area, and inter-area routing across an OSPF backbone is used when they are not. An inter-area router communicates with border routers in each of the areas to which it provides connectivity.

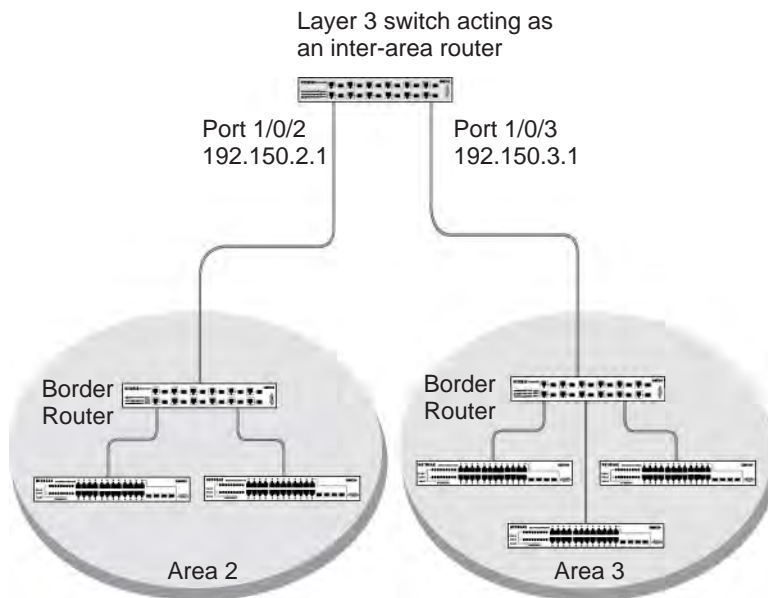
The switch operating as a router and running OSPF determines the best route using the assigned cost and the type of the OSPF route. The order for choosing a route if more than one type of route exists is as follows:

- Intra-area.
- Inter-area.
- External type 1: The route is external to the AS.
- External type 2: The route was learned from other protocols such as RIP.

## Inter-area Router

The examples in this section show you how to configure the switch first as an inter-area router and then as a border router. They show two areas, each with its own border router connected to one inter-area router.

The following figure shows a network segment with an inter-area router connecting areas 0.0.0.2 and 0.0.0.3. The sample script shows the commands used to configure the switch as the inter-area router in the diagram by enabling OSPF on port 1/0/2 in area 0.0.0.2 and port 1/0/3 in area 0.0.0.3.



**Figure 15. Network segment with an inter-area router connecting areas 0.0.0.2 and 0.0.0.3**

## CLI: Configure an Inter-area Router

1. Enable routing for the switch.

```
(Netgear Switch) #config
(Netgear Switch) (Config)#ip routing
(Netgear Switch) (Config)#exit
```

2. Assign IP addresses to ports.

```
(Netgear Switch) #config
(Netgear Switch) (Config)#interface 1/0/2
(Netgear Switch) (Interface 1/0/2)#routing
(Netgear Switch) (Interface 1/0/2)#ip address 192.150.2.1 255.255.255.0
(Netgear Switch) (Interface 1/0/2)#exit
(Netgear Switch) (Config)#interface 1/0/3
(Netgear Switch) (Interface 1/0/3)#routing
(Netgear Switch) (Interface 1/0/3)#ip address 192.150.3.1 255.255.255.0
(Netgear Switch) (Interface 1/0/3)#exit
(Netgear Switch) (Config)#exit
```

3. Specify the router ID, and enable OSPF for the switch. Set disable1583 compatibility to prevent a routing loop.

```
(Netgear Switch) #config
(Netgear Switch) (Config)#router ospf
(Netgear Switch) (Config router)#enable
(Netgear Switch) (Config router)#router-id 192.150.9.9
(Netgear Switch) (Config router)#no 1583compatibility
(Netgear Switch) (Config router)#exit
(Netgear Switch) (Config)#exit
```

4. Enable OSPF, and set the OSPF priority and cost for the ports.

```
(Netgear Switch) #config
(Netgear Switch) (Config)#interface 1/0/2
(Netgear Switch) (Interface 1/0/2)#ip ospf
(Netgear Switch) (Interface 1/0/2)#ip ospf areaid 0.0.0.2
(Netgear Switch) (Interface 1/0/2)#ip ospf priority 128
(Netgear Switch) (Interface 1/0/2)#ip ospf cost 32
(Netgear Switch) (Interface 1/0/2)#exit

(Netgear Switch) (Config)#interface 1/0/3
(Netgear Switch) (Interface 1/0/3)#ip ospf
(Netgear Switch) (Interface 1/0/3)#ip ospf areaid 0.0.0.3
(Netgear Switch) (Interface 1/0/3)#ip ospf priority 255
(Netgear Switch) (Interface 1/0/3)#ip ospf cost 64
(Netgear Switch) (Interface 1/0/3)#exit
(Netgear Switch) (Config)#exit
```



# Local Browser Interface: Configure an Inter-area Router

1. Enable IP routing on the switch.

- a. Select **Routing > IP > Basic > IP Configuration**.

A screen similar to the following displays.

| System  | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table   | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |
| <div> <div>IP</div> <div>IP Configuration</div> </div> <div> <div>• Basic</div> <div>• IP Configuration</div> <div>• Statistics</div> <div>• Advanced</div> </div> <div> <div>Default Time to Live</div> <div>64</div> </div> <div> <div>Routing Mode</div> <div> <input checked="" type="radio"/> Enable           <input type="radio"/> Disable         </div> </div> <div> <div>ICMP Echo Replies</div> <div> <input checked="" type="radio"/> Enable           <input type="radio"/> Disable         </div> </div> <div> <div>ICMP Redirects</div> <div> <input type="radio"/> Enable           <input checked="" type="radio"/> Disable         </div> </div> <div> <div>ICMP Rate Limit Interval</div> <div> <input type="text" value="1000"/> <small>(0 to 2147483647 ms)</small> </div> </div> <div> <div>ICMP Rate Limit Burst Size</div> <div> <input type="text" value="100"/> <small>(1 to 200)</small> </div> </div> <div> <div>Maximum Next Hops</div> <div> <input type="text" value="16"/> </div> </div> <div> <div>Maximum Routes</div> <div> <input type="text" value="12288"/> </div> </div> <div> <div>Select to configure Global Default Gateway</div> <div> <input type="checkbox"/> </div> </div> <div> <div>Global Default Gateway</div> <div> <input type="text" value="0.0.0.0"/> </div> </div> |           |         |      |          |            |             |        |                  |      |           |                |

- b. For Routing Mode, select the **Enable** radio button.

- c. Click **Apply** to save the settings.

2. Assign IP address 192.150.2.1 to port 1/0/2.

- a. Select **Routing > IP > Advanced > IP Interface Configuration**.

A screen similar to the following displays.

| System   | Switching   | Routing | QoS                             | Security    | Monitoring    | Maintenance  | Help                | Index            |      |           |                |      |             |         |                                 |            |             |              |                     |                                |  |  |        |             |               |        |        |   |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
|--|-------------|---------|---------------------------------|-------------|---------------|--------------|---------------------|------------------|------|-----------|----------------|------|-------------|---------|---------------------------------|------------|-------------|--------------|---------------------|--------------------------------|--|--|--------|-------------|---------------|--------|--------|---|--|--|------|---------|---------|---------|--------|--------------------------------|--|--|------|---------|---------|---------|--------|--------------------------------|--|--|------|---------|---------|---------|--------|--------------------------------|--|--|------|---------|---------|---------|--------|
| Routing Table  | IP          | IPv6    | VLAN                            | ARP         | RIP           | OSPF         | OSPFv3              | Router Discovery | VRRP | Multicast | IPv6 Multicast |      |             |         |                                 |            |             |              |                     |                                |  |  |        |             |               |        |        |   |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <div> <div>IP</div> <div>IP Interface Configuration</div> </div> <div> <div>• Basic</div> <div>• Advanced</div> <div>• IP Configuration</div> <div>• Statistics</div> <div>• IP Interface Configuration</div> <div>• Secondary IP</div> </div> <div> <div>1 2 All</div> <table border="1"> <thead> <tr> <th>Port</th> <th>Description</th> <th>VLAN ID</th> <th>IP Address Configuration Method</th> <th>IP Address</th> <th>Subnet Mask</th> <th>Routing Mode</th> <th>Administrative Mode</th> </tr> </thead> <tbody> <tr> <td><input type="checkbox"/> 1/0/1</td> <td></td> <td></td> <td>Manual</td> <td>192.150.2.1</td> <td>255.255.255.0</td> <td>Enable</td> <td>Enable</td> </tr> <tr> <td><input checked="" type="checkbox"/> 1/0/2</td> <td></td> <td></td> <td>None</td> <td>0.0.0.0</td> <td>0.0.0.0</td> <td>Disable</td> <td>Enable</td> </tr> <tr> <td><input type="checkbox"/> 1/0/3</td> <td></td> <td></td> <td>None</td> <td>0.0.0.0</td> <td>0.0.0.0</td> <td>Disable</td> <td>Enable</td> </tr> <tr> <td><input type="checkbox"/> 1/0/4</td> <td></td> <td></td> <td>None</td> <td>0.0.0.0</td> <td>0.0.0.0</td> <td>Disable</td> <td>Enable</td> </tr> <tr> <td><input type="checkbox"/> 1/0/5</td> <td></td> <td></td> <td>None</td> <td>0.0.0.0</td> <td>0.0.0.0</td> <td>Disable</td> <td>Enable</td> </tr> </tbody> </table> </div> |             |         |                                 |             |               |              |                     |                  |      |           |                | Port | Description | VLAN ID | IP Address Configuration Method | IP Address | Subnet Mask | Routing Mode | Administrative Mode | <input type="checkbox"/> 1/0/1 |  |  | Manual | 192.150.2.1 | 255.255.255.0 | Enable | Enable | <input checked="" type="checkbox"/> 1/0/2 |  |  | None | 0.0.0.0 | 0.0.0.0 | Disable | Enable | <input type="checkbox"/> 1/0/3 |  |  | None | 0.0.0.0 | 0.0.0.0 | Disable | Enable | <input type="checkbox"/> 1/0/4 |  |  | None | 0.0.0.0 | 0.0.0.0 | Disable | Enable | <input type="checkbox"/> 1/0/5 |  |  | None | 0.0.0.0 | 0.0.0.0 | Disable | Enable |
| Port   | Description | VLAN ID | IP Address Configuration Method | IP Address  | Subnet Mask   | Routing Mode | Administrative Mode |                  |      |           |                |      |             |         |                                 |            |             |              |                     |                                |  |  |        |             |               |        |        |   |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input type="checkbox"/> 1/0/1   |             |         | Manual                          | 192.150.2.1 | 255.255.255.0 | Enable       | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |                                |  |  |        |             |               |        |        |   |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input checked="" type="checkbox"/> 1/0/2  |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |                                |  |  |        |             |               |        |        |   |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input type="checkbox"/> 1/0/3   |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |                                |  |  |        |             |               |        |        |   |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input type="checkbox"/> 1/0/4   |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |                                |  |  |        |             |               |        |        |   |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input type="checkbox"/> 1/0/5   |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |                                |  |  |        |             |               |        |        |   |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |

- b. Scroll down and select the interface **1/0/2** check box.

Now 1/0/2 appears in the Interface field at the top.

- c. Enter the following information:
  - In the **IP Address** field, enter **192.150.2.1**.
  - In the **Subnet Mask** field, enter **255.255.255.0**.
  - In the **Administrative Mode** field, select **Enable**.
- d. Click **Apply** to save the settings.
3. Assign IP address 192.150.3.1 to port 1/0/3:
  - a. Select **Routing > IP > Advanced > IP Interface Configuration**.

A screen similar to the following displays.

System

Switching

Routing

QoS

Security

Monitoring

Maintenance

Help

Index

Routing Table

IP

IPv6

VLAN

ARP

RIP

OSPF

OSPFv3

Router Discovery

VRRP

Multicast

IPv6 Multicast

IP

IP Interface Configuration

• Basic

• Advanced

• IP Configuration

• Statistics

• IP Interface Configuration

• Secondary IP

1

2

All

| Port                                      | Description | VLAN ID | IP Address Configuration Method | IP Address  | Subnet Mask   | Routing Mode | Administrative Mode |
|---|-------------|---------|---------------------------------|-------------|---------------|--------------|---------------------|
| <input type="checkbox"/> 1/0/1            |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 1/0/2            |             |         | Manual                          | 192.150.2.1 | 255.255.255.0 | Enable       | Enable              |
| <input checked="" type="checkbox"/> 1/0/3 |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 1/0/4            |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 1/0/5            |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |

- b. Scroll down and select the interface **1/0/3** check box.  
Now 1/0/3 appears in the Interface field at the top.
- c. Enter the following information:
  - In the **IP Address** field, enter **192.150.3.1**.
  - In the **Network Mask** field, enter **255.255.255.0**.
  - In the **Administrative Mode** field, select **Enable**.
- d. Click **Apply** to save the settings.
4. Specify the router ID, and enable OSPF for the switch.
  - a. Select **Routing > OSPF > Advanced > OSPF Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

| OSPF                         | Default Route Advertise Configuration   |
|------------------------------|---|
| • Basic                      | Default Information Originate <input checked="" type="radio"/> Disable <input type="radio"/> Enable |
| • Advanced                   | Always <input type="radio"/> True <input checked="" type="radio"/> False                            |
| • OSPF Configuration         | Metric <input type="text" value="0"/> (0 to 16777214)   |
| • Common Area Configuration  | Metric Type <input type="radio"/> External Type 1 <input checked="" type="radio"/> External Type 2  |
| • Stub Area Configuration    |   |
| • NSSA Area Configuration    |   |
| • Area Range Configuration   |   |
| • Interface Configuration    | OSPF Configuration  |
| • Interface Statistics       | Router ID <input type="text" value="192.150.9.9"/>  |
| • Neighbor Table             | Admin Mode <input type="text" value="Enable"/>  |
| • Link State Database        | ASBR Mode <input type="text" value="Disable"/>  |
| • Virtual Link Configuration | RFC 1583 Compatibility <input type="text" value="Disable"/>   |
| • Route Redistribution       | ABR Status <input type="text" value=""/>  |
| • NSF OSPF Summary           | Opaque LSA Status <input type="text" value="Enable"/>   |
|                              | Exit Overflow Interval (secs) <input type="text" value="0"/> (0 to 2147483647)                      |
|                              | SPF Delay Time(secs) <input type="text" value="5"/> (0 to 65535)                                    |
|                              | SPF Hold Time(secs) <input type="text" value="10"/> (0 to 65535)                                    |

b. Under OSPF Configuration, enter the following information:

- In the **Router ID** field, enter **192.150.9.9**.
- In the **OSPF Admin Mode** field, select **Enable**.
- In the **RFC 1583 Compatibility** field, select **Disable**.

c. Click **Apply** to save the settings.

5. Enable OSPF on port 1/0/2.

a. Select **Routing > OSPF > Advanced > Interface Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

| OSPF                        | OSPF Interface Configuration |
|-----------------------------|------------------------------|
| • Basic                     | 1 2 All                      |
| • Advanced                  |                              |
| • OSPF Configuration        |                              |
| • Common Area Configuration |                              |
| • Stub Area Configuration   |                              |
| • NSSA Area Configuration   |                              |
| • Area Range Configuration  |                              |
| • Interface Configuration   |                              |
| • Interface Statistics      |                              |

| Interface | IP Address  | Subnet Mask   | Area ID | Admin Mode | Router Priority | Retransmit Interval | Hello Interval | Dead Interval | lfransit Delay Interval |
|-----------|-------------|---------------|---------|------------|-----------------|---------------------|----------------|---------------|-------------------------|
| 1/0/2     | 192.150.2.1 | 255.255.255.0 | 0.0.0.2 | Enable     | 128             | 5                   | 10             | 40            | 1                       |
| 1/0/1     | 0.0.0.0     | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                       |
| 1/0/2     | 192.150.2.1 | 255.255.255.0 | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                       |
| 1/0/3     | 192.150.3.1 | 255.255.255.0 | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                       |
| 1/0/4     | 0.0.0.0     | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                       |
| 1/0/5     | 0.0.0.0     | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                       |
| 1/0/6     | 0.0.0.0     | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                       |
| 1/0/7     | 0.0.0.0     | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                       |
| 1/0/8     | 0.0.0.0     | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                       |



# OSPF on a Border Router

The example is shown as CLI commands and as a local browser interface procedure. For an OSPF sample network, see [Figure 15 on page 109](#).

## CLI: Configure OSPF on a Border Router

1. Enable routing for the switch.

```
(Netgear Switch) #config
(Netgear Switch) (Config)#ip routing
```

2. Enable routing and assign IPs for ports 1/0/2, 1/0/3, and 1/0/4.

```
(Netgear Switch) (Config)#interface 1/0/2
(Netgear Switch) (Interface 1/0/2)#routing
(Netgear Switch) (Interface 1/0/2)#ip address 192.150.2.2 255.255.255.0
(Netgear Switch) (Interface 1/0/2)#exit
(Netgear Switch) (Config)#interface 1/0/3
(Netgear Switch) (Interface 1/0/3)#routing
(Netgear Switch) (Interface 1/0/3)#ip address 192.130.3.1 255.255.255.0
(Netgear Switch) (Interface 1/0/3)#exit
(Netgear Switch) (Config)#interface 1/0/4
(Netgear Switch) (Interface 1/0/4)#routing
(Netgear Switch) (Interface 1/0/4)#ip address 192.64.4.1 255.255.255.0
(Netgear Switch) (Interface 1/0/4)#exit
```

3. Specify the router ID, and enable OSPF for the switch.

Set disable 1583compatibility to prevent a routing loop.

```
(Netgear Switch) (Config)#router ospf
(Netgear Switch) (Config router)#enable
(Netgear Switch) (Config router)#router-id 192.130.1.1
(Netgear Switch) (Config router)#no 1583compatibility
(Netgear Switch) (Config router)#exit
(Netgear Switch) (Config)#exit
```

#### 4. Enable OSPF for the ports, and set the OSPF priority and cost for the ports.

```
(Netgear Switch) #config
(Netgear Switch) (Config)#interface 1/0/2
(Netgear Switch) (Interface 1/0/2)#ip ospf
(Netgear Switch) (Interface 1/0/2)#ip ospf areaid 0.0.0.2
(Netgear Switch) (Interface 1/0/2)#ip ospf priority 128
(Netgear Switch) (Interface 1/0/2)#ip ospf cost 32
(Netgear Switch) (Interface 1/0/2)#exit

(Netgear Switch) (Config)#interface 1/0/3
(Netgear Switch) (Interface 1/0/3)#ip ospf
(Netgear Switch) (Interface 1/0/3)#ip ospf areaid 0.0.0.2
(Netgear Switch) (Interface 1/0/3)#ip ospf priority 255
(Netgear Switch) (Interface 1/0/3)#ip ospf cost 64
(Netgear Switch) (Interface 1/0/3)#exit

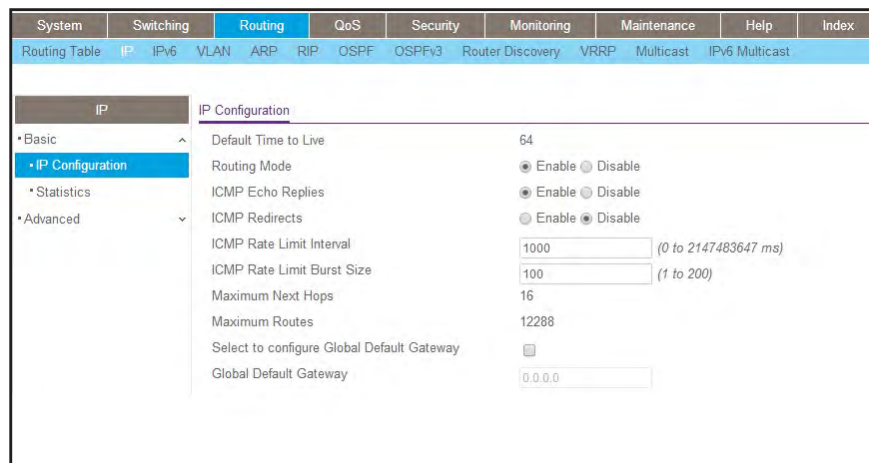
(Netgear Switch) (Config)#interface 1/0/4
(Netgear Switch) (Interface 1/0/4)#ip ospf
(Netgear Switch) (Interface 1/0/4)#ip ospf areaid 0.0.0.2
(Netgear Switch) (Interface 1/0/4)#ip ospf priority 255
(Netgear Switch) (Interface 1/0/4)#ip ospf cost 64
(Netgear Switch) (Interface 1/0/4)#exit
(Netgear Switch) (Config)#exit
```

## Local Browser Interface: Configure OSPF on a Border Router

### 1. Enable IP routing on the switch.

#### a. Select **Routing > IP > Basic > IP Configuration**.

A screen similar to the following displays.





- b. For Routing Mode, select the **Enable** radio button.
  - c. Click **Apply** to save the settings.
2. Assign IP address 192.150.2.2 to port 1/0/2.
  - a. Select **Routing > IP > Advanced > IP Interface Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

| IP                           |         | IP Interface Configuration |  |  |  |  |  |  |  |  |
|------------------------------|---------|----------------------------|--|--|--|--|--|--|--|--|
| • Basic                      | 1 2 All |                            |  |  |  |  |  |  |  |  |
| • Advanced                   |         |                            |  |  |  |  |  |  |  |  |
| • IP Configuration           |         |                            |  |  |  |  |  |  |  |  |
| • Statistics                 |         |                            |  |  |  |  |  |  |  |  |
| • IP Interface Configuration |         |                            |  |  |  |  |  |  |  |  |
| • Secondary IP               |         |                            |  |  |  |  |  |  |  |  |

| Port                                      | Description | VLAN ID | IP Address Configuration Method | IP Address  | Subnet Mask   | Routing Mode | Administrative Mode |
|---|-------------|---------|---------------------------------|-------------|---------------|--------------|---------------------|
| <input type="checkbox"/> 1/0/1            |             |         | Manual                          | 192.150.2.2 | 255.255.255.0 | Enable       | Enable              |
| <input checked="" type="checkbox"/> 1/0/2 |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 1/0/3            |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 1/0/4            |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 1/0/5            |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |

- b. Scroll down and select the interface **1/0/2** check box.

Now 1/0/2 appears in the Interface field at the top.
  - c. Enter the following information:
    - In the **IP Address Configuration Method** field, select **Manual**.
    - In the **IP Address** field, enter **192.150.2.2**.
    - In the **Network Mask** field, enter **255.255.255.0**.
    - In the **Admin Mode** field, select **Enable**.
  - d. Click **Apply** to save the settings.
3. Assign IP address 192.130.3.1 to port 1/0/3:
    - a. Select **Routing > IP > Advanced > IP Interface Configuration**.



A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

| IP                           |         | IP Interface Configuration |  |  |  |  |  |  |  |
|------------------------------|---------|----------------------------|--|--|--|--|--|--|--|
| • Basic                      | 1 2 All |                            |  |  |  |  |  |  |  |
| • Advanced                   |         |                            |  |  |  |  |  |  |  |
| • IP Configuration           |         |                            |  |  |  |  |  |  |  |
| • Statistics                 |         |                            |  |  |  |  |  |  |  |
| • IP Interface Configuration |         |                            |  |  |  |  |  |  |  |
| • Secondary IP               |         |                            |  |  |  |  |  |  |  |

| Port                                      | Description | VLAN ID | IP Address Configuration Method | IP Address  | Subnet Mask   | Routing Mode | Administrative Mode |
|---|-------------|---------|---------------------------------|-------------|---------------|--------------|---------------------|
| <input checked="" type="checkbox"/> 1/0/3 |             |         | Manual                          | 192.130.3.1 | 255.255.255.0 | Enable       | Enable              |
| <input type="checkbox"/> 1/0/1            |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 1/0/2            |             |         | Manual                          | 192.150.2.2 | 255.255.255.0 | Enable       | Enable              |
| <input type="checkbox"/> 1/0/3            |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 1/0/4            |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 1/0/5            |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |

- b. Scroll down and select the interface **1/0/3** check box.

Now 1/0/3 appears in the Interface field at the top.

- c. Enter the following information:

- In the **IP Address Configuration Method** field, select **Manual**.
- In the **IP Address** field, enter **192.130.3.1**.
- In the **Network Mask** field, enter **255.255.255.0**.
- In the **Admin Mode** field, select **Enable**.

- d. Click **Apply** to save the settings.

4. Assign IP address 192.64.4.1 to port 1/0/4.

- a. Select **Routing > IP > Advanced > IP Interface Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

| IP                           |         | IP Interface Configuration |  |  |  |  |  |  |  |
|------------------------------|---------|----------------------------|--|--|--|--|--|--|--|
| • Basic                      | 1 2 All |                            |  |  |  |  |  |  |  |
| • Advanced                   |         |                            |  |  |  |  |  |  |  |
| • IP Configuration           |         |                            |  |  |  |  |  |  |  |
| • Statistics                 |         |                            |  |  |  |  |  |  |  |
| • IP Interface Configuration |         |                            |  |  |  |  |  |  |  |
| • Secondary IP               |         |                            |  |  |  |  |  |  |  |

| Port                                      | Description | VLAN ID | IP Address Configuration Method | IP Address  | Subnet Mask   | Routing Mode | Administrative Mode |
|---|-------------|---------|---------------------------------|-------------|---------------|--------------|---------------------|
| <input type="checkbox"/> 1/0/4            |             |         | Manual                          | 192.64.4.1  | 255.255.255.0 | Enable       | Enable              |
| <input type="checkbox"/> 1/0/1            |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 1/0/2            |             |         | Manual                          | 192.150.2.2 | 255.255.255.0 | Enable       | Enable              |
| <input type="checkbox"/> 1/0/3            |             |         | Manual                          | 192.130.3.1 | 255.255.255.0 | Enable       | Enable              |
| <input checked="" type="checkbox"/> 1/0/4 |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 1/0/5            |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |

- b. Scroll down and select the interface **1/0/4** check box. Now 1/0/4 appears in the Interface field at the top.

- c. Enter the following information:
  - In the **IP Address Configuration Method** field, select **Manual**.
  - In the **IP Address** field, enter **192.64.4.1**.
  - In the **Network Mask** field, enter **255.255.255.0**.
  - In the **Admin Mode** field, select **Enable**.
- d. Click **Apply** to save the settings.
5. Specify the router ID, and enable OSPF for the switch.
  - a. Select **Routing > OSPF > Advanced > OSPF Configuration**.

A screen similar to the following displays.

| System   | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|--|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table  | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |
| <div> <div> <div>OSPF</div> <ul style="list-style-type: none"> <li>• Basic</li> <li>• Advanced               <ul style="list-style-type: none"> <li>• <b>OSPF Configuration</b></li> <li>• Common Area Configuration</li> <li>• Stub Area Configuration</li> <li>• NSSA Area Configuration</li> <li>• Area Range Configuration</li> <li>• Interface Configuration</li> <li>• Interface Statistics</li> <li>• Neighbor Table</li> <li>• Link State Database</li> <li>• Virtual Link Configuration</li> </ul> </li> </ul> </div> <div> <div>Default Route Advertise Configuration</div> <div> <div>Default Information Originate</div> <div> <input checked="" type="radio"/> Disable               <input type="radio"/> Enable             </div> </div> <div> <div>Always</div> <div> <input type="radio"/> True               <input checked="" type="radio"/> False             </div> </div> <div> <div>Metric</div> <div> <input type="text" value="0"/> (0 to 16777214)             </div> </div> <div> <div>Metric Type</div> <div> <input type="radio"/> External Type 1               <input checked="" type="radio"/> External Type 2             </div> </div> </div> <div> <div>OSPF Configuration</div> <div> <div>Router ID</div> <div><input type="text" value="192.130.1.1"/></div> </div> <div> <div>Admin Mode</div> <div> <input type="text" value="Enable"/> </div> </div> <div> <div>ASBR Mode</div> <div><input type="text" value="Disable"/></div> </div> <div> <div>RFC 1583 Compatibility</div> <div> <input type="text" value="Disable"/> </div> </div> <div> <div>ABR Status</div> <div><input type="text" value=""/></div> </div> <div> <div>Opaque LSA Status</div> <div> <input type="text" value="Enable"/> </div> </div> <div> <div>Exit Overflow Interval (secs)</div> <div> <input type="text" value="0"/> (0 to 2147483647)             </div> </div> </div> </div> |           |         |      |          |            |             |        |                  |      |           |                |

- b. Under OSPF Configuration, enter the following information:
  - In the **Router ID** field, enter **192.130.1.1**.
  - In the **OSPF Admin Mode** field, select **Enable**.
  - In the **RFC 1583 Compatibility** field, select **Disable**.
- c. Click **Apply** to save the settings.
6. Enable OSPF on the port 1/0/2.
  - a. Select **Routing > OSPF > Advanced > Interface Configuration**.

A screen similar to the following displays.

The screenshot shows the 'OSPF Interface Configuration' screen. On the left, a sidebar lists configuration categories: Advanced, OSPF Configuration, Common Area Configuration, Stub Area Configuration, NSSA Area Configuration, Area Range Configuration, Interface Configuration (selected), and Interface Statistics. The main area displays a table of interfaces with columns: Interface, IP Address, Subnet Mask, Area ID, Admin Mode, Router Priority, Retransmit Interval, Hello Interval, Dead Interval, and ltransit Delay Interval. The table lists interfaces 1/0/1 through 1/0/6. Interface 1/0/2 is highlighted, and its configuration is shown at the top of the table: IP Address 192.150.2.2, Subnet Mask 255.255.255.0, Area ID 0.0.0.2, Admin Mode Enable, Router Priority 128, Retransmit Interval 5, Hello Interval 10, Dead Interval 40, and ltransit Delay Interval 1.

| Interface | IP Address  | Subnet Mask   | Area ID | Admin Mode | Router Priority | Retransmit Interval | Hello Interval | Dead Interval | ltransit Delay Interval |
|-----------|-------------|---------------|---------|------------|-----------------|---------------------|----------------|---------------|-------------------------|
| 1/0/1     | 0.0.0.0     | 0.0.0.0       | 0       | Disable    | 128             | 5                   | 10             | 40            | 1                       |
| 1/0/2     | 192.150.2.2 | 255.255.255.0 | 0.0.0.2 | Enable     | 128             | 5                   | 10             | 40            | 1                       |
| 1/0/3     | 192.130.3.1 | 255.255.255.0 | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                       |
| 1/0/4     | 192.64.4.1  | 255.255.255.0 | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                       |
| 1/0/5     | 0.0.0.0     | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                       |
| 1/0/6     | 0.0.0.0     | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                       |

b. Under Interface Configuration, scroll down and select the interface **1/0/2** check box.

Now 1/0/2 appears in the Interface field at the top.

- In the **OSPF Area ID** field, enter **0.0.0.2**.
- In the **OSPF Admin Mode** field, select **Enable**.
- In the **Router Priority (0 to 255)** field, enter **128**.
- In the **Metric Cost** field, enter **32**.

c. Click **Apply** to save the settings.

7. Enable OSPF on port 1/0/3.

a. Select **Routing > OSPF > Advanced > Interface Configuration**.

A screen similar to the following displays.

The screenshot shows the 'OSPF Interface Configuration' screen, similar to the previous one, but with interface 1/0/3 selected. The table lists interfaces 1/0/1 through 1/0/6. Interface 1/0/3 is highlighted, and its configuration is shown at the top of the table: IP Address 192.130.3.1, Subnet Mask 255.255.255.0, Area ID 0.0.0.3, Admin Mode Enable, Router Priority 255, Retransmit Interval 5, Hello Interval 10, Dead Interval 40, and ltransit Delay Interval 1.

| Interface | IP Address  | Subnet Mask   | Area ID | Admin Mode | Router Priority | Retransmit Interval | Hello Interval | Dead Interval | ltransit Delay Interval |
|-----------|-------------|---------------|---------|------------|-----------------|---------------------|----------------|---------------|-------------------------|
| 1/0/1     | 0.0.0.0     | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                       |
| 1/0/2     | 192.150.2.2 | 255.255.255.0 | 0.0.0.2 | Enable     | 128             | 5                   | 10             | 40            | 1                       |
| 1/0/3     | 192.130.3.1 | 255.255.255.0 | 0.0.0.3 | Enable     | 255             | 5                   | 10             | 40            | 1                       |
| 1/0/4     | 192.64.4.1  | 255.255.255.0 | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                       |
| 1/0/5     | 0.0.0.0     | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                       |
| 1/0/6     | 0.0.0.0     | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                       |

b. Under Interface Configuration, scroll down and select the interface **1/0/3** check box.

Now 1/0/3 appears in the Interface field at the top.

- In the **OSPF Area ID** field, enter **0.0.0.3**.
- In the **OSPF Admin Mode** field, select **Enable**.

- In the **Priority** field, enter **255**.
  - In the **Metric Cost** field, enter **64**.
- c. Click **Apply** to save the settings.
8. Enable OSPF on port 1/0/4.
- a. Select **Routing > OSPF > Advanced > Interface Configuration**.

A screen similar to the following displays.

System

Switching

Routing

QoS

Security

Monitoring

Maintenance

Help

Index

Routing Table

IP

IPv6

VLAN

ARP

RIP

OSPF

OSPFv3

Router Discovery

VRRP

Multicast

IPv6 Multicast

\* Advanced

• OSPF Configuration

• Common Area Configuration

• Stub Area Configuration

• NSSA Area Configuration

• Area Range Configuration

• Interface Configuration

• Interface Statistics

OSPF Interface Configuration

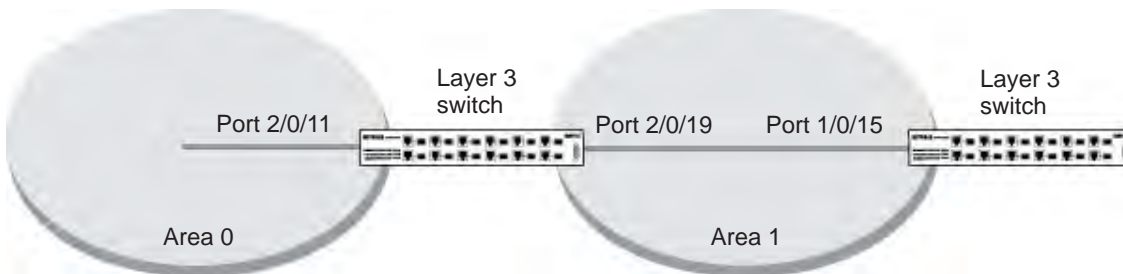
1 2 All

| <input type="checkbox"/>            | Interface | IP Address  | Subnet Mask   | Area ID | Admin Mode | Router Priority | Retransmit Interval | Hello Interval | Dead Interval | lfrtransit Delay Interval |
|-------------------------------------|-----------|-------------|---------------|---------|------------|-----------------|---------------------|----------------|---------------|---------------------------|
| <input type="checkbox"/>            | 1/0/4     | 192.64.4.1  | 255.255.255.0 | 0.0.0.2 | Enable     | 255             | 5                   | 10             | 40            | 1                         |
| <input type="checkbox"/>            | 1/0/1     | 0.0.0.0     | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                         |
| <input type="checkbox"/>            | 1/0/2     | 192.150.2.2 | 255.255.255.0 | 0.0.0.2 | Enable     | 128             | 5                   | 10             | 40            | 1                         |
| <input type="checkbox"/>            | 1/0/3     | 192.130.3.1 | 255.255.255.0 | 0.0.0.3 | Enable     | 255             | 5                   | 10             | 40            | 1                         |
| <input checked="" type="checkbox"/> | 1/0/4     | 192.64.4.1  | 255.255.255.0 | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                         |
| <input type="checkbox"/>            | 1/0/5     | 0.0.0.0     | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                         |
| <input type="checkbox"/>            | 1/0/6     | 0.0.0.0     | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                         |

- b. Under Interface Configuration, scroll down and select the interface **1/0/4** check box.
- Now 1/0/4 appears in the Interface field at the top.
- In the **OSPF Area ID** field, enter **0.0.0.2**.
  - In the **OSPF Admin Mode** field, select the **Enable**.
  - In the **Priority** field, enter **255**.
  - In the **Metric Cost** field, enter **64**.
- c. Click **Apply** to save the settings.

## Stub Areas

The example is shown as CLI commands and as a local browser interface procedure.



**Figure 16. Area 1 is a stub area**

## CLI: Configure Area 1 as a Stub Area on A1

1. Enable routing on the switch.

```
(Netgear Switch) #config  
(Netgear Switch) (Config)#ip routing
```

2. Set the router ID to 1.1.1.1.

```
(Netgear Switch) (Config)#router ospf  
(Netgear Switch) (Config-router)#router-id 1.1.1.1
```

3. Configure area 0.0.0.1 as a stub area.

```
(Netgear Switch) (Config-router)#area 0.0.0.1 stub
```

4. Switch A injects a default route only to area 0.0.0.1.

```
(Netgear Switch) (Config-router)#no area 0.0.0.1 stub summarylsa  
(Netgear Switch) (Config-router)#exit
```

5. Enable OSPF area 0 on ports 2/0/11.

```
(Netgear Switch) (Config)#interface 2/0/11  
(Netgear Switch) (Interface 2/0/11)#routing  
(Netgear Switch) (Interface 2/0/11)#ip address 192.168.10.1 255.255.255.0  
(Netgear Switch) (Interface 2/0/11)#ip ospf  
(Netgear Switch) (Interface 2/0/11)#exit
```

6. Enable OSPF area 0.0.0.1 on 2/0/19.

```
(Netgear Switch) (Config)#interface 2/0/19  
(Netgear Switch) (Interface 2/0/19)#routing  
(Netgear Switch) (Interface 2/0/19)#ip address 192.168.20.1 255.255.255.0  
(Netgear Switch) (Interface 2/0/19)#ip ospf  
(Netgear Switch) (Interface 2/0/19)#ip ospf areaid 0.0.0.1  
(Netgear Switch) (Interface 2/0/19)#exit
```

```
(Netgear Switch) (Config)#ex
(Netgear Switch) #show ip ospf neighbor interface all
```

| Router ID | IP Address   | Neighbor Interface | State |
|-----------|--------------|--------------------|-------|
| 4.4.4.4   | 192.168.10.2 | 2/0/11             | Full  |
| 2.2.2.2   | 192.168.20.2 | 2/0/19             | Full  |

```
(Netgear Switch) #show ip route
```

Total Number of Routes..... 4

| Network Address | Subnet Mask   | Protocol   | Next Hop Intf | Next Hop IP Address |
|-----------------|---------------|------------|---------------|---------------------|
| 14.1.1.0        | 255.255.255.0 | OSPF Inter | 2/0/11        | 192.168.10.2        |
| 14.1.2.0        | 255.255.255.0 | OSPF Inter | 2/0/11        | 192.168.10.2        |
| 192.168.10.0    | 255.255.255.0 | Local      | 2/0/11        | 192.168.10.1        |
| 192.168.20.0    | 255.255.255.0 | Local      | 2/0/19        | 192.168.20.1        |

## Local Browser Interface: Configure Area 1 as a Stub Area on A1

1. Enable IP routing on the switch.
  - a. Select **Routing > IP > Basic > IP Configuration**.

A screen similar to the following displays.

The screenshot shows the Netgear web interface with the 'Routing' tab selected. Under 'Routing', the 'IP' sub-tab is active, and the 'IP Configuration' page is displayed. The sidebar on the left shows 'Basic', 'IP Configuration', 'Statistics', and 'Advanced' options. The main content area shows the following settings:

- Default Time to Live: 64
- Routing Mode: ☒ Enable ☐ Disable
- ICMP Echo Replies: ☒ Enable ☐ Disable
- ICMP Redirects: ☐ Enable ☒ Disable
- ICMP Rate Limit Interval: 1000 (0 to 2147483647 ms)
- ICMP Rate Limit Burst Size: 100 (1 to 200)
- Maximum Next Hops: 16
- Maximum Routes: 12288
- Select to configure Global Default Gateway: ☐
- Global Default Gateway: 0.0.0.0

- b. For Routing Mode, select the **Enable** radio button.
  - c. Click **Apply** to save the settings.
2. Assign IP address 192.168.10.1 to port 2/0/11.
  - a. Select **Routing > IP > Advanced > IP Interface Configuration**.



A screen similar to the following displays.

| System        | Switching | Routing | QoS  |     | Security | Monitoring | Maintenance | Help             | Index |           |                |
|---------------|-----------|---------|------|-----|----------|------------|-------------|------------------|-------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP | RIP      | OSPF       | OSPFv3      | Router Discovery | VRRP  | Multicast | IPv6 Multicast |

IP

IP Interface Configuration

• Basic

• Advanced

• IP Configuration

• Statistics

• IP Interface Configuration

• Secondary IP

1 2 All

| <input type="checkbox"/>            | Port   | Description          | VLAN ID | IP Address Configuration Method | IP Address   | Subnet Mask   | Routing Mode | Administrative Mode |
|-------------------------------------|--------|----------------------|---------|---------------------------------|--------------|---------------|--------------|---------------------|
| <input type="checkbox"/>            | 2/0/11 | <input type="text"/> |         | Manual                          | 192.168.10.1 | 255.255.255.0 | Enable       | Enable              |
| <input type="checkbox"/>            | 2/0/1  |                      |         | None                            | 0.0.0.0      | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/>            | 2/0/2  |                      |         | None                            | 0.0.0.0      | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/>            | 2/0/3  |                      |         | None                            | 0.0.0.0      | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/>            | 2/0/4  |                      |         | None                            | 0.0.0.0      | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/>            | 2/0/5  |                      |         | None                            | 0.0.0.0      | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/>            | 2/0/6  |                      |         | None                            | 0.0.0.0      | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/>            | 2/0/7  |                      |         | None                            | 0.0.0.0      | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/>            | 2/0/8  |                      |         | None                            | 0.0.0.0      | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/>            | 2/0/9  |                      |         | None                            | 0.0.0.0      | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/>            | 2/0/10 |                      |         | None                            | 0.0.0.0      | 0.0.0.0       | Disable      | Enable              |
| <input checked="" type="checkbox"/> | 2/0/11 |                      |         | None                            | 0.0.0.0      | 0.0.0.0       | Disable      | Enable              |

- b. Scroll down and select the interface **2/0/11** check box.

Now 2/0/11 appears in the Interface field at the top.

- c. Enter the following information:

- In the **IP Address Configuration Method** field, select **Manual**.
- In the **IP Address** field, enter **192.168.10.1**.
- In the **Network Mask** field, enter **255.255.255.0**.
- In the **Admin Mode** field, select **Enable**.

- d. Click **Apply** to save the settings.

3. Assign IP address 192.168.20.1 to port 2/0/19:

- a. Select **Routing > IP > Advanced > IP Interface Configuration**.

A screen similar to the following displays.

System

Switching

Routing

QoS

Security

Monitoring

Maintenance

Help

Index

Routing Table

IP

IPv6

VLAN

ARP

RIP

OSPF

OSPFv3

Router Discovery

VRRP

Multicast

IPv6 Multicast

IP

IP Interface Configuration

Basic

Advanced

IP Configuration

Statistics

IP Interface Configuration

Secondary IP

1

2

All

|                                     | Port   | Description | VLAN ID | IP Address Configuration Method | IP Address   | Subnet Mask   | Routing Mode | Administrative Mode |
|-------------------------------------|--------|-------------|---------|---------------------------------|--------------|---------------|--------------|---------------------|
| <input checked="" type="checkbox"/> | 2/0/19 |             |         | Manual                          | 192.168.20.1 | 255.255.255.0 | Enable       | Enable              |
| <input type="checkbox"/>            | 2/0/1  |             |         | None                            | 0.0.0.0      | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/>            | 2/0/2  |             |         | None                            | 0.0.0.0      | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/>            | 2/0/3  |             |         | None                            | 0.0.0.0      | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/>            | 2/0/4  |             |         | None                            | 0.0.0.0      | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/>            | 2/0/5  |             |         | None                            | 0.0.0.0      | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/>            | 2/0/6  |             |         | None                            | 0.0.0.0      | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/>            | 2/0/7  |             |         | None                            | 0.0.0.0      | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/>            | 2/0/8  |             |         | None                            | 0.0.0.0      | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/>            | 2/0/9  |             |         | None                            | 0.0.0.0      | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/>            | 2/0/10 |             |         | None                            | 0.0.0.0      | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/>            | 2/0/11 |             |         | Manual                          | 192.168.10.1 | 255.255.255.0 | Enable       | Enable              |

- b. Scroll down and select the interface **2/0/19** check box.

Now 2/0/19 appears in the Interface field at the top.



- c. Enter the following information:
  - In the **IP Address Configuration Method** field, select **Manual**.
  - In the **IP Address** field, enter **192.168.20.1**.
  - In the **Network Mask** field, enter **255.255.255.0**.
  - In the **Admin Mode** field, select **Enable**.
- d. Click **Apply** to save the settings.
4. Specify the router ID, and enable OSPF for the switch.
  - a. Select **Routing > OSPF > Basic > OSPF Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

OSPF

OSPF Configuration

Basic

OSPF Configuration

Advanced

Admin Mode

Router ID

Disable

Enable

1.1.1.1

- b. Under OSPF Configuration, in the **Router ID** field, enter **1.1.1.1**.
- c. Click **Apply** to save the settings.
5. Enable OSPF on the port 2/0/11.
  - a. Select **Routing > OSPF > Advanced > Interface Configuration**.

A screen similar to the following displays.

System

Switching

Routing

QoS

Security

Monitoring

Maintenance

Help

Index

Routing Table

IP

IPv6

VLAN

ARP

RIP

OSPF

OSPFv3

Router Discovery

VRRP

Multicast

IPv6 Multicast

OSPF

OSPF Interface Configuration

1

2

All

Basic

Advanced

OSPF Configuration

Common Area Configuration

Stub Area Configuration

NSSA Area Configuration

Area Range Configuration

Interface Configuration

Interface Statistics

Neighbor Table

Link State Database

|  | Interface | IP Address   | Subnet Mask   | Area ID | Admin Mode | Router Priority | Retransmit Interval | Hello Interval | Dead Interval | Iftransit Delay Interval |
|--|-----------|--------------|---------------|---------|------------|-----------------|---------------------|----------------|---------------|--------------------------|
|  | 2/0/11    | 192.168.10.1 | 255.255.255.0 | 0.0.0.0 | Enable     | 1               | 5                   | 10             | 40            | 1                        |
|  | 2/0/1     | 0.0.0.0      | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                        |
|  | 2/0/2     | 0.0.0.0      | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                        |
|  | 2/0/3     | 0.0.0.0      | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                        |
|  | 2/0/4     | 0.0.0.0      | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                        |
|  | 2/0/5     | 0.0.0.0      | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                        |
|  | 2/0/6     | 0.0.0.0      | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                        |
|  | 2/0/7     | 0.0.0.0      | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                        |
|  | 2/0/8     | 0.0.0.0      | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                        |
|  | 2/0/9     | 0.0.0.0      | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                        |
|  | 2/0/10    | 0.0.0.0      | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                        |
|  | 2/0/11    | 192.168.10.1 | 255.255.255.0 | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                        |
|  | 2/0/12    | 0.0.0.0      | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                        |

- b. Under Interface Configuration, scroll down and select the interface **2/0/11** check box.

Now 2/0/11 appears in the Interface field at the top.

- In the **OSPF Area ID** field, enter **0.0.0.0**.
- In the **Admin Mode** field, select **Enable**.

c. Click **Apply** to save the settings.

6. Enable OSPF on the port 2/0/19.

a. Select **Routing > OSPF > Advanced > Interface Configuration**.

A screen similar to the following displays.

| System  | Switching |              |               | Routing |            | QoS             | Security            | Monitoring       | Maintenance   | Help                     | Index          |  |           |            |             |         |            |                 |                     |                |               |                          |  |        |              |               |         |        |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |        |         |         |   |         |   |   |    |    |   |  |        |              |               |   |        |   |   |    |    |   |  |        |         |         |   |         |   |   |    |    |   |
|---|-----------|--------------|---------------|---------|------------|-----------------|---------------------|------------------|---------------|--------------------------|----------------|--|-----------|------------|-------------|---------|------------|-----------------|---------------------|----------------|---------------|--------------------------|--|--------|--------------|---------------|---------|--------|---|---|----|----|---|--|-------|---------|---------|---|---------|---|---|----|----|---|--|-------|---------|---------|---|---------|---|---|----|----|---|--|-------|---------|---------|---|---------|---|---|----|----|---|--|-------|---------|---------|---|---------|---|---|----|----|---|--|-------|---------|---------|---|---------|---|---|----|----|---|--|-------|---------|---------|---|---------|---|---|----|----|---|--|-------|---------|---------|---|---------|---|---|----|----|---|--|-------|---------|---------|---|---------|---|---|----|----|---|--|-------|---------|---------|---|---------|---|---|----|----|---|--|--------|---------|---------|---|---------|---|---|----|----|---|--|--------|--------------|---------------|---|--------|---|---|----|----|---|--|--------|---------|---------|---|---------|---|---|----|----|---|
| Routing Table   | IP        | IPv6         | VLAN          | ARP     | RIP        | OSPF            | OSPFv3              | Router Discovery | VRRP          | Multicast                | IPv6 Multicast |  |           |            |             |         |            |                 |                     |                |               |                          |  |        |              |               |         |        |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |        |         |         |   |         |   |   |    |    |   |  |        |              |               |   |        |   |   |    |    |   |  |        |         |         |   |         |   |   |    |    |   |
| OSPF  |           |              |               |         |            |                 |                     |                  |               |                          |                |  |           |            |             |         |            |                 |                     |                |               |                          |  |        |              |               |         |        |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |        |         |         |   |         |   |   |    |    |   |  |        |              |               |   |        |   |   |    |    |   |  |        |         |         |   |         |   |   |    |    |   |
| OSPF Interface Configuration  |           |              |               |         |            |                 |                     |                  |               |                          |                |  |           |            |             |         |            |                 |                     |                |               |                          |  |        |              |               |         |        |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |        |         |         |   |         |   |   |    |    |   |  |        |              |               |   |        |   |   |    |    |   |  |        |         |         |   |         |   |   |    |    |   |
| 1 2 All   |           |              |               |         |            |                 |                     |                  |               |                          |                |  |           |            |             |         |            |                 |                     |                |               |                          |  |        |              |               |         |        |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |        |         |         |   |         |   |   |    |    |   |  |        |              |               |   |        |   |   |    |    |   |  |        |         |         |   |         |   |   |    |    |   |
| <table><tr><th></th><th>Interface</th><th>IP Address</th><th>Subnet Mask</th><th>Area ID</th><th>Admin Mode</th><th>Router Priority</th><th>Retransmit Interval</th><th>Hello Interval</th><th>Dead Interval</th><th>Iftransit Delay Interval</th></tr><tr><td></td><td>2/0/19</td><td>192.168.20.1</td><td>255.255.255.0</td><td>0.0.0.1</td><td>Enable</td><td>1</td><td>5</td><td>10</td><td>40</td><td>1</td></tr><tr><td></td><td>2/0/1</td><td>0.0.0.0</td><td>0.0.0.0</td><td>0</td><td>Disable</td><td>1</td><td>5</td><td>10</td><td>40</td><td>1</td></tr><tr><td></td><td>2/0/2</td><td>0.0.0.0</td><td>0.0.0.0</td><td>0</td><td>Disable</td><td>1</td><td>5</td><td>10</td><td>40</td><td>1</td></tr><tr><td></td><td>2/0/3</td><td>0.0.0.0</td><td>0.0.0.0</td><td>0</td><td>Disable</td><td>1</td><td>5</td><td>10</td><td>40</td><td>1</td></tr><tr><td></td><td>2/0/4</td><td>0.0.0.0</td><td>0.0.0.0</td><td>0</td><td>Disable</td><td>1</td><td>5</td><td>10</td><td>40</td><td>1</td></tr><tr><td></td><td>2/0/5</td><td>0.0.0.0</td><td>0.0.0.0</td><td>0</td><td>Disable</td><td>1</td><td>5</td><td>10</td><td>40</td><td>1</td></tr><tr><td></td><td>2/0/6</td><td>0.0.0.0</td><td>0.0.0.0</td><td>0</td><td>Disable</td><td>1</td><td>5</td><td>10</td><td>40</td><td>1</td></tr><tr><td></td><td>2/0/7</td><td>0.0.0.0</td><td>0.0.0.0</td><td>0</td><td>Disable</td><td>1</td><td>5</td><td>10</td><td>40</td><td>1</td></tr><tr><td></td><td>2/0/8</td><td>0.0.0.0</td><td>0.0.0.0</td><td>0</td><td>Disable</td><td>1</td><td>5</td><td>10</td><td>40</td><td>1</td></tr><tr><td></td><td>2/0/9</td><td>0.0.0.0</td><td>0.0.0.0</td><td>0</td><td>Disable</td><td>1</td><td>5</td><td>10</td><td>40</td><td>1</td></tr><tr><td></td><td>2/0/10</td><td>0.0.0.0</td><td>0.0.0.0</td><td>0</td><td>Disable</td><td>1</td><td>5</td><td>10</td><td>40</td><td>1</td></tr><tr><td></td><td>2/0/11</td><td>192.168.10.1</td><td>255.255.255.0</td><td>0</td><td>Enable</td><td>1</td><td>5</td><td>10</td><td>40</td><td>1</td></tr><tr><td></td><td>2/0/12</td><td>0.0.0.0</td><td>0.0.0.0</td><td>0</td><td>Disable</td><td>1</td><td>5</td><td>10</td><td>40</td><td>1</td></tr></table> |           |              |               |         |            |                 |                     |                  |               |                          |                |  | Interface | IP Address | Subnet Mask | Area ID | Admin Mode | Router Priority | Retransmit Interval | Hello Interval | Dead Interval | Iftransit Delay Interval |  | 2/0/19 | 192.168.20.1 | 255.255.255.0 | 0.0.0.1 | Enable | 1 | 5 | 10 | 40 | 1 |  | 2/0/1 | 0.0.0.0 | 0.0.0.0 | 0 | Disable | 1 | 5 | 10 | 40 | 1 |  | 2/0/2 | 0.0.0.0 | 0.0.0.0 | 0 | Disable | 1 | 5 | 10 | 40 | 1 |  | 2/0/3 | 0.0.0.0 | 0.0.0.0 | 0 | Disable | 1 | 5 | 10 | 40 | 1 |  | 2/0/4 | 0.0.0.0 | 0.0.0.0 | 0 | Disable | 1 | 5 | 10 | 40 | 1 |  | 2/0/5 | 0.0.0.0 | 0.0.0.0 | 0 | Disable | 1 | 5 | 10 | 40 | 1 |  | 2/0/6 | 0.0.0.0 | 0.0.0.0 | 0 | Disable | 1 | 5 | 10 | 40 | 1 |  | 2/0/7 | 0.0.0.0 | 0.0.0.0 | 0 | Disable | 1 | 5 | 10 | 40 | 1 |  | 2/0/8 | 0.0.0.0 | 0.0.0.0 | 0 | Disable | 1 | 5 | 10 | 40 | 1 |  | 2/0/9 | 0.0.0.0 | 0.0.0.0 | 0 | Disable | 1 | 5 | 10 | 40 | 1 |  | 2/0/10 | 0.0.0.0 | 0.0.0.0 | 0 | Disable | 1 | 5 | 10 | 40 | 1 |  | 2/0/11 | 192.168.10.1 | 255.255.255.0 | 0 | Enable | 1 | 5 | 10 | 40 | 1 |  | 2/0/12 | 0.0.0.0 | 0.0.0.0 | 0 | Disable | 1 | 5 | 10 | 40 | 1 |
|   | Interface | IP Address   | Subnet Mask   | Area ID | Admin Mode | Router Priority | Retransmit Interval | Hello Interval   | Dead Interval | Iftransit Delay Interval |                |  |           |            |             |         |            |                 |                     |                |               |                          |  |        |              |               |         |        |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |        |         |         |   |         |   |   |    |    |   |  |        |              |               |   |        |   |   |    |    |   |  |        |         |         |   |         |   |   |    |    |   |
|   | 2/0/19    | 192.168.20.1 | 255.255.255.0 | 0.0.0.1 | Enable     | 1               | 5                   | 10               | 40            | 1                        |                |  |           |            |             |         |            |                 |                     |                |               |                          |  |        |              |               |         |        |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |        |         |         |   |         |   |   |    |    |   |  |        |              |               |   |        |   |   |    |    |   |  |        |         |         |   |         |   |   |    |    |   |
|   | 2/0/1     | 0.0.0.0      | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10               | 40            | 1                        |                |  |           |            |             |         |            |                 |                     |                |               |                          |  |        |              |               |         |        |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |        |         |         |   |         |   |   |    |    |   |  |        |              |               |   |        |   |   |    |    |   |  |        |         |         |   |         |   |   |    |    |   |
|   | 2/0/2     | 0.0.0.0      | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10               | 40            | 1                        |                |  |           |            |             |         |            |                 |                     |                |               |                          |  |        |              |               |         |        |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |        |         |         |   |         |   |   |    |    |   |  |        |              |               |   |        |   |   |    |    |   |  |        |         |         |   |         |   |   |    |    |   |
|   | 2/0/3     | 0.0.0.0      | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10               | 40            | 1                        |                |  |           |            |             |         |            |                 |                     |                |               |                          |  |        |              |               |         |        |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |        |         |         |   |         |   |   |    |    |   |  |        |              |               |   |        |   |   |    |    |   |  |        |         |         |   |         |   |   |    |    |   |
|   | 2/0/4     | 0.0.0.0      | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10               | 40            | 1                        |                |  |           |            |             |         |            |                 |                     |                |               |                          |  |        |              |               |         |        |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |        |         |         |   |         |   |   |    |    |   |  |        |              |               |   |        |   |   |    |    |   |  |        |         |         |   |         |   |   |    |    |   |
|   | 2/0/5     | 0.0.0.0      | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10               | 40            | 1                        |                |  |           |            |             |         |            |                 |                     |                |               |                          |  |        |              |               |         |        |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |        |         |         |   |         |   |   |    |    |   |  |        |              |               |   |        |   |   |    |    |   |  |        |         |         |   |         |   |   |    |    |   |
|   | 2/0/6     | 0.0.0.0      | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10               | 40            | 1                        |                |  |           |            |             |         |            |                 |                     |                |               |                          |  |        |              |               |         |        |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |        |         |         |   |         |   |   |    |    |   |  |        |              |               |   |        |   |   |    |    |   |  |        |         |         |   |         |   |   |    |    |   |
|   | 2/0/7     | 0.0.0.0      | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10               | 40            | 1                        |                |  |           |            |             |         |            |                 |                     |                |               |                          |  |        |              |               |         |        |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |        |         |         |   |         |   |   |    |    |   |  |        |              |               |   |        |   |   |    |    |   |  |        |         |         |   |         |   |   |    |    |   |
|   | 2/0/8     | 0.0.0.0      | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10               | 40            | 1                        |                |  |           |            |             |         |            |                 |                     |                |               |                          |  |        |              |               |         |        |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |        |         |         |   |         |   |   |    |    |   |  |        |              |               |   |        |   |   |    |    |   |  |        |         |         |   |         |   |   |    |    |   |
|   | 2/0/9     | 0.0.0.0      | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10               | 40            | 1                        |                |  |           |            |             |         |            |                 |                     |                |               |                          |  |        |              |               |         |        |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |        |         |         |   |         |   |   |    |    |   |  |        |              |               |   |        |   |   |    |    |   |  |        |         |         |   |         |   |   |    |    |   |
|   | 2/0/10    | 0.0.0.0      | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10               | 40            | 1                        |                |  |           |            |             |         |            |                 |                     |                |               |                          |  |        |              |               |         |        |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |        |         |         |   |         |   |   |    |    |   |  |        |              |               |   |        |   |   |    |    |   |  |        |         |         |   |         |   |   |    |    |   |
|   | 2/0/11    | 192.168.10.1 | 255.255.255.0 | 0       | Enable     | 1               | 5                   | 10               | 40            | 1                        |                |  |           |            |             |         |            |                 |                     |                |               |                          |  |        |              |               |         |        |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |        |         |         |   |         |   |   |    |    |   |  |        |              |               |   |        |   |   |    |    |   |  |        |         |         |   |         |   |   |    |    |   |
|   | 2/0/12    | 0.0.0.0      | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10               | 40            | 1                        |                |  |           |            |             |         |            |                 |                     |                |               |                          |  |        |              |               |         |        |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |       |         |         |   |         |   |   |    |    |   |  |        |         |         |   |         |   |   |    |    |   |  |        |              |               |   |        |   |   |    |    |   |  |        |         |         |   |         |   |   |    |    |   |

b. Under Interface Configuration, scroll down and select the interface **2/0/19** check box.

Now 2/0/19 appears in the Interface field at the top.

- In the **OSPF Area ID** field, enter **0.0.0.1**.
- In the **OSPF Admin Mode** field, select **Enable**.

c. Click **Apply** to save the settings.

7. Configure area 0.0.0.1 as a stub area.

a. Select **Routing > OSPF > Advanced > Stub Area Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

| OSPF  | OSPF Stub Area Configuration   |                          |                |                          |                     |                   |                     |         |  |  |  |  |         |
|---|--|--------------------------|----------------|--------------------------|---------------------|-------------------|---------------------|---------|--|--|--|--|---------|
| <ul style="list-style-type: none"> <li>Basic</li> <li>Advanced               <ul style="list-style-type: none"> <li>OSPF Configuration</li> <li>Common Area Configuration</li> <li>Stub Area Configuration</li> </ul> </li> </ul> | <table border="1"> <thead> <tr> <th>Area ID</th> <th>SPF Runs</th> <th>Area Border Router Count</th> <th>Area LSA Count</th> <th>Area LSA Checksum</th> <th>Import Summary LSAs</th> </tr> </thead> <tbody> <tr> <td>0.0.0.1</td> <td></td> <td></td> <td></td> <td></td> <td>Disable</td> </tr> </tbody> </table> | Area ID                  | SPF Runs       | Area Border Router Count | Area LSA Count      | Area LSA Checksum | Import Summary LSAs | 0.0.0.1 |  |  |  |  | Disable |
| Area ID   | SPF Runs   | Area Border Router Count | Area LSA Count | Area LSA Checksum        | Import Summary LSAs |                   |                     |         |  |  |  |  |         |
| 0.0.0.1   |  |                          |                |                          | Disable             |                   |                     |         |  |  |  |  |         |

- b. Enter the following information:
  - In the **Area ID** field, enter **0.0.0.1**.
  - In the **Import Summary LSAs** field, select **Disable**.
- c. Click **Add** to save the settings.

## CLI: Configure Area 1 as a Stub Area on A2

1. Enable routing on the switch.

```
(Netgear Switch) #config
(Netgear Switch) (Config)#ip routing
(Netgear Switch) (Config)#router ospf
```

2. Set the router ID to 2.2.2.2.

```
(Netgear Switch) (Config-router)#router-id 2.2.2.2
```

3. Configure area 0.0.0.1 as a stub area.

```
(Netgear Switch) (Config-router)#area 0.0.0.1 stub
```

#### 4. Enable OSPF area 0.0.0.1 on the 1/0/15.

```
(Netgear Switch) (Config-router)#exit
(Netgear Switch) (Config-router)#exit
(Netgear Switch) (Config)#interface 1/0/15
(Netgear Switch) (Interface 1/0/15)#routing
(Netgear Switch) (Interface 1/0/15)#ip address 192.168.20.2 255.255.255.0
(Netgear Switch) (Interface 1/0/15)#ip ospf
(Netgear Switch) (Interface 1/0/15)#ip ospf areaid 0.0.0.1

(Netgear Switch) (Interface 1/0/15)#exit
(Netgear Switch) (Config)#exit
(Netgear Switch) #show ip route
```

Total Number of Routes..... 2

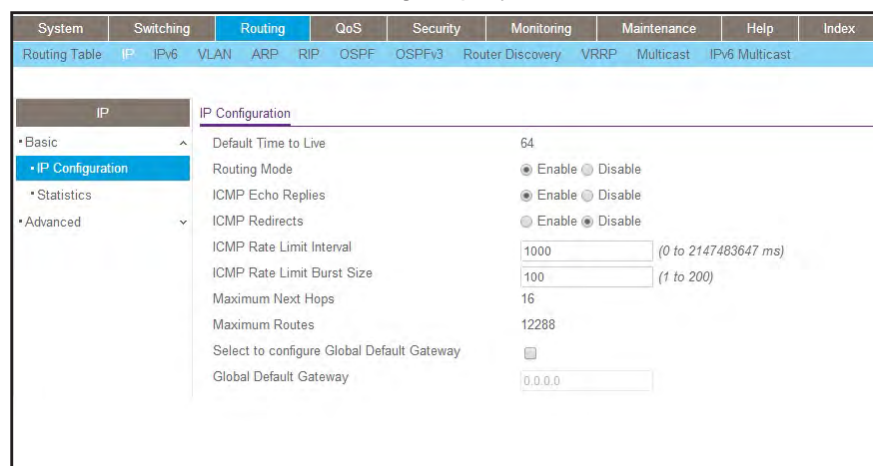
| Network<br>Address | Subnet<br>Mask | Protocol   | Next Hop<br>Intf | Next Hop<br>IP Address |
|--------------------|----------------|------------|------------------|------------------------|
| 0.0.0.0            | 0.0.0.0        | OSPF Inter | 1/0/15           | 192.168.20.1           |
| 192.168.20.0       | 255.255.255.0  | Local      | 1/0/15           | 192.168.20.2           |

## Local Browser Interface: Configure Area 1 as a Stub Area on A2

### 1. Enable IP routing on the switch.

#### a. Select **Routing > IP > Basic > IP Configuration**.

A screen similar to the following displays.



#### b. For Routing Mode, select the **Enable** radio button.

#### c. Click **Apply** to save the settings.

2. Assign IP address 192.168.10.1 to port 1/0/15.

a. Select **Routing > IP > Advanced > IP Interface Configuration**.

A screen similar to the following displays.

| Port   | Description | VLAN ID | IP Address Configuration Method | IP Address   | Subnet Mask   | Routing Mode | Administrative Mode |
|--------|-------------|---------|---------------------------------|--------------|---------------|--------------|---------------------|
| 1/0/15 |             |         | Manual                          | 192.168.20.2 | 255.255.255.0 | Enable       | Enable              |
| 1/0/1  |             |         | None                            | 0.0.0.0      | 0.0.0.0       | Disable      | Enable              |
| 1/0/2  |             |         | None                            | 0.0.0.0      | 0.0.0.0       | Disable      | Enable              |
| 1/0/3  |             |         | None                            | 0.0.0.0      | 0.0.0.0       | Disable      | Enable              |
| 1/0/4  |             |         | None                            | 0.0.0.0      | 0.0.0.0       | Disable      | Enable              |

b. Scroll down and select the interface **1/0/15** check box.

Now 1/0/15 appears in the Interface field at the top.

c. Enter the following information:

- In the **IP Address Configuration Method** field, select **Manual**.
- In the **IP Address** field, enter **192.168.20.2**.
- In the **Network Mask** field, enter **255.255.255.0**.
- In the **Admin Mode** field, select **Enable**.

d. Click **Apply** to save the settings.

3. Specify the router ID, and enable OSPF for the switch.

a. Select **Routing > OSPF > Basic > OSPF Configuration**.

A screen similar to the following displays.

| OSPF       | OSPF Configuration  |
|------------|---|
| Admin Mode | <input type="radio"/> Disable <input checked="" type="radio"/> Enable |
| Router ID  | 2.2.2.2   |

b. In the **Router ID** field, enter **2.2.2.2**.

- c. Click **Apply** to save the settings.
4. Enable OSPF on port 1/0/15.
  - a. Select **Routing > OSPF > Advanced > Interface Configuration**.

A screen similar to the following displays.

| Interface                      | IP Address   | Subnet Mask   | Area ID | Admin Mode | Router Priority | Retransmit Interval | Hello Interval | Dead Interval | lfransit Delay Interval |
|--------------------------------|--------------|---------------|---------|------------|-----------------|---------------------|----------------|---------------|-------------------------|
| 1/0/15                         | 192.168.20.2 | 255.255.255.0 | 0.0.0.1 | Enable     | 1               | 5                   | 10             | 40            | 1                       |
| <input type="checkbox"/> 1/0/1 | 0.0.0.0      | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                       |
| <input type="checkbox"/> 1/0/2 | 0.0.0.0      | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                       |
| <input type="checkbox"/> 1/0/3 | 0.0.0.0      | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                       |
| <input type="checkbox"/> 1/0/4 | 0.0.0.0      | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                       |
| <input type="checkbox"/> 1/0/5 | 0.0.0.0      | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                       |
| <input type="checkbox"/> 1/0/6 | 0.0.0.0      | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                       |
| <input type="checkbox"/> 1/0/7 | 0.0.0.0      | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                       |
| <input type="checkbox"/> 1/0/8 | 0.0.0.0      | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                       |

- b. Under Interface Configuration, scroll down and select the interface **1/0/15** check box. Now 1/0/15 appears in the Interface field at the top.
  - In the **OSPF Area ID** field, enter **0.0.0.1**.
  - In the **OSPF Admin Mode** field, select **Enable**.
- c. Click **Apply** to save the settings.
5. Configure area 0.0.0.1 as a stub area.
  - a. Select **Routing > OSPF > Advanced > Stub Area Configuration**.

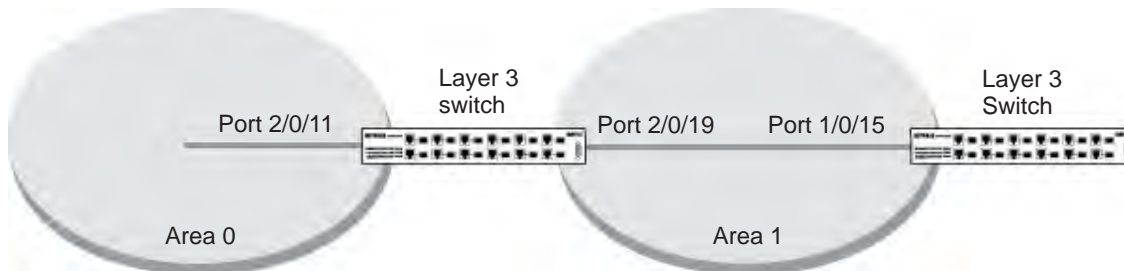
A screen similar to the following displays.

| Area ID | SPF Runs | Area Border Router Cost | Area LSA Cost | Area LSA Checksum | Import Summary LSAs | Default Cost | Type of Service |
|---------|----------|-------------------------|---------------|-------------------|---------------------|--------------|-----------------|
| 0.0.0.1 |          |                         |               |                   | Disable             |              |                 |

- b. In the **Area ID** field, enter **0.0.0.1**.
- c. Click **Add** to save the settings.



# NSSA Areas



**Figure 17. NSSA area**

The example is shown as CLI commands and as a local browser interface procedure.

## CLI: Configure Area 1 as an NSSA Area

1. Enable routing on the switch.

```
(Netgear Switch) #config
(Netgear Switch) (Config)#router ospf
(Netgear Switch) (Config)#ip routing
```

2. Configure area 0.0.0.1 as an NSSA area.

```
(Netgear Switch) (Config)#router ospf
(Netgear Switch) (Config-router)#router-id 1.1.1.1
(Netgear Switch) (Config-router)#area 0.0.0.1 nssa
```

3. Stop importing summary LSAs to area 0.0.0.1.

```
(Netgear Switch) (Config-router)#area 0.0.0.1 nssa no-summary
```



**4. Enable area 0.0.0.1 on port 2/0/19.**

```

(Netgear Switch) (Config-router)#exit
(Netgear Switch) (Config)#interface 2/0/11
(Netgear Switch) (Interface 2/0/11)#routing
(Netgear Switch) (Interface 2/0/11)#ip address 192.168.10.1 255.255.255.0
(Netgear Switch) (Interface 2/0/11)#ip ospf
(Netgear Switch) (Interface 2/0/11)#exit
(Netgear Switch) (Config)#interface 2/0/19
(Netgear Switch) (Interface 2/0/19)#routing
(Netgear Switch) (Interface 2/0/19)#ip address 192.168.20.1 255.255.255.0
(Netgear Switch) (Interface 2/0/19)#ip ospf
(Netgear Switch) (Interface 2/0/19)#ip ospf areaid 0.0.0.1

(Netgear Switch) (Interface 2/0/19)#exit
(Netgear Switch) (Config)#exit
(Netgear Switch) #show ip route
Total Number of Routes..... 2

```

| Network<br>Address | Subnet<br>Mask | Protocol     | Next Hop<br>Intf | Next Hop<br>IP Address |
|--------------------|----------------|--------------|------------------|------------------------|
| 14.1.1.0           | 255.255.255.0  | OSPF Inter   | 2/0/11           | 192.168.10.2           |
| 14.1.2.0           | 255.255.255.0  | OSPF Inter   | 2/0/11           | 192.168.10.2           |
| 192.168.10.0       | 255.255.255.0  | Local        | 2/0/11           | 192.168.10.1           |
| 192.168.20.0       | 255.255.255.0  | Local        | 2/0/19           | 192.168.20.1           |
| 192.168.40.0       | 255.255.255.0  | OSPF NSSA T2 | 2/0/19           | 192.168.20.2           |
| 192.168.41.0       | 255.255.255.0  | OSPF NSSA T2 | 2/0/19           | 192.168.20.2           |
| 192.168.42.0       | 255.255.255.0  | OSPF NSSA T2 | 2/0/19           | 192.168.20.2           |

# Local Browser Interface: Configure Area 1 as an NSSA Area on A1

1. Enable IP routing on the switch.
  - a. Select **Routing > IP > Basic > IP Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

IP

IP Configuration

Basic

IP Configuration

Statistics

Advanced

Default Time to Live: 64  
 Routing Mode: ☒ Enable ☐ Disable  
 ICMP Echo Replies: ☒ Enable ☐ Disable  
 ICMP Redirects: ☐ Enable ☒ Disable  
 ICMP Rate Limit Interval: 1000 (0 to 2147483647 ms)  
 ICMP Rate Limit Burst Size: 100 (1 to 200)  
 Maximum Next Hops: 16  
 Maximum Routes: 12288  
 Select to configure Global Default Gateway: ☐  
 Global Default Gateway: 0.0.0.0

- b. For Routing Mode, select the **Enable** radio button.
  - c. Click **Apply** to save the settings.
2. Assign IP address 192.168.10.1 to port 2/0/11.
  - a. Select **Routing > IP > Advanced > IP Interface Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

IP

IP Interface Configuration

Basic

Advanced

Statistics

IP Interface Configuration

Secondary IP

1 2 All  

| Port                                       | Description | VLAN ID | IP Address Configuration Method | IP Address   | Subnet Mask   | Routing Mode | Administrative Mode |
|--|-------------|---------|---------------------------------|--------------|---------------|--------------|---------------------|
| <input type="checkbox"/> 2/0/1             |             |         | Manual                          | 192.168.10.1 | 255.255.255.0 | Enable       | Enable              |
| <input type="checkbox"/> 2/0/2             |             |         | None                            | 0.0.0.0      | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 2/0/3             |             |         | None                            | 0.0.0.0      | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 2/0/4             |             |         | None                            | 0.0.0.0      | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 2/0/5             |             |         | None                            | 0.0.0.0      | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 2/0/6             |             |         | None                            | 0.0.0.0      | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 2/0/7             |             |         | None                            | 0.0.0.0      | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 2/0/8             |             |         | None                            | 0.0.0.0      | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 2/0/9             |             |         | None                            | 0.0.0.0      | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 2/0/10            |             |         | None                            | 0.0.0.0      | 0.0.0.0       | Disable      | Enable              |
| <input checked="" type="checkbox"/> 2/0/11 |             |         | None                            | 0.0.0.0      | 0.0.0.0       | Disable      | Enable              |

- b. Scroll down and select the interface **2/0/11** check box.  
Now 2/0/11 appears in the Interface field at the top.
  - c. Enter the following information:
    - In the **IP Address** field, enter **192.168.10.1**.

- In the **Network Mask** field, enter **255.255.255.0**.
  - In the **Admin Mode** field, select **Enable**.
  - d. Click **Apply** to save the settings.
3. Assign IP address 192.168.20.1 to port 2/0/19.
- a. Select **Routing > IP > Advanced > IP Interface Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

IP

• Basic

• Advanced

• IP Configuration

• Statistics

• IP Interface Configuration

• Secondary IP

IP Interface Configuration

12All

| Port   | Description | VLAN ID | IP Address Configuration Method | IP Address   | Subnet Mask   | Routing Mode | Administrative Mode |
|--------|-------------|---------|---------------------------------|--------------|---------------|--------------|---------------------|
| 2/0/19 |             |         | Manual                          | 192.168.20.1 | 255.255.255.0 | Enable       | Enable              |
| 2/0/1  |             |         | None                            | 0.0.0.0      | 0.0.0.0       | Disable      | Enable              |
| 2/0/2  |             |         | None                            | 0.0.0.0      | 0.0.0.0       | Disable      | Enable              |
| 2/0/3  |             |         | None                            | 0.0.0.0      | 0.0.0.0       | Disable      | Enable              |
| 2/0/4  |             |         | None                            | 0.0.0.0      | 0.0.0.0       | Disable      | Enable              |
| 2/0/5  |             |         | None                            | 0.0.0.0      | 0.0.0.0       | Disable      | Enable              |
| 2/0/6  |             |         | None                            | 0.0.0.0      | 0.0.0.0       | Disable      | Enable              |
| 2/0/7  |             |         | None                            | 0.0.0.0      | 0.0.0.0       | Disable      | Enable              |
| 2/0/8  |             |         | None                            | 0.0.0.0      | 0.0.0.0       | Disable      | Enable              |
| 2/0/9  |             |         | None                            | 0.0.0.0      | 0.0.0.0       | Disable      | Enable              |
| 2/0/10 |             |         | None                            | 0.0.0.0      | 0.0.0.0       | Disable      | Enable              |
| 2/0/11 |             |         | Manual                          | 192.168.10.1 | 255.255.255.0 | Enable       | Enable              |

- b. Scroll down and select the interface **2/0/19** check box.
- Now 2/0/19 appears in the Interface field at the top.
- c. Enter the following information:
- In the **IP Address** field, enter **192.168.20.1**.
  - In the **Subnet Mask** field, enter **255.255.255.0**.
  - In the **Admin Mode** field, select **Enable**.
- d. Click **Apply** to save the settings.
4. Specify the router ID, and enable OSPF for the switch.
- a. Select **Routing > OSPF > Basic > OSPF Configuration**.

A screen similar to the following displays.

The screenshot shows the 'OSPF Configuration' page. The 'Admin Mode' is set to 'Enable' and the 'Router ID' is set to '2.2.2.2'.

- b. Under OSPF Configuration, in the **Router ID** field, enter **2.2.2.2**.
- c. Click **Apply** to save the settings.
5. Enable OSPF on port 2/0/11.
  - a. Select **Routing > OSPF > Advanced > Interface Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

OSPF

Basic

Advanced

OSPF Configuration

Common Area Configuration

Stub Area Configuration

NSSA Area Configuration

Area Range Configuration

Interface Configuration

Interface Statistics

Neighbor Table

Link State Database

OSPF Interface Configuration

12All

|  | Interface | IP Address   | Subnet Mask   | Area ID | Admin Mode | Router Priority | Retransmit Interval | Hello Interval | Dead Interval | lfransit Delay Interval |
|--|-----------|--------------|---------------|---------|------------|-----------------|---------------------|----------------|---------------|-------------------------|
|  | 2/0/11    | 192.168.10.1 | 255.255.255.0 | 0.0.0.0 | Enable     | 1               | 5                   | 10             | 40            | 1                       |
|  | 2/0/1     | 0.0.0.0      | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                       |
|  | 2/0/2     | 0.0.0.0      | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                       |
|  | 2/0/3     | 0.0.0.0      | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                       |
|  | 2/0/4     | 0.0.0.0      | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                       |
|  | 2/0/5     | 0.0.0.0      | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                       |
|  | 2/0/6     | 0.0.0.0      | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                       |
|  | 2/0/7     | 0.0.0.0      | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                       |
|  | 2/0/8     | 0.0.0.0      | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                       |
|  | 2/0/9     | 0.0.0.0      | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                       |
|  | 2/0/10    | 0.0.0.0      | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                       |
|  | 2/0/11    | 192.168.10.1 | 255.255.255.0 | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                       |
|  | 2/0/12    | 0.0.0.0      | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                       |

- b. Scroll down and select the interface **2/0/11** check box.  
Now 2/0/11 appears in the Interface field at the top.
  - In the **OSPF Area ID** field, enter **0.0.0.0**.
  - In the **OSPF Admin Mode** field, select **Enable**.
- c. Click **Apply** to save the settings.
6. Enable OSPF on port 2/0/19.
  - a. Select **Routing > OSPF > Advanced > Interface Configuration**.

A screen similar to the following displays.

| Interface | IP Address   | Subnet Mask   | Area ID | Admin Mode | Router Priority | Retransmit Interval | Hello Interval | Dead Interval | Transit Delay Interval |
|-----------|--------------|---------------|---------|------------|-----------------|---------------------|----------------|---------------|------------------------|
| 2/0/19    | 192.168.20.1 | 255.255.255.0 | 0.0.0.1 | Enable     | 1               | 5                   | 10             | 40            | 1                      |
| 2/0/1     | 0.0.0.0      | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                      |
| 2/0/2     | 0.0.0.0      | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                      |
| 2/0/3     | 0.0.0.0      | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                      |
| 2/0/4     | 0.0.0.0      | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                      |
| 2/0/5     | 0.0.0.0      | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                      |
| 2/0/6     | 0.0.0.0      | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                      |
| 2/0/7     | 0.0.0.0      | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                      |
| 2/0/8     | 0.0.0.0      | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                      |
| 2/0/9     | 0.0.0.0      | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                      |
| 2/0/10    | 0.0.0.0      | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                      |
| 2/0/11    | 192.168.10.1 | 255.255.255.0 | 0       | Enable     | 1               | 5                   | 10             | 40            | 1                      |
| 2/0/12    | 0.0.0.0      | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                      |

- b. Scroll down and select the interface **2/0/19** check box.

2/0/19 now appears in the Interface field at the top.

- c. Enter the following information:

- In the **OSPF Area ID** field, enter **0.0.0.1**.
- In the **OSPF Admin Mode** field, select **Enable**.

- d. Click **Apply** to save the settings.

7. Configure area 0.0.0.1 as an NSSA area.

- a. Select **Routing > OSPF > Advanced > NSSA Area Configuration**.

A screen similar to the following displays.

| Area ID | SPF Runs | Area Border Router Count | Area LSA Count | Area LSA Checksum | Import Summary LSAs | Admin Mode | Metric Value | Metric Type | Translating Role |
|---------|----------|--------------------------|----------------|-------------------|---------------------|------------|--------------|-------------|------------------|
| 0.0.0.1 |          |                          |                |                   |                     | Disable    |              |             |                  |

- b. Enter the following information.

- In the **Area ID** field, enter **0.0.0.1**.
- In the **Import Summary LSA's** field, select **Disable**.

- c. Click **Add** to save the settings.

## CLI: Configure Area 1 as an NSSA Area on A2

1. Enable routing on the switch.

```
(Netgear Switch) #config  
(Netgear Switch) (Config)#ip routing  
(Netgear Switch) (Config)#router ospf
```

2. Set the router ID to 2.2.2.2.

```
(Netgear Switch) (Config-router)#router-id 2.2.2.2
```

3. Configure the area 0.0.0.1 as an NSSA area.

```
(Netgear Switch) (Config-router)# area 0.0.0.1 nssa
```

4. Redistribute the RIP routes into the OSPF.

```
(Netgear Switch) (Config-router)#redistribute rip  
(Netgear Switch) (Config-router)#redistribute rip subnets
```

**5. Enable OSPF area 0.0.0.1 on port 1/0/15.**

```

(Netgear Switch) (Config-router)#exit
(Netgear Switch) (Config)#interface 1/0/11
(Netgear Switch) (Interface 1/0/11)#routing
(Netgear Switch) (Interface 1/0/11)#ip address 192.168.30.1 255.255.255.0
(Netgear Switch) (Interface 1/0/11)#ip rip
(Netgear Switch) (Interface 1/0/11)#exit
(Netgear Switch) (Config)#interface 1/0/15
(Netgear Switch) (Interface 1/0/15)#routing
(Netgear Switch) (Interface 1/0/15)#ip address 192.168.20.2 255.255.255.0
(Netgear Switch) (Interface 1/0/15)#ip ospf
(Netgear Switch) (Interface 1/0/15)#ip ospf areaid 0.0.0.1
(Netgear Switch) (Interface 1/0/15)#exit
(Netgear Switch) (Config)#exit
(Netgear Switch) #show ip route
Total Number of Routes..... 6

```

| Network<br>Address | Subnet<br>Mask | Protocol   | Next Hop<br>Intf | Next Hop<br>IP Address |
|--------------------|----------------|------------|------------------|------------------------|
| 0.0.0.0            | 0.0.0.0        | OSPF Inter | 1/0/15           | 192.168.20.1           |
| 192.168.20.0       | 255.255.255.0  | Local      | 1/0/15           | 192.168.20.2           |
| 192.168.30.0       | 255.255.255.0  | Local      | 1/0/11           | 192.168.30.1           |
| 192.168.40.0       | 255.255.255.0  | RIP        | 1/0/11           | 192.168.30.2           |
| 192.168.41.0       | 255.255.255.0  | RIP        | 1/0/11           | 192.168.30.2           |
| 192.168.42.0       | 255.255.255.0  | RIP        | 1/0/11           | 192.168.30.2           |



## Local Browser Interface: Configure Area 1 as an NSSA Area on A2

1. Enable IP routing on the switch.
  - a. Select **Routing > IP > Basic > IP Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

IP

IP Configuration

- Basic
  - Default Time to Live: 64
- IP Configuration
  - Routing Mode: ☒ Enable ☐ Disable
  - ICMP Echo Replies: ☒ Enable ☐ Disable
  - ICMP Redirects: ☐ Enable ☒ Disable
  - ICMP Rate Limit Interval: 1000 (0 to 2147483647 ms)
  - ICMP Rate Limit Burst Size: 100 (1 to 200)
  - Maximum Next Hops: 16
  - Maximum Routes: 12288
  - Select to configure Global Default Gateway: ☐
  - Global Default Gateway: 0.0.0.0
- Statistics
- Advanced

- b. mFor Routing Mode, select the **Enable** radio button.
  - c. Click **Apply** to save the settings.
2. Assign IP address 192.168.30.1 to port 1/0/11.
  - a. Select **Routing > IP > Advanced > IP Interface Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

IP

IP Interface Configuration

1 2 All

| Port                                       | Description | VLAN ID | IP Address Configuration Method | IP Address   | Subnet Mask   | Routing Mode | Administrative Mode |
|--|-------------|---------|---------------------------------|--------------|---------------|--------------|---------------------|
| <input checked="" type="checkbox"/> 1/0/11 |             |         | Manual                          | 192.168.30.1 | 255.255.255.0 | Enable       | Enable              |
| <input type="checkbox"/> 1/0/1             |             |         | None                            | 0.0.0.0      | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 1/0/2             |             |         | None                            | 0.0.0.0      | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 1/0/3             |             |         | None                            | 0.0.0.0      | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 1/0/4             |             |         | None                            | 0.0.0.0      | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 1/0/5             |             |         | None                            | 0.0.0.0      | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 1/0/6             |             |         | None                            | 0.0.0.0      | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 1/0/7             |             |         | None                            | 0.0.0.0      | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 1/0/8             |             |         | None                            | 0.0.0.0      | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 1/0/9             |             |         | None                            | 0.0.0.0      | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 1/0/10            |             |         | None                            | 0.0.0.0      | 0.0.0.0       | Disable      | Enable              |
| <input checked="" type="checkbox"/> 1/0/11 |             |         | None                            | 0.0.0.0      | 0.0.0.0       | Disable      | Enable              |

- b. Scroll down and select the interface **1/0/11** check box.  
Now 1/0/11 appears in the Interface field at the top.
  - c. Enter the following information:
    - In the **IP Address Configuration Method** field, select **Manual**.

- In the **IP Address** field, enter **192.168.30.1**.
  - In the **Network Mask** field, enter **255.255.255.0**.
  - In the **Routing Mode** field, select **Enable**.
- d. Click **Apply** to save the settings.
3. Assign IP address 192.168.20.2 to port 1/0/15.
- a. Select **Routing > IP > Advanced > IP Interface Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

| IP                           |         | IP Interface Configuration |  |  |  |  |  |  |
|------------------------------|---------|----------------------------|--|--|--|--|--|--|
| • Basic                      | 1 2 All |                            |  |  |  |  |  |  |
| • Advanced                   |         |                            |  |  |  |  |  |  |
| • IP Configuration           |         |                            |  |  |  |  |  |  |
| • Statistics                 |         |                            |  |  |  |  |  |  |
| • IP Interface Configuration |         |                            |  |  |  |  |  |  |
| • Secondary IP               |         |                            |  |  |  |  |  |  |

| Port                                       | Description | VLAN ID | IP Address Configuration Method | IP Address   | Subnet Mask   | Routing Mode | Administrative Mode |
|--|-------------|---------|---------------------------------|--------------|---------------|--------------|---------------------|
| <input checked="" type="checkbox"/> 1/0/15 |             |         | Manual                          | 192.168.20.2 | 255.255.255.0 | Enable       | Enable              |
| <input type="checkbox"/> 1/0/1             |             |         | None                            | 0.0.0.0      | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 1/0/2             |             |         | None                            | 0.0.0.0      | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 1/0/3             |             |         | None                            | 0.0.0.0      | 0.0.0.0       | Disable      | Enable              |

- b. Under Configuration, scroll down and select the interface **1/0/15** check box.  
Now 1/0/15 appears in the Interface field at the top.
- c. Enter the following information:
- In the **IP Address Configuration Method** field, select **Manual**.
  - In the **IP Address** field, enter **192.168.20.2**.
  - In the **Network Mask** field, enter **255.255.255.0**.
  - In the **Routing Mode** field, select **Enable**.
- d. Click **Apply** to save the settings.
4. Specify the router ID, and enable OSPF for the switch.
- a. Select **Routing > OSPF > Basic > OSPF Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

OSPF

Basic

OSPF Configuration

Advanced

Admin Mode

Router ID

☐ Disable
 ☒ Enable

2.2.2.2

- b. Under OSPF Configuration, in the **Router ID** field, enter **2.2.2.2**.
  - c. Click **Apply** to save the settings.
5. Enable RIP on port 1/0/11.
  - a. Select **Routing > RIP > Advanced > Interface Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

RIP

Basic

RIP Interface Configuration

Advanced

1 2 All

| Interface                                  | Send Version | Receive Version | RIP Mode | Authentication Type | Authentication Key | Authentication Key ID |
|--|--------------|-----------------|----------|---------------------|--------------------|-----------------------|
| <input checked="" type="checkbox"/> 1/0/11 | RIP-2        | Both            | Enable   | None                |                    | 0                     |
| <input type="checkbox"/> 1/0/1             | RIP-2        | Both            | Disable  | None                |                    | 0                     |
| <input type="checkbox"/> 1/0/2             | RIP-2        | Both            | Disable  | None                |                    | 0                     |
| <input type="checkbox"/> 1/0/3             | RIP-2        | Both            | Disable  | None                |                    | 0                     |
| <input type="checkbox"/> 1/0/4             | RIP-2        | Both            | Disable  | None                |                    | 0                     |
| <input type="checkbox"/> 1/0/5             | RIP-2        | Both            | Disable  | None                |                    | 0                     |
| <input type="checkbox"/> 1/0/6             | RIP-2        | Both            | Disable  | None                |                    | 0                     |
| <input type="checkbox"/> 1/0/7             | RIP-2        | Both            | Disable  | None                |                    | 0                     |
| <input type="checkbox"/> 1/0/8             | RIP-2        | Both            | Disable  | None                |                    | 0                     |
| <input type="checkbox"/> 1/0/9             | RIP-2        | Both            | Disable  | None                |                    | 0                     |
| <input type="checkbox"/> 1/0/10            | RIP-2        | Both            | Disable  | None                |                    | 0                     |
| <input checked="" type="checkbox"/> 1/0/11 | RIP-2        | Both            | Disable  | None                |                    | 0                     |

- b. Enter the following information:
    - In the **Interface** field, select **1/0/11**.
    - For RIP Admin Mode, select the **Enable** radio button.
  - c. Click **Apply** to save the settings.
6. Enable OSPF on port 1/0/15.
  - a. Select **Routing > OSPF > Advanced > Interface Configuration**.

A screen similar to the following displays.

| Interface                                  | IP Address   | Subnet Mask   | Area ID | Admin Mode | Router Priority | Retransmit Interval | Hello Interval | Dead Interval | lfransit Delay Interval |
|--|--------------|---------------|---------|------------|-----------------|---------------------|----------------|---------------|-------------------------|
| <input checked="" type="checkbox"/> 1/0/15 | 192.168.20.2 | 255.255.255.0 | 0.0.0.1 | Disable    | 1               | 5                   | 10             | 40            | 1                       |
| <input type="checkbox"/> 1/0/1             | 0.0.0.0      | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                       |
| <input type="checkbox"/> 1/0/2             | 0.0.0.0      | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                       |
| <input type="checkbox"/> 1/0/3             | 0.0.0.0      | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                       |
| <input type="checkbox"/> 1/0/4             | 0.0.0.0      | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                       |
| <input type="checkbox"/> 1/0/5             | 0.0.0.0      | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                       |
| <input type="checkbox"/> 1/0/6             | 0.0.0.0      | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                       |
| <input type="checkbox"/> 1/0/7             | 0.0.0.0      | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                       |
| <input type="checkbox"/> 1/0/8             | 0.0.0.0      | 0.0.0.0       | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                       |

- b. Scroll down and select the interface **1/0/15** check box. Now 1/0/15 appears in the Interface field at the top.
  - c. Enter the following information:
    - In the **OSPF Area ID** field, enter **0.0.0.1**.
    - In the **OSPF Admin Mode** field, select **Enable**.
  - d. Click **Apply** to save the settings.
7. Configure area 0.0.0.1 as an NSSA area.
- a. Select **Routing > OSPF > Advanced > NSSA Area Configuration**.

A screen similar to the following displays.

| Area ID | SPF Runs | Area Border Router Count | Area LSA Count | Area LSA Checksum | Import Summary LSAs | Admin Mode | Metric Value | Metric Type | Translate Role | Translate Interval |
|---------|----------|--------------------------|----------------|-------------------|---------------------|------------|--------------|-------------|----------------|--------------------|
| 0.0.0.1 |          |                          |                |                   | Disable             |            |              |             |                |                    |

- b. In the **Area ID** field, enter **0.0.0.1**.
  - c. Click **Add** to save the settings.
8. Redistribute the RIP routes into the OSPF area.
- a. Select **Routing > OSPF > Advanced > Route Redistribution**.

A screen similar to the following displays.

| Source                                  | Redistribute | Metric | Metric Type | Tag | Subnets | Distribute List |
|---|--------------|--------|-------------|-----|---------|-----------------|
| <input checked="" type="checkbox"/> RIP | Enable       |        |             |     |         |                 |
| <input type="checkbox"/> Connected      | Disable      |        |             |     |         |                 |
| <input type="checkbox"/> Static         | Disable      |        |             |     |         |                 |
| <input checked="" type="checkbox"/> RIP | Disable      |        |             |     |         |                 |
| <input type="checkbox"/> OSPF           | Disable      |        |             |     |         |                 |
| <input type="checkbox"/> BGP            | Disable      |        |             |     |         |                 |

- b. Scroll down and select the **RIP** check box.  
Now RIP appears in the **Source** field at the top.
- c. Enter the following information:  
In the **Redistribute** field, select **Enable**.
- d. Under Route Redistribution, in the **Available Source** list, select **RIP**.
- e. Click **Add** to add a route redistribution.

## VLAN Routing OSPF

For larger networks Open Shortest Path First (OSPF) is generally used in preference to RIP. OSPF offers the following benefits to the administrator of a large and/or complex network:

- Less network traffic:
  - Routing table updates are sent only when a change has occurred
  - Only the part of the table that has changed is sent
  - Updates are sent to a multicast, not a broadcast, address
- Hierarchical management, allowing the network to be subdivided

The top level of the hierarchy of an OSPF network is known as an autonomous system (AS) or routing domain, and is a collection of networks with a common administration and routing strategy. The AS is divided into areas: intra-area routing is used when a source and destination address are in the same area, and inter-area routing across an OSPF backbone is used when they are not. An inter-area router communicates with border routers in each of the areas to which it provides connectivity.

The switch operating as a router and running OSPF will determine the best route using the assigned cost and the type of the OSPF route. The order for choosing a route if more than one type of route exists is as follows:

- Intra-area
- Inter-area
- External type 1: the route is external to the AS
- External Type 2: the route was learned from other protocols such as RIP

## CLI: Configure VLAN Routing OSPF

This example adds support for OSPF to the configuration created in the base VLAN routing example in [Figure 12, Layer 3 switch configured for port routing on page 89](#).

### 1. Configure the switch as an inter-area router.

```
(Netgear Switch) #vlan data
(Netgear Switch) (Vlan)#vlan 10
(Netgear Switch) (Vlan)#vlan 20
(Netgear Switch) (Vlan)#vlan routing 10
(Netgear Switch) (Vlan)#vlan routing 20
(Netgear Switch) (Vlan)#exit
(Netgear Switch) #conf
(Netgear Switch) (Config)#ip routing
(Netgear Switch) (Config)#vlan port tagging all 10
(Netgear Switch) (Config)#vlan port tagging all 20
(Netgear Switch) (Config)#interface 1/0/2
(Netgear Switch) (Interface 1/0/2)#vlan participation include 10
(Netgear Switch) (Interface 1/0/2)#vlan pvid 10
(Netgear Switch) (Interface 1/0/2)#exit
(Netgear Switch) (Config)#interface 1/0/3
(Netgear Switch) (Interface 1/0/3)#vlan participation include 20
(Netgear Switch) (Interface 1/0/3)#vlan pvid 20
(Netgear Switch) (Interface 1/0/3)#exit
(Netgear Switch) (Config)#interface vlan 10
(Netgear Switch) (Interface vlan 10)#ip address 192.150.3.1 255.255.255.0
(Netgear Switch) (Interface vlan 10)#exit
(Netgear Switch) (Config)#interface vlan 20
(Netgear Switch) (Interface vlan 20)#ip address 192.150.4.1 255.255.255.0
(Netgear Switch) (Interface vlan 20)#exit
```

## 2. Specify the router ID and enable OSPF for the switch.

```
(Netgear Switch) (Config)#router ospf
(Netgear Switch) (Config router)#router-id 192.150.9.9
(Netgear Switch) (Config router)#enable
(Netgear Switch) (Config router)#exit
```

## 3. Enable OSPF for the VLAN and physical router ports.

```
(Netgear Switch) (Config)#interface vlan 10
(Netgear Switch) (Interface vlan 10)#ip ospf areaid 0.0.0.2
(Netgear Switch) (Interface vlan 10)#ip ospf
(Netgear Switch) (Interface vlan 10)#exit
(Netgear Switch) (Config)#interface vlan 20
(Netgear Switch) (Interface vlan 20)#ip ospf areaid 0.0.0.3
(Netgear Switch) (Interface vlan 20)#ip ospf
(Netgear Switch) (Interface vlan 20)#exit
```

## 4. Set the OSPF priority and cost for the VLAN and physical router ports.

```
(Netgear Switch) (Config)#interface vlan 10
(Netgear Switch) (Interface vlan 10)#ip ospf priority 128
(Netgear Switch) (Interface vlan 10)#ip ospf cost 32
(Netgear Switch) (Interface vlan 10)#exit
(Netgear Switch) (Config)#interface vlan 20
(Netgear Switch) (Interface vlan 20)#ip ospf priority 255
(Netgear Switch) (Interface vlan 20)#ip ospf cost 64
(Netgear Switch) (Interface vlan 20)#exit
(Netgear Switch) (Config)#exit
```

# Local Browser Interface: Configure VLAN Routing OSPF

## 1. Configure a VLAN and include ports 1/0/2 in the VLAN.

- a. Select **Routing > VLAN > VLAN Routing Wizard**.



A screen similar to the following displays.

The screenshot shows the 'VLAN Routing Wizard' configuration page. The 'Vlan ID' field contains '10', the 'IP Address' field contains '192.150.3.1', and the 'Network Mask' field contains '255.255.255.0'. Under the 'Unit 1' section, a grid of ports is displayed. Port 2 is highlighted with a gray box and the letter 'T', indicating it is selected for tagging.

- b. Enter the following information:
    - In the **Vlan ID** field, enter **10**.
    - In the **IP Address** field, enter **192.150.3.1**.
    - In the **Network Mask** field, enter **255.255.255.0**.
  - c. Click **Unit 1**. The ports display:
 

Click the gray box under port **2** until **T** displays. The T specifies that the egress packet is tagged for the port.
  - d. Click **Apply** to save the VLAN that includes ports 2.
2. Configure a VLAN, and include port 1/0/3 in the VLAN.
    - a. Select **Routing > VLAN > VLAN Routing Wizard**.

A screen similar to the following displays.

The screenshot shows the 'VLAN Routing Wizard' configuration page. The 'Vlan ID' field contains '20', the 'IP Address' field contains '192.150.4.1', and the 'Network Mask' field contains '255.255.255.0'. Under the 'Unit 1' section, a grid of ports is displayed. Port 3 is highlighted with a gray box and the letter 'T', indicating it is selected for tagging.

- b. Enter the following information:
  - In the **Vlan ID** field, enter **20**.
  - In the **IP Address** field, enter **192.150.4.1**.
  - In the **Network Mask** field, enter **255.255.255.0**.
- c. Click **Unit 1**. The ports display:
 

Click the gray box under port **3** until **T** displays. The T specifies that the egress packet is tagged for the port.

- d. Click **Apply** to save the VLAN that includes port 3.
3. Enable OSPF on the switch.
  - a. Select **Routing > OSPF > Basic > OSPF Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

OSPF

Basic

OSPF Configuration

Advanced

Admin Mode

Router ID

Disable

Enable

192.150.9.9

- b. For **OSPF Admin Mode**, select the **Enable** radio button.
- c. In the **Router ID** field, enter **192.150.9.9**.
- d. Click **Apply** to save the setting.
4. Enable OSPF on VLAN 10.
  - a. Select **Routing > OSPF > Advanced > Interface Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

OSPF

Basic

Advanced

OSPF Configuration

Common Area Configuration

Sub Area Configuration

NSSA Area Configuration

Area Range Configuration

Interface Configuration

OSPF Interface Configuration

1 2 VLANs All

Go To Interface

Go

| Interface | IP Address  | Subnet Mask   | Area ID | Admin Mode | Router Priority | Retransmit Interval | Hello Interval | Dead Interval | Interval Delay | LSA Ack Interval | RTU Ignore | Passive Mode | Interface Type |
|-----------|-------------|---------------|---------|------------|-----------------|---------------------|----------------|---------------|----------------|------------------|------------|--------------|----------------|
| Vlan 10   | 192.150.3.1 | 255.255.255.0 | 0.0.0.2 | Enable     | 128             | 5                   | 10             | 40            | 1              | 1                | Disable    | Disable      | Broadcast      |
| Vlan 10   | 192.150.3.1 | 255.255.255.0 | 0       | Disable    | 1               | 5                   | 10             | 40            | 1              | 1                | Disable    | Disable      | Broadcast      |
| Vlan 20   | 192.150.4.1 | 255.255.255.0 | 0       | Disable    | 1               | 5                   | 10             | 40            | 1              | 1                | Disable    | Disable      | Broadcast      |

1 2 VLANs All

Go To Interface

Go

- b. Under Interface Configuration, click **VLANs** to show all the VLAN interfaces.
- c. Scroll down and select the interface **0/2/1** check box. Now 0/2/1 appears in the Interface field at the top.
- d. Enter the following information:
  - In the **OSPF Area ID** field, enter **0.0.0.2**.
  - In the **OSPF Admin Mode** field, select **Enable**.
  - In the **Priority** field, enter **128**.
  - In the **Metric Cost** field, enter **32**.

- e. Click **Apply** to save the settings.
5. Enable OSPF on VLAN 20.
  - a. Select **Routing > OSPF > Advanced > Interface Configuration**.

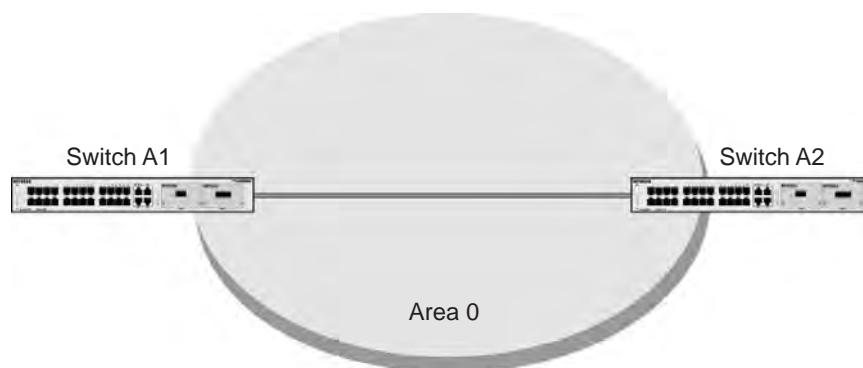
A screen similar to the following displays.

| Interface | IP Address  | Subnet Mask   | Area ID | Admin Mode | Router Priority | Retransmit Interval | Hello Interval | Dead Interval | Transmit Delay Interval | LSA Ack Interval | MTU Ignore | Passive Mode | Network Type |
|-----------|-------------|---------------|---------|------------|-----------------|---------------------|----------------|---------------|-------------------------|------------------|------------|--------------|--------------|
| vlan 20   | 192.150.4.1 | 255.255.255.0 | 0.0.0.3 | Enable     | 255             | 5                   | 10             | 40            | 1                       | 1                | Disable    | Disable      | Broadcast    |
| vlan 10   | 192.150.3.1 | 255.255.255.0 | 0.0.0.2 | Enable     | 128             | 5                   | 10             | 40            | 1                       | 1                | Disable    | Disable      | Broadcast    |
| vlan 20   | 192.150.4.1 | 255.255.255.0 | 0       | Disable    | 1               | 5                   | 10             | 40            | 1                       | 1                | Disable    | Disable      | Broadcast    |

- b. Under Interface Configuration, click **VLANs** to show all the VLAN interfaces.
- c. Scroll down and select the interface **0/2/2** check box. Now 0/2/2 appears in the Interface field at the top.
- d. Enter the following information:
  - In the **OSPF Area ID** field, enter **0.0.0.3**.
  - In the **OSPF Admin Mode** field, select the **Enable**.
  - In the **Priority** field, enter **255**.
  - In the **Metric Cost** field, enter **64**.
- e. Click **Apply** to save the settings.

## OSPFv3

OSPFv3 is the Open Shortest Path First routing protocol for IPv6. It is similar to OSPFv2 in its concept of a link state database, intra- and inter-area, and AS external routes and virtual links. It differs from its IPv4 counterpart in a number of respects, including the following: Peering is done through link-local addresses; the protocol is link based rather than network based; and addressing semantics have been moved to leaf LSAs, which eventually allow its use for both IPv4 and IPv6. Point-to-point links are also supported in order to enable operation over tunnels. It is possible to enable OSPF and OSPFv3 at the same time. OSPF works with IPv4, and OSPFv3 works with IPv6. The following example shows how to configure OSPFv3 on a IPv6 network.



**Figure 18. OSPFv3 Protocol for IPv6**

## CLI: Configure OSPFv3

1. On A1, enable IPv6 unicast routing on the switch.

```
(Netgear Switch) (Config)#ipv6 unicast-routing
```

2. Enable OSPFv3, and assign 1.1.1.1 to router ID.

```
(Netgear Switch) (Config)#ipv6 router ospf
(Netgear Switch) (Config-rtr)#enable
(Netgear Switch) (Config-rtr)#router-id 1.1.1.1
(Netgear Switch) (Config-rtr)#exit
```

3. Enable routing mode on the interface 1/0/1, and assign the IP address 2000::1 to IPv6.

```
(Netgear Switch) (Config)#interface 1/0/1
(Netgear Switch) (Interface 1/0/1)#routing
(Netgear Switch) (Interface 1/0/1)#ipv6 address 2000::1/64
(Netgear Switch) (Interface 1/0/1)#ipv6 enable
```

4. Enable OSPFv3 on the interface 1/0/1, and set the OSPF network mode to broadcast.

```
(Netgear Switch) (Interface 1/0/1)#ipv6 ospf
(Netgear Switch) (Interface 1/0/1)#ipv6 ospf network broadcast
(Netgear Switch) #show ipv6 ospf neighbor
```

| Router ID | Priority | Intf ID | Interface | State          | DeadTime |
|-----------|----------|---------|-----------|----------------|----------|
| 2.2.2.2   | 1        | 13      | 1/0/1     | Full/BACKUP-DR | 34       |

**5. On A2, enable IPv6 unicast routing on the switch.**

```
(Netgear Switch) (Config)#ipv6 unicast-routing
```

**6. Enable OSPFv3, and assign 2.2.2.2 as the router ID.**

```
(Netgear Switch) (Config)#ipv6 router ospf
(Netgear Switch) (Config-rtr)#enable
(Netgear Switch) (Config-rtr)#router-id 2.2.2.2
(Netgear Switch) (Config-rtr)#exit
```

**7. Enable routing mode on interface 1/0/13, and assign the IP address 2000::2 to IPv6.**

```
(Netgear Switch) (Config)#interface 1/0/13
(Netgear Switch) (Interface 1/0/13)#routing
(Netgear Switch) (Interface 1/0/13)#ipv6 address 2000::2/64
(Netgear Switch) (Interface 1/0/13)#ipv6 enable
```

**8. Enable OSPFv3 on interface 1/0/13, and set the OSPF network mode to broadcast.**

```
(Netgear Switch) (Interface 1/0/13)#ipv6 ospf
(Netgear Switch) (Interface 1/0/13)#ipv6 ospf network broadcast
(Netgear Switch) #show ipv6 ospf neighbor
```

| Router ID | Priority | IntfID | Interface | State    | DeadTime |
|-----------|----------|--------|-----------|----------|----------|
| -----     | -----    | -----  | -----     | -----    | -----    |
| 1.1.1.1   | 1        | 1      | 1/0/13    | Full/ DR | 34       |

## Local Browser Interface: Configure OSPFv3

1. Enable IPv6 unicast routing on the switch.
  - a. Select **Routing > IPv6 > Basic > IPv6 Global Configuration**.

A screen similar to the following displays.

| System   | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|--|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table  | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |
| <div> <div>IPv6</div> <div>IPv6 Global Configuration</div> </div> <div> <div> <div>• Basic</div> <div>• Global Configuration</div> <div>• Route Table</div> <div>• Advanced</div> </div> <div> <div>IPv6 Unicast Routing</div> <div>Hop Limit</div> <div>ICMPv6 Rate Limit Error Interval</div> <div>ICMPv6 Rate Limit Burst Size</div> </div> <div> <div> <input type="radio"/> Disable           <input checked="" type="radio"/> Enable         </div> <div>64 (1 to 255)</div> <div>1000 (0 to 2147483647 msecs)</div> <div>100 (1 to 200)</div> </div> </div> |           |         |      |          |            |             |        |                  |      |           |                |

- b. For IPv6 Unicast Routing Mode, select the **Enable** radio button.
  - c. Click **Apply** to save the settings.
2. Specify the router ID, and enable OSPFv3 for the switch.
  - a. Select **Routing > OSPFv3 > Basic > OSPFv3 Configuration**.

A screen similar to the following displays.

| System   | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|--|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table  | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |
| <div> <div>OSPFv3</div> <div>OSPFv3 Configuration</div> </div> <div> <div> <div>• Basic</div> <div>• OSPFv3 Configuration</div> <div>• Advanced</div> </div> <div> <div>Admin Mode</div> <div>Router ID</div> </div> <div> <div> <input type="radio"/> Disable           <input checked="" type="radio"/> Enable         </div> <div>1.1.1.1</div> </div> </div> |           |         |      |          |            |             |        |                  |      |           |                |

- b. Under the OSPF Configuration, enter the following information:
    - In the **Router ID** field, enter **1.1.1.1**.
    - For Admin Mode, select the **Enable** radio button.
  - c. Click **Apply** to save the settings.
3. Enable IPv6 on port 1/0/1.
  - a. Select **Routing > IPv6 > Advanced > IP Interface Configuration**.

A screen similar to the following displays.

| Interface | IPv6 Mode | DHCPv6 Client Mode | Stateless Address AutoConfig Mode | Routing Mode | Admin Mode | Operational Mode | MTU  | Duplicate Address Detection Transmits |
|-----------|-----------|--------------------|-----------------------------------|--------------|------------|------------------|------|---------------------------------------|
| 1/0/1     | Enable    | Disable            | Disable                           | Enable       | Enable     | Disable          | 1500 | 1                                     |
| 1/0/2     | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500 | 1                                     |

- b. Scroll down and select the interface **1/0/1** check box. Now 1/0/1 appears in the Interface field at the top.
  - c. Enter the following information:
    - In the **IPv6 Mode** field, select **Enable**.
    - In the **Routing Mode** field, select **Enable**.
  - d. Click **Apply** to save the settings.
4. Assign the IP address 2001::1 to port 1/0/1.
- a. Select **Routing > IPv6 > Advanced > IP Interface Configuration**.

A screen similar to the following displays.

| IPv6 Prefix               | Prefix Length | EUI64   | Valid Life Time | Preferred Life Time | Onlink Flag | Autonomous Flag | Current State |
|---------------------------|---------------|---------|-----------------|---------------------|-------------|-----------------|---------------|
| 2001::1                   | 64            | Disable |                 |                     |             |                 | [ACTIVE]      |
| fe80::220c:c8ff:fe4d:9e39 | 64            | Disable |                 |                     |             |                 |               |

- b. Under IPv6 Prefix Selection, in the **Interface** list, select **1/0/1**.
- c. Under IPv6 Interface Configuration, enter the following information:
  - In the **IPv6 Prefix** field, enter **2001::1**.
  - In the **Length** field, enter **64**.
  - In the **EUI64** field, select **Disable**.
  - In the **Onlink Flag** field, select **Disable**.
  - In the **Autonomous Flag** field, select **Disable**.



- d. Click **Add** to save the settings.
5. Enable OSPFv3 on port 1/0/1.
  - a. Select **Routing > OSPFv3 > Advanced > Interface Configuration**.

A screen similar to the following displays.

| System        | Switching |      |      | Routing |     | QoS  | Security | Monitoring       | Maintenance | Help      | Index          |  |
|---------------|-----------|------|------|---------|-----|------|----------|------------------|-------------|-----------|----------------|--|
| Routing Table | IP        | IPv6 | VLAN | ARP     | RIP | OSPF | OSPFv3   | Router Discovery | VRRP        | Multicast | IPv6 Multicast |  |

OSPFv3

• Basic

• Advanced

• OSPFv3 Configuration

• Common Area Configuration

• Stub Area Configuration

• NSSA Area Configuration

• Area Range Configuration

• Interface Configuration

OSPFv3 Interface Configuration

1 2 VLANs All

| <input type="checkbox"/>            | Interface | IPv6 Address | Area ID | Admin Mode | Router Priority | Retransmit Interval | Hello Interval | Dead Interval | LSA Ack Interval | lfransit Delay Interval | MTU Ignore |
|-------------------------------------|-----------|--------------|---------|------------|-----------------|---------------------|----------------|---------------|------------------|-------------------------|------------|
|                                     | 1/0/1     |              | 0.0.0.0 | Enable     | 1               | 5                   | 10             | 40            | 1                | 1                       | Disable    |
| <input checked="" type="checkbox"/> | 1/0/1     |              | 0.0.0.0 | Disable    | 1               | 5                   | 10             | 40            | 1                | 1                       | Disable    |
| <input type="checkbox"/>            | 1/0/2     |              | 0.0.0.0 | Disable    | 1               | 5                   | 10             | 40            | 1                | 1                       | Disable    |
| <input type="checkbox"/>            | 1/0/3     |              | 0.0.0.0 | Disable    | 1               | 5                   | 10             | 40            | 1                | 1                       | Disable    |
| <input type="checkbox"/>            | 1/0/4     |              | 0.0.0.0 | Disable    | 1               | 5                   | 10             | 40            | 1                | 1                       | Disable    |
| <input type="checkbox"/>            | 1/0/5     |              | 0.0.0.0 | Disable    | 1               | 5                   | 10             | 40            | 1                | 1                       | Disable    |
| <input type="checkbox"/>            | 1/0/6     |              | 0.0.0.0 | Disable    | 1               | 5                   | 10             | 40            | 1                | 1                       | Disable    |
| <input type="checkbox"/>            | 1/0/7     |              | 0.0.0.0 | Disable    | 1               | 5                   | 10             | 40            | 1                | 1                       | Disable    |
| <input type="checkbox"/>            | 1/0/8     |              | 0.0.0.0 | Disable    | 1               | 5                   | 10             | 40            | 1                | 1                       | Disable    |

- b. Under IP Interface Configuration, scroll down and select the interface **1/0/1** check box. Now 1/0/1 appears in the Interface field at the top.
  - In the **OSPF Area ID** field, enter **0.0.0.0**.
  - In the **Admin Mode** field, select **Enable**.
- c. Click **Apply** to save the settings.
6. Display the OSPFv3 Neighbor Table.
  - a. Select **Routing > OSPFv3 > Advanced > Neighbor Table**.

A screen similar to the following displays.

|               |           |         |      |          |            |             |        |                  |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

- OSPFv3 Configuration
- Common Area Configuration
- Stub Area Configuration
- NSSA Area Configuration
- Area Range Configuration
- Interface Configuration
- Interface Statistics
- Neighbor Table

OSPFv3 Neighbor Table

Search Interface

Go

| Interface | Interface Identifier | Router ID | Area ID | Options | Router Priority | State             | Dead Time(secs) | Events | Retransmission Queue length |
|-----------|----------------------|-----------|---------|---------|-----------------|-------------------|-----------------|--------|-----------------------------|
| 1/0/1     | 105                  | 2.2.2.2   | 0.0.0.0 | 19      | 1               | Loading/BACKUP-DR | 39              | 4      | 0                           |

To use the local browser interface to configure OSPF on switch A2, repeat this process for switch A2.

# 8

## PBR

---

### Policy-based routing

This chapter includes the following sections:

- [Policy-Based Routing Concepts](#)
- [Route-Map Statements](#)
- [PBR Processing Logic](#)
- [PBR Configurations](#)
- [PBR Example](#)

# Policy-Based Routing Concepts

Normally, switches make forwarding decisions based on routing tables, which get populated by information given by dynamic routing protocols or static routing, to forward packets to destination addresses. Policy-based routing (PBR) is a feature that enables network administrators to define forwarding behavior based on packet contents. PBR is used to override traditional destination-based routing behavior.

Configuring PBR involves configuring a route map with the `match` and `set` commands and then applying the corresponding route map to the inbound traffic on routing interfaces. One interface can contain only one route-map tag, but administrators can create multiple route-map entries with different sequence numbers. These entries are evaluated in sequence-number order until the first match is found. If no match is found, packets are routed as usual.

## Route-Map Statements

A route-map statement that is used for PBR is configured as permit or deny. If the statement is marked as deny, traditional destination-based routing is performed on the packet that meet the match criteria:

- If users specify any match/set statements in a route-map statement that are marked as deny, they will not be effective because traditional destination-based routing is performed on packets meeting the specified match criteria.
- If the statement is marked as permit, and if the packet meets all the match criteria, then the `set` commands in the route-map statement are applied.

If no match is found in the route map, the packet is not dropped. Packets are forwarded using the routing decision that is made by performing destination-based routing.

If network administrators do not want to revert to normal forwarding, but instead want to drop a packet that does not match the specified criteria, a `set` statement needs to be configured to route the packets to interface null 0 as the last entry in the route map.

Packets that are generated by the switch itself are not normally policy routed. But a provision in other industry standard products applies a policy through a local PBR. All packets originating on the switch are then subject to the local PBR. However, this feature is not supported.

Starting with Software Version 10.2, the NETGEAR switch supports the route-map infrastructure for BGP. Match parameters defined in this chapter for policy-based routing operate in isolation with BGP. These options do not interfere with BGP protocol processing or policy propagation in any way.

For example, if a match clause is placed in a route-map statement based on the length of the packet, BGP does not honor that clause. As stated earlier, these statements apply for L3 routed traffic (mainly data traffic) to override a routing decision.

To classify L3 routed traffic, the switch supports the following packet entities:

- The size of the packet
- Protocol of the payload (Protocol ID field in IP header)
- Source MAC address
- Source IP address
- Destination IP address
- Priority (802.1P priority)

NETGEAR's policy-based routing feature overrides routing decisions taken by the switch and makes the packet follow different actions specified in the following order to define forwarding criteria:

- **List of next hop IP addresses.** The IP address can specify the adjacent next hop router in the path toward the destination to which the packets should be forwarded. The first IP address associated with a currently active ARP entry is used to route the packets.
- **List of default next hop IP addresses.** This list indicates the next-hop routers to which a packet must be routed if no active route exists for the packet's destination address in the routing table. With the policy-based routing feature, a default route in the routing table is not considered an active route for an unknown destination address.
- **IP precedence.** A numeric value can be specified to set the precedence in the IP packets being forwarded. IP precedence value implies 3 IP precedence bits in the IP packet header. With 3 bits, network administrators have 8 possible values for the IP precedence. This value will be set in IPV4 header of packets when configured.

## PBR Processing Logic

The processing logic used by policy-based routing is as follows when a packet is received on an interface configured with a route map, the forwarding logic processes each route-map statement according to the sequence number.

The route map with a permit statement uses the following logic:

- The incoming packet is matched against the criteria in the match term specified in the route map. This match command can refer to an IP/MAC access list. An ACL that is used in the match term itself includes one or more permit or deny rules. Now, the incoming packet is matched against the rules in the AC, and a permit or deny decision is reached.
- If the decision reached in the previous step is permit, then policy-based routing executes the action specified in set terms of the route-map statement over an incoming packet.
- If the decision reached in the earlier step is deny, then policy-based routing does not apply any action that is specified in set terms in the route-map statement. In this situation, the counter for this match statement is not incremented and the processing logic moves to next route-map statement in the sequence. If no next route-map statement exists, the processing logic terminates and the packet goes through standard destination-based routing logic.

The route map with a deny statement uses the following logic:

- The incoming packet is matched against the criteria in the match term specified in the route map. This match command can refer to an IP/MAC access list. An ACL that is used in the match term itself has one or more permit or deny rules. Now, the incoming packet is matched against the rules in the ACL, and a permit or deny decision is reached.
- If the decision reached in the previous step is permit, then policy-based routing processing logic terminates and the packet goes through standard destination-based routing logic.
- If the decision reached in the earlier step is deny, the counter for this match statement is not incremented and the processing logic moves to next route-map statement in the sequence. If no next route-map statement exists, the processing logic terminates and the packet goes through standard destination-based routing logic.

The following table specifies the desired actions:

**Table 2. Desired actions**

| ACL    | Match | Outcome | Route Map | Action |
|--------|-------|---------|-----------|--------|
| Permit | Yes   | Permit  | Permit    | Set    |
| Permit | No    | Deny    | Permit    | Next   |
| Permit | Yes   | Permit  | Deny      | Route  |
| Permit | No    | Deny    | Deny      | Next   |
| Deny   | Yes   | Deny    | Permit    | Next   |
| Deny   | No    | Deny    | Permit    | Next   |
| Deny   | Yes   | Deny    | Deny      | Next   |
| Deny   | No    | Deny    | Deny      | Next   |

The following actions are taken:

- **Next.** Fall through to the next route map, and if no further route maps exist, route using the default routing table.
- **Set.** Route according to the action in the set clause.
- **Route** (alone). Route using the default routing table.

# PBR Configurations

PBR is configurable on the following types of eligible routing interfaces:

- Physical ports
- VLAN interfaces

On VLAN interfaces, when an ACL is applied, it implies that when any packet arrives with a corresponding VLAN ID on any port, it is matched and a corresponding action is taken.

The same phenomenon applies to ACLs specified in the match clause of PBR. That is, if a PBR route map is applied on a VLAN interface, any packet coming with a corresponding VLAN ID on any port is matched against PBR rules corresponding to the match ACL clause and the corresponding set actions are taken into effect. To perform policy-based routing based on VLAN ID as the matching criteria for incoming packets, apply an ACL rule on the VLAN interface, but do not configure a rule with the VLAN ID as the match condition.

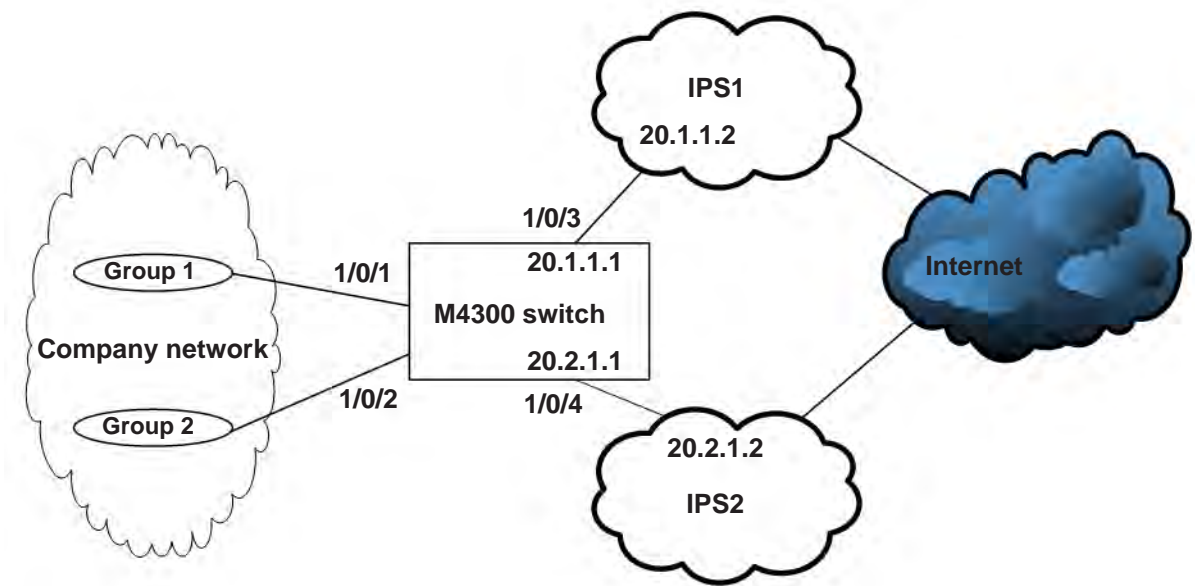
PBR supports the preconfiguration of the route map on routing interfaces. If routing is not enabled on an interface, the route map can still be applied on that particular interface. When routing is not enabled on an interface, route-map configuration is not pushed into hardware. Rather, it is maintained only in configuration. As soon as routing is enabled on that particular interface, configuration is applied to hardware.

## PBR Example

Network administrators can use PBR when load sharing must be done for the incoming traffic across multiple paths based on packet entities in the incoming traffic.

Normally, to optimally utilize the data networks of the organization, the bulk traffic associated with the company activity must use a higher-bandwidth, high-cost (price of link) link while the basic connectivity continues over a lower bandwidth, low-cost link for interactive traffic. For such applications, policy-based routing is the right fit.

Consider the network that is composed of two groups with different IP address ranges. If group1 addresses must be routed through ISP1 and group2 addresses must be routed through ISP2, the switch that is connected with different groups must be policy routed. Configure a match in the route map on the IP address range of different groups. This way, an equal access as well as source IP address-sensitive routing is achieved through PBR.



**Figure 19. PBR topology**

1. Create an IP ACL 1 to match 10.1.0.0/16.

```
(Netgear Switch) (Config) #access-list 1 permit 10.1.0.0 0.0.255.255
```

2. Create an IP ACL 2 to match 10.2.0.0/16.

```
(Netgear Switch) (Config)#access-list 2 permit 10.2.0.0 0.0.255.255
```

3. Create a route map pbr\_1 with sequence number 10 to match ip ACL 1.

```
(Netgear Switch) (Config) #route-map pbr_1 permit 10
(Netgear Switch) (route-map) #match ip address 1
(Netgear Switch) (route-map) #set ip next-hop 20.1.1.2
(Netgear Switch) (route-map) #exit
```

4. Create a route map pbr\_1 with sequence number 11 to match ip ACL 2.

```
(Netgear Switch) (Config) # route-map pbr_1 permit 11
(Netgear Switch) (route-map) #match ip address 2
(Netgear Switch) (route-map) #set ip next-hop 20.2.1.2
(Netgear Switch) (route-map) #exit
```



**5. Create VLAN 30 and put interface 1/0/1 and 1/0/2 into it.**

```
(Netgear Switch) #vlan database
(Netgear Switch) (Vlan) #vlan 30
(Netgear Switch) (Vlan) #vlan routing 30
(Netgear Switch) (Vlan) #exit
(Netgear Switch) (Config) #interface 1/0/1-1/0/2
(Netgear Switch) (Interface 1/0/1-1/0/2) #vlan participation include 30
(Netgear Switch) (Interface 1/0/1-1/0/2) #vlan pvid 30
(Netgear Switch) (Interface 1/0/1-1/0/2) #exit
(Netgear Switch) (Config) #interface vlan 30
(Netgear Switch) (Interface vlan 30) #routing
(Netgear Switch) (Interface vlan 30) #ip address 10.1.1.1 255.0.0.0
(Netgear Switch) (Interface vlan 30) #exit
```

**6. Enable PBR on VLAN 30.**

```
(Netgear Switch) (Config) #interface vlan 30
(Netgear Switch) (Interface vlan 30) #routing
(Netgear Switch) (Interface vlan 30) #ip policy route-map pbr_1
(Netgear Switch) (Interface vlan 30) #exit
```

**7. Configure IP address 20.1.1.1 on interface 1/0/3.**

```
(Netgear Switch) (Config) #interface 1/0/3
(Netgear Switch) (Interface 1/0/3) #routing
(Netgear Switch) (Interface 1/0/3) #ip add 20.1.1.1 /16
```

**8. Configure IP address 20.2.1.1 on interface 1/0/4.**

```
(Netgear Switch) (Config) #interface 1/0/4
(Netgear Switch) (Interface 1/0/4) #routing
(Netgear Switch) (Interface 1/0/4) #ip add 20.2.1.1 /16
```

# 9

## ARP

---

### Proxy Address Resolution Protocol

This chapter includes the following sections:

- [Proxy ARP Concepts](#)
- [Proxy ARP Examples](#)

# Proxy ARP Concepts

Proxy ARP allows a router to answer ARP requests when the target IP address is not that of the router itself but a destination that the router can reach. If a host does not know the default gateway, proxy ARP can learn the first hop. Machines in one physical network appear to be part of another logical network. Without proxy ARP, a router responds to an ARP request only if the target IP address is an address configured on the interface where the ARP request arrived.

# Proxy ARP Examples

The following are examples of the commands used in the proxy ARP feature.

## CLI: show ip interface

```
(Netgear Switch) #show ip interface ?

<slot/port>          Enter an interface in slot/port format.
brief                Display summary information about IP configuration
                     settings for all ports.

(Netgear Switch) #show ip interface 0/24

Routing Mode..... Disable
Administrative Mode..... Enable
Forward Net Directed Broadcasts..... Disable
Proxy ARP..... Disable
Active State..... Inactive
Link Speed Data Rate..... Inactive
MAC Address..... 08:00:17:05:05:02
Encapsulation Type..... Ethernet
IP MTU..... 1500
```

## CLI: ip proxy-arp

```
(Netgear Switch) (Interface 0/24)#ip proxy-arp ?

<cr>                               Press Enter to execute the command.

(Netgear Switch) (Interface 0/24)#ip proxy-arp
```

## Local Browser Interface: Configure Proxy ARP on a Port

### 1. Select **Routing > IP > Advanced > IP Interface Configuration**.

A screen similar to the following displays.

System

Switching

Routing

QoS

Security

Monitoring

Maintenance

Help

Index

Routing Table

IP

IPv6

VLAN

ARP

RIP

OSPF

OSPFv3

Router Discovery

VRRP

Multicast

IPv6 Multicast

IP

IP Interface Configuration

• Basic

• Advanced

• IP Configuration

• Statistics

• IP Interface Configuration

• Secondary IP

1 2 VLANs All

| Forward Net Directed Broadcasts | Active State | MAC Address       | Encapsulation Type | Proxy Arp | Local Proxy Arp | Bandwidth | ICMP Destination Unreachables |
|---------------------------------|--------------|-------------------|--------------------|-----------|-----------------|-----------|-------------------------------|
| Disable                         | Inactive     | 20:0C:C8:4D:95:98 | Ethernet           | Enable    | Disable         | 100000    | Enable                        |
| Disable                         | Active       | 20:0C:C8:4D:95:98 | Ethernet           | Enable    | Disable         | 1000000   | Enable                        |
| Disable                         | Inactive     | 20:0C:C8:4D:95:98 | Ethernet           | Enable    | Disable         | 100000    | Enable                        |
| Disable                         | Inactive     | 20:0C:C8:4D:95:98 | Ethernet           | Enable    | Disable         | 100000    | Enable                        |

- Under Configuration, scroll down and select the Interface **1/0/3** check box. Now 1/0/3 appears in the Interface field at the top.
- In the **Proxy Arp** field, select **Enable**.
- Click **Apply** to save the settings.

# 10

## 10 VRRP

---

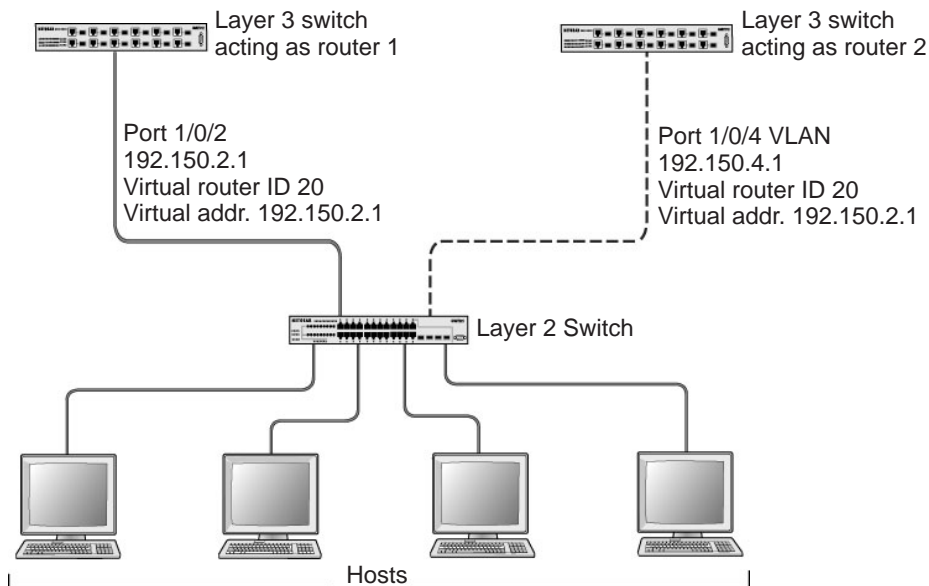
### Virtual Router Redundancy Protocol

This chapter includes the following sections:

- [Virtual Router Redundancy Protocol Concepts](#)
- [VRRP on a Master Router](#)
- [VRRP on a Backup Router](#)

# Virtual Router Redundancy Protocol Concepts

When an end station is statically configured with the address of the router that will handle its routed traffic, a single point of failure is introduced into the network. If the router goes down, the end station is unable to communicate. Since static configuration is a convenient way to assign router addresses, Virtual Router Redundancy Protocol (VRRP) was developed to provide a backup mechanism.



**Figure 20. VRRP**

VRRP eliminates the single point of failure associated with static default routes by enabling a backup router to take over from a master router without affecting the end stations using the route. The end stations use a virtual IP address that is recognized by the backup router if the master router fails. Participating routers use an election protocol to determine which router is the master router at any given time. A given port could appear as more than one virtual router to the network. Also, more than one port on the switch can be configured as a virtual router. Either a physical port or a routed VLAN can participate.

# VRRP on a Master Router

This example shows how to configure the switch to support VRRP. Router 1 is the default master router for the virtual route, and Router 2 is the backup router.

## CLI: Configure VRRP on a Master Router

1. Enable routing for the switch. IP forwarding will then be enabled by default.

```
(Netgear Switch) #config  
(Netgear Switch) (Config)#ip routing
```

2. Configure the IP addresses and subnet masks for the port that will participate in the protocol.

```
(Netgear Switch) (Config)#interface 1/0/2  
(Netgear Switch) (Interface 1/0/2)#routing  
(Netgear Switch) (Interface 1/0/2)#ip address 192.150.2.1 255.255.0.0  
(Netgear Switch) (Interface 1/0/2)#exit
```

3. Enable VRRP for the switch.

```
(Netgear Switch) (Config)#ip vrrp
```

4. Assign virtual router IDs to port that will participate in the protocol.

```
(Netgear Switch) (Config)#interface 1/0/2  
(Netgear Switch) (Interface 1/0/2)#ip vrrp 20
```

5. Specify the IP address that the virtual router function will recognize. Note that the virtual IP address on port 1/0/2 is the same as the port's actual IP address therefore, this router will always be the VRRP master when it is active. The default priority is 255.

```
(Netgear Switch) (Interface 1/0/2)#ip vrrp 20 ip 192.150.2.1
```

6. Enable VRRP on the port.

```
(Netgear Switch) (Interface 1/0/2)#ip vrrp 20 mode  
(Netgear Switch) (Interface 1/0/2)#exit  
(Netgear Switch) (Config)#exit
```



## Local Browser Interface: Configure VRRP on a Master Router

1. Enable IP routing on the switch.

- a. Select **Routing > IP > Basic > IP Configuration**.

A screen similar to the following displays.

| System   | Switching | Routing   | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|--|-----------|---|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table  | IP        | IPv6  | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |
| <div> <div>IP</div> <div>IP Configuration</div> </div>   |           |   |      |          |            |             |        |                  |      |           |                |
| <ul style="list-style-type: none"> <li>Basic</li> <li><b>IP Configuration</b></li> <li>Statistics</li> <li>Advanced</li> </ul> |           | <div> <div>Default Time to Live</div> <div>64</div> </div> <div> <div>Routing Mode</div> <div> <input checked="" type="radio"/> Enable           <input type="radio"/> Disable         </div> </div> <div> <div>ICMP Echo Replies</div> <div> <input checked="" type="radio"/> Enable           <input type="radio"/> Disable         </div> </div> <div> <div>ICMP Redirects</div> <div> <input type="radio"/> Enable           <input checked="" type="radio"/> Disable         </div> </div> <div> <div>ICMP Rate Limit Interval</div> <div> <input type="text" value="1000"/> <small>(0 to 2147483647 ms)</small> </div> </div> <div> <div>ICMP Rate Limit Burst Size</div> <div> <input type="text" value="100"/> <small>(1 to 200)</small> </div> </div> <div> <div>Maximum Next Hops</div> <div><input type="text" value="4"/></div> </div> <div> <div>Maximum Routes</div> <div><input type="text" value="8160"/></div> </div> <div> <div>Select to configure Global Default Gateway</div> <div><input type="checkbox"/></div> </div> <div> <div>Global Default Gateway</div> <div><input type="text" value="192.168.10.1"/></div> </div> |      |          |            |             |        |                  |      |           |                |

- b. For Routing Mode, select the **Enable** radio button.

- c. Click **Apply** to save the settings.

2. Assign the IP address 192.150.2.1 to port 1/0/2:

- a. Select **Routing > IP > Advanced > IP Interface Configuration**.

A screen similar to the following displays.

| System   | Switching   | Routing  | QoS                             | Security    | Monitoring    | Maintenance  | Help                | Index            |      |           |                |      |             |         |                                 |            |             |              |                     |                                |  |  |        |             |               |        |        |   |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
|--|-------------|--|---------------------------------|-------------|---------------|--------------|---------------------|------------------|------|-----------|----------------|------|-------------|---------|---------------------------------|------------|-------------|--------------|---------------------|--------------------------------|--|--|--------|-------------|---------------|--------|--------|---|--|--|------|---------|---------|---------|--------|--------------------------------|--|--|------|---------|---------|---------|--------|
| Routing Table  | IP          | IPv6   | VLAN                            | ARP         | RIP           | OSPF         | OSPFv3              | Router Discovery | VRRP | Multicast | IPv6 Multicast |      |             |         |                                 |            |             |              |                     |                                |  |  |        |             |               |        |        |   |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <div> <div>IP</div> <div>IP Interface Configuration</div> </div>   |             |  |                                 |             |               |              |                     |                  |      |           |                |      |             |         |                                 |            |             |              |                     |                                |  |  |        |             |               |        |        |   |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <ul style="list-style-type: none"> <li>Basic</li> <li>Advanced</li> <li>IP Configuration</li> <li>Statistics</li> <li><b>IP Interface Configuration</b></li> <li>Secondary IP</li> </ul> |             | <div>1 3 VLANs All</div> <table border="1"> <thead> <tr> <th>Port</th> <th>Description</th> <th>VLAN ID</th> <th>IP Address Configuration Method</th> <th>IP Address</th> <th>Subnet Mask</th> <th>Routing Mode</th> <th>Administrative Mode</th> </tr> </thead> <tbody> <tr> <td><input type="checkbox"/> 1/0/1</td> <td></td> <td></td> <td>Manual</td> <td>192.150.2.1</td> <td>255.255.255.0</td> <td>Enable</td> <td>Enable</td> </tr> <tr> <td><input checked="" type="checkbox"/> 1/0/2</td> <td></td> <td></td> <td>None</td> <td>0.0.0.0</td> <td>0.0.0.0</td> <td>Disable</td> <td>Enable</td> </tr> <tr> <td><input type="checkbox"/> 1/0/3</td> <td></td> <td></td> <td>None</td> <td>0.0.0.0</td> <td>0.0.0.0</td> <td>Disable</td> <td>Enable</td> </tr> </tbody> </table> |                                 |             |               |              |                     |                  |      |           |                | Port | Description | VLAN ID | IP Address Configuration Method | IP Address | Subnet Mask | Routing Mode | Administrative Mode | <input type="checkbox"/> 1/0/1 |  |  | Manual | 192.150.2.1 | 255.255.255.0 | Enable | Enable | <input checked="" type="checkbox"/> 1/0/2 |  |  | None | 0.0.0.0 | 0.0.0.0 | Disable | Enable | <input type="checkbox"/> 1/0/3 |  |  | None | 0.0.0.0 | 0.0.0.0 | Disable | Enable |
| Port   | Description | VLAN ID  | IP Address Configuration Method | IP Address  | Subnet Mask   | Routing Mode | Administrative Mode |                  |      |           |                |      |             |         |                                 |            |             |              |                     |                                |  |  |        |             |               |        |        |   |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input type="checkbox"/> 1/0/1   |             |  | Manual                          | 192.150.2.1 | 255.255.255.0 | Enable       | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |                                |  |  |        |             |               |        |        |   |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input checked="" type="checkbox"/> 1/0/2  |             |  | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |                                |  |  |        |             |               |        |        |   |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input type="checkbox"/> 1/0/3   |             |  | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |                                |  |  |        |             |               |        |        |   |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |

- b. Scroll down and select the Interface **1/0/2** check box.

Now 1/0/2 appears in the Interface field at the top.

- c. Enter the following information:

- In the **IP Address** field, enter **192.150.2.1**.
- In the **Network Mask** field, enter **255.255.0.0**.
- In the **Routing Mode** field, select **Enable**.

- d. Click **Apply** to save the settings.

3. Enable VRRP on port 1/0/2.

- a. Select **Routing > VRRP > Advanced > VRRP Configuration**.

A screen similar to the following displays.

| VRID (1 to 255) | Interface | Interface IP Address | Primary IP Address | Mode   | State |
|-----------------|-----------|----------------------|--------------------|--------|-------|
| 20              | 1/0/2     |                      | 192.150.2.1        | Active |       |

- b. Under Global Configuration, next to the Admin Mode, select **Enable** radio button.
- c. Enter the following information in the VRRP Configuration:
  - In the **VRID (1 to 255)** field, enter **20**.
  - In the **Interface** field, select **1/0/2**.
  - In the **Primary IP Address** field, enter **192.150.2.1**.
  - In the **Mode** field, select **Active**.
- d. Click **Apply** to save the settings.

## VRRP on a Backup Router

The example is shown as CLI commands and as a local browser interface procedure.

### CLI: Configure VRRP on a Backup Router

1. Enable routing for the switch. IP forwarding will then be enabled by default.

```
(Netgear Switch) #config
(Netgear Switch) (Config)#ip routing
```

2. Configure the IP addresses and subnet masks for the port that will participate in the protocol.

```
(Netgear Switch) (Config)#interface 1/0/4
(Netgear Switch) (Interface 1/0/4)#routing
(Netgear Switch) (Interface 1/0/4)#ip address 192.150.4.1 255.255.0.0
(Netgear Switch) (Interface 1/0/4)#exit
```

3. Enable VRRP for the switch.

```
(Netgear Switch) (Config)#ip vrrp
```

4. Assign virtual router IDs to port that will participate in the protocol.

```
(Netgear Switch) (Config)#interface 1/0/4
(Netgear Switch) (Interface 1/0/4)#ip vrrp 20
```

5. Specify the IP address that the virtual router function will recognize. Since the virtual IP address on port 1/0/4 is the same as Router 1's port 1/0/2 actual IP address, this router will always be the VRRP backup when Router 1 is active.

```
(Netgear Switch) (Interface 1/0/4)#ip vrrp 20 ip 192.150.2.1
```

6. Set the priority for the port. The default priority is 100.

```
(Netgear Switch) (Interface 1/0/4)#ip vrrp 20 priority 254
```

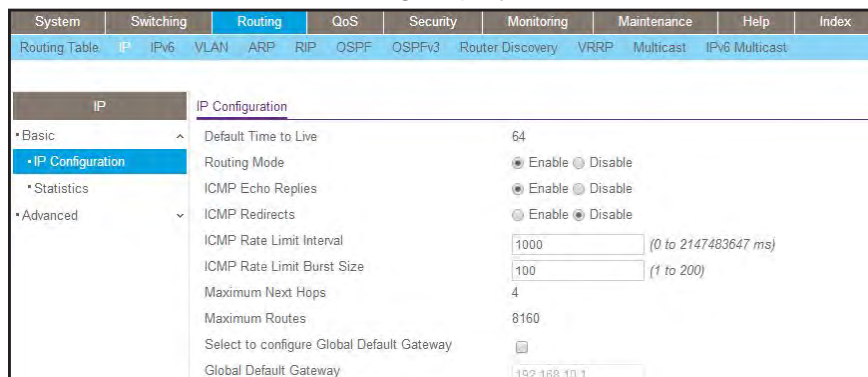
7. Enable VRRP on the port.

```
(Netgear Switch) (Interface 1/0/4)#ip vrrp 20 mode
(Netgear Switch) (Interface 1/0/4)#exit
(Netgear Switch) (Config)#exit
```

## Local Browser Interface: Configure VRRP on a Backup Router

1. Enable IP routing on the switch.
  - a. Select **Routing > IP > IP Configuration**.

A screen similar to the following displays.



- b. For Routing Mode, select the **Enable** radio button.
  - c. Click **Apply** to save the settings.
2. Assign IP address 192.150.4.1 to port 1/0/4.
  - a. Select **Routing > IP > Advanced > IP Interface Configuration**.

A screen similar to the following displays.

| Port                                      | Description | VLAN ID | IP Address Configuration Method | IP Address  | Subnet Mask | Routing Mode | Administrative Mode |
|---|-------------|---------|---------------------------------|-------------|-------------|--------------|---------------------|
| 1/0/4                                     |             |         | Manual                          | 192.150.4.1 | 255.255.0.0 | Enable       | Enable              |
| <input type="checkbox"/> 1/0/1            |             |         | None                            | 0.0.0.0     | 0.0.0.0     | Disable      | Enable              |
| <input type="checkbox"/> 1/0/2            |             |         | None                            | 0.0.0.0     | 0.0.0.0     | Disable      | Enable              |
| <input type="checkbox"/> 1/0/3            |             |         | None                            | 0.0.0.0     | 0.0.0.0     | Disable      | Enable              |
| <input checked="" type="checkbox"/> 1/0/4 |             |         | None                            | 0.0.0.0     | 0.0.0.0     | Disable      | Enable              |
| <input type="checkbox"/> 1/0/5            |             |         | None                            | 0.0.0.0     | 0.0.0.0     | Disable      | Enable              |
| <input type="checkbox"/> 1/0/6            |             |         | None                            | 0.0.0.0     | 0.0.0.0     | Disable      | Enable              |

- b. Scroll down and select the Interface **1/0/4** check box.

Now 1/0/4 appears in the Interface field at the top.

- c. Enter the following information:

- In the **IP Address** field, enter **192.150.4.1**.
- In the **Network Mask** field, enter **255.255.0.0**.
- In the **Administrative Mode** field, select **Enable**.

- d. Click **Apply** to save the settings.

3. Enable VRRP on port 1/0/4.

- a. Select **Routing > VRRP > Basic > VRRP Configuration**.

A screen similar to the following displays.

| VRID (1 to 255) | Interface | Pre-empt Mode | Accept Mode | Configured Priority (1 to 254) | Operational Priority | Advertisement Interval (1 to 255) | Interface IP Address | Owner | VMAC Address | Primary IP Address | Auth Type |
|-----------------|-----------|---------------|-------------|--------------------------------|----------------------|-----------------------------------|----------------------|-------|--------------|--------------------|-----------|
| 1               | 1/0/4     |               |             | 254                            |                      | 1                                 |                      |       |              | 192.150.2.1        |           |

- b. Under Global Configuration, for Admin Mode, select the **Enable** radio button.

- c. Enter the following information:

- In the **VRID (1 to 255)** field, enter **20**.
- In the **Interface** field, select **1/0/4**.
- In the **Priority (1 to 255)**, enter **254**.
- In the **Primary IP Address** field, enter **192.150.2.1**.
- In the **Status** list, select **Active**.

- d. Click **Add** to save the settings.

# 11

## ACLs

---

### Access Control Lists

This chapter includes the following sections:

- [Access Control List Concepts](#)
- [MAC ACLs](#)
- [Set Up an IP ACL with Two Rules](#)
- [One-Way Access Using a TCP Flag in an ACL](#)
- [Use ACLs to Configure Isolated VLANs on a Layer 3 Switch](#)
- [Set up a MAC ACL with Two Rules](#)
- [Configure ACL Mirroring](#)
- [Configure ACL Redirection](#)
- [Add ACL Remarks](#)
- [Change the Sequence of an ACL Rule](#)
- [Configure a Management ACL](#)
- [Configure IPv6 ACLs](#)

# Access Control List Concepts

Access control lists (ACLs) can control the traffic entering a network. Normally ACLs reside in a firewall router or in a router connecting two internal networks. When you configure ACLs, you can selectively admit or reject inbound traffic, thereby controlling access to your network or to specific resources on your network.

You can set up ACLs to control traffic at Layer 2-, or Layer 3. MAC ACLs are used for Layer 2. IP ACLs are used for Layer 3. Each ACL contains a set of rules that apply to inbound traffic. Each rule specifies whether the contents of a given field should be used to permit or deny access to the network, and may apply to one or more of the fields within a packet.

The following limitations apply to ACLs. These limitations are platform-dependent.

- The maximum of number of ACLs is 100.
- The maximum number of rules per ACL is 8–10.
- Stacking systems do not support redirection.
- The system does not support MAC ACLs and IP ACLs on the same interface.
- The system supports ACLs set up for inbound traffic only.

## MAC ACLs

MAC ACLs are Layer 2 ACLs. You can configure the rules to inspect the following fields of a packet (limited by platform):

- Source MAC address with mask.
- Destination MAC address with mask.
- VLAN ID (or range of IDs).
- Class of Service (CoS) (802.1p).
- EtherType:
  - Secondary CoS (802.1p).
  - Secondary VLAN (or range of IDs).
- L2 ACLs can apply to one or more interfaces.
- Multiple access lists can be applied to a single interface: the sequence number determines the order of execution.
- You can assign packets to queues using the assign queue option.
- You can redirect packets using the redirect option.

## IP ACLs

IP ACLs classify for Layer 3. Each ACL is a set of up to 10 rules applied to inbound traffic. Each rule specifies whether the contents of a given field should be used to permit or deny access to the network, and can apply to one or more of the following fields within a packet:

- Source IP address
- Destination IP address
- Source Layer 4 port
- Destination Layer 4 port
- ToS byte
- Protocol number

Note that the order of the rules is important: When a packet matches multiple rules, the first rule takes precedence. Also, once you define an ACL for a given port, all traffic not specifically permitted by the ACL is denied access.

## ACL Configuration

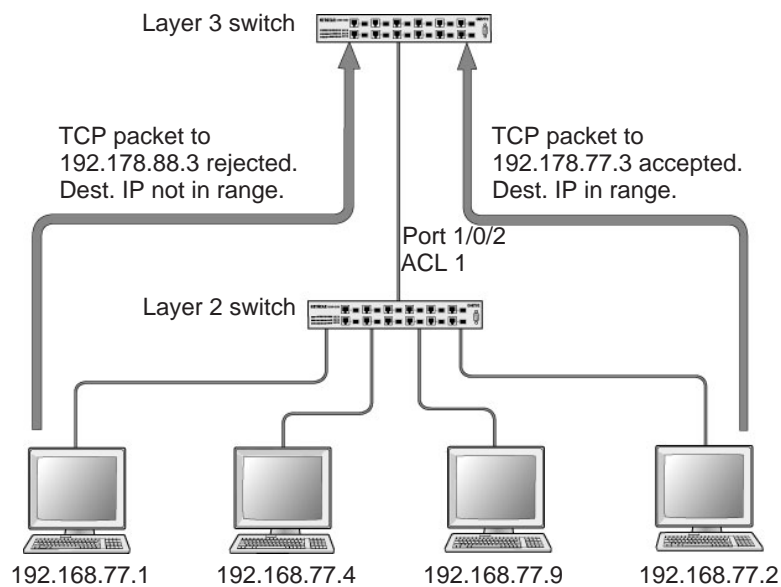
To configure ACLs:

1. Create an ACL by specifying a name (MAC ACL or named IP ACL) or a number (IP ACL).
2. Add new rules to the ACL.
3. Configure the match criteria for the rules.
4. Apply the ACL to one or more interfaces.

## Set Up an IP ACL with Two Rules

This section shows you how to set up an IP ACL with two rules, one applicable to TCP traffic and one to UDP traffic. The content of the two rules is the same. TCP and UDP packets will be accepted by the switch only if the source and destination stations have IP addresses within the defined sets.





**Figure 21. IP ACL with rules for TCP traffic and UDP traffic**

## CLI: Set Up an IP ACL with Two Rules

The following is an example of configuring ACL support on a 7000 Series Managed Switch.

Create ACL 101. Define the first rule: The ACL will permit packets that match the specified source IP address (after the mask has been applied), that are carrying TCP traffic, and that are sent to the specified destination IP address.

1. Enter these commands:

```
(Netgear Switch) #config
(Netgear Switch) (Config)#access-list 101 permit tcp 192.168.77.0 0.0.0.255
192.178.77.0 0.0.0.255
```

2. Define the second rule for ACL 101 to set conditions for UDP traffic similar to those for TCP traffic.

```
(Netgear Switch) (Config)#access-list 101 permit udp 192.168.77.0 0.0.0.255
192.178.77.0 0.0.0.255
```

3. Apply the rule to inbound traffic on port 1/0/2. Only traffic matching the criteria will be accepted.

```
(Netgear Switch) (Config)#interface 1/0/2
(Netgear Switch) (Interface 1/0/2)#ip access-group 101 in
(Netgear Switch) (Interface 1/0/2)#exit
(Netgear Switch) (Config)#exit
```

## Local Browser Interface: Set Up an IP ACL with Two Rules

1. Create IP ACL 101 on the switch.
  - a. Select **Security > ACL > IP ACL**.

A screen similar to the following displays.

| System              | Switching | Routing             | QoS             | Security | Monitoring | Maintenance | Help | Index |
|---------------------|-----------|---------------------|-----------------|----------|------------|-------------|------|-------|
| Management Security | Access    | Port Authentication | Traffic Control | Control  | ACL        |             |      |       |

ACL
 

- ACL Wizard
- Basic
- Advanced
- **IP ACL**
- IP Rules
- IP Extended Rules
- IPv6 ACL
- IPv6 Rules
- IP Binding Configuration
- Binding Table
- VLAN Binding Table

**IP ACL Configuration**

Current Number of ACL: 0
 Maximum ACL: 100

**IP ACL Table**

| IP ACL ID | Rules | Type |
|-----------|-------|------|
| 101       |       |      |

- b. In the **IP ACL ID** field, enter **101**.
  - c. Click **Add** to create ACL 101.
2. Create a new rule associated with ACL 101.
    - a. Select **Security > ACL > IP ACL > IP Extended Rules**.

A screen similar to the following displays.

| System              | Switching | Routing             | QoS             | Security | Monitoring | Maintenance | Help | Index |
|---------------------|-----------|---------------------|-----------------|----------|------------|-------------|------|-------|
| Management Security | Access    | Port Authentication | Traffic Control | Control  | ACL        |             |      |       |

ACL
 

- ACL Wizard
- Basic
- Advanced
- IP ACL
- IP Rules
- **IP Extended Rules**
- IPv6 ACL
- IPv6 Rules
- IP Binding Configuration
- Binding Table
- VLAN Binding Table

**IP Rules**

ACL ID/Name: 101
 Add Delete Cancel

**Extended ACL Rule Table**

| Rule ID                                    | Action | Logging | Assign Queue ID | Admin Interface | Redirect Interface | Match Entry | Protocol Type | TCR Flag | Established | Source IP Address | Source IP Mask | Source IP Port Action | Source IP Port | Source IP Start Port | Source IP End Port | Destination IP Address |
|--|--------|---------|-----------------|-----------------|--------------------|-------------|---------------|----------|-------------|-------------------|----------------|-----------------------|----------------|----------------------|--------------------|------------------------|
| No rules have been configured for this ACL |        |         |                 |                 |                    |             |               |          |             |                   |                |                       |                |                      |                    |                        |

- b. For ACL ID, select **101**.

- c. Click **Add** to create a new rule.
3. Create a new ACL rule and add it to ACL 101.
  - a. After you click the **Add** button in step 2, a screen similar to the following displays.

The screenshot shows the 'Extended ACL Rule Configuration(100-199)' window. On the left, a sidebar lists configuration options: ACL Wizard, Basic, Advanced, IP ACL, IP Rules, IP Extended Rules (selected), IPv6 ACL, IPv6 Rules, IP Binding Configuration, Binding Table, and VLAN Binding Table. The main area contains the following fields and values:

- ACL ID/Name:** 101
- Rule ID:** 22
- Action:** ☒ Permit, ☐ Deny, ☐ Disable
- Egress Queue:** (0-6)
- Logging:** ☐ Enable, ☒ Disable
- Interface:** (empty)
- Match Every:** ☒ True, ☐ False
- Protocol Type:** TCP
- TCP Flag:** RST
- Source IP Address:** 192.168.77.0
- Source IP Mask:** 0.0.0.255
- Destination IP Address:** 192.178.77.0
- Destination IP Mask:** 0.0.0.255

- a. In the Extended ACL Rule Configuration, enter the following information:
  - In the **Rule ID (1 to 23)** field, enter **1**.
  - For Action, select the **Permit** radio button.
  - In the **Protocol Type** list, select **TCP**.
  - In the **Source IP Address** field, enter **192.168.77.0**.
  - In the **Source IP Mask** field, enter **0.0.0.255**.
  - In the **Destination IP Address** field, enter **192.178.77.0**.
  - In the **Destination IP Mask** field, enter **0.0.0.255**.
- b. Click **Apply** to save the settings.
4. Create another ACL rule and add it to the ACL 101.
  - a. After you click the **Add** button in step 3, a screen similar to the following displays.

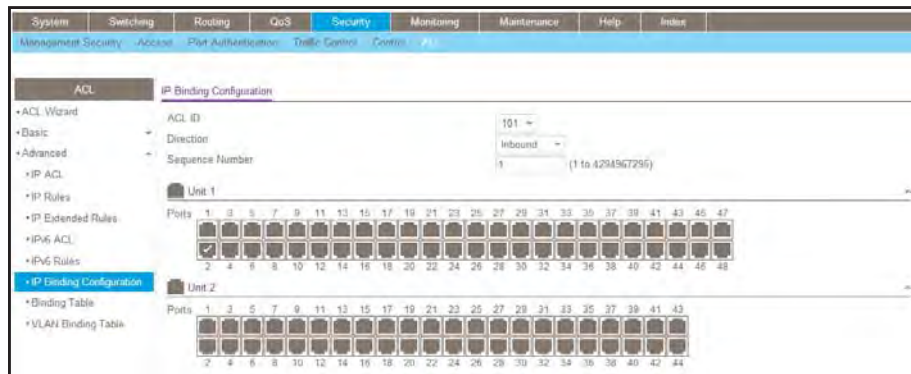
The screenshot shows the 'Extended ACL Rule Configuration(100-199)' window. On the left, a sidebar lists configuration options: ACL Wizard, Basic, Advanced, IP ACL, IP Rules, IP Extended Rules (selected), IPv6 ACL, IPv6 Rules, IP Binding Configuration, Binding Table, and VLAN Binding Table. The main area contains the following fields and values:

- ACL ID/Name:** 101
- Rule ID:** 1
- Action:** ☒ Permit, ☐ Deny, ☐ Disable
- Egress Queue:** (0-6)
- Logging:** ☐ Enable, ☒ Disable
- Interface:** (empty)
- Match Every:** ☒ True, ☐ False
- Protocol Type:** TCP
- TCP Flag:** RST
- Source IP Address:** 192.168.77.0
- Source IP Mask:** 0.0.0.255
- Destination IP Address:** 192.178.77.0
- Destination IP Mask:** 0.0.0.255

- b. Under Extended ACL Rule Configuration, enter the following information:
  - In the **Rule ID (1 to 23)** field, enter **22**.
  - For Action, select the **Permit** radio button.

- In the **Protocol Type** list, select **UDP**.
  - In the **Source IP Address** field, enter **192.168.77.0**.
  - In the **Source IP Mask** field, enter **0.0.0.255**.
  - In the **Destination IP Address** field, enter **192.178.77.0**.
  - In the **Destination IP Mask** field, enter **0.0.0.255**.
- c. Click **Apply** to save the settings.
5. Apply ACL 101 to port 2.
- a. Select **Security > ACL > IP ACL > IP Binding Configuration**.

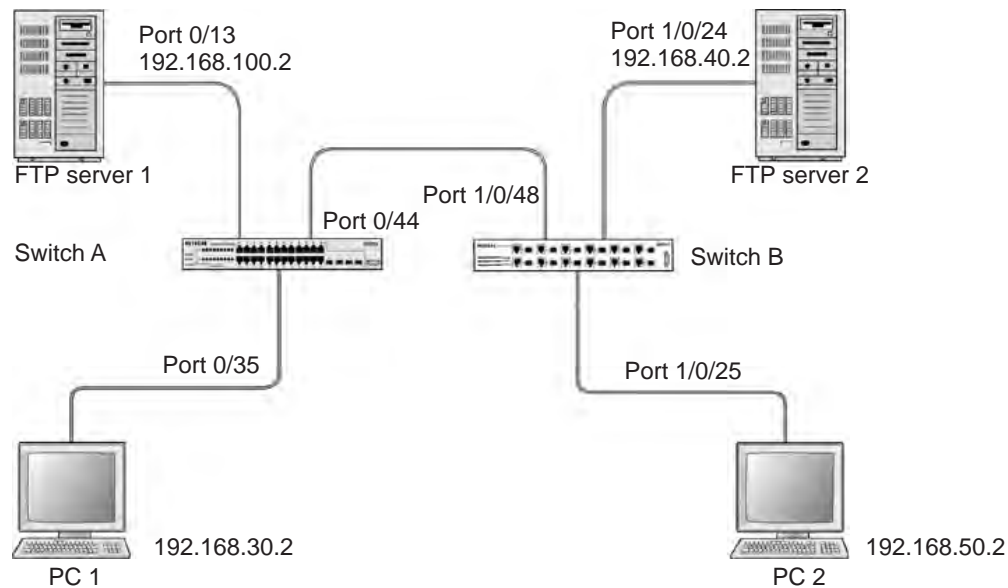
A screen similar to the following displays.



- b. Under IP Binding Configuration, enter the following information:
- In the **ACL ID** list, select **10**.
  - In the **Sequence Number** field, enter **1**.
- c. Click **Unit 1**. The ports display.
- d. Click the gray box under port **2**. A check mark displays in the box.
- e. Click **Apply** to save the settings.

# One-Way Access Using a TCP Flag in an ACL

This example shows how to set up one-way access using a TCP flag in an ACL. PC 1 can access FTP server 1 and FTP server 2, but PC 2 can access only FTP server 2.



**Figure 22. One-Way Web access using a TCP flag in an ACL**

## CLI: Configure One-Way Access Using a TCP Flag in an ACL

This is a two-step process:

- [Step 1: Configure the VLAN and IP addresses on Switch A on page 179](#)
- [Step 2: Configure on Switch B on page 181](#)

Step 1: Configure the VLAN and IP addresses on Switch A

(See [Figure 22, One-Way Web access using a TCP flag in an ACL.](#))

**1. Create VLAN 30 with port 0/35 and assign IP address 192.168.30.1/24.**

```
(Netgear Switch) #vlan database
(Netgear Switch) (Vlan)#vlan 30
(Netgear Switch) (Vlan)#vlan routing 30
(Netgear Switch) (Vlan)#exit
(Netgear Switch) #config
(Netgear Switch) (Config)#interface 0/35
(Netgear Switch) (Interface 0/35)#vlan pvid 30
(Netgear Switch) (Interface 0/35)#vlan participation include 30
(Netgear Switch) (Interface 0/35)#exit
(Netgear Switch) (Config)#interface vlan 30
(Netgear Switch) (Interface-vlan 30)#routing
(Netgear Switch) (Interface-vlan 30)#ip address 192.168.30.1 255.255.255.0
(Netgear Switch) (Interface-vlan 30)#exit
(Netgear Switch) (Config)#exit
```

**2. Create VLAN 100 with port 0/13 and assign IP address 192.168.100.1/24.**

```
(Netgear Switch) #vlan database
(Netgear Switch) (Vlan)#vlan 100
(Netgear Switch) (Vlan)#vlan routing 100
(Netgear Switch) (Vlan)#exit
(Netgear Switch) #configure
(Netgear Switch) (Config)#interface 0/13
(Netgear Switch) (Interface 0/13)#vlan pvid 100
(Netgear Switch) (Interface 0/13)#vlan participation include 100
(Netgear Switch) (Interface 0/13)#exit
(Netgear Switch) (Config)#interface vlan 100
(Netgear Switch) (Interface-vlan 100)#routing
(Netgear Switch) (Interface-vlan 100)#ip address 192.168.100.1 255.255.255.0
(Netgear Switch) (Interface-vlan 100)#exit
(Netgear Switch) (Config)#exit
```

**3. Create VLAN 200 with port 0/44 and assign IP address 192.168.200.1/24.**

```
(Netgear Switch) #vlan database
(Netgear Switch) (Vlan)#vlan 200
(Netgear Switch) (Vlan)#vlan routing 200
(Netgear Switch) (Vlan)#exit
(Netgear Switch) #configure
(Netgear Switch) (Config)#interface 0/44
(Netgear Switch) (Interface 0/44)#vlan pvid 200
(Netgear Switch) (Interface 0/44)#vlan participation include 200
(Netgear Switch) (Interface 0/44)#exit
(Netgear Switch) (Config)#interface vlan 200
(Netgear Switch) (Interface-vlan 200)#routing
(Netgear Switch) (Interface-vlan 200)#ip address 192.168.200.1 255.255.255.0
(Netgear Switch) (Interface-vlan 200)#exit
```

**4. Add two static routes so that the switch forwards the packets for which the destinations are 192.168.40.0/24 and 192.168.50.0/24 to the correct next hops.**

```
(Netgear Switch) (Config)#ip routing
(Netgear Switch) (Config)#ip route 192.168.40.0 255.255.255.0 192.168.200.2
(Netgear Switch) (Config)#ip route 192.168.50.0 255.255.255.0 192.168.200.2
```

**5. Create an ACL that denies all the packets with TCP flags +syn-ack.**

```
(Netgear Switch) (Config)#access-list 101 deny tcp any flag +syn -ack
```

**6. Create an ACL that permits all the IP packets.**

```
(Netgear Switch) (Config)#access-list 102 permit ip any
```

**7. Apply ACLs 101 and 102 to port 0/44; the sequence of 101 is 1 and of 102 is 2.**

```
(Netgear Switch) (Config)#interface 0/44
(Netgear Switch) (Interface 0/44)#ip access-group 101 in 1
(Netgear Switch) (Interface 0/44)#ip access-group 102 in 2
(Netgear Switch) (Interface 0/44)#exit
```



## Step 2: Configure on Switch B

(See Figure 22, One-Way Web access using a TCP flag in an ACL on page 178.)

### 1. Create VLAN 40 with port 1/0/24 and assign IP address 192.168.40.1/24.

```
(Netgear Switch) #vlan database
(Netgear Switch) (Vlan)#vlan 40
(Netgear Switch) (Vlan)#vlan routing 40
(Netgear Switch) #configure
(Netgear Switch) (Config)#interface 1/0/24
(Netgear Switch) (Interface 1/0/24)#vlan pvid 40
(Netgear Switch) (Interface 1/0/24)#vlan participation include 40
(Netgear Switch) (Interface 1/0/24)#exit
(Netgear Switch) (Config)#interface vlan 40
(Netgear Switch) (Interface-vlan 40)#routing
(Netgear Switch) (Interface-vlan 40)#ip address 192.168.40.1 255.255.255.0
(Netgear Switch) (Interface-vlan 40)#exit
```

### 2. Create VLAN 50 with port 1/0/25 and assign IP address 192.168.50.1/24.

```
(Netgear Switch)(Config)#exit
(Netgear Switch) #vlan database
(Netgear Switch) (Vlan)#vlan 50
(Netgear Switch) (Vlan)#vlan routing 50
(Netgear Switch) (Vlan)#exit
(Netgear Switch) #configure
(Netgear Switch) (Config)#interface 1/0/25
(Netgear Switch) (Interface 1/0/25)#vlan pvid 50
(Netgear Switch) (Interface 1/0/25)#vlan participation include 50
(Netgear Switch) (Interface 1/0/25)#exit
(Netgear Switch) (Config)#interface vlan 50
(Netgear Switch) (Interface-vlan 50)#routing
(Netgear Switch) (Interface-vlan 50)#ip address 192.168.50.1 255.255.255.0
(Netgear Switch) (Interface-vlan 50)#exit
(Netgear Switch) (Config)#exit
```

### 3. Create VLAN 200 with port 1/0/48 and assign IP address 192.168.200.1/24.

```
(Netgear Switch) #vlan database
(Netgear Switch) (Vlan)#vlan 200
(Netgear Switch) (Vlan)#vlan routing 200
(Netgear Switch) (Config)#interface 1/0/48
(Netgear Switch) (Interface 1/0/48)#vlan pvid 200
(Netgear Switch) (Interface 1/0/48)#vlan participation include 200
(Netgear Switch) (Interface 1/0/48)#exit
(Netgear Switch) #interface vlan 200
(Netgear Switch) (Interface-vlan 200)#routing
(Netgear Switch) (Interface-vlan 200)#ip address 192.168.200.2 255.255.255.0
(Netgear Switch) (Interface-vlan 200)#exit
```

### 4. Add two static routes so that the switch forwards the packets with destinations 192.168.100.0/24 and 192.168.30.0/24 to the correct next hops.

```
(Netgear Switch) (Config)#ip routing
(Netgear Switch) (Config)#ip route 192.168.100.0 255.255.255.0 192.168.200.1
(Netgear Switch) (Config)#ip route 192.168.30.0 255.255.255.0 192.168.200.1
```

## Local Browser Interface: Configure One-Way Access Using a TCP Flag in an ACL

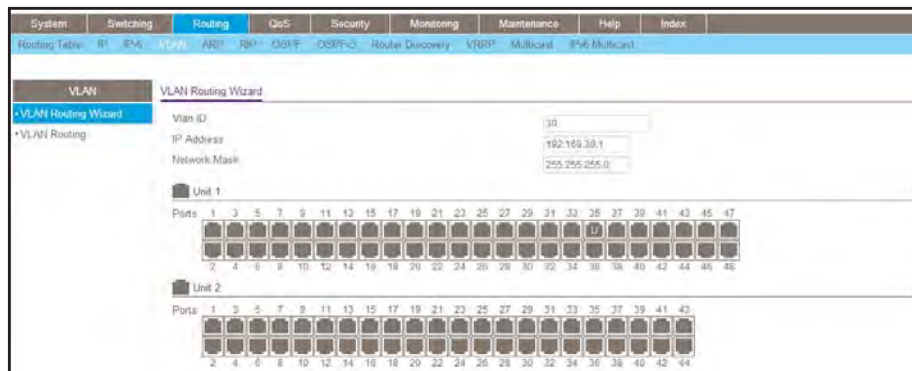
This is a two-part process:

- [Configuring VLAN and IP addresses on switch A on page 182](#)
- [Configuring the Switch B on page 190](#)

### Configuring VLAN and IP addresses on switch A

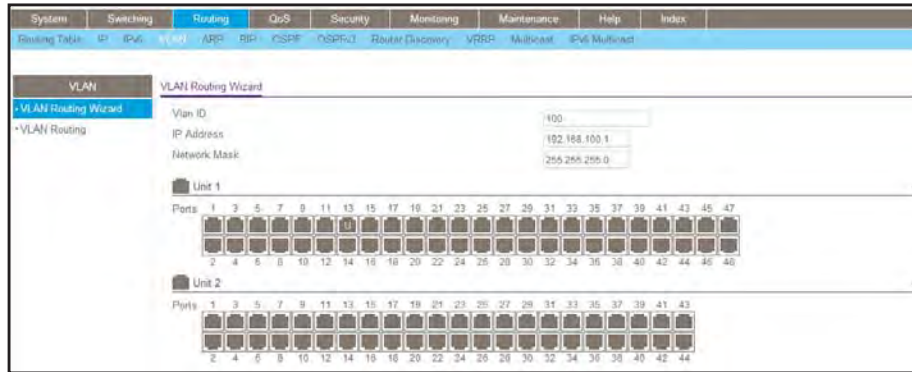
1. Create VLAN 30 with IP address 192.168.30.1/24.
  - a. Select **Routing > VLAN > VLAN Routing Wizard**.

A screen similar to the following displays.



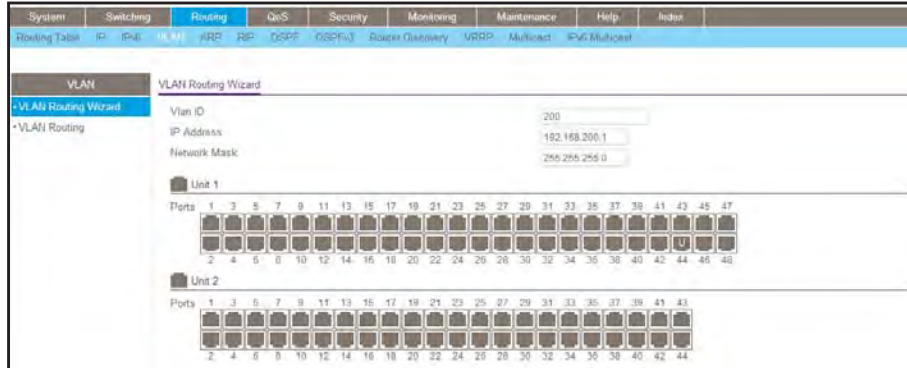
- b. In the VLAN Routing Wizard, enter the following information:
    - In the **Vlan ID** field, enter **30**.
    - In the **IP Address** field, enter **192.168.30.1**.
    - In the **Network Mask** field, enter **255.255.255.0**.
  - c. Click **Unit 1**. The ports display.
  - d. Click the gray box under port **35** twice until **U** displays.  
The U specifies that the egress packet is untagged for the port.
  - e. Click **Apply** to save VLAN 30.
2. Create VLAN 100 with IP address 192.168.100.1/24.
    - a. Select **Routing > VLAN > VLAN Routing Wizard**.

A screen similar to the following displays.



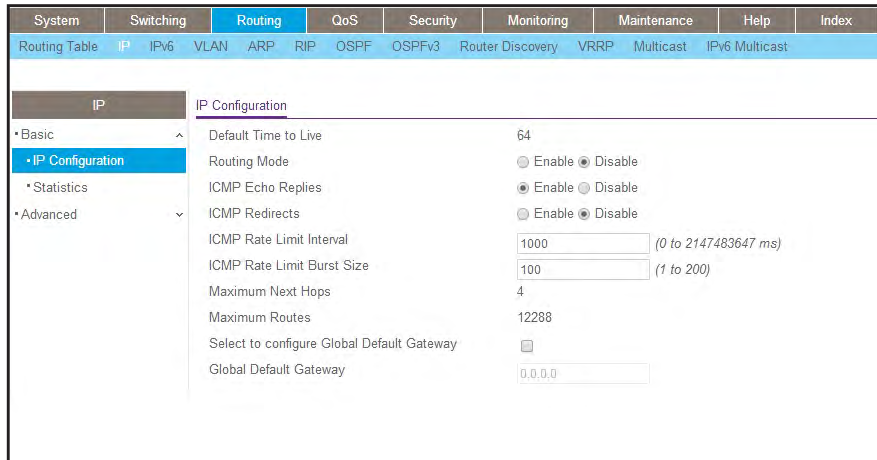
- b. Enter the following information:
    - In the **Vlan ID** field, enter **100**.
    - In the **IP Address** field, enter **192.168.100.1**.
    - In the **Network Mask** field, enter **255.255.255.0**.
  - c. Click **Unit 1**. The ports display.
  - d. Click the gray box under port **13** twice until **U** displays.  
The U specifies that the egress packet is untagged for the port.
  - e. Click **Apply** to save VLAN 100.
3. Create VLAN 200 with IP address 192.168.200.1/24.
    - a. Select **Routing > VLAN > VLAN Routing Wizard**.

A screen similar to the following displays.



- b. Enter the following information:
    - In the **Vlan ID** field, enter **200**.
    - In the **IP Address** field, enter **192.168.200.1**.
    - In the **Network Mask** field, enter **255.255.255.0**.
  - c. Click **Unit 1**. The ports display.
  - d. Click the gray box under port **44** twice until **U** displays.  
The U specifies that the egress packet is untagged for the port.
  - e. Click **Apply** to save VLAN 200.
4. Enable IP routing.
- a. Select **Routing > IP > Basic > IP Configuration**.

A screen similar to the following displays.



- b. Under IP Configuration, make the following selections:
    - For Routing Mode, select the **Enable** radio button.
    - For IP Forwarding Mode, select the **Enable** radio button.
  - c. Click **Apply** to enable IP routing.
5. Add a static route with IP address 192.268.40.0/24:

a. Select **Routing > Routing Table > Basic > Route Configuration**.

A screen similar to the following displays.

The screenshot shows the 'Configure Routes' page in a web management interface. The left sidebar has 'Routing Table' expanded, with 'Route Configuration' selected. The main area has a 'Configure Routes' tab. Below it, there's a table for configuring static routes. The first row is filled with: Route Type: Static, Network Address: 192.168.40.0, Subnet Mask: 255.255.255.0, Next Hop Address: 192.168.200.2, Preference: (empty), and Description: (empty). Below this is a 'Learned Routes' section with an empty table.

b. Under Configure Routes, make the following selection and enter the following information:

- In the **Route Type** list, select **Static**.
- In the **Network Address** field, enter **192.168.40.0**.
- In the **Subnet Mask** field, enter **255.255.255.0**.
- In the **Next Hop IP Address** field, enter **192.168.200.2**.

c. Click **Add**.

6. Create a static route with IP address 192.168.50.0/24:

a. Select **Routing > Routing Table > Basic > Route Configuration**.

A screen similar to the following displays.

This screenshot shows the 'Configure Routes' page after adding a second route. The 'Configure Routes' table now has two rows. The first row is: Route Type: Static, Network Address: 192.168.50.0, Subnet Mask: 255.255.255.0, Next Hop Address: 192.168.200.2, Preference: (empty), Description: (empty). The second row is: Route Type: Static, Network Address: 192.168.40.0, Subnet Mask: 255.255.255.0, Next Hop Address: 192.168.200.2, Preference: 1, Description: (empty). The 'Learned Routes' section remains empty.

b. Under Configure Routes, make the following selection and enter the following information:

- In the **Route Type** list, select **Static**.
- In the **Network Address** field, enter **192.168.50.0**.
- In the **Subnet Mask** field, enter **255.255.255.0**.
- In the **Next Hop IP Address** field, enter **192.168.200.2**.

c. Click **Add**.

7. Create an ACL with ID 101.

- a. Select **Security > ACL > Advanced > IP ACL**.

A screen similar to the following displays.

| IP ACL Configuration  |     |  |
|-----------------------|-----|--|
| Current Number of ACL | 0   |  |
| Maximum ACL           | 100 |  |

| IP ACL Table |       |      |
|--------------|-------|------|
| IP ACL ID    | Rules | Type |
| 101          |       |      |

- b. In the IP ACL Table, in the **IP ACL ID** field, enter **101**.

- c. Click **Add**.

8. Create an ACL with ID 102.

- a. Select **Security > ACL > Advanced > IP ACL**.

A screen similar to the following displays.

| IP ACL Configuration  |     |  |
|-----------------------|-----|--|
| Current Number of ACL | 1   |  |
| Maximum ACL           | 100 |  |

| IP ACL Table |       |                 |
|--------------|-------|-----------------|
| IP ACL ID    | Rules | Type            |
| 102          |       |                 |
| 101          | 0     | Extended IP ACL |

- b. In the IP ACL Table, in the **IP ACL ID** field, enter **102**.

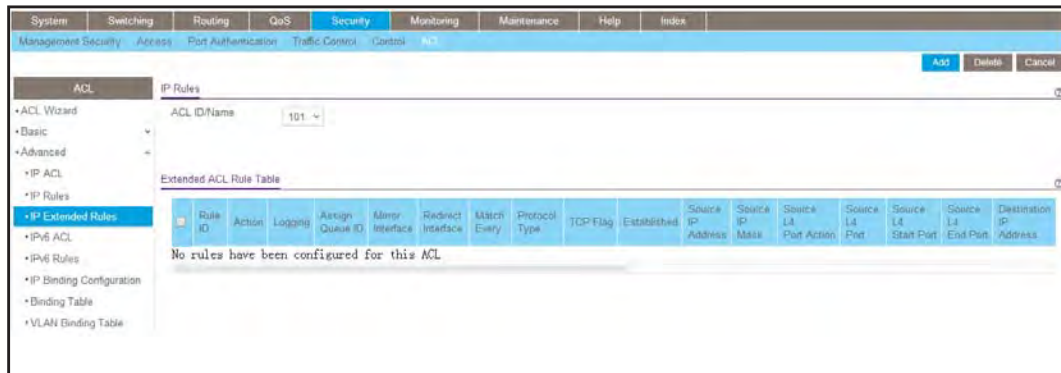
- c. Click **Add**.

9. Add and configure an IP extended rule that is associated with ACL 101.

- a. Select **Security > ACL > Advanced > IP Extended Rules**.

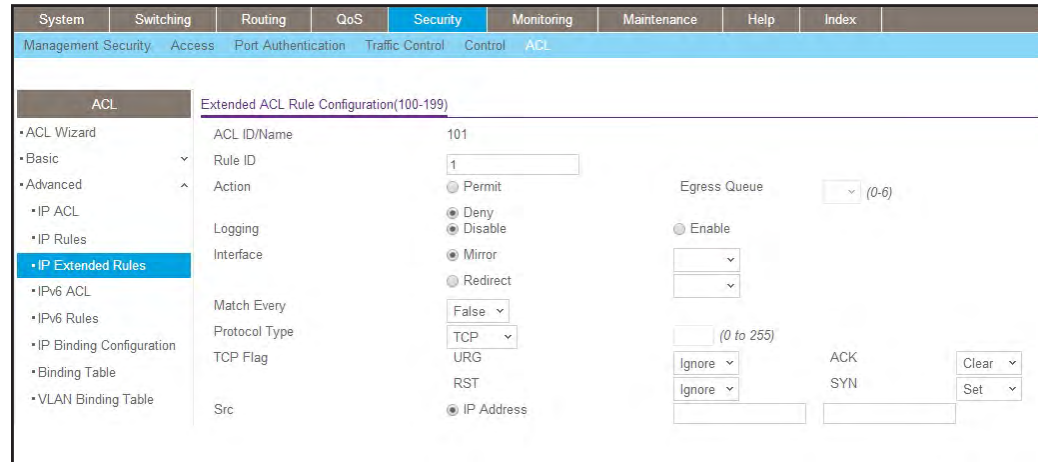


A screen similar to the following displays.



- b. Under IP Extended Rules, in the **ACL ID** list, select **101**.
- c. Click **Add**.

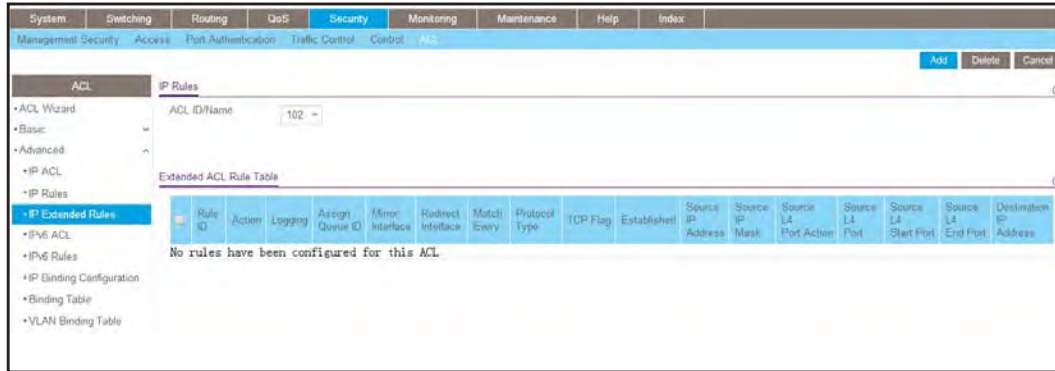
A screen similar to the following displays.



- d. Under Extended ACL Rule Configuration (100-199), enter the following information and make the following selections:
    - In the **Rule ID** field, enter **1**.
    - For Action mode, select the **Deny** radio button.
    - In the **Match Every** field, select **False**.
    - In the **Protocol Type** list, select **TCP**.
    - For TCP Flag, in the **SYN** field, select **Set**, and in the **ACK** field, select **Clear**.
  - e. Click **Apply** to save the settings.
10. Add and configure an IP extended rule that is associated with ACL 102.
- a. Select **Security > ACL > Advanced > IP Extended Rules**.

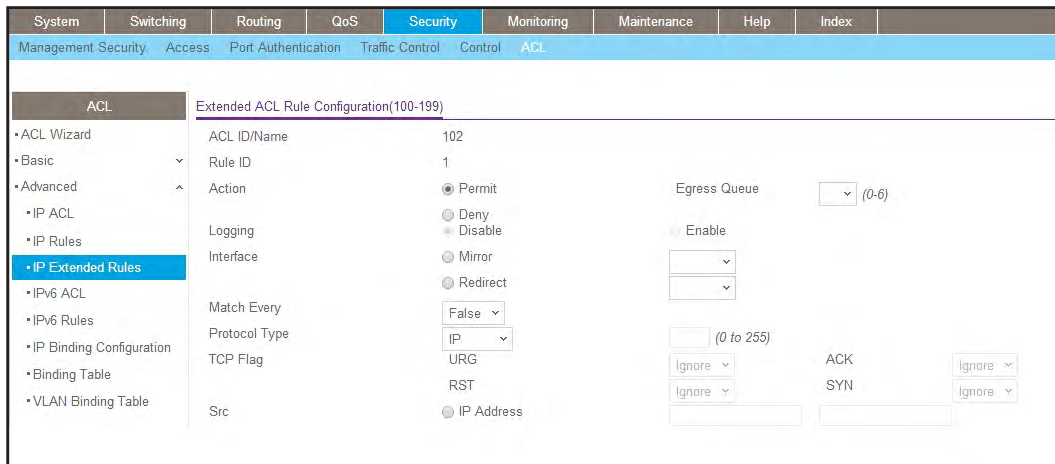


A screen similar to the following displays.



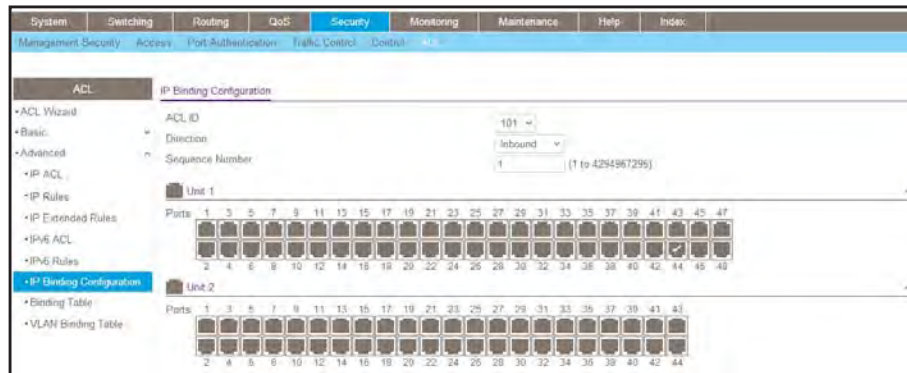
- b. Under IP Extended Rules, in the **ACL ID** list, select **102**.
- c. Click **Add**.

A screen similar to the following displays.



- d. Under Extended ACL Rule Configuration (100-199), enter the following information and make the following selections:
    - In the **Rule ID** field, enter **1**.
    - For Action, select the **Permit** radio button.
    - In the **Match Every** field, select **False**.
    - In the **Protocol Type** list, select **IP**.
  - e. Click **Apply** to save the settings.
11. Apply ACL 101 to port 44.
- a. Select **Security > ACL > Advanced > IP Binding Configuration**.

A screen similar to the following displays.



- b. Under Binding Configuration, specify the following:
    - In the **ACL ID** list, select **101**.
    - In the **Sequence Number** field, enter **1**.
  - c. Click **Unit 1**. The ports display.
  - d. Click the gray box under port **44**. A check mark displays in the box.
  - e. Click **Apply** to save the settings.
12. Apply ACL 102 to port 44.
- a. Select **Security > ACL > Advanced > IP Binding Configuration**.

A screen similar to the following displays.



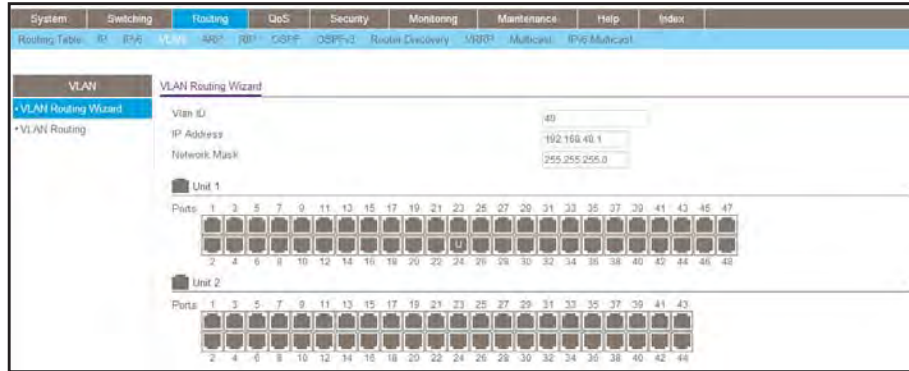
- b. Under Binding Configuration, make the following selection and enter the following information:
  - In the **ACL ID** list, select **102**.
  - In the **Sequence Number** field, enter **2**.
- c. Click **Unit 1**. The ports display.
- d. Click the gray box under port **44**.  
A check mark displays in the box.
- e. Click **Apply** to save the settings.

## Configuring the Switch B

1. Create VLAN 40 with IP address 192.168.40.1/24.

- a. Select **Routing > VLAN > VLAN Routing Wizard**.

A screen similar to the following displays.



- b. Enter the following information:
  - In the **Vlan ID** field, enter **40**.
  - In the **IP Address** field, enter **192.168.40.1**.
  - In the **Network Mask** field, enter **255.255.255.0**.
- c. Click **Unit 1**. The ports display.
- d. Click the gray box under port **24** twice until **U** displays.

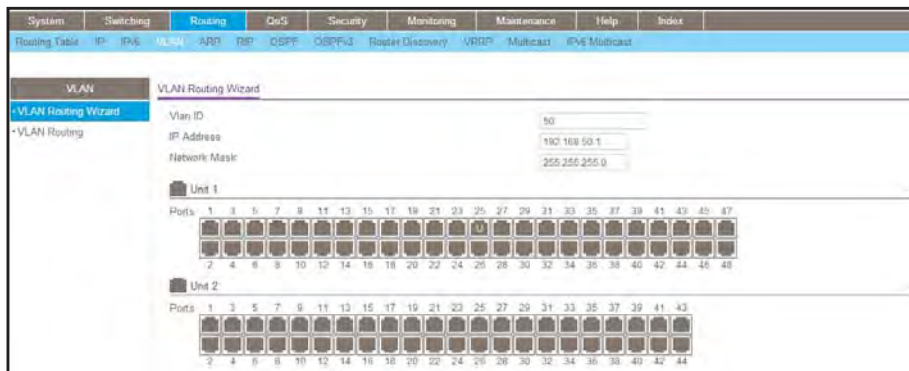
The U specifies that the egress packet is untagged for the port.

- e. Click **Apply** to save VLAN 40.

2. Create VLAN 50 with IP address 192.168.50.1/24:

- a. Select **Routing > VLAN > VLAN Routing Wizard**.

A screen similar to the following displays.



- b. Enter the following information:
  - In the **Vlan ID** field, enter **50**.
  - In the **IP Address** field, enter **192.168.50.1**.
  - In the **Network Mask** field, enter **255.255.255.0**.

- c. Click **Unit 1**. The ports display.
- d. Click the gray box under port **25** twice until **U** displays.

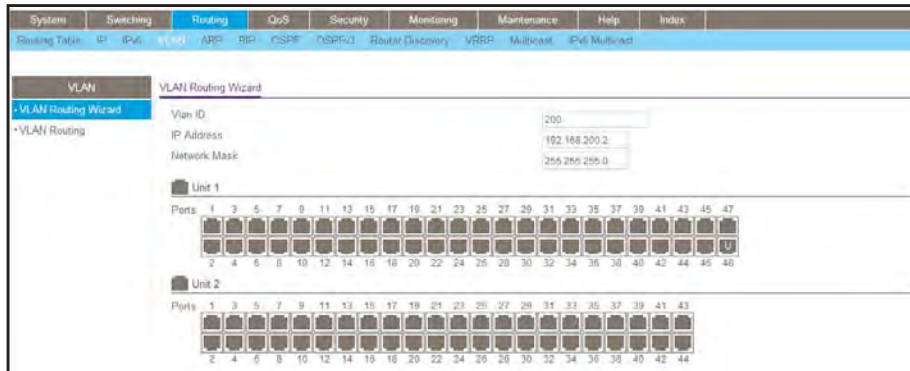
The U specifies that the egress packet is untagged for the port.

- e. Click **Apply** to save VLAN 50.

3. Create VLAN 200 with IP address 192.168.200.2/24.

- a. Select **Routing > VLAN > VLAN Routing Wizard**.

A screen similar to the following displays.



- b. Enter the following information:
  - In the **Vlan ID** field, enter **200**.
  - In the **IP Address** field, enter **192.168.200.2**.
  - In the **Network Mask** field, enter **255.255.255.0**.

- c. Click **Unit 1**. The ports display.

- d. Click the gray box under port **48** twice until U displays.

The U specifies that the egress packet is untagged for the port.

- e. Click **Apply** to save VLAN 200.

4. Create a static route with IP address 192.168.100.0/24:

- a. Select **Routing > Routing Table > Basic > Route Configuration**.

A screen similar to the following displays.



- b. Under Configure Routes, make the following selections and enter the following information:
- Select **Static** in the **Route Type** field.
  - In the **Network Address** field, enter **192.168.100.0**.
  - In the **Subnet Mask** field, enter **255.255.255.0**.
  - In the **Next Hop IP Address** field, enter **192.168.200.1**.
- c. Click **Add**.
5. Create a static route with IP address 192.168.30.0/24:
- a. Select **Routing > Routing Table > Basic > Route Configuration**.

A screen similar to the following displays.

The screenshot shows the 'Configure Routes' interface with a table for configuring static routes. The table has columns for Route Type, Network Address, Subnet Mask, Next Hop Address, Preference, and Description. Two static routes are listed: one for 192.168.30.0/24 with next hop 192.168.200.2 and preference 1, and another for 192.168.100.0/24 with next hop 192.168.200.2 and preference 1.

| Route Type | Network Address | Subnet Mask   | Next Hop Address | Preference | Description |
|------------|-----------------|---------------|------------------|------------|-------------|
| Static     | 192.168.30.0    | 255.255.255.0 | 192.168.200.2    | 1          |             |
| Static     | 192.168.100.0   | 255.255.255.0 | 192.168.200.2    | 1          |             |

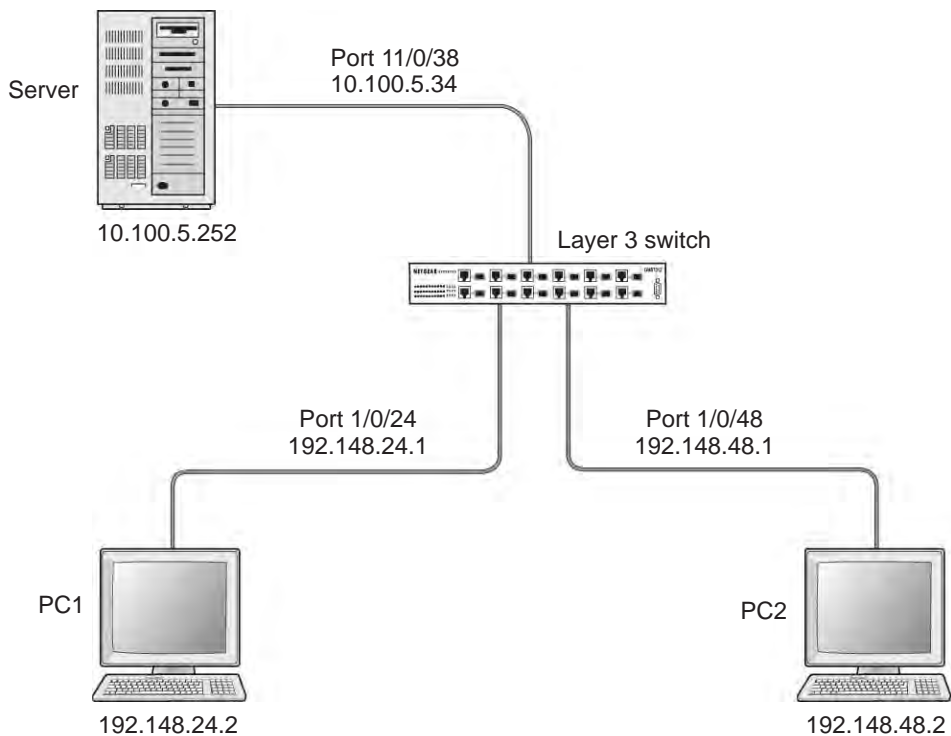
Below the configuration table, there is a 'Learned Routes' section with a table showing learned routes:

| Network Address | Subnet Mask   | Protocol | Route Type | Next Hop Interface | Next Hop Address | Preference | Metric |
|-----------------|---------------|----------|------------|--------------------|------------------|------------|--------|
| 192.168.100.0   | 255.255.255.0 | Static   | Static     | vlan 200           | 192.168.200.2    | 1          | 0      |
| 192.168.200.0   | 255.255.255.0 | Local    | Connected  | vlan 200           | 192.168.200.1    | 0          | 1      |

- b. Under Configure Routes, make the following selection and enter the following information:
- In the **Route Type** field, select **Static**.
  - In the **Network Address** field, enter **192.168.30.0**.
  - In the **Subnet Mask** field, enter **255.255.255.0**.
  - In the **Next Hop IP Address** field, enter **192.168.200.1**.
- c. Click **Add**.

# Use ACLs to Configure Isolated VLANs on a Layer 3 Switch

This example shows how to isolate VLANs on a Layer 3 switch by using ACLs. In this example, PC 1 is in VLAN 24, PC 2 is in VLAN 48, and the server is in VLAN 38. PC 1 and PC 2 are isolated by an ACL but can both access the server. The example is shown as CLI commands and as a local browser interface procedure.



**Figure 23. Using ACLs to isolate VLANs on a Layer 3 switch**

## CLI: Configure One-Way Access Using a TCP Flag in ACL Commands

### 1. Enter the following CLI commands.

```
(Netgear Switch) #vlan database
(Netgear Switch) (Vlan)#vlan 24
(Netgear Switch) (Vlan)#vlan routing 24
(Netgear Switch) (Vlan)#exit
(Netgear Switch) #config
(Netgear Switch) (Config)#interface 1/0/24
(Netgear Switch) (Interface 1/0/24)#vlan participation include 24
(Netgear Switch) (Interface 1/0/24)#vlan pvid 24
(Netgear Switch) (Interface 1/0/24)#exit

(Netgear Switch) (Config)#interface vlan 24
(Netgear Switch) (Interface-vlan 24)#routing
(Netgear Switch) (Interface-vlan 24)#ip address 192.168.24.1 255.255.255.0
(Netgear Switch) (Interface-vlan 24)#exit
(Netgear Switch) (Config)#exit
```

### 2. Create VLAN 48, add port 1/0/48 to it, and assign IP address 192.168.48.1 to it.

```
(Netgear Switch) #vlan database
(Netgear Switch) (Vlan)#vlan 48
(Netgear Switch) (Vlan)#vlan routing 48
(Netgear Switch) (Vlan)#exit
(Netgear Switch) #config
(Netgear Switch) (Config)#interface 1/0/48
(Netgear Switch) (Interface 1/0/48)#vlan participation include 48
(Netgear Switch) (Interface 1/0/48)#vlan pvid 48
(Netgear Switch) (Interface 1/0/48)#exit

(Netgear Switch) (Config)#vlan interface vlan 48
(Netgear Switch) (Interface-vlan 48)#routing
(Netgear Switch) (Interface-vlan 48)#ip address 192.168.48.1 255.255.255.0
(Netgear Switch) (Interface-vlan 48)#exit
(Netgear Switch) (Config)#exit
```



**3. Create VLAN 38, add port 1/0/38 to it, and assign IP address 10.100.5.34 to it.**

```
(Netgear Switch) #vlan database
(Netgear Switch) (Vlan)#vlan 38
(Netgear Switch) (Vlan)#vlan routing
(Netgear Switch) (Vlan)#exit
(Netgear Switch) #config
(Netgear Switch) (Config)#interface 1/0/38
(Netgear Switch) (Interface 1/0/38)#vlan participation include 38
(Netgear Switch) (Interface 1/0/38)#vlan pvid 38
(Netgear Switch) (Interface 1/0/38)#exit
(Netgear Switch) (Config)#interface vlan 38
(Netgear Switch) (Interface-vlan 38)#routing
(Netgear Switch) (Interface-vlan 38)#ip address 10.100.5.34 255.255.255.0
(Netgear Switch) (Interface-vlan 38)#exit
```

**4. Enable IP routing on the switch.**

```
(Netgear Switch) (Config)#ip routing
```

**5. Add a default route so that all the traffic without a destination is forwarded according to this default route.**

```
(Netgear Switch) (Config)#ip route default 10.100.5.252
```

**6. Create ACL 101 to deny all traffic that has the destination IP address 192.168.24.0/24.**

```
(Netgear Switch) (Config)#access-list 101 deny ip any 192.168.24.0 0.0.0.255
```

**7. Create ACL 102 to deny all traffic that has the destination IP address 192.168.48.0/24.**

```
(Netgear Switch) (Config)#access-list 102 deny ip any 192.168.48.0 0.0.0.255
```

**8. Create ACL 103 to permit all other traffic.**

```
(Netgear Switch) (Config)#access-list 103 permit ip any any
```

9. Deny all traffic with the destination IP address 192.168.48.0/24, and permit all other traffic.

```
(Netgear Switch) (Config)#interface 1/0/24
(Netgear Switch) (Interface 1/0/24)#ip access-group 102 in 1
(Netgear Switch) (Interface 1/0/24)#ip access-group 103 in 2
(Netgear Switch) (Interface 1/0/24)#exit
```

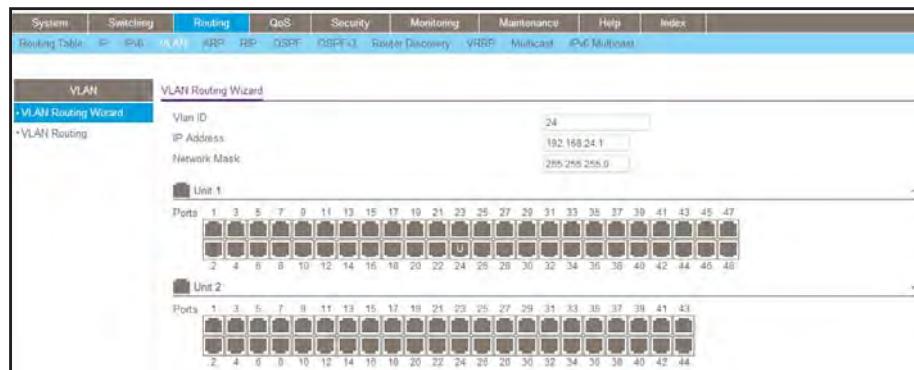
10. Deny all traffic with the destination IP address 192.168.24.0/24, and permit all other traffic.

```
(Netgear Switch) (Config)#interface 1/0/48
(Netgear Switch) (Interface 1/0/48)#ip access-group 101 in 1
(Netgear Switch) (Interface 1/0/48)#ip access-group 103 in 2
(Netgear Switch) (Interface 1/0/48)#exit
```

## Local Browser Interface: Configure One-Way Access Using a TCP Flag in an ACL

1. Create VLAN 24 with IP address 192.168.24.1.
  - a. Select **Routing > VLAN > VLAN Routing Wizard**.

A screen similar to the following displays.



- b. Enter the following information:
  - In the **Vlan ID** field, enter **24**.
  - In the **IP Address** field, enter **192.168.24.1**.
  - In the **Network Mask** field, enter **255.255.255.0**.
- c. Click **Unit 1**. The ports display.
- d. Click the gray box under port **24** twice until **U** displays.

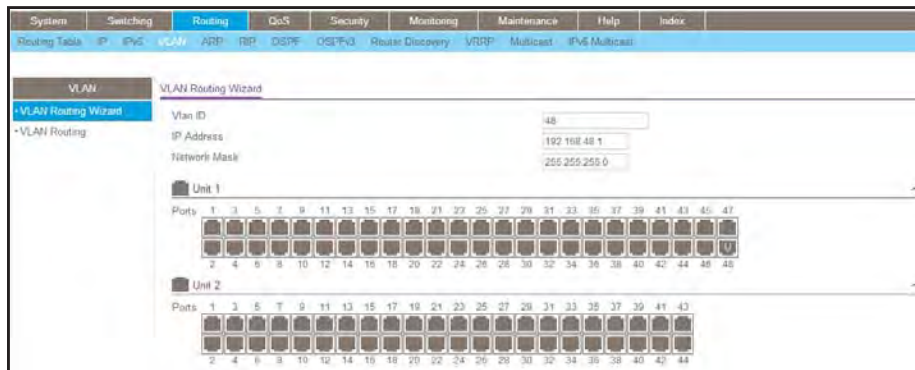
The U specifies that the egress packet is untagged for the port.

- e. Click **Apply** to save VLAN 24.

2. Create VLAN 48 with IP address 192.168.48.1.

a. Select **Routing > VLAN > VLAN Routing Wizard**.

A screen similar to the following displays.



b. Enter the following information:

- In the **Vlan ID** field, enter **48**.
- In the **IP Address** field, enter **192.168.48.1**.
- In the **Network Mask** field, enter **255.255.255.0**.

c. Click **Unit 1**. The ports display.

d. Click the gray box under port **48** twice until **U** displays.

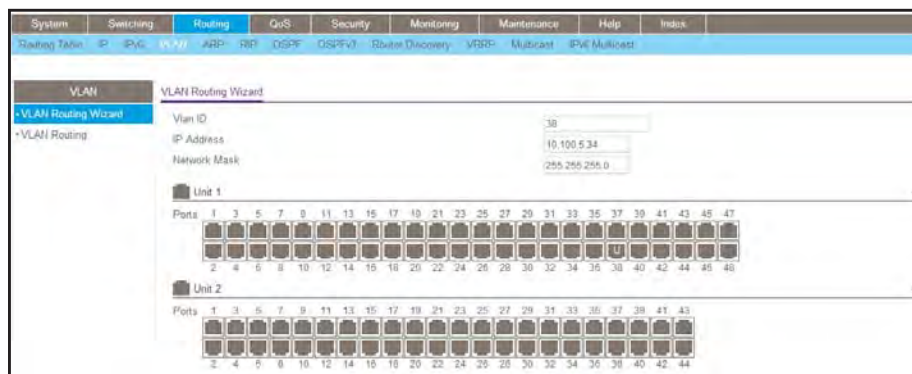
The U specifies that the egress packet is untagged for the port.

e. Click **Apply** to save VLAN 48.

3. Create VLAN 38 with IP address 10.100.5.34.

a. Select **Routing > VLAN > VLAN Routing Wizard**.

A screen similar to the following displays.



b. Enter the following information in the VLAN Routing Wizard:

- In the **Vlan ID** field, enter **38**.
- In the **IP Address** field, enter **10.100.5.34**.
- In the **Network Mask** field, enter **255.255.255.0**.

c. Click **Unit 1**. The ports display.

d. Click the gray box under port **38** twice until **U** displays.

The U specifies that the egress packet is untagged for the port.

e. Click **Apply** to save VLAN 38.

4. Enable IP routing:

a. Select **Routing > IP > Basic > IP Configuration**.

A screen similar to the following displays.

| System   | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|--|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table  | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |
| <div> <div>IP</div> <div>IP Configuration</div> </div> <div> <div>• Basic</div> <div>• IP Configuration</div> <div>• Statistics</div> <div>• Advanced</div> </div> <div> <div>Default Time to Live</div> <div>64</div> </div> <div> <div>Routing Mode</div> <div> <input checked="" type="radio"/> Enable           <input type="radio"/> Disable         </div> </div> <div> <div>ICMP Echo Replies</div> <div> <input checked="" type="radio"/> Enable           <input type="radio"/> Disable         </div> </div> <div> <div>ICMP Redirects</div> <div> <input type="radio"/> Enable           <input checked="" type="radio"/> Disable         </div> </div> <div> <div>ICMP Rate Limit Interval</div> <div> <input type="text" value="1000"/> <small>(0 to 2147483647 ms)</small> </div> </div> <div> <div>ICMP Rate Limit Burst Size</div> <div> <input type="text" value="100"/> <small>(1 to 200)</small> </div> </div> <div> <div>Maximum Next Hops</div> <div>4</div> </div> <div> <div>Maximum Routes</div> <div>12288</div> </div> <div> <div>Select to configure Global Default Gateway</div> <div> <input type="checkbox"/> </div> </div> <div> <div>Global Default Gateway</div> <div> <input type="text" value="0.0.0.0"/> </div> </div> |           |         |      |          |            |             |        |                  |      |           |                |

b. Under IP Configuration, make the following selections:

- For Routing Mode, select the **Enable** radio button.
- For IP Forwarding Mode, select the **Enable** radio button.

c. Click **Apply** to enable IP routing.

5. Create an ACL with ID 101.

a. Select **Security > ACL > Advanced > IP ACL**.

A screen similar to the following displays.

| System  | Switching | Routing             | QoS             | Security | Monitoring | Maintenance | Help | Index |           |       |      |     |  |  |
|---|-----------|---------------------|-----------------|----------|------------|-------------|------|-------|-----------|-------|------|-----|--|--|
| Management Security   | Access    | Port Authentication | Traffic Control | Control  | ACL        |             |      |       |           |       |      |     |  |  |
| <div> <div>ACL</div> <div>IP ACL Configuration</div> </div> <div> <div>• ACL Wizard</div> <div>• Basic</div> <div>• Advanced</div> <div>• IP ACL</div> <div>• IP Rules</div> <div>• IP Extended Rules</div> <div>• IPv6 ACL</div> <div>• IPv6 Rules</div> <div>• IP Binding Configuration</div> <div>• Binding Table</div> <div>• VLAN Binding Table</div> </div> <div> <div>Current Number of ACL</div> <div> <input type="text" value="0"/> </div> </div> <div> <div>Maximum ACL</div> <div> <input type="text" value="100"/> </div> </div> <div> <div>IP ACL Table</div> <table border="1"> <thead> <tr> <th>IP ACL ID</th> <th>Rules</th> <th>Type</th> </tr> </thead> <tbody> <tr> <td>101</td> <td></td> <td></td> </tr> </tbody> </table> </div> |           |                     |                 |          |            |             |      |       | IP ACL ID | Rules | Type | 101 |  |  |
| IP ACL ID   | Rules     | Type                |                 |          |            |             |      |       |           |       |      |     |  |  |
| 101   |           |                     |                 |          |            |             |      |       |           |       |      |     |  |  |

b. In the IP ACL Table, in the **IP ACL ID** field, enter **101**.

c. Click **Add**.

## 6. Create an ACL with ID 102.

a. Select **Security > ACL > Advanced > IP ACL**.

A screen similar to the following displays.

The screenshot shows the 'IP ACL Configuration' page. On the left, the 'ACL' menu is expanded, and 'IP ACL' is selected. The 'IP ACL Table' section displays a table with the following data:

| IP ACL ID | Rules | Type            |
|-----------|-------|-----------------|
| 102       |       |                 |
| 101       | 0     | Extended IP ACL |

b. In the IP ACL Table, in the **IP ACL ID** field, enter **102**.c. Click **Add**.

## 7. Create an ACL with ID 103.

a. Select **Security > ACL > Advanced > IP ACL**.

A screen similar to the following displays.

The screenshot shows the 'IP ACL Configuration' page. On the left, the 'ACL' menu is expanded, and 'IP ACL' is selected. The 'IP ACL Table' section displays a table with the following data:

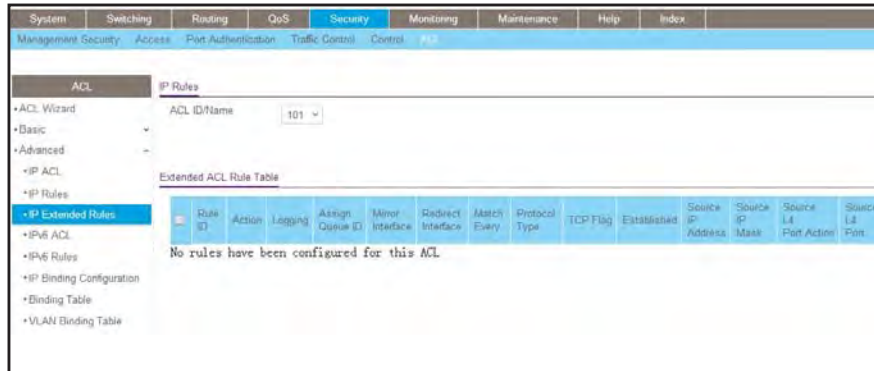
| IP ACL ID | Rules | Type            |
|-----------|-------|-----------------|
| 103       |       |                 |
| 101       | 0     | Extended IP ACL |
| 102       | 0     | Extended IP ACL |

b. In the **IP ACL ID** field of the IP ACL Table, enter **103**.c. Click **Add**.

## 8. Add and configure an IP extended rule that is associated with ACL 101:

a. Select **Security > ACL > Advanced > IP Extended Rules**.

A screen similar to the following displays.



- b. Under IP Extended Rules, in the **ACL ID** field, select **101**.
- c. Click **Add**.

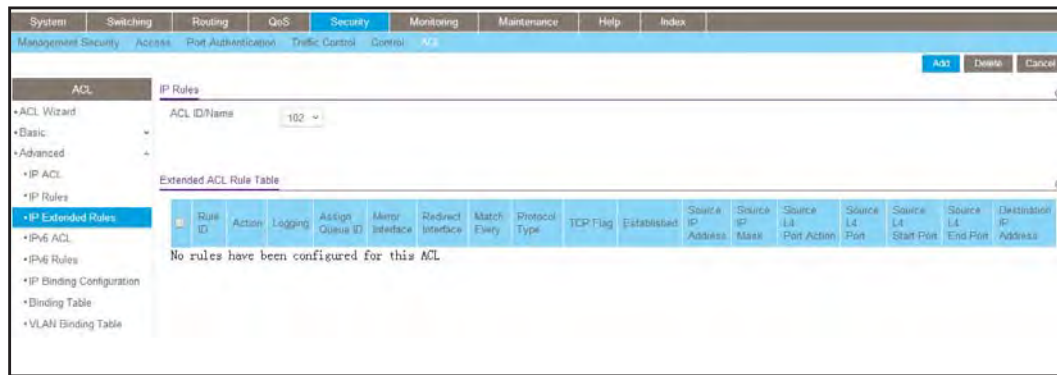
A screen similar to the following displays.



- d. Under Extended ACL Rule Configuration (100-199), enter the following information and make the following selections:
  - In the **Rule ID** field, enter **1**.
  - For Action, select the **Deny** radio button.
  - In the **Match Every** field, select **False**.
  - In the **Destination IP Address** field, enter **192.168.24.0**.
  - In the **Destination IP Mask** field, enter **0.0.0.255**.
- e. Click **Apply** to save the settings.
9. Add and configure an IP extended rule that is associated with ACL 102.
  - a. Select **Security > ACL > Advanced > IP Extended Rules**.

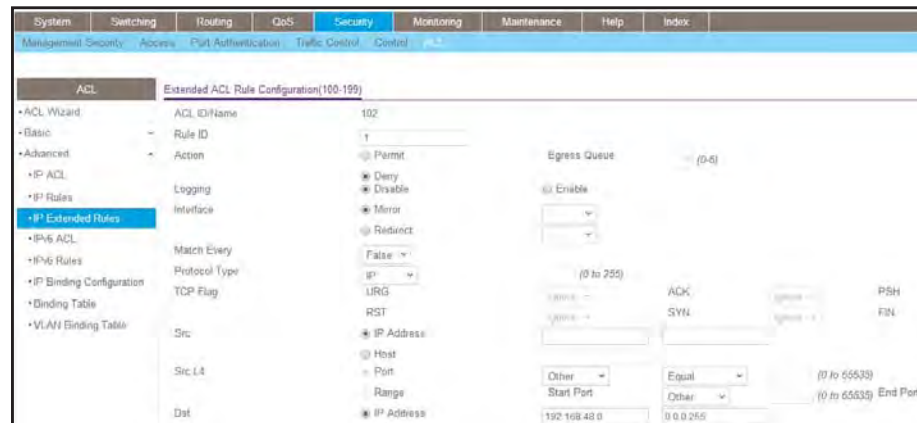


A screen similar to the following displays.



- b. Under IP Extended Rules, in the **ACL ID** field, select **102**.
- c. Click **Add**.

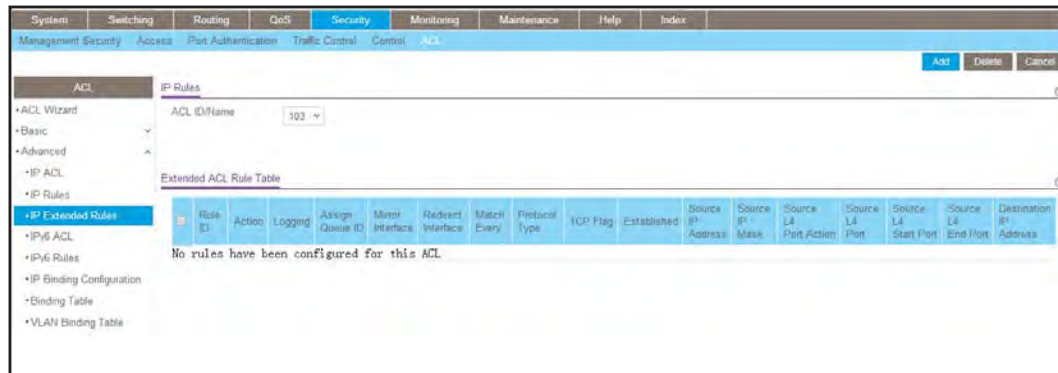
A screen similar to the following displays.



- d. Under Extended ACL Rule Configuration (100-199), enter the following information and make the following selections:
    - In the **Rule ID** field, enter **1**.
    - For Action mode, select the **Deny** radio button.
    - In the **Match Every** field, select **False**.
    - In the **Destination IP Address** field, enter **192.168.48.0**.
    - In the **Destination IP Mask** field, enter **0.0.0.255**.
  - e. Click **Apply** to save the settings.
10. Add and configure an IP extended rule that is associated with ACL 103:
- a. Select **Security > ACL > Advanced > IP Extended Rules**.

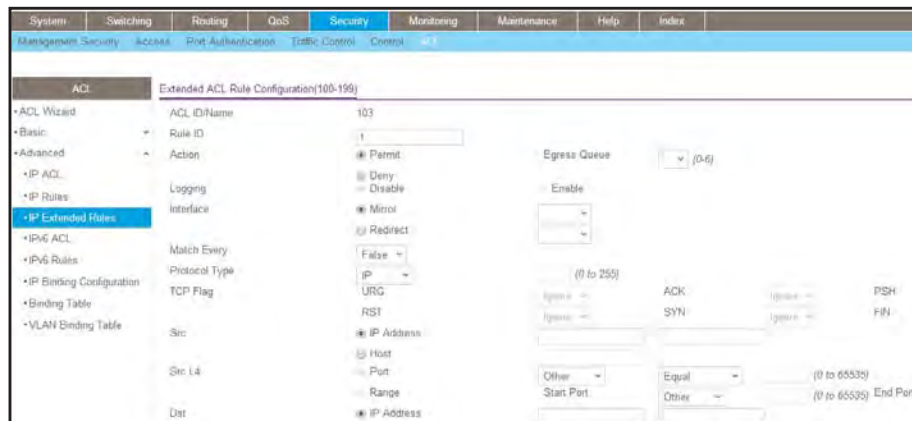


A screen similar to the following displays.



- b. Under IP Extended Rules, in the **ACL ID** field, select **103**.
- c. Click **Add**.

A screen similar to the following displays.



- d. Under Extended ACL Rule Configuration (100-199), enter the following information and make the following selections:
    - In the **Rule ID** field, enter **1**.
    - For Action mode, select the **Permit** radio button.
    - In the **Match Every** field, select **False**.
    - In the **Protocol Type** field, select **IP**.
  - e. Click **Apply** to save the settings.
11. Apply ACL 102 to port 24:
- a. Select **Security > ACL > Advanced > IP Binding Configuration**.

A screen similar to the following displays.



b. Under Binding Configuration, make the following selection and enter the following information:

- In the **ACL ID** field, select **102**.
- In the **Sequence Number** field, enter **1**.

c. Click **Unit 1**. The ports display.

d. Click the gray box under port **24**.

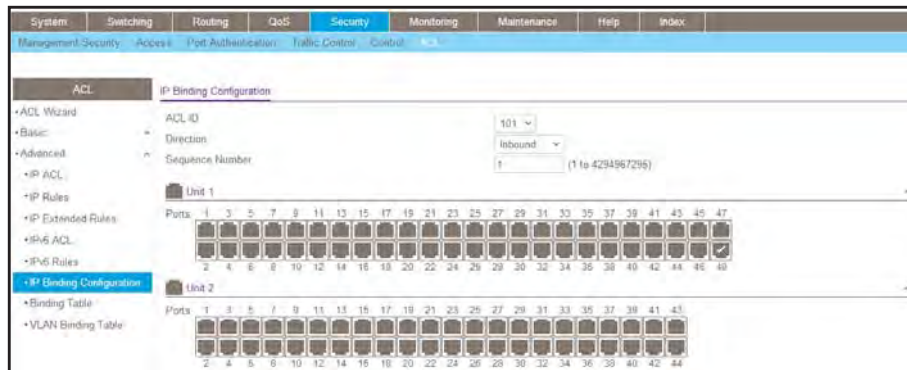
A check mark displays in the box.

e. Click **Apply** to save the settings.

12. Apply ACL 101 to port 48:

a. Select **Security > ACL > Advanced > IP Binding Configuration**.

A screen similar to the following displays.



b. Under Binding Configuration, make the following selection and enter the following information:

- In the **ACL ID** field, select **101**.
- In the **Sequence Number** field, enter **1**.

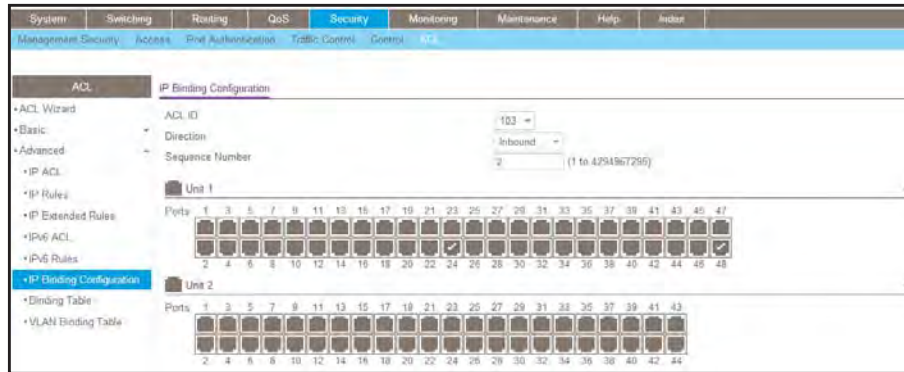
c. Click **Unit 1**. The ports display.

d. Click the gray box under port **48**.

A check mark displays in the box.

- e. Click **Apply** to save the settings.
13. Apply ACL 103 to port 24 and port 48:
  - a. Select **Security > ACL > Advanced > IP Binding Configuration**.

A screen similar to the following displays.



- b. Under Binding Configuration, make the following selection and enter the following information:
  - In the **ACL ID** field, select **103**.
  - In the **Sequence Number** field, enter **2**.
- c. Click **Unit 1**. The ports display.  
Configure the following ports:
  - Click the gray box under port **24**. A check mark displays in the box.
  - Click the gray box under port **48**. A check mark displays in the box.
- d. Click **Apply** to save the settings.

## Set up a MAC ACL with Two Rules

The example is shown as CLI commands and as a local browser interface procedure.

### CLI: Set up a MAC ACL with Two Rules

1. Create a new MAC ACL `acl_bpdu`.

```
(Netgear Switch) #
(Netgear Switch) #config
(Netgear Switch) (Config)#mac access-list extended acl_bpdu
```

2. Deny all the traffic that has destination MAC 01:80:c2:xx:xx:xx.

```
(Netgear Switch) (Config-mac-access-list)#deny any 01:80:c2:00:00:00
00:00:00:ff:ff:ff
```

3. Permit all the other traffic.

```
(Netgear Switch) (Config-mac-access-list)#permit any
(Netgear Switch) (Config-mac-access-list)#exit
```

4. Apply the MAC ACL acl\_bpdu to port 1/0/2.

```
(Netgear Switch) (Config)#interface 1/0/2
(Netgear Switch) (Interface 1/0/2)#mac access-group acl_bpdu in
```

## Local Browser Interface: Set up a MAC ACL with Two Rules

1. Create MAC ACL 101 on the switch.
  - a. Select **Security > ACL > MAC ACL**.

A screen similar to the following displays.

| System  | Switching | Routing   | QoS | Security | Monitoring | Maintenance | Help | Index |      |       |           |          |  |  |
|---|-----------|-----------|-----|----------|------------|-------------|------|-------|------|-------|-----------|----------|--|--|
| Management Security Access Port Authentication Traffic Control Control ACL  |           |           |     |          |            |             |      |       |      |       |           |          |  |  |
| <div> <div> <div>ACL</div> <div> <div>• ACL Wizard</div> <div>• Basic</div> <div>• <b>MAC ACL</b></div> <div>• MAC Rules</div> <div>• MAC Binding Configuration</div> <div>• Binding Table</div> <div>• Advanced</div> </div> </div> <div> <div>MAC ACL</div> <div> <div>Current Number of ACL</div> <div>Maximum ACL</div> </div> <div>MAC ACL Table</div> <table border="1"> <thead> <tr> <th>Name</th> <th>Rules</th> <th>Direction</th> </tr> </thead> <tbody> <tr> <td>acl_bpdu</td> <td></td> <td></td> </tr> </tbody> </table> </div> </div> |           |           |     |          |            |             |      |       | Name | Rules | Direction | acl_bpdu |  |  |
| Name  | Rules     | Direction |     |          |            |             |      |       |      |       |           |          |  |  |
| acl_bpdu  |           |           |     |          |            |             |      |       |      |       |           |          |  |  |

- b. In the **Name** field, enter **acl\_bpdu**.
  - c. Click **Add** to create ACL acl\_bpdu.
2. Create a new rule that is associated with the ACL acl\_bpdu.
  - a. Select **Security > ACL > MAC ACL > MAC Rules**.

A screen similar to the following displays.

The screenshot shows the ACL configuration page. On the left, the 'MAC Rules' section is selected. The 'ACL Name' field is set to 'acl\_bpdu'. The 'Rule Table' contains the following data:

| ID | Action | Assign Queue Id | Mirror Interface | Redirect Interface | Match Every | CoS | Destination MAC   | Destination MAC Mask |
|----|--------|-----------------|------------------|--------------------|-------------|-----|-------------------|----------------------|
| 1  | Deny   |                 |                  |                    |             |     | 01:80:c2:00:00:00 | 00:00:00:ff:ff:ff    |

- a. In the **ACL Name** field, select **acl\_bpdu**.
  - b. In the **Action** field, select **Deny**.
  - c. Enter the following information in the Rule Table.
    - In the **ID** field, enter **1**.
    - In the **Destination MAC** field, enter **01:80:c2:00:00:00**.
    - In the **Destination MAC Mask** field, enter **00:00:00:ff:ff:ff**.
  - d. Click the **Add** button.
3. Create another rule that is associated with the ACL **acl\_bpdu**.
    - a. Select **Security > ACL > MAC ACL > MAC Rules**.

A screen similar to the following displays.

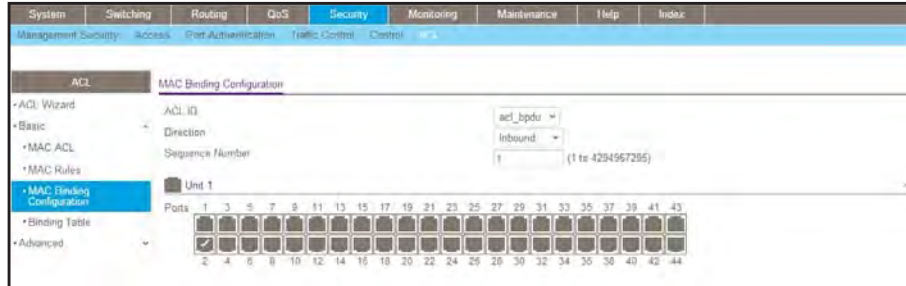
The screenshot shows the ACL configuration page with two rules in the 'Rule Table':

| ID | Action | Assign Queue Id | Mirror Interface | Redirect Interface | Match Every | CoS | Destination MAC   | Destination MAC Mask |
|----|--------|-----------------|------------------|--------------------|-------------|-----|-------------------|----------------------|
| 1  | Deny   |                 |                  |                    | False       |     | 01:80:C2:00:00:00 | 00:00:00:FF:FF:FF    |
| 2  | Permit |                 |                  |                    |             |     |                   |                      |

- a. Select **acl\_bpdu** in the **ACL Name** field.
- b. Enter the following information in the Rule Table.
  - In the **ID** field, enter **2**.
  - In the **Action** field, select **Permit**.

- c. Click the **Add** button.
4. Apply the ACL `acl_bpdu` to port 2.
  - a. Select **Security > ACL > MAC ACL > MAC Binding Configuration**.

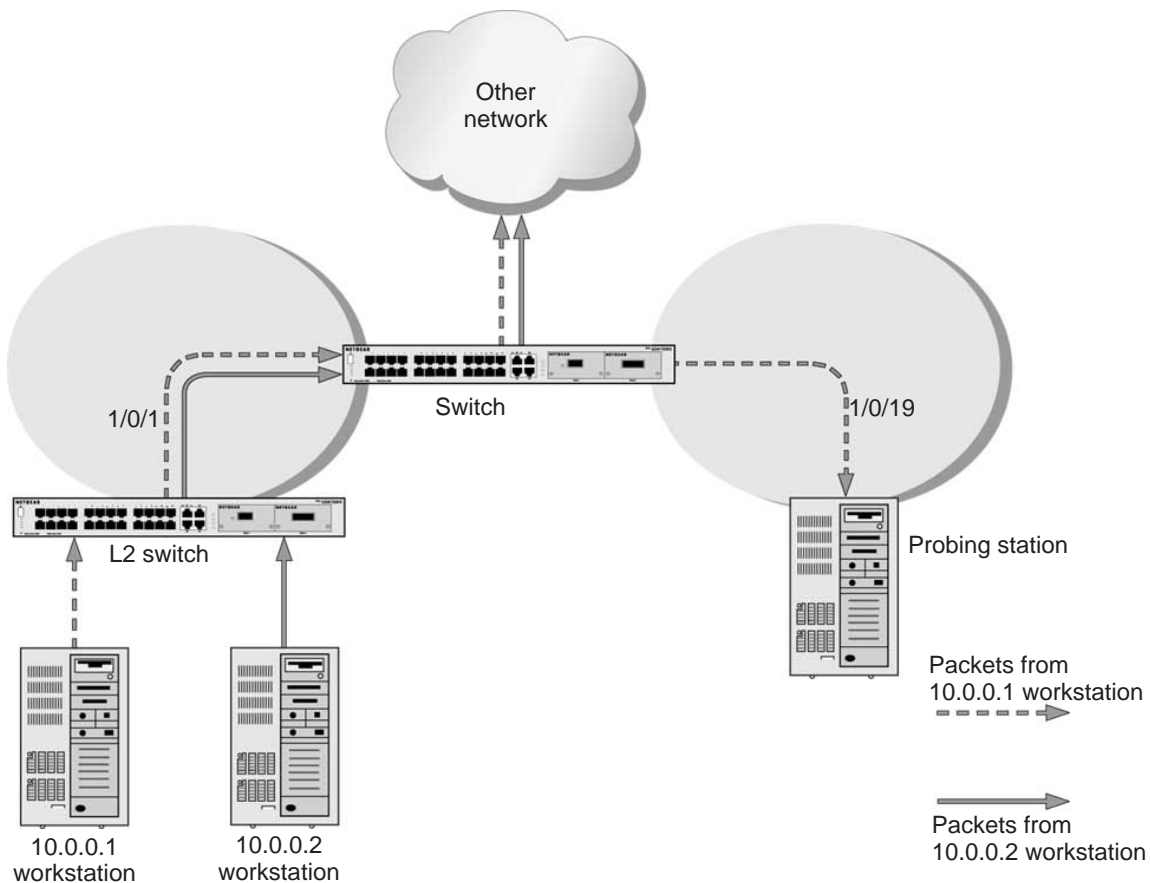
A screen similar to the following displays.



- b. Enter the following information in the MAC Binding Configuration.
  - IN the **ACL ID** field, select `acl_bpdu`.
  - In the **Sequence Number** field, enter `1`.
- c. Click the **Unit 1**. The ports display.
- d. Click the gray box under port **2**. A check mark displays in the box.
- e. Click **Apply** to save the settings.

## Configure ACL Mirroring

This feature extends the existing port mirroring functionality by allowing you to mirror a designated traffic stream in an interface using ACL rules. Define an ACL rule matching the desired traffic with the option mirror to an interface. Any traffic matching this rule will be copied to the specified mirrored interface.



**Figure 24. ACL mirroring**

## CLI: Configure ACL Mirroring

The script in this section shows how to mirror the traffic stream received from a host in an interface. These examples mirror the traffic from the host 10.0.0.1 connected to the interface 1/0/1.

1. Create an IP access control list with the name monitorHost.

```
(Netgear Switch) (Config)# ip access-list monitorHost
```

2. Define the rules to match host 10.0.0.1 and to permit all others.

```
(Netgear Switch) (Config-ipv4-acl)# permit ip 10.0.0.1 0.0.0.0 any mirror 1/0/19
(Netgear Switch) (Config-ipv4-acl)# permit every
```



**3. Bind the ACL with interface 1/0/1.**

```
(Netgear Switch) (Interface 1/0/1)#ip access-group monitorHost in 1
```

**4. View the configuration.**

```
(Netgear Switch) # show ip access-lists
Current number of ACLs: 1 Maximum number of ACLs: 100
```

| ACL ID/Name | Rules | Direction | Interface(s) | VLAN(s) |
|-------------|-------|-----------|--------------|---------|
| monitorHost | 2     | inbound   | 1/0/1        |         |

```
(Netgear Switch) #show ip access-lists monitorHost

ACL Name: monitorHost
Inbound Interface(s): 1/0/1

Rule Number: 1
Action..... permit
Match All..... FALSE
Protocol..... 255(ip)
Source IP Address..... 10.0.0.1
Source IP Mask..... 0.0.0.0
Mirror Interface..... 1/0/19

Rule Number: 2
Action..... permit
Match All..... TRUE
```

## Local Browser Interface: Configure ACL Mirroring

1. Create an IP access control list with the name monitorHost on the switch.

- a. Select **Security > ACL > Advanced > IP ACL**.

A screen similar to the following displays.

| System  | Switching | Routing | QoS | Security | Monitoring | Maintenance | Help | Index |           |       |      |             |  |  |
|---|-----------|---------|-----|----------|------------|-------------|------|-------|-----------|-------|------|-------------|--|--|
| Management Security Access Port Authentication Traffic Control Control ACL  |           |         |     |          |            |             |      |       |           |       |      |             |  |  |
| <div> <div> <div>ACL</div> <div> <ul style="list-style-type: none"> <li>• ACL Wizard</li> <li>• Basic</li> <li>• Advanced</li> <li>• <b>IP ACL</b></li> <li>• IP Rules</li> <li>• IP Extended Rules</li> <li>• IPv6 ACL</li> <li>• IPv6 Rules</li> <li>• IP Binding Configuration</li> <li>• Binding Table</li> <li>• VLAN Binding Table</li> </ul> </div> </div> <div> <div>IP ACL Configuration</div> <div> <div>Current Number of ACL</div> <div>1</div> </div> <div> <div>Maximum ACL</div> <div>100</div> </div> </div> </div> <div> <div>IP ACL Table</div> <table border="1"> <thead> <tr> <th>IP ACL ID</th> <th>Rules</th> <th>Type</th> </tr> </thead> <tbody> <tr> <td>monitorHost</td> <td></td> <td></td> </tr> </tbody> </table> </div> |           |         |     |          |            |             |      |       | IP ACL ID | Rules | Type | monitorHost |  |  |
| IP ACL ID   | Rules     | Type    |     |          |            |             |      |       |           |       |      |             |  |  |
| monitorHost   |           |         |     |          |            |             |      |       |           |       |      |             |  |  |

- b. In the **IP ACL ID** field, enter **monitorHost**.

- c. Click **Add** to create ACL monitorHost.

A screen similar to the following displays.

| System   | Switching | Routing      | QoS | Security | Monitoring | Maintenance | Help | Index |           |       |      |             |   |              |
|--|-----------|--------------|-----|----------|------------|-------------|------|-------|-----------|-------|------|-------------|---|--------------|
| Management Security Access Port Authentication Traffic Control Control ACL   |           |              |     |          |            |             |      |       |           |       |      |             |   |              |
| <div> <div> <div>ACL</div> <div> <ul style="list-style-type: none"> <li>• ACL Wizard</li> <li>• Basic</li> <li>• Advanced</li> <li>• <b>IP ACL</b></li> <li>• IP Rules</li> <li>• IP Extended Rules</li> <li>• IPv6 ACL</li> <li>• IPv6 Rules</li> <li>• IP Binding Configuration</li> <li>• Binding Table</li> <li>• VLAN Binding Table</li> </ul> </div> </div> <div> <div>IP ACL Configuration</div> <div> <div>Current Number of ACL</div> <div>2</div> </div> <div> <div>Maximum ACL</div> <div>100</div> </div> </div> </div> <div> <div>IP ACL Table</div> <table border="1"> <thead> <tr> <th>IP ACL ID</th> <th>Rules</th> <th>Type</th> </tr> </thead> <tbody> <tr> <td>monitorHost</td> <td>0</td> <td>Named IP ACL</td> </tr> </tbody> </table> </div> |           |              |     |          |            |             |      |       | IP ACL ID | Rules | Type | monitorHost | 0 | Named IP ACL |
| IP ACL ID  | Rules     | Type         |     |          |            |             |      |       |           |       |      |             |   |              |
| monitorHost  | 0         | Named IP ACL |     |          |            |             |      |       |           |       |      |             |   |              |

2. Create a rule to match host 10.0.0.1 in the ACL monitorHost.

- a. Select **Security > ACL > Advanced > IP Extended Rules**.

A screen similar to the following displays.

The screenshot shows the 'Security' > 'ACL' configuration page. On the left, the 'ACL' menu is expanded, and 'IP Extended Rules' is selected. The main area shows the 'IP Rules' configuration for 'monitorHost'. The 'Extended ACL Rule Table' is currently empty, with a message indicating that no rules have been configured for this ACL.

b. Click **Add**.

A screen similar to the following displays.

The screenshot shows the 'Extended ACL Rule Configuration' page for rule ID 1. The configuration is as follows:

- ACL ID/Name:** monitorHost
- Rule ID:** 1
- Action:** ☒ Permit, ☐ Deny, ☐ Disable
- Egress Queue:** (0-6)
- Logging:** ☐ Enable, ☒ Disable
- Interface:** ☒ Mirror, ☐ Redirect
- Match Every:** ☒ True, ☐ False
- Protocol Type:** ☒ IP, ☐ UDP, ☐ TCP
- TCP Flag:** ☐ URG, ☐ RST, ☐ SYN, ☐ ACK
- Src:** ☒ IP Address, ☐ Host
- Src IP Address:** 10.0.0.1
- Src IP Mask:** 0.0.0.0

c. In the **Rule ID** field, enter **1**.

d. For Action, select the **Permit** radio button.

e. In the **Mirror Interface** list, select **1/0/19**.

f. In the **Src IP Address** field, enter **10.0.0.1**.

g. In the **Src IP Mask** field, enter **0.0.0.0**.

h. Click **Apply**.

3. Create a rule to match every other traffic.

a. Select **Security > ACL > Advanced > IP Extended Rules**.

A screen similar to the following displays.

The screenshot shows the 'Security' tab in the configuration interface. Under 'ACL', the 'IP Rules' section is active. The 'Extended ACL Rule Table' displays a single rule:

| Rule ID | Action | Logging | Assign Queue ID | Mirror Interface | Redirect Interface | Match Every | Protocol Type | TCP Flag | Established | Source IP Address | Source IP Mask | Source Port Action | Source Port |
|---------|--------|---------|-----------------|------------------|--------------------|-------------|---------------|----------|-------------|-------------------|----------------|--------------------|-------------|
| 1       | Permit |         |                 | 1/0/13           |                    | False       | 4 (IP)        |          |             | 10.0.0.1          | 0.0.0.0        |                    |             |

b. Click **Add**.

A screen similar to the following displays.

The screenshot shows the 'Extended ACL Rule Configuration(100-199)' page. The configuration for Rule ID 2 is as follows:

- ACL ID/Name:** monitorHost
- Rule ID:** 2
- Action:** ☒ Permit, ☐ Deny, ☐ Mirror, ☐ Redirect
- Egress Queue:** (0-6)
- Logging:** ☐ Enable, ☒ Disable
- Interface:** (dropdown)
- Match Every:** ☒ True, ☐ False
- Protocol Type:** IP (dropdown)
- TCP Flag:** URG, RST, ☒ IP Address, ☐ Host
- ACK:** Ignore (dropdown)
- SYN:** Ignore (dropdown)

c. In the **Rule ID** field, enter **2**.

d. Select the **Permit** radio button.

e. In the **Match Every** field, select **True**.

f. Click **Apply**.

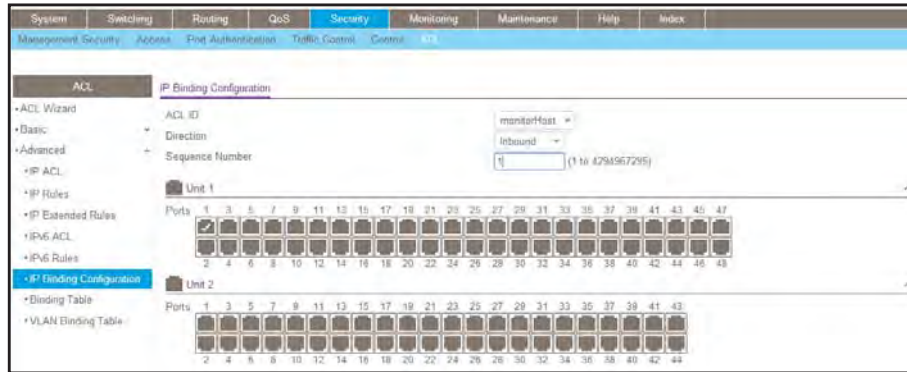
A screen similar to the following displays.

The screenshot shows the 'Security' tab in the configuration interface. Under 'ACL', the 'IP Rules' section is active. The 'Extended ACL Rule Table' now displays two rules:

| Rule ID | Action | Logging | Assign Queue ID | Mirror Interface | Redirect Interface | Match Every | Protocol Type | TCP Flag | Established | Source IP Address | Source IP Mask | Source Port Action | Source Port |
|---------|--------|---------|-----------------|------------------|--------------------|-------------|---------------|----------|-------------|-------------------|----------------|--------------------|-------------|
| 1       | Permit |         |                 | 1/0/13           |                    | False       | 4 (IP)        |          |             | 10.0.0.1          | 0.0.0.0        |                    |             |
| 2       | Permit |         |                 |                  |                    | True        |               |          |             |                   |                |                    |             |

4. Bind the ACL with interface 1/0/1.
  - a. Select **Security > ACL > Advanced > IP Binding Configuration**.

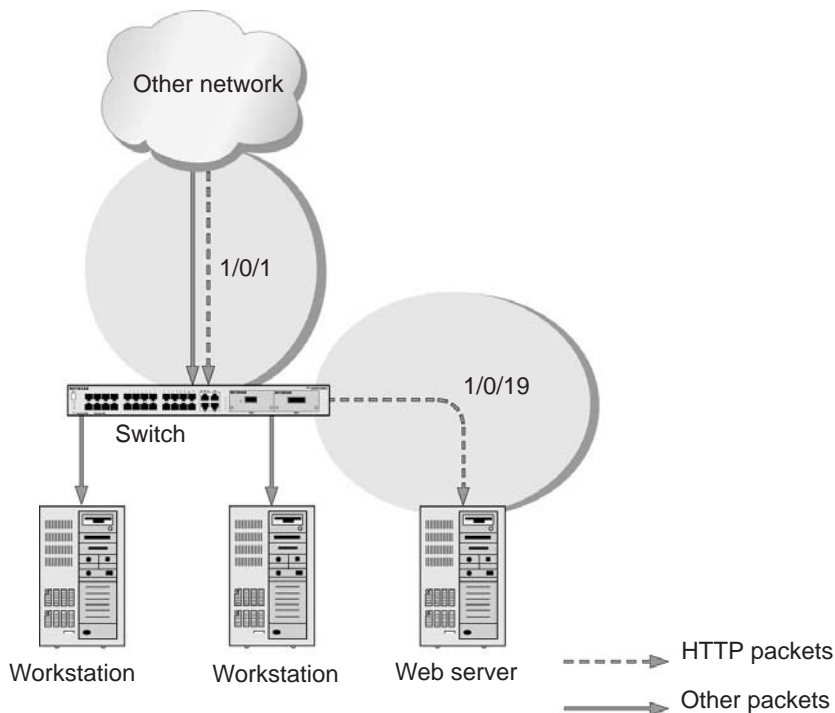
A screen similar to the following displays.



- b. In the **Sequence Number** field, enter 1.
- c. In the Port Selection Table, click **Unit 1** to display all the ports for the device.
- d. Select the **Port 1** check box.
- e. Click **Apply**.

## Configure ACL Redirection

This feature redirects a specified traffic stream to a specified interface.



**Figure 25. ACL Redirect**

## CLI: Redirect a Traffic Stream

The script in this section shows how to redirect an HTTP traffic stream received in an interface to the specified interface. This example redirects the HTTP traffic stream received in port 1/0/1 to port 1/0/19.

1. Create an IP access control list with the name redirectHTTP.

```
(Netgear Switch) (Config)#ip access-list redirectHTTP
```

2. Define a rule to match the HTTP stream and define a rule to permit all others.

```
(Netgear Switch) (Config-ipv4-acl)# permit tcp any any eq http redirect 1/0/19
(Netgear Switch) (Config-ipv4-acl)# permit every
```

3. Bind the ACL with interface 1/0/1.

```
(Netgear Switch) (Interface 1/0/1)#ip access-group redirectHTTP in 1
```

4. View the configuration.

```
(Netgear Switch) # show ip access-lists
Current number of ACLs: 1 Maximum number of ACLs: 100

ACL ID/Name          Rules  Direction  Interface(s)      VLAN(s)
-----
redirectHTTP         2      inbound    1/0/1

(Netgear Switch) #show ip access-lists redirectHTTP

ACL Name: redirectHTTP
Inbound Interface(s): 1/0/1

Rule Number: 1
Action..... permit
Match All..... FALSE
Protocol..... 6(tcp)
Destination L4 Port Keyword..... 80(www/http)
Redirect Interface..... 1/0/19

Rule Number: 2
Action..... permit
Match All..... TRUE
```

## Local Browser Interface: Redirect a Traffic Stream

This example redirects the HTTP traffic stream received in port 1/0/1 to port 1/0/19.

1. Create an IP access control list with the name **redirectHTTP**.

- a. Select **Security > ACL > Advanced > IP ACL**.

A screen similar to the following displays.

| System              | Switching | Routing             | QoS             | Security | Monitoring | Maintenance | Help | Index |
|---------------------|-----------|---------------------|-----------------|----------|------------|-------------|------|-------|
| Management Security | Access    | Port Authentication | Traffic Control | Control  | ACL        |             |      |       |

ACL

- ACL Wizard
- Basic
- Advanced
- **IP ACL**
- IP Rules
- IP Extended Rules
- IPv6 ACL
- IPv6 Rules
- IP Binding Configuration
- Binding Table
- VLAN Binding Table

IP ACL Configuration

Current Number of ACL

1

Maximum ACL

100

IP ACL Table

| IP ACL ID    | Rules | Type |
|--------------|-------|------|
| redirectHTTP |       |      |

- b. In the **IP ACL** field, enter **redirectHTTP**.
- c. Click **Add** to create the IP ACL **redirectHTTP**.

A screen similar to the following displays.

| System              | Switching | Routing             | QoS             | Security | Monitoring | Maintenance | Help | Index |
|---------------------|-----------|---------------------|-----------------|----------|------------|-------------|------|-------|
| Management Security | Access    | Port Authentication | Traffic Control | Control  | ACL        |             |      |       |

ACL

- ACL Wizard
- Basic
- Advanced
- **IP ACL**
- IP Rules
- IP Extended Rules
- IPv6 ACL
- IPv6 Rules
- IP Binding Configuration
- Binding Table
- VLAN Binding Table

IP ACL Configuration

Current Number of ACL

2

Maximum ACL

100

IP ACL Table

| IP ACL ID    | Rules | Type         |
|--------------|-------|--------------|
|              |       |              |
| redirectHTTP | 0     | Named IP ACL |

2. Create a rule to redirect HTTP traffic.
  - a. Select **Security > ACL > Advanced > IP Extended Rules**.



A screen similar to the following displays.

The screenshot shows the 'Security' tab with the 'ACL' sub-tab selected. On the left, the 'IP Extended Rules' option is highlighted. The main area shows the 'Extended ACL Rule Table' for the 'redirectHTTP' ACL. The table has columns for Rule ID, Action, Logging, Assign Queue ID, Mirror Interface, Redirect Interface, Match Every, Protocol Type, TCP Flag, Established, Source IP Address, Source IP Mask, and Source L4 Port Action. Below the table, a message states: 'No rules have been configured for this ACL.'

b. Click **Add**.

A screen similar to the following displays.

The screenshot shows the 'Extended ACL Rule Configuration' page for rule ID '1'. The 'Action' is set to 'Permit'. The 'Redirect Interface' is '1/0/19'. The 'Dst L4 Port' is 'http'. Other fields include 'Rule ID' (1), 'Match Every' (checked), 'Protocol Type' (TCP), 'TCP Flag' (URG), 'Src' (IP Address), 'Src L4' (Port), 'Dst' (IP Address), 'Egress Queue' (0-6), 'Enable' (checked), 'ACK' (Ignore), 'SYN' (Ignore), 'PSH' (Ignore), 'RST' (Ignore), 'Other Start Port' (0 to 65535), and 'Other End Port' (0 to 65535).

c. In the **Rule ID** field, enter **1**.

d. In the **protocol** field, select **www-http**.

e. For Action, select the **Permit** radio button.

f. In the **Redirect Interface** list, select **1/0/19**.

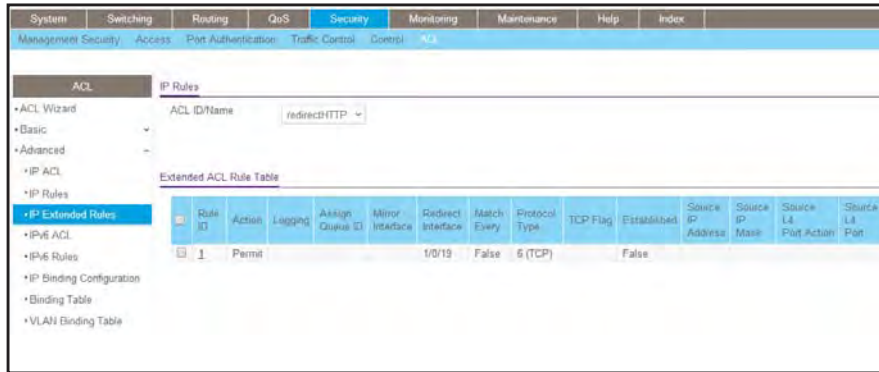
g. In the **Dst L4 Port** list, select **http**.

h. Click **Apply**. The Extended ACL Rules screen displays, as described in the next step in this procedure.

3. Create a rule to match every other traffic.

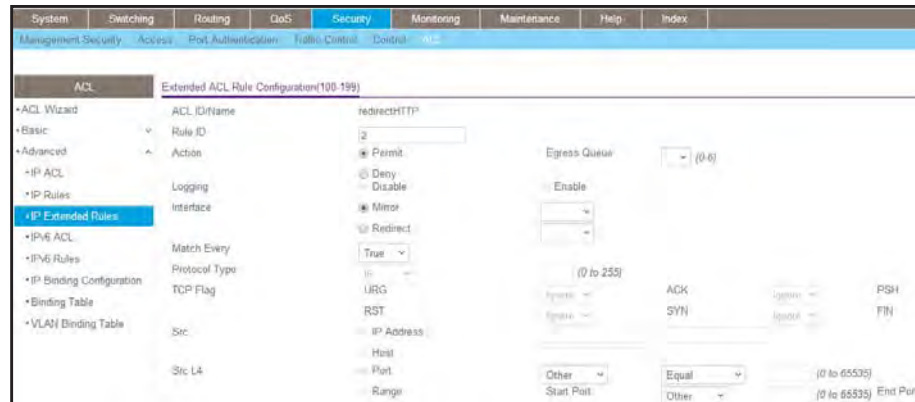
a. Select **Security > ACL > Advanced > IP Extended Rules**.

A screen similar to the following displays.



b. Click **Add**.

A screen similar to the following displays.



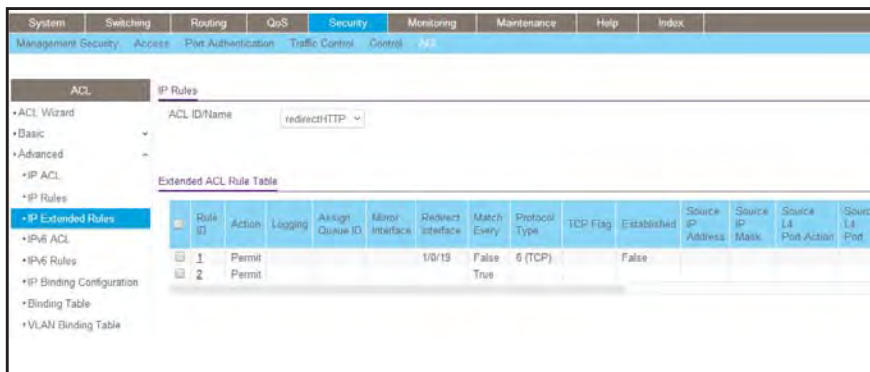
c. In the **Rule ID** field, enter **2**.

d. For Action, select the **Permit** radio button.

e. In the **Match Every** field, select **True**.

f. Click **Apply**.

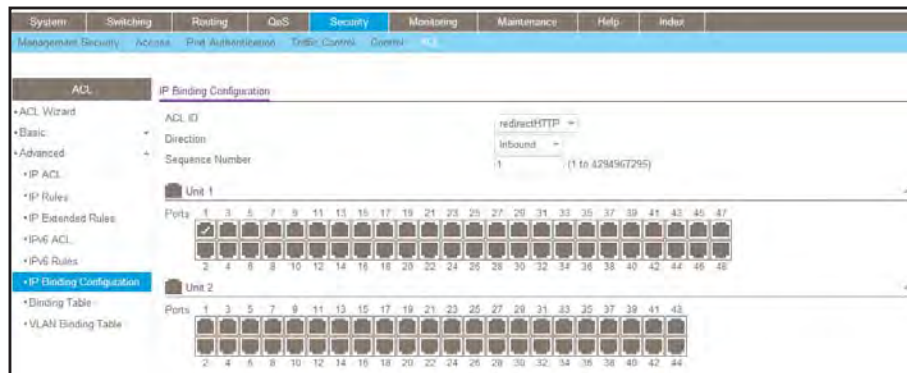
A screen similar to the following displays.



4. Bind the ACL with interface 1/0/1.

a. Select **Security > ACL > Advanced > IP Binding Configuration**.

A screen similar to the following displays.



- b. In the **Sequence Number** field, enter **1**.
- c. In the Port Selection Table, click **Unit 1** to display all the ports.
- d. Select the check box below Port 1.
- e. Click **Apply**.

## Add ACL Remarks

You can use the **remark** keyword to include comments (remarks) for ACL rule entries in a MAC or IP ACL. Remarks can help you and other users to understand ACL rules. Each remark line is limited to 100 characters. Remarks can consist of characters in the range A–Z, a–z, and 0–9 and of special characters such as spaces, hyphens, and underscores. If you want to create remarks for a permit or deny rule, you must create the remarks before you create the rule. If you remove a rule, all associated remarks are removed as well. If remarks are no longer applicable, you can remove them. You can also add remarks to a MAC or IP ACL without adding any rules, save the remarks, and add the rules later.

The following example shows how you can add remarks to rules:

1. Create an ACL.

```
(Netgear Switch) (Config)#ip access-list acl_voice
```

2. Add a remark before you add a rule.

```
(Netgear Switch) (Config-ipv4-acl)#remark "permit VOIP packets whose DSCP is EF"
(Netgear Switch) (Config-ipv4-acl)#permit ip any any dscp ef
(Netgear Switch) (Config-ipv4-acl)#remark "deny all of other packets"
(Netgear Switch) (Config-ipv4-acl)#deny ip any any
(Netgear Switch) (Config-ipv4-acl)#exit
(Netgear Switch) (Config)#exit
```

### 3. Check the configuration using the **show running-config** command.

```
(Netgear Switch) #show running-config
.....
ip access-list acl_voice
remark "permit VOIP packets whose DSCP is EF"
permit ip any any dscp ef
remark "deny all of other packets"
deny ip any any
exit
```

## Change the Sequence of an ACL Rule

The association of sequence numbers with access control list (ACL) rules can simplify the process of changing an ACL and can make it easier to identify the rules. Sequence numbers let you position ACL rule entries within an ACL, resort entries, and remove entries.

You can renumber ACL rule entries to create room to insert a new rule entry. For example, you can specify a sequence number to insert a rule entry in the middle of an existing ACL.

Each ACL rule entry requires a sequence number: If you do not assign a number manually, the switch assigns it automatically. The following applies to sequence numbers:

- If you do not manually assign a sequence number for the rule, the switch automatically assign a sequence number that is 10 greater than the last sequence number in the ACL, and the rule is placed at the end of the list. If the rule is the first one in the ACL, a sequence number of 10 is assigned. If the automatically assigned sequence number exceeds the maximum possible value, creation of the ACL rule fails.
- You cannot create a rule with a sequence number that duplicates an existing sequence number.
- If you reboot the switch, the start sequence number and increment number for ACL rules are not saved.

The following example shows how you can insert an ACL rule, let the switch automatically assign a sequence number, change the start sequence number and the sequence increment number (that is, the number by which the sequence increases), and insert an ACL rule at a particular position:

### 1. Create an IP ACL named voice\_acl without specifying a sequence number.

```
(Netgear Switch) #config
(Netgear Switch) (Config)#ip access-list voice_acl
(Netgear Switch) (Config-ipv4-acl)#permit ip any any dscp cs5
(Netgear Switch) (Config-ipv4-acl)#permit ip any any dscp ef
(Netgear Switch) (Config-ipv4-acl)#deny ip any any
(Netgear Switch) (Config-ipv4-acl)#exit
```

**2. Verify that the sequence numbers are assigned by the switch.**

The first sequence number is 10, the second sequence number is 20, and so on.

```
(Netgear Switch) (Config)#show ip access-lists voice_acl
ACL Name: voice_acl

Sequence Number: 10
Action..... permit
Match All..... False
Protocol..... 255(ip)
IP DSCP..... 40(cs5)

Sequence Number: 20
Action..... permit
Match All..... False
Protocol..... 255(ip)
IP DSCP..... 46(ef)

Sequence Number: 30
Action..... deny
Match All..... TRUE
```

**3. If you must add more than 10 ACL rules, change the start sequence number and sequence increment number before you add ACL rules. In the following example, the start sequence number is 1000 and the sequence increment number is 100.**

```
(Netgear Switch) (Config)#ip access-list resequence voice_acl 1000 100
(Netgear Switch) (Config)#show ip access-lists voice_acl
ACL Name: voice_acl

Sequence Number: 1000
Action..... permit
Match All..... False
Protocol..... 255(ip)
IP DSCP..... 40(cs5)

Sequence Number: 1100
Action..... permit
Match All..... False
Protocol..... 255(ip)
IP DSCP..... 46(ef)

Sequence Number: 1200
Action..... deny
Match All..... TRUE
```

4. Insert a new ACL rule at a particular position. For example, insert a new ACL rule with sequence number 900 at the first position. The new rule drops all packets that arrive from IP address 192.168.1.1.

```
(Netgear Switch) #config
(Netgear Switch) (Config)#ip access-list voice_acl
(Netgear Switch) (Config-ipv4-acl)#900 deny ip 192.168.1.1 255.255.255.0 any
(Netgear Switch) (Config-ipv4-acl)#exit
(Netgear Switch) (Config)#exit
(Netgear Switch) #show ip access-lists voice_acl

ACL Name: voice_acl

Sequence Number: 900
Action..... deny
Match All..... False
Protocol..... 255(ip)
Source IP Address..... 192.168.1.1
Source IP Wildcard Mask..... 255.255.255.0

Sequence Number: 1000
Action..... permit
Match All..... False
Protocol..... 255(ip)
IP DSCP..... 40(cs5)

Sequence Number: 1100
Action..... permit
Match All..... False
Protocol..... 255(ip)
IP DSCP..... 46(ef)

Sequence Number: 1200
Action..... deny
Match All..... TRUE
```

## Configure a Management ACL

A management ACL lets you control access to the switch. You can permit specific hosts to access the switch and deny access to all other hosts. You can also specify a specific access method for a permitted host. For example, you can specify that a host can access the switch over a Telnet connection only

The following examples show how to configure a management ACL.

## Example 1: Permit Any Host to Access the Switch Through Telnet or HTTP:

Permit any host to access the managed VLAN IP address of 169.254.100.100 through a Telnet or HTTP connection:

```
(Netgear Switch) (Config)#ip access-list acl_for_cpu
(Netgear Switch) (Config-ipv4-acl)#permit tcp any 169.254.100.100 0.0.0.0 eq telnet
(Netgear Switch) (Config-ipv4-acl)#deny tcp any any eq http
(Netgear Switch) (Config-ipv4-acl)#permit tcp any 169.254.100.100 0.0.0.0 eq http
(Netgear Switch) (Config-ipv4-acl)#deny tcp any any eq http
(Netgear Switch) (Config-ipv4-acl)#deny every
(Netgear Switch) (Config-ipv4-acl)#exit
(Netgear Switch) (Config)#ip access-group acl_for_cpu control-plane
```

## Example 2: Permit a Specific Host to Access the Switch Through SSH Only

Permit a specific host access the switch over an SSH connection only.

```
(Netgear Switch) (Config)#ip access-list acl_for_cpu
(Netgear Switch) (Config-ipv4-acl)#permit tcp 10.100.5.13 0.0.0.0 any eq ssh
(Netgear Switch) (Config-ipv4-acl)#deny tcp any any eq ssh
(Netgear Switch) (Config-ipv4-acl)#permit every
(Netgear Switch) (Config-ipv4-acl)#exit
(Netgear Switch) (Config)#ip access-group acl_for_cpu control-plane
```

## Configure IPv6 ACLs

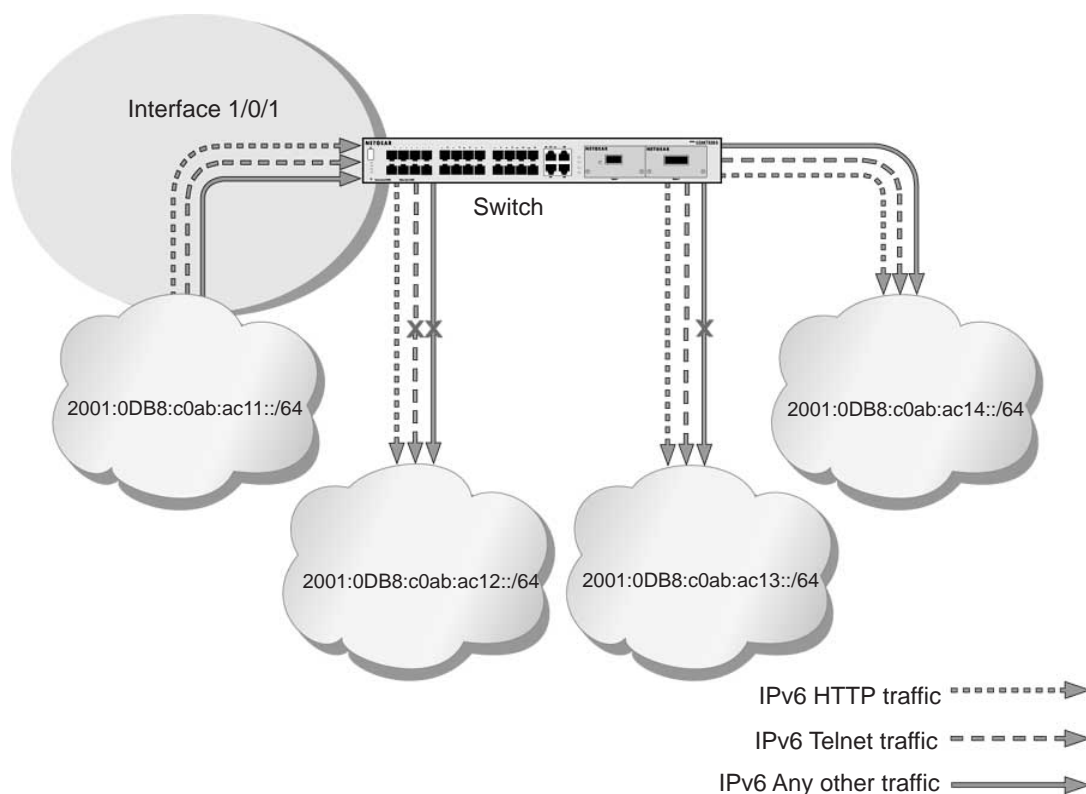
This feature extends the existing IPv4 ACL by providing support for IPv6 packet classification. Each ACL is a set of up to 12 rules applied to inbound traffic. Each rule specifies whether the contents of a given field should be used to permit or deny access to the network, and can apply to one or more of the following fields within a packet:

- Source IPv6 prefix
- Destination IPv6 prefix
- Protocol number
- Source Layer 4 port
- Destination Layer 4 port



- DSCP value
- Flow label

Note that the order of the rules is important: When a packet matches multiple rules, the first rule takes precedence. Also, once you define an ACL for a given port, all traffic not specifically permitted by the ACL is denied access.



**Figure 26. IPv6 ACLs**

The script in this section shows you how to set up an IPv6 ACL with the following three rules:

- **Rule-1.** Permits every traffic to the destination network 2001:DB8:C0AB:AC14::/64.
- **Rule-2.** Permits IPv6 TELNET traffic to the destination network 2001:DB8:C0AB:AC13::/64.
- **Rule-3.** Permits IPv6 HTTP traffic to any destination.

## CLI: Configure an IPv6 ACL

1. Create the access control list with the name `ipv6-acl`.

```
(Netgear Switch) (Config)# ipv6 access-list ipv6-acl
```

2. Define three rules to:

- Permit *any* IPv6 traffic to the destination network `2001:DB8:C0AB:AC14::/64` from the source network `2001:DB8:C0AB:AC11::/64`.
- Permit IPv6 *Telnet* traffic to the destination network `2001:DB8:C0AB:AC13::/64` from the source network `2001:DB8:C0AB:AC11::/64`.
- Permit IPv6 HTTP traffic to *any* destination network from the source network `2001:DB8:C0AB:AC11::/64`.

```
(Netgear Switch) (Config-ipv6-acl)# permit ipv6 2001:DB8:C0AB:AC11::/64
2001:DB8:C0AB:AC14::/64
(Netgear Switch) (Config-ipv6-acl)# permit tcp 2001:DB8:C0AB:AC11::/64
2001:DB8:C0AB:AC13::/64 eq telnet
(Netgear Switch) (Config-ipv6-acl)# permit tcp 2001:DB8:C0AB:AC11::/64 any eq http
```

3. Apply the rules to inbound traffic on port `1/0/1`. Only traffic matching the criteria will be accepted.

```
(Netgear Switch) (Config)#interface 1/0/1
(Netgear Switch) (Interface 1/0/1)# ipv6 traffic-filter ipv6-acl in
(Netgear Switch) (Interface 1/0/1)# exit
(Netgear Switch) (Config)#exit
```

**4. View the configuration.**

```
(Netgear Switch) #show ipv6 access-lists
Current number of all ACLs: 1   Maximum number of all ACLs: 100

IPv6 ACL Name          Rules    Direction    Interface(s)    VLAN(s)
-----
ipv6-acl                3        inbound      1/0/1

(Netgear Switch) #show ipv6 access-lists ipv6-acl

ACL Name: ipv6-acl
Inbound Interface(s): 1/0/1

Rule Number: 1
Action..... permit
Protocol..... 255(ipv6)
Source IP Address..... 2001:DB8:C0AB:AC11::/64
Destination IP Address..... 2001:DB8:C0AB:AC14::/64

Rule Number: 2
Action..... permit
Protocol..... 6(tcp)
Source IP Address..... 2001:DB8:C0AB:AC11::/64
Destination IP Address..... 2001:DB8:C0AB:AC13::/64
Destination L4 Port Keyword..... 23(telnet)
```

```
Rule Number: 3
Action..... permit
Protocol..... 6(tcp)
Source IP Address..... 2001:DB8:C0AB:AC11::/64
Destination L4 Port Keyword..... 80(www/http)
```

## Local Browser Interface: Configure an IPv6 ACL

1. Create the access control list with the name ipv6-acl.
  - a. Select **Security > ACL > Advanced > IPv6 ACL**.
  - b. In the IPv6 ACL Table, in the **IPv6 ACL** field, enter **ipv6-acl**.

A screen similar to the following displays.

| System              | Switching | Routing             | QoS             | Security | Monitoring | Maintenance | Help | Index |
|---------------------|-----------|---------------------|-----------------|----------|------------|-------------|------|-------|
| Management Security | Access    | Port Authentication | Traffic Control | Control  | ACL        |             |      |       |

**ACL**

- ACL Wizard
- Basic
- Advanced
  - IP ACL
  - IP Rules
  - IP Extended Rules
  - **IPv6 ACL**
  - IPv6 Rules
  - IP Binding Configuration
  - Binding Table
  - VLAN Binding Table

**IPv6 Configuration**

Current Number of ACL:

Maximum ACL:

**IPv6 ACL Table**

| IPv6 ACL | Rules | Type     |
|----------|-------|----------|
| ipv6-acl |       | IPv6 ACL |

- c. Click **Add**.

A screen similar to the following displays.

| System              | Switching | Routing             | QoS             | Security | Monitoring | Maintenance | Help | Index |
|---------------------|-----------|---------------------|-----------------|----------|------------|-------------|------|-------|
| Management Security | Access    | Port Authentication | Traffic Control | Control  | ACL        |             |      |       |

**ACL**

- ACL Wizard
- Basic
- Advanced
  - IP ACL
  - IP Rules
  - IP Extended Rules
  - **IPv6 ACL**
  - IPv6 Rules
  - IP Binding Configuration
  - Binding Table
  - VLAN Binding Table

**IPv6 Configuration**

Current Number of ACL:

Maximum ACL:

**IPv6 ACL Table**

| IPv6 ACL | Rules | Type     |
|----------|-------|----------|
| IPv6 ACL |       | IPv6 ACL |
| ipv6-acl | 0     | IPv6 ACL |

2. Define the first rule (1 of 3).
  - a. Select **Security > ACL > Advanced > IPv6 Rules**.

A screen similar to the following displays.

The screenshot shows the 'Security > ACL' configuration page. On the left, the 'ACL' menu is expanded, and 'IPv6 Rules' is selected. The main area shows the 'IPv6 Rules' configuration for the ACL named 'ipv6-acl'. Below the 'IPv6 ACL Rule Table' header, a message states: 'No rules have been configured for this ACL'.

b. In the **ACL Name** list, select **ipv6-acl**.

c. Click **Add**.

A screen similar to the following displays.

The screenshot shows the 'IPv6 ACL Rule Configuration' page. The 'Rule ID' is set to 1, and the 'Action' is 'Permit'. The 'Source' is configured with 'IPv6 Address' 2001:DB8:C0AB:AC11:: and 'Source L4' 64. The 'Destination' is configured with 'IPv6 Address' 2001:DB8:C0AB:AC14:: and 'Destination L4' 64. The 'Protocol Type' is 'IPv6'. The 'Egress Queue' is set to (0-6). The 'Match Every' section shows 'Protocol Type' as 'IPv6' and 'TCP Flag' as 'URG'. The 'ACK' and 'SYN' checkboxes are checked, and the 'PSH' checkbox is unchecked.

d. In the **Rule ID** field, enter **1**.

e. For Action, select the **Permit** radio button.

f. In the **Source Prefix** field, enter **2001:DB8:C0AB:AC11::**.

g. In the **Source Prefix Length** field, enter **64**.

h. In the **Destination Prefix** field, enter **2001:DB8:C0AB:AC14::**.

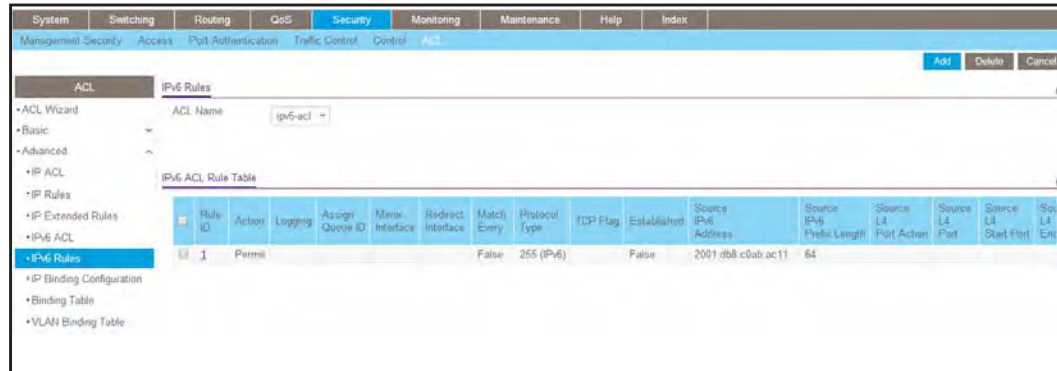
i. In the **Destination Prefix Length** field, enter **64**.

j. Click **Apply**.

3. Add Rule 2.

a. Select **Security > ACL > Advanced > IPv6 Rules**.

A screen similar to the following displays.



- b. In the **ACL Name** list, select **ipv6-acl**.
- c. Click **Add**.

A screen similar to the following displays.



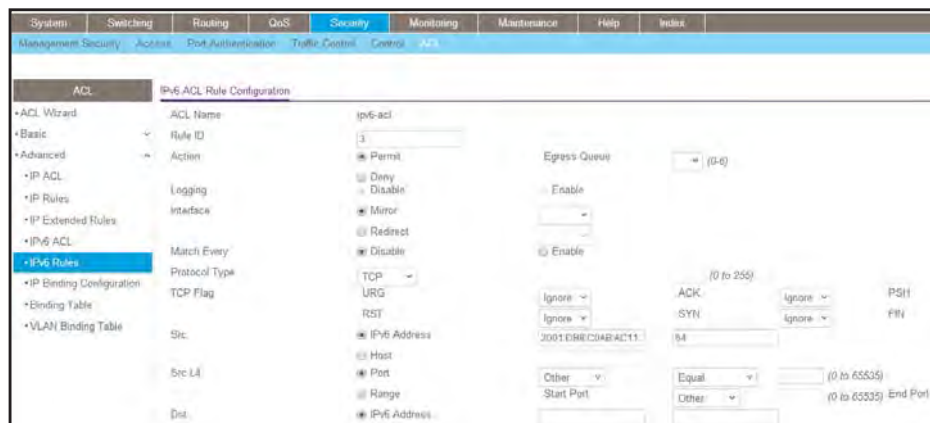
- d. In the **Rule ID** field, enter **2**.
  - e. For Action, select the **Permit** radio button.
  - f. In the **Protocol Type** list, select **TCP**.
  - g. In the **Source Prefix** field, enter **2001:DB8:C0AB:AC11::**.
  - h. In the **Source Prefix Length** field, enter **64**.
  - i. In the **Destination Prefix** field, enter **2001:DB8:C0AB:AC13::**.
  - j. In the **Destination Prefix Length** field, enter **64**.
  - k. In the **Destination L4 Port** list, select **telnet**.
  - l. Click **Apply**.
4. Add Rule 3.
    - a. Select **Security > ACL > Advanced > IPv6 Rules**.

A screen similar to the following displays.



- b. In the **ACL Name** list, select **ipv6-acl**.
- c. Click **Add**.

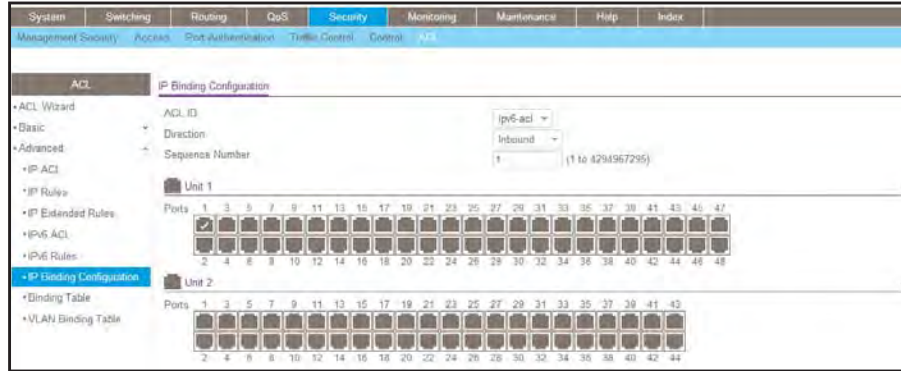
A screen similar to the following displays.



- d. In the **Rule ID** field, enter **3**.
  - e. For Action, select the **Permit** radio button.
  - f. In the **Protocol Type** list, select **TCP**.
  - g. In the **Source Prefix** field, enter **2001:DB8:C0AB:AC11::**.
  - h. In the **Source Prefix Length** field, enter **64**.
  - i. In the **Destination L4 Port** list, select **http**.
  - j. Click **Apply**.
5. Apply the rules to inbound traffic on port 1/0/1.
- Only traffic matching the criteria will be accepted.
- a. Select **Security > ACL > Advanced > IP Binding Configuration**.
  - b. In the **ACL ID** list, select **ipv6-acl**.
  - c. In the **Sequence Number** list, select **1**.
  - d. Click **Unit 1**.
  - e. Select **Port 1**.



A screen similar to the following displays.

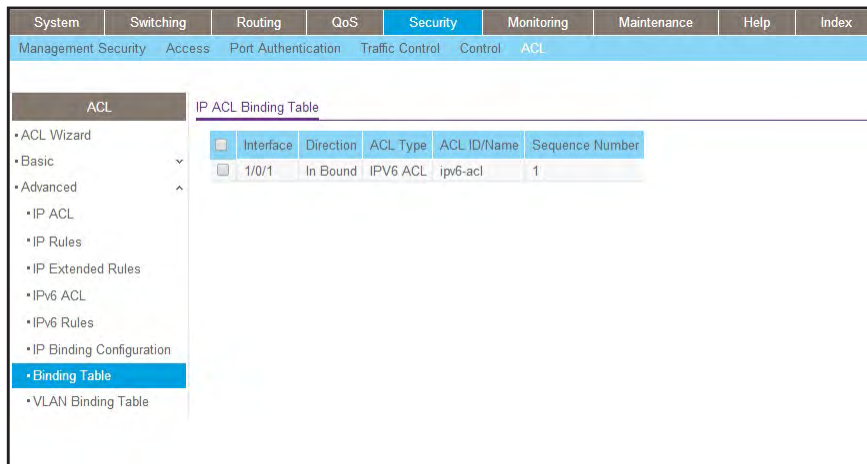


f. Click the **Apply** button.

6. View the binding table.

Select **Security > ACL > Advanced > Binding Table**.

A screen similar to the following displays.



# 12

## 12 CoS Queuing

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### Class of Service queuing

This chapter describes Class of Service (CoS) queue mapping, CoS Configuration, and traffic shaping features. The chapter includes the following sections:

- [CoS Queuing Concepts](#)
- [Show the Trust Mode for a Class of Service](#)
- [Set the Trust Mode for a Class of Service](#)
- [Configure Cos-queue Min-bandwidth and Strict Priority Scheduler Mode](#)
- [Set the CoS Trust Mode for an Interface](#)
- [Configure Traffic Shaping](#)

# CoS Queuing Concepts

Each port has one or more queues for packet transmission. During configuration, you can determine the mapping and configuration of these queues.

Based on the service rate and other criteria you configure, queues provide preference to specified packets. If a delay is necessary, the system holds packets until the scheduler authorizes transmission. As queues become full, packets are dropped. Packet drop precedence indicates the packet's sensitivity to being dropped during queue congestion.

You can CoS on a per-interface basis:

- You can configure CoS mapping.
- Queue parameters and queue management are configurable per interface.
- Some hardware implementations allow queue depth management using tail dropping or weighted random early discard (WRED).
- Some hardware implementations allow queue depth management using tail dropping.
- The operation of CoS queuing involves queue mapping and queue configuration.

## CoS Queue Mapping

CoS queue mapping uses trusted and untrusted ports.

### Trusted Ports

- The system takes at face value certain priority designations for arriving packets.
- Trust applies only to packets that have that trust information.
- There can be only one trust field at a time - per port.
  - 802.1p user priority (This is the default trust mode and is managed through switching configuration.)
  - IP precedence
  - IP DiffServ Code Point (DSCP)

The system can assign the service level based upon the 802.1p priority field of the L2 header. You configure this by mapping the 802.1p priorities to one of three traffic class queues.

These queues are:

- **Queue 2.** Minimum of 50 percent of available bandwidth
- **Queue 1.** Minimum of 33 percent of available bandwidth
- **Queue 0.** Lowest priority, minimum of 17 percent of available bandwidth

For untagged traffic, you can specify the default 802.1p priority on a per-port basis.

## Untrusted Ports

- No incoming packet priority designation is trusted; therefore, the default priority value for the port is used.
- All ingress packets from untrusted ports, where the packet is classified by an ACL or a DiffServ policy, are directed to specific CoS queues on the appropriate egress port. That specific CoS queue is determined by either the default priority of the port or a DiffServ or ACL-assigned queue attribute.
- Used when trusted port mapping is unable to be honored - for instance, when a non-IP DSCP packet arrives at a port configured to trust IP DSCP.

## CoS Queue Configuration

CoS queue configuration involves port egress queue configuration and drop precedence configuration (per queue). The design of these on a per-queue, per-drop precedence basis allows you to create the service characteristics that you want for different types of traffic.

Port egress queue configuration:

- Scheduler type, strict vs. weighted
- Minimum guaranteed bandwidth
- Maximum allowed bandwidth per-queue shaping
- Queue management type, tail drop vs. WRED

Drop precedence configuration (per queue):

- WRED parameters
  - Minimum threshold
  - Maximum threshold
  - Drop probability
  - Scale factor
- Tail drop parameters, threshold

Per-interface basis:

- Queue management type, rail Drop vs. WRED

Only if per-queue configuration is not supported

- WRED decay exponent
- Traffic shaping for an entire interface

# Show the Trust Mode for a Class of Service

The example is shown as CLI commands and as a local browser interface procedure.

## CLI: Show the Trust Mode for a Class of Service

To use the CLI to show CoS trust mode, use these commands:

```
(Netgear Switch) #show classofservice trust?
<cr>   Press Enter to execute the command.
(Netgear Switch) #show classofservice trust
Class of Service Trust Mode: Dot1P
```

## Local Browser Interface: Show the Trust Mode for a Class of Service

Select **QoS > CoS > Basic > CoS Configuration**.

A screen similar to the following displays.

| System             | Switching | Routing  | QoS | Security             | Monitoring | Maintenance | Help | Index |
|--------------------|-----------|--|-----|----------------------|------------|-------------|------|-------|
| CoS DiffServ       |           |  |     |                      |            |             |      |       |
| CoS Configuration  |           |  |     |                      |            |             |      |       |
| *Basic             |           | <input checked="" type="radio"/> Global <span>All</span> |     | Global Trust Mode    |            |             |      |       |
|                    |           |  |     | trust dot1p          |            |             |      |       |
| *CoS Configuration |           | <input type="radio"/> Interface <span>1/0/1</span>       |     | Interface Trust Mode |            |             |      |       |
|                    |           |  |     | trust dot1p          |            |             |      |       |
| *Advanced          |           |  |     |                      |            |             |      |       |

# Set the Trust Mode for a Class of Service

The example is shown as CLI commands and as a local browser interface procedure.

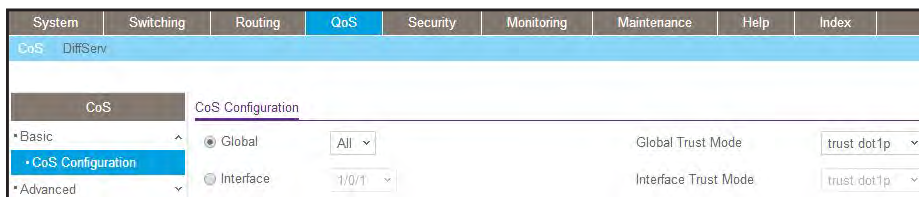
## CLI: Set the Trust Mode for a Class of Service

```
(Netgear Switch) (Config)#classofservice?
dot1p-mapping          Configure dot1p priority mapping.
ip-dscp-mapping        Maps an IP DSCP value to an internal traffic class.
trust                  Sets the Class of Service Trust Mode of an Interface.
(Netgear Switch) (Config)#classofservice trust?
dot1p                  Sets the Class of Service Trust Mode of an Interface
                       to 802.1p.
ip-dscp                Sets the Class of Service Trust Mode of an Interface
                       to IP DSCP.
(Netgear Switch) (Config)#classofservice trust dot1p?
<cr>                  Press Enter to execute the command.
(Netgear Switch) (Config)#classofservice trust dot1p
```

## Local Browser Interface: Set the Trust Mode for a Class of Service

1. Select **QoS > CoS > Basic > CoS Configuration**.

A screen similar to the following displays.



2. Select the **Global** radio button.
3. In the **Global Trust Mode** list, select **trust dot1p**.
4. Click **Apply** to save the settings.

# Configure Cos-queue Min-bandwidth and Strict Priority Scheduler Mode

The example is shown as CLI commands and as a local browser interface procedure.

## CLI: Configure Cos-queue Min-bandwidth and Strict Priority Scheduler Mode

```
(Netgear Switch) (Config)#cos-queue min-bandwidth?
<bw-0>                Enter the minimum bandwidth percentage for Queue 0.
(Netgear Switch) (Config)#cos-queue min-bandwidth 15
Incorrect input! Use 'cos-queue min-bandwidth <bw-0>..<bw-7>.'.
(Netgear Switch) (Config)#cos-queue min-bandwidth 15 25 10 5 5 20 10 10
(Netgear Switch) (Config)#cos-queue strict?
<queue-id>            Enter a Queue Id from 0 to 7.
(Netgear Switch) (Config)#cos-queue strict 1?
<cr>                  Press Enter to execute the command.
<queue-id>            Enter an additional Queue Id from 0 to 7.
(Netgear Switch) (Config)#cos-queue strict 1
```

## Local Browser Interface: Configure CoS-queue Min-bandwidth and Strict Priority Scheduler Mode

1. For Interface 1/0/2, set the minimum bandwidth to 15 for queue 0.
  - a. Select **QoS > CoS > Advanced > Interface Queue Configuration**.

A screen similar to the following displays.

| System   | Switching | Routing           | QoS            | Security              | Monitoring | Maintenance | Help | Index |           |          |                   |                |                       |                                |     |    |            |            |                                |   |   |          |          |   |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                 |   |   |          |          |                                 |   |   |          |          |
|--|-----------|-------------------|----------------|-----------------------|------------|-------------|------|-------|-----------|----------|-------------------|----------------|-----------------------|--------------------------------|-----|----|------------|------------|--------------------------------|---|---|----------|----------|---|---|---|----------|----------|--------------------------------|---|---|----------|----------|--------------------------------|---|---|----------|----------|--------------------------------|---|---|----------|----------|--------------------------------|---|---|----------|----------|--------------------------------|---|---|----------|----------|--------------------------------|---|---|----------|----------|--------------------------------|---|---|----------|----------|---------------------------------|---|---|----------|----------|---------------------------------|---|---|----------|----------|
| CoS DiffServ   |           |                   |                |                       |            |             |      |       |           |          |                   |                |                       |                                |     |    |            |            |                                |   |   |          |          |   |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                 |   |   |          |          |                                 |   |   |          |          |
| CoS Interface Queue Configuration  |           |                   |                |                       |            |             |      |       |           |          |                   |                |                       |                                |     |    |            |            |                                |   |   |          |          |   |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                 |   |   |          |          |                                 |   |   |          |          |
| 1 2 3 LAG All Go To Interface <input type="text"/> Go  |           |                   |                |                       |            |             |      |       |           |          |                   |                |                       |                                |     |    |            |            |                                |   |   |          |          |   |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                 |   |   |          |          |                                 |   |   |          |          |
| <table><tr><th>Interface</th><th>Queue ID</th><th>Minimum Bandwidth</th><th>Scheduler Type</th><th>Queue Management Type</th></tr><tr><td><input type="checkbox"/> 1/0/2</td><td>0 ▾</td><td>15</td><td>Weighted ▾</td><td>TailDrop ▾</td></tr><tr><td><input type="checkbox"/> 1/0/1</td><td>0</td><td>0</td><td>Weighted</td><td>TailDrop</td></tr><tr><td><input checked="" type="checkbox"/> 1/0/2</td><td>0</td><td>0</td><td>Weighted</td><td>TailDrop</td></tr><tr><td><input type="checkbox"/> 1/0/3</td><td>0</td><td>0</td><td>Weighted</td><td>TailDrop</td></tr><tr><td><input type="checkbox"/> 1/0/4</td><td>0</td><td>0</td><td>Weighted</td><td>TailDrop</td></tr><tr><td><input type="checkbox"/> 1/0/5</td><td>0</td><td>0</td><td>Weighted</td><td>TailDrop</td></tr><tr><td><input type="checkbox"/> 1/0/6</td><td>0</td><td>0</td><td>Weighted</td><td>TailDrop</td></tr><tr><td><input type="checkbox"/> 1/0/7</td><td>0</td><td>0</td><td>Weighted</td><td>TailDrop</td></tr><tr><td><input type="checkbox"/> 1/0/8</td><td>0</td><td>0</td><td>Weighted</td><td>TailDrop</td></tr><tr><td><input type="checkbox"/> 1/0/9</td><td>0</td><td>0</td><td>Weighted</td><td>TailDrop</td></tr><tr><td><input type="checkbox"/> 1/0/10</td><td>0</td><td>0</td><td>Weighted</td><td>TailDrop</td></tr><tr><td><input type="checkbox"/> 1/0/11</td><td>0</td><td>0</td><td>Weighted</td><td>TailDrop</td></tr></table> |           |                   |                |                       |            |             |      |       | Interface | Queue ID | Minimum Bandwidth | Scheduler Type | Queue Management Type | <input type="checkbox"/> 1/0/2 | 0 ▾ | 15 | Weighted ▾ | TailDrop ▾ | <input type="checkbox"/> 1/0/1 | 0 | 0 | Weighted | TailDrop | <input checked="" type="checkbox"/> 1/0/2 | 0 | 0 | Weighted | TailDrop | <input type="checkbox"/> 1/0/3 | 0 | 0 | Weighted | TailDrop | <input type="checkbox"/> 1/0/4 | 0 | 0 | Weighted | TailDrop | <input type="checkbox"/> 1/0/5 | 0 | 0 | Weighted | TailDrop | <input type="checkbox"/> 1/0/6 | 0 | 0 | Weighted | TailDrop | <input type="checkbox"/> 1/0/7 | 0 | 0 | Weighted | TailDrop | <input type="checkbox"/> 1/0/8 | 0 | 0 | Weighted | TailDrop | <input type="checkbox"/> 1/0/9 | 0 | 0 | Weighted | TailDrop | <input type="checkbox"/> 1/0/10 | 0 | 0 | Weighted | TailDrop | <input type="checkbox"/> 1/0/11 | 0 | 0 | Weighted | TailDrop |
| Interface  | Queue ID  | Minimum Bandwidth | Scheduler Type | Queue Management Type |            |             |      |       |           |          |                   |                |                       |                                |     |    |            |            |                                |   |   |          |          |   |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                 |   |   |          |          |                                 |   |   |          |          |
| <input type="checkbox"/> 1/0/2   | 0 ▾       | 15                | Weighted ▾     | TailDrop ▾            |            |             |      |       |           |          |                   |                |                       |                                |     |    |            |            |                                |   |   |          |          |   |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                 |   |   |          |          |                                 |   |   |          |          |
| <input type="checkbox"/> 1/0/1   | 0         | 0                 | Weighted       | TailDrop              |            |             |      |       |           |          |                   |                |                       |                                |     |    |            |            |                                |   |   |          |          |   |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                 |   |   |          |          |                                 |   |   |          |          |
| <input checked="" type="checkbox"/> 1/0/2  | 0         | 0                 | Weighted       | TailDrop              |            |             |      |       |           |          |                   |                |                       |                                |     |    |            |            |                                |   |   |          |          |   |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                 |   |   |          |          |                                 |   |   |          |          |
| <input type="checkbox"/> 1/0/3   | 0         | 0                 | Weighted       | TailDrop              |            |             |      |       |           |          |                   |                |                       |                                |     |    |            |            |                                |   |   |          |          |   |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                 |   |   |          |          |                                 |   |   |          |          |
| <input type="checkbox"/> 1/0/4   | 0         | 0                 | Weighted       | TailDrop              |            |             |      |       |           |          |                   |                |                       |                                |     |    |            |            |                                |   |   |          |          |   |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                 |   |   |          |          |                                 |   |   |          |          |
| <input type="checkbox"/> 1/0/5   | 0         | 0                 | Weighted       | TailDrop              |            |             |      |       |           |          |                   |                |                       |                                |     |    |            |            |                                |   |   |          |          |   |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                 |   |   |          |          |                                 |   |   |          |          |
| <input type="checkbox"/> 1/0/6   | 0         | 0                 | Weighted       | TailDrop              |            |             |      |       |           |          |                   |                |                       |                                |     |    |            |            |                                |   |   |          |          |   |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                 |   |   |          |          |                                 |   |   |          |          |
| <input type="checkbox"/> 1/0/7   | 0         | 0                 | Weighted       | TailDrop              |            |             |      |       |           |          |                   |                |                       |                                |     |    |            |            |                                |   |   |          |          |   |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                 |   |   |          |          |                                 |   |   |          |          |
| <input type="checkbox"/> 1/0/8   | 0         | 0                 | Weighted       | TailDrop              |            |             |      |       |           |          |                   |                |                       |                                |     |    |            |            |                                |   |   |          |          |   |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                 |   |   |          |          |                                 |   |   |          |          |
| <input type="checkbox"/> 1/0/9   | 0         | 0                 | Weighted       | TailDrop              |            |             |      |       |           |          |                   |                |                       |                                |     |    |            |            |                                |   |   |          |          |   |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                 |   |   |          |          |                                 |   |   |          |          |
| <input type="checkbox"/> 1/0/10  | 0         | 0                 | Weighted       | TailDrop              |            |             |      |       |           |          |                   |                |                       |                                |     |    |            |            |                                |   |   |          |          |   |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                 |   |   |          |          |                                 |   |   |          |          |
| <input type="checkbox"/> 1/0/11  | 0         | 0                 | Weighted       | TailDrop              |            |             |      |       |           |          |                   |                |                       |                                |     |    |            |            |                                |   |   |          |          |   |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                 |   |   |          |          |                                 |   |   |          |          |



- b. In the **Queue ID** list, select **0**.
- c. Under Interface Queue Configuration, scroll down and select the interface **1/0/2** check box.

Now 1/0/2 appears in the Interface field at the top.

- d. Enter the following information:
    - In the **Minimum Bandwidth** field, enter **15**.
    - In the **Scheduler Type** list, select **Weighted**.
  - e. Click **Apply** to save the settings.
2. For interface 1/0/2, set the minimum bandwidth 25 for queue 1, and set the scheduler type to strict.
    - a. Select **QoS > CoS > Advanced > Interface Queue Configuration**.

A screen similar to the following displays.

| Interface                                 | Queue ID | Minimum Bandwidth | Scheduler Type | Queue Management Type |
|---|----------|-------------------|----------------|-----------------------|
| 1/0/1                                     | 0        | 0                 | Weighted       | TailDrop              |
| <input checked="" type="checkbox"/> 1/0/2 | 1        | 25                | Strict         | TailDrop              |
| 1/0/3                                     | 0        | 0                 | Weighted       | TailDrop              |
| 1/0/4                                     | 0        | 0                 | Weighted       | TailDrop              |
| 1/0/5                                     | 0        | 0                 | Weighted       | TailDrop              |
| 1/0/6                                     | 0        | 0                 | Weighted       | TailDrop              |
| 1/0/7                                     | 0        | 0                 | Weighted       | TailDrop              |
| 1/0/8                                     | 0        | 0                 | Weighted       | TailDrop              |
| 1/0/9                                     | 0        | 0                 | Weighted       | TailDrop              |
| 1/0/10                                    | 0        | 0                 | Weighted       | TailDrop              |
| 1/0/11                                    | 0        | 0                 | Weighted       | TailDrop              |

- b. In the **Queue ID** list, select **1**.
- c. Under Interface Queue Configuration, scroll down and select the interface **1/0/2** check box.

Now 1/0/2 appears in the Interface field at the top.

- d. Enter the following information:
  - In the **Minimum Bandwidth** field, enter **25**.
  - In the **Scheduler Type** list, select **Strict**.
- e. Click **Apply** to save the settings.

# Set the CoS Trust Mode for an Interface

The example is shown as CLI commands and as a local browser interface procedure.

## CLI: Set the CoS Trust Mode for an Interface

```
(Netgear Switch) (Interface 1/0/3)#classofservice trust?
dot1p                Sets the Class of Service Trust Mode of an Interface
                      to 802.1p.
ip-dscp              Sets the Class of Service Trust Mode of an Interface
                      to IP DSCP.
(Netgear Switch) (Interface 1/0/3)#classofservice trust dot1p?
<cr>                 Press Enter to execute the command.
(Netgear Switch) (Interface 1/0/3)#classofservice trust dot1p
```

---

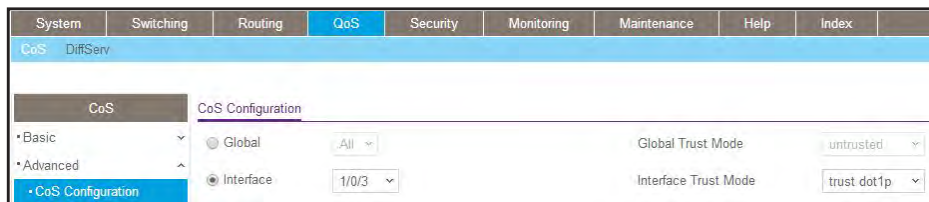
**Note:** The traffic class value range is 0--6 instead of 0--7 because queue 7 is reserved in a stacking build for stack control, and therefore you cannot configure it.

---

## Local Browser Interface: Set the CoS Trust Mode for an Interface

1. Select **QoS > CoS > Advanced > CoS Configuration**.

A screen similar to the following displays.



2. Under CoS Configuration, select the **Interface** radio button.
3. In the **Interface** list, select **1/0/3**.
4. In the **Interface Trust Mode** list, select **trust dot1p**.
5. Click **Apply** to save the settings.

# Configure Traffic Shaping

Traffic shaping controls the amount and volume of traffic transmitted through a network. This has the effect of smoothing temporary traffic bursts over time. Use the **traffic-shape** command to enable traffic shaping by specifying the maximum transmission bandwidth limit for all interfaces (Global Config) or for a single interface (Interface Config).

The *<bw>* value is a percentage that ranges from 0 to 100 in increments of 5. The default bandwidth value is 0, meaning no upper limit is enforced, which allows the interface to transmit up to its maximum line rate.

The *<bw>* value is independent of any per-queue maximum bandwidth values in effect for the interface and should be considered as a second-level transmission rate control mechanism that regulates the output of the entire interface regardless of which queues originate the outbound traffic.

## CLI: Configure Traffic Shaping

```
(Netgear Switch) (Config)#traffic-shape?
<bw>                               Enter the shaping bandwidth percentage from 0 to 100
                                   in increments of 5.
(Netgear Switch) (Config)#traffic-shape 70?
<cr>                               Press Enter to execute the command.
(Netgear Switch) (Config)#traffic-shape 70
(Netgear Switch) (Config)#
```

## Local Browser Interface: Configure Traffic Shaping

1. Set the shaping bandwidth percentage to 70 percent.
  - a. Select **QoS > CoS > Advanced > CoS Interface Configuration**.

A screen similar to the following displays.

| Interface | Interface Trust Mode | Interface Shaping Rate |
|-----------|----------------------|------------------------|
| 1/0/3     | 802.1p               | 70                     |
| 1/0/1     | Untrusted            | 0                      |
| 1/0/2     | Untrusted            | 0                      |
| 1/0/3     | Untrusted            | 0                      |
| 1/0/4     | Untrusted            | 0                      |
| 1/0/5     | Untrusted            | 0                      |

- b. Under CoS Interface Configuration, scroll down and select the interface **1/0/3** check box.

Now 1/0/3 appears in the Interface field at the top.

- c. In the **Interface Shaping Rate (0 to 100)** field, enter **70**.
- d. Click **Apply** to save the settings.

# 13

## DiffServ

---

### Differentiated Services

This chapter includes the following sections:

- [Differentiated Services Concepts](#)
- [DiffServ](#)
- [DiffServ for VoIP](#)
- [Auto VoIP](#)
- [DiffServ for IPv6](#)
- [Color Conform Policy](#)
- [WRED Explicit Congestion Notification](#)

# Differentiated Services Concepts

Differentiated services (DiffServ) is one technique for implementing Quality of Service (QoS) policies. Using DiffServ in your network allows you to directly configure the relevant parameters on the switches and routers rather than using a resource reservation protocol. This section explains how to configure the switch to identify which traffic class a packet belongs to, and how it should be handled to provide the quality of service you want. As implemented on the switch, DiffServ allows you to control what traffic is accepted and what traffic is discarded.

How you configure DiffServ support on the switch varies, depending on the role of the switch in your network:

- **Edge device.** An edge device handles ingress traffic, flowing toward the core of the network, and egress traffic, flowing away from the core. An edge device segregates inbound traffic into a small set of traffic classes, and is responsible for determining a packet's classification. Classification is based primarily on the contents of the Layer 3 and Layer 4 headers, and is recorded in the Differentiated Services Code Point (DSCP) added to a packet's IP header.
- **Interior node.** A switch in the core of the network is responsible for forwarding packets, rather than for classifying them. It decodes the DSCP code point in an incoming packet, and provides buffering and forwarding services using the appropriate queue management algorithms.

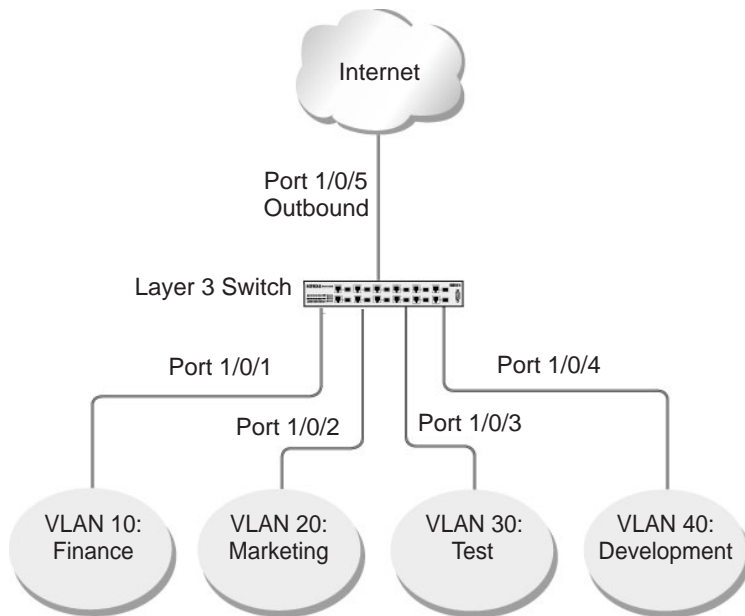
Before configuring DiffServ on a particular switch, you must determine the QoS requirements for the network as a whole. The requirements are expressed in terms of rules, which are used to classify inbound traffic on a particular interface. The switch software does not support DiffServ in the outbound direction.

Rules are defined in terms of classes, policies, and services:

- **Class.** A class consists of a set of rules that identify which packets belong to the class. Inbound traffic is separated into traffic classes based on Layer 3 and Layer 4 header data and the VLAN ID, and marked with a corresponding DSCP value. One type of class is supported: All, which specifies that every match criterion defined for the class must be true for a match to occur.
- **Policy.** Defines the QoS attributes for one or more traffic classes. An example of an attribute is the ability to mark a packet at ingress. The 7000 Series Managed Switch supports a traffic conditions policy. This type of policy is associated with an inbound traffic class and specifies the actions to be performed on packets meeting the class rules:
  - Marking the packet with a given DSCP code point, IP precedence, or CoS
  - Policing packets by dropping or re-marking those that exceed the class's assigned data rate
  - Counting the traffic within the class
- **Service.** Assigns a policy to an interface for inbound traffic.

# DiffServ

This example shows how a network administrator can provide equal access to the Internet (or other external network) to different departments within a company. Each of four departments has its own Class B subnet that is allocated 25 percent of the available bandwidth on the port accessing the Internet.



**Figure 27. Class B subnet with differentiated services**

The example is shown as CLI commands and as a local browser interface procedure.

## CLI: Configure DiffServ

1. Ensure that the DiffServ operation is enabled for the switch.

```
(Netgear Switch) #config  
(Netgear Switch) (Config)#diffserv
```



2. Create a DiffServ class of type all for each of the departments, and name them. Define the match criteria of source IP address for the new classes.

```
(Netgear Switch) (Config)#class-map match-all finance_dept
(Netgear Switch) (Config class-map)#match srcip 172.16.10.0 255.255.255.0
(Netgear Switch) (Config class-map)#exit

(Netgear Switch) (Config)#class-map match-all marketing_dept
(Netgear Switch) (Config class-map)#match srcip 172.16.20.0 255.255.255.0
(Netgear Switch) (Config class-map)#exit

(Netgear Switch) (Config)#class-map match-all test_dept
(Netgear Switch) (Config class-map)#match srcip 172.16.30.0 255.255.255.0
(Netgear Switch) (Config class-map)#exit

(Netgear Switch) (Config)#class-map match-all development_dept
(Netgear Switch) (Config class-map)#match srcip 172.16.40.0 255.255.255.0
(Netgear Switch) (Config class-map)#exit
```

3. Create a DiffServ policy for inbound traffic named 'internet\_access', adding the previously created department classes as instances within this policy.

This policy uses the assign-queue attribute to put each department's traffic on a different egress queue. This is how the DiffServ inbound policy connects to the CoS queue settings established in the following example.

```
(Netgear Switch) (Config)#policy-map internet_access in
(Netgear Switch) (Config policy-map)#class finance_dept
(Netgear Switch) (Config policy-class-map)#assign-queue 1
(Netgear Switch) (Config policy-class-map)#exit
(Netgear Switch) (Config policy-map)#class marketing_dept
(Netgear Switch) (Config policy-class-map)#assign-queue 2
(Netgear Switch) (Config policy-class-map)#exit
(Netgear Switch) (Config policy-map)#class test_dept
(Netgear Switch) (Config policy-class-map)#assign-queue 3
(Netgear Switch) (Config policy-class-map)#exit
(Netgear Switch) (Config policy-map)#class development_dept
(Netgear Switch) (Config policy-class-map)#assign-queue 4
(Netgear Switch) (Config policy-class-map)#exit
(Netgear Switch) (Config policy-map)#exit
```

**4. Attach the defined policy to interfaces 1/0/1 through 1/0/4 in the inbound direction.**

```
(Netgear Switch) (Config)#interface 1/0/1
(Netgear Switch) (Interface 1/0/1)#service-policy in internet_access
(Netgear Switch) (Interface 1/0/1)#exit

(Netgear Switch) (Config)#interface 1/0/2
(Netgear Switch) (Interface 1/0/2)#service-policy in internet_access
(Netgear Switch) (Interface 1/0/2)#exit

(Netgear Switch) (Config)#interface 1/0/3
(Netgear Switch) (Interface 1/0/3)#service-policy in internet_access
(Netgear Switch) (Interface 1/0/3)#exit

(Netgear Switch) (Config)#interface 1/0/4
(Netgear Switch) (Interface 1/0/4)#service-policy in internet_access
(Netgear Switch) (Interface 1/0/4)#exit
```

**5. Set the CoS queue configuration for the (presumed) egress interface 1/0/5 such that each of queues 1, 2, 3, and 4 gets a minimum guaranteed bandwidth of 25 percent. All queues for this interface use weighted round robin scheduling by default. The DiffServ inbound policy designates that these queues are to be used for the departmental traffic through the assign-queue attribute. It is presumed that the switch will forward this traffic to interface 1/0/5 based on a normal destination address lookup for Internet traffic.**

```
(Netgear Switch) (Config)#interface 1/0/5
(Netgear Switch) (Interface 1/0/5)#cos-queue min-bandwidth 0 25 25 25 25 0 0 0
(Netgear Switch) (Interface 1/0/5)#exit
(Netgear Switch) (Config)#exit
```

## Local Browser Interface: Configure DiffServ

### 1. Enable Diffserv.

#### a. Select **QoS > DiffServ > Basic > DiffServ Configuration**.

A screen similar to the following displays.

| MIB Table               | Current Size | Max Size |
|-------------------------|--------------|----------|
| Class Table             | 0            | 32       |
| Class Rule table        | 0            | 416      |
| Policy table            | 0            | 64       |
| Policy Instance table   | 0            | 1792     |
| Policy Attributes table | 0            | 5376     |
| Service table           | 0            | 208      |

#### b. For Diffserv Admin Mode, select the **Enable** radio button.

#### c. Click **Apply** to save the settings.

### 2. Create the class finance\_dept.

#### a. Select **QoS > DiffServ > Advanced > Class Configuration**.

A screen similar to the following displays.

| Class Name   | Class Type |
|--------------|------------|
| finance_dept | All        |

#### b. Enter the following information:

- In the **Class Name** field, enter **finance\_dept**.
- In the **Class Type** list, select **All**.

#### c. Click **Add** to create a new class finance\_dept.

#### d. Click the **finance\_dept** to configure this class.

A screen similar to the following displays.

The screenshot shows the 'DiffServ Class Configuration' screen. The left sidebar has a tree view with 'Class Configuration' selected. The main area has a 'Class Information' section with 'Class Name' set to 'marketing\_dept' and 'Class Type' set to 'All'. Below this is the 'DiffServ Class Configuration' section with various match criteria. The 'Source IP' field is set to '172.16.10.0' and the 'Source Mask' field is set to '255.255.255.0'.

- e. Under Diffserv Class Configuration, enter the following information:
  - In the **Source IP Address** field, enter **172.16.10.0**.
  - In the **Source Mask** field, enter **255.255.255.0**.
- f. Click **Apply**.
3. Create the class marketing\_dept:
  - a. Select **QoS > DiffServ > Advanced > Class Configuration**.

A screen similar to the following displays.

The screenshot shows the 'DiffServ Class Configuration' screen. The left sidebar has a tree view with 'Class Configuration' selected. The main area has a 'Class Information' section with 'Class Name' set to 'marketing\_dept' and 'Class Type' set to 'All'. Below this is a table with two rows: 'marketing\_dept' and 'finance\_dept'. The 'marketing\_dept' row has 'Class Name' set to 'marketing\_dept' and 'Class Type' set to 'All'.

- b. Enter the following information:
  - In the **Class Name** field, enter **marketing\_dept**.
  - In the **Class Type** list, select **All**.
- c. Click **Add** to create a new class marketing\_dept.
- d. Click **marketing\_dept** to configure this class.

A screen similar to the following displays.

The screenshot shows the 'DiffServ Class Configuration' page. The left sidebar has a tree view with 'DiffServ' expanded, and 'Class Configuration' selected. The main area is titled 'DiffServ Class Configuration' and contains several sections: 'Class Information' (Class Name: Accounting\_dept, Class Type: All), 'DiffServ Class Configuration' (Match Every, Reference Class, Class Of Service, VLAN, Secondary Class of Service, Secondary VLAN, Ethernet Type, Source MAC, Destination MAC, Protocol Type, Source IP), and 'Source IP' (Address: 172.16.20.0, Mask: 255.255.255.0).

e. Under Diffserv Class Configuration, enter the following information:

- In the **Source IP Address** field, enter **172.16.20.0**.
- In the **Source Mask** field, enter **255.255.255.0**.

f. Click **Apply**.

4. Create the class test\_dept:

a. Select **QoS > DiffServ > Advanced > Class Configuration**.

A screen similar to the following displays.

The screenshot shows the 'DiffServ Class Configuration' page. The left sidebar has a tree view with 'DiffServ' expanded, and 'Class Configuration' selected. The main area is titled 'DiffServ Class Configuration' and contains a table with columns 'Class Name' and 'Class Type'. The table has three rows: 'Test\_dept' (All), 'finance\_dept' (All), and 'Marketing\_dept' (All). The 'Class Name' field is set to 'Test\_dept' and the 'Class Type' is set to 'All'.

b. Enter the following information:

- In the **Class Name** field, enter **test\_dept**.
- In the **Class Type** list, select **All**.

c. Click **Add** to create a new class test\_dept.

d. Click **test\_dept** to configure this class.

A screen similar to the following displays.

The screenshot shows the 'DiffServ Class Configuration' page. The left sidebar has a tree view with 'DiffServ' expanded, and 'Class Configuration' selected. The main area is titled 'DiffServ Class Configuration' and contains several sections: 'Class Information' (Class Name: dev\_dept, Class Type: All), 'Match Every' (selected), 'Reference Class', 'Class Of Service', 'VLAN', 'Secondary Class of Service', 'Secondary VLAN', 'Ethernet Type', 'Source MAC', 'Destination MAC', 'Protocol Type', and 'Source IP'. The 'Source IP' field is set to 172.16.30.0 and the 'Source Mask' is set to 255.255.255.0.

- e. Under Diffserv Class Configuration, enter the following information:
    - In the **Source IP Address** field, enter **172.16.30.0**.
    - In the **Source Mask** field, enter **255.255.255.0**.
  - f. Click **Apply**.
5. Create class development\_dept.
- a. Select **QoS > DiffServ > Advanced > Class Configuration**.

A screen similar to the following displays.

The screenshot shows the 'DiffServ Class Configuration' page. The left sidebar has a tree view with 'DiffServ' expanded, and 'Class Configuration' selected. The main area is titled 'DiffServ Class Configuration' and contains a table of existing classes and a form to add a new class. The table has columns 'Class Name' and 'Class Type'. The existing classes are: 'development\_dept' (All), 'finance\_dept' (All), 'Marketing\_dept' (All), and 'Test\_dept' (All). The form to add a new class has 'Class Name' set to 'development\_dept' and 'Class Type' set to 'All'.

- b. Enter the following information:
  - In the **Class Name** field, enter **development\_dept**.
  - In the **Class Type** list, select **All**.
- c. Click the **Add** to create a new class development\_dept.
- d. Click **development\_dept** to configure this class.

A screen similar to the following displays.

The screenshot shows the 'DiffServ Class Configuration' page. The left sidebar contains a tree view with 'DiffServ' expanded, showing 'Class Configuration' selected. The main area is titled 'DiffServ Class Configuration' and contains a list of configuration options on the left and their corresponding fields on the right. The 'Source IP' field is set to '172.16.40.0' and the 'Source Mask' is set to '255.255.255.0'.

- e. Under Diffserv Class Configuration, enter the following information:
  - In the **Source IP Address** field, enter **172.16.40.0**.
  - In the **Source Mask** field, enter **255.255.255.0**.
- f. Click **Apply**.
6. Create a policy named internet\_access and add the class finance\_dept to it.
  - a. Select **QoS > DiffServ > Advanced > Policy Configuration**.

A screen similar to the following displays.

The screenshot shows the 'DiffServ Policy Configuration' page. The left sidebar contains a tree view with 'DiffServ' expanded, showing 'Policy Configuration' selected. The main area is titled 'Policy Configuration' and contains a table with the following data:

| Policy Name     | Policy Type | Member Class |
|-----------------|-------------|--------------|
| internet_access |             | finance_dept |

- b. Enter the following information:
  - In the **Policy Selector** field, enter **internet\_access**.
  - In the **Member Class** list, select the **finance\_dept**.
- c. Click **Add** to create a new policy internet\_access.
7. Add the class marketing\_dept into the policy internet\_access.
  - a. Select **QoS > DiffServ > Advanced > Policy Configuration**.



A screen similar to the following displays.

| Policy Name     | Policy Type | Member Class   |
|-----------------|-------------|----------------|
| internet_access | In          | Marketing_dept |
| internet_access | In          | finance_dept   |
| internet_access | In          | Marketing_dept |

- b. Under Policy Configuration, scroll down and select the **internet\_access** check box. internet\_access now appears in the Policy Selector field at the top.
  - c. In the **Member Class** list, select **marketing\_dept**.
  - d. Click **Apply** to add the class marketing\_dept to the policy internet\_access.
8. Add the class test\_dept into the policy internet\_access.
- a. Select **QoS > DiffServ > Advanced > Policy Configuration**.

A screen similar to the following displays.

| Policy Name     | Policy Type | Member Class   |
|-----------------|-------------|----------------|
| internet_access | In          | Marketing_dept |
| internet_access | In          | finance_dept   |
| internet_access | In          | Marketing_dept |

- b. Under Policy Configuration, scroll down and select the **internet\_access** check box. Internet\_access now appears in the Policy Selector field at the top.
  - c. In the **Member Class** list, select **test\_dept**.
  - d. Click **Apply** to add the class test\_dept to the policy internet\_access.
9. Add the class development\_dept into the policy internet\_access.
- a. Select **QoS > DiffServ > Advanced > Policy Configuration**.

A screen similar to the following displays.

| Policy Name     | Policy Type | Member Class   |
|-----------------|-------------|----------------|
| internet_access | In          | Development    |
| internet_access | In          | finance_dept   |
| internet_access | In          | Marketing_dept |

- b. Under Policy Configuration, scroll down and select the **internet\_access** check box. Now internet\_access appears in the Policy Selector field at the top.
  - c. In the **Member Class** list, select **development\_dept**.
  - d. Click **Apply** to add the class development\_dept to the policy internet\_access.
10. Assign queue 1 to finance\_dept.
- a. Select **QoS > DiffServ > Advanced > Policy Configuration**.

A screen similar to the following displays.

| Policy Name     | Policy Type | Member Class   |
|-----------------|-------------|----------------|
| internet_access | In          | finance_dept   |
| internet_access | In          | Marketing_dept |
| internet_access | In          | Test_dept      |
| internet_access | In          | Development    |

- b. Click the **internet\_access** check box for the member class finance\_dept.

A screen similar to the following displays.

| Class Information |   |
|-------------------|---|
| Policy Name       | internet_access   |
| Policy Type       | In  |
| Member Class Name | finance_dept  |
| Policy Attribute  |   |
| Policy Attribute  | <input checked="" type="radio"/> Assign Queue 1<br><input type="radio"/> Drop<br><input type="radio"/> Mark VLAN CoS 0<br><input type="radio"/> Mark CoS As Secondary CoS 0<br><input type="radio"/> Mark IP Precedence 0<br><input type="radio"/> Mirror<br><input type="radio"/> Redirect<br><input type="radio"/> Mark IP DSCP af11<br><input type="radio"/> Simple Policy |

- c. In the **Assign Queue** list, select **1**.
  - d. Click **Apply**.
11. Assign queue 2 to marketing\_dept.
- a. Select **QoS > DiffServ > Advanced > Policy Configuration**.

A screen similar to the following displays.

| System   | Switching   | Routing        | QoS | Security | Monitoring | Maintenance | Help | Index |             |             |              |  |    |              |  |    |                |  |    |           |  |    |             |
|--|-------------|----------------|-----|----------|------------|-------------|------|-------|-------------|-------------|--------------|--|----|--------------|--|----|----------------|--|----|-----------|--|----|-------------|
| CoS DiffServ   |             |                |     |          |            |             |      |       |             |             |              |  |    |              |  |    |                |  |    |           |  |    |             |
| DiffServ   |             |                |     |          |            |             |      |       |             |             |              |  |    |              |  |    |                |  |    |           |  |    |             |
| <ul style="list-style-type: none"> <li>DiffServ Wizard</li> <li>Basic</li> <li>Advanced           <ul style="list-style-type: none"> <li>DiffServ Configuration</li> <li>Class Configuration</li> <li>IPv6 Class Configuration</li> <li><b>Policy Configuration</b></li> <li>Service Interface Configuration</li> <li>Service Statistics</li> </ul> </li> </ul>  |             |                |     |          |            |             |      |       |             |             |              |  |    |              |  |    |                |  |    |           |  |    |             |
| Policy Configuration   |             |                |     |          |            |             |      |       |             |             |              |  |    |              |  |    |                |  |    |           |  |    |             |
| <table border="1"> <thead> <tr> <th>Policy Name</th> <th>Policy Type</th> <th>Member Class</th> </tr> </thead> <tbody> <tr> <td><input type="checkbox"/> internet_access</td> <td>In</td> <td>finance_dept</td> </tr> <tr> <td><input type="checkbox"/> internet_access</td> <td>In</td> <td>Marketing_dept</td> </tr> <tr> <td><input type="checkbox"/> internet_access</td> <td>In</td> <td>Test_dept</td> </tr> <tr> <td><input type="checkbox"/> internet_access</td> <td>In</td> <td>Development</td> </tr> </tbody> </table> |             |                |     |          |            |             |      |       | Policy Name | Policy Type | Member Class | <input type="checkbox"/> internet_access | In | finance_dept | <input type="checkbox"/> internet_access | In | Marketing_dept | <input type="checkbox"/> internet_access | In | Test_dept | <input type="checkbox"/> internet_access | In | Development |
| Policy Name  | Policy Type | Member Class   |     |          |            |             |      |       |             |             |              |  |    |              |  |    |                |  |    |           |  |    |             |
| <input type="checkbox"/> internet_access   | In          | finance_dept   |     |          |            |             |      |       |             |             |              |  |    |              |  |    |                |  |    |           |  |    |             |
| <input type="checkbox"/> internet_access   | In          | Marketing_dept |     |          |            |             |      |       |             |             |              |  |    |              |  |    |                |  |    |           |  |    |             |
| <input type="checkbox"/> internet_access   | In          | Test_dept      |     |          |            |             |      |       |             |             |              |  |    |              |  |    |                |  |    |           |  |    |             |
| <input type="checkbox"/> internet_access   | In          | Development    |     |          |            |             |      |       |             |             |              |  |    |              |  |    |                |  |    |           |  |    |             |

- b. Click the **internet\_access** check box for marketing\_dept.

A screen similar to the following displays.

| System   | Switching  | Routing  | QoS | Security | Monitoring | Maintenance | Help | Index |                  |  |  |    |                   |                |
|--|--|--|-----|----------|------------|-------------|------|-------|------------------|--|--|----|-------------------|----------------|
| CoS DiffServ   |  |  |     |          |            |             |      |       |                  |  |  |    |                   |                |
| DiffServ   |  |  |     |          |            |             |      |       |                  |  |  |    |                   |                |
| <ul style="list-style-type: none"> <li>DiffServ Wizard</li> <li>Basic</li> <li>Advanced           <ul style="list-style-type: none"> <li>DiffServ Configuration</li> <li>Class Configuration</li> <li>IPv6 Class Configuration</li> <li><b>Policy Configuration</b></li> <li>Service Interface Configuration</li> <li>Service Statistics</li> </ul> </li> </ul>  |  |  |     |          |            |             |      |       |                  |  |  |    |                   |                |
| Class Information  |  |  |     |          |            |             |      |       |                  |  |  |    |                   |                |
| <table border="1"> <tbody> <tr> <td>Policy Name</td> <td>internet_access</td> </tr> <tr> <td>Policy Type</td> <td>In</td> </tr> <tr> <td>Member Class Name</td> <td>Marketing_dept</td> </tr> </tbody> </table>  |  |  |     |          |            |             |      |       | Policy Name      | internet_access  | Policy Type  | In | Member Class Name | Marketing_dept |
| Policy Name  | internet_access  |  |     |          |            |             |      |       |                  |  |  |    |                   |                |
| Policy Type  | In   |  |     |          |            |             |      |       |                  |  |  |    |                   |                |
| Member Class Name  | Marketing_dept   |  |     |          |            |             |      |       |                  |  |  |    |                   |                |
| Policy Attribute   |  |  |     |          |            |             |      |       |                  |  |  |    |                   |                |
| <table border="1"> <tbody> <tr> <td>Policy Attribute</td> <td> <input checked="" type="radio"/> Assign Queue           <input type="radio"/> Drop           <input type="radio"/> Mark VLAN CoS           <input type="radio"/> Mark CoS As Secondary CoS           <input type="radio"/> Mark IP Precedence           <input type="radio"/> Mirror           <input type="radio"/> Redirect           <input type="radio"/> Mark IP DSCP           <input type="radio"/> Simple Policy         </td> <td>           2           <input type="text"/> <br/> <input type="text"/> <br/> <input type="text"/> <br/> <input type="text"/> <br/> <input type="text"/> <br/>           af11         </td> </tr> </tbody> </table> |  |  |     |          |            |             |      |       | Policy Attribute | <input checked="" type="radio"/> Assign Queue <input type="radio"/> Drop <input type="radio"/> Mark VLAN CoS <input type="radio"/> Mark CoS As Secondary CoS <input type="radio"/> Mark IP Precedence <input type="radio"/> Mirror <input type="radio"/> Redirect <input type="radio"/> Mark IP DSCP <input type="radio"/> Simple Policy | 2 <input type="text"/><br><input type="text"/><br><input type="text"/><br><input type="text"/><br><input type="text"/><br>af11 |    |                   |                |
| Policy Attribute   | <input checked="" type="radio"/> Assign Queue <input type="radio"/> Drop <input type="radio"/> Mark VLAN CoS <input type="radio"/> Mark CoS As Secondary CoS <input type="radio"/> Mark IP Precedence <input type="radio"/> Mirror <input type="radio"/> Redirect <input type="radio"/> Mark IP DSCP <input type="radio"/> Simple Policy | 2 <input type="text"/><br><input type="text"/><br><input type="text"/><br><input type="text"/><br><input type="text"/><br>af11 |     |          |            |             |      |       |                  |  |  |    |                   |                |
| <div>Color Mode</div> <div>Color Blind</div>   |  |  |     |          |            |             |      |       |                  |  |  |    |                   |                |

- c. In the **Assign Queue** list, select **2**.

- d. Click **Apply**.

12. Assign queue 3 to test\_dept.

- a. Select **QoS > DiffServ > Advanced > Policy Configuration**.

A screen similar to the following displays.

| Policy Name     | Policy Type | Member Class   |
|-----------------|-------------|----------------|
| internet_access | In          | finance_dept   |
| internet_access | In          | Marketing_dept |
| internet_access | In          | Test_dept      |
| internet_access | In          | Development    |

- b. Click the **internet\_access** check mark for test\_dept.

A screen similar to the following displays.

| Policy Name     | Policy Type | Member Class Name |
|-----------------|-------------|-------------------|
| internet_access | In          | Test_dept         |

| Policy Attribute          | Value |
|---------------------------|-------|
| Assign Queue              | 3     |
| Drop                      |       |
| Mark VLAN CoS             | 0     |
| Mark CoS As Secondary CoS |       |
| Mark IP Precedence        | 0     |
| Mirror                    |       |
| Redirect                  |       |
| Mark IP DSCP              | all   |
| Simple Policy             |       |

- c. In the **Assign Queue** list, select **3**.

- d. Click **Apply**.

13. Assign queue 4 to development\_dept.

- a. Select **QoS > DiffServ > Advanced > Policy Configuration**.

A screen similar to the following displays.

| System   | Switching   | Routing        | QoS | Security | Monitoring | Maintenance | Help | Index |             |             |              |  |    |              |  |    |                |  |    |           |  |    |             |
|--|-------------|----------------|-----|----------|------------|-------------|------|-------|-------------|-------------|--------------|--|----|--------------|--|----|----------------|--|----|-----------|--|----|-------------|
| CoS DiffServ   |             |                |     |          |            |             |      |       |             |             |              |  |    |              |  |    |                |  |    |           |  |    |             |
| DiffServ   |             |                |     |          |            |             |      |       |             |             |              |  |    |              |  |    |                |  |    |           |  |    |             |
| <ul style="list-style-type: none"> <li>DiffServ Wizard</li> <li>Basic</li> <li>Advanced           <ul style="list-style-type: none"> <li>DiffServ Configuration</li> <li>Class Configuration</li> <li>IPv6 Class Configuration</li> <li><b>Policy Configuration</b></li> <li>Service Interface Configuration</li> <li>Service Statistics</li> </ul> </li> </ul>  |             |                |     |          |            |             |      |       |             |             |              |  |    |              |  |    |                |  |    |           |  |    |             |
| Policy Configuration   |             |                |     |          |            |             |      |       |             |             |              |  |    |              |  |    |                |  |    |           |  |    |             |
| <table border="1"> <thead> <tr> <th>Policy Name</th> <th>Policy Type</th> <th>Member Class</th> </tr> </thead> <tbody> <tr> <td><input type="checkbox"/> internet_access</td> <td>In</td> <td>finance_dept</td> </tr> <tr> <td><input type="checkbox"/> internet_access</td> <td>In</td> <td>Marketing_dept</td> </tr> <tr> <td><input type="checkbox"/> internet_access</td> <td>In</td> <td>Test_dept</td> </tr> <tr> <td><input type="checkbox"/> internet_access</td> <td>In</td> <td>Development</td> </tr> </tbody> </table> |             |                |     |          |            |             |      |       | Policy Name | Policy Type | Member Class | <input type="checkbox"/> internet_access | In | finance_dept | <input type="checkbox"/> internet_access | In | Marketing_dept | <input type="checkbox"/> internet_access | In | Test_dept | <input type="checkbox"/> internet_access | In | Development |
| Policy Name  | Policy Type | Member Class   |     |          |            |             |      |       |             |             |              |  |    |              |  |    |                |  |    |           |  |    |             |
| <input type="checkbox"/> internet_access   | In          | finance_dept   |     |          |            |             |      |       |             |             |              |  |    |              |  |    |                |  |    |           |  |    |             |
| <input type="checkbox"/> internet_access   | In          | Marketing_dept |     |          |            |             |      |       |             |             |              |  |    |              |  |    |                |  |    |           |  |    |             |
| <input type="checkbox"/> internet_access   | In          | Test_dept      |     |          |            |             |      |       |             |             |              |  |    |              |  |    |                |  |    |           |  |    |             |
| <input type="checkbox"/> internet_access   | In          | Development    |     |          |            |             |      |       |             |             |              |  |    |              |  |    |                |  |    |           |  |    |             |

- b. Click the **internet\_access** check mark for development\_dept.

A screen similar to the following displays.

| System  | Switching  | Routing                     | QoS | Security | Monitoring | Maintenance | Help | Index |                  |  |                             |    |                   |             |
|---|--|-----------------------------|-----|----------|------------|-------------|------|-------|------------------|--|-----------------------------|----|-------------------|-------------|
| CoS DiffServ  |  |                             |     |          |            |             |      |       |                  |  |                             |    |                   |             |
| DiffServ  |  |                             |     |          |            |             |      |       |                  |  |                             |    |                   |             |
| <ul style="list-style-type: none"> <li>DiffServ Wizard</li> <li>Basic</li> <li>Advanced           <ul style="list-style-type: none"> <li>DiffServ Configuration</li> <li>Class Configuration</li> <li>IPv6 Class Configuration</li> <li><b>Policy Configuration</b></li> <li>Service Interface Configuration</li> <li>Service Statistics</li> </ul> </li> </ul>   |  |                             |     |          |            |             |      |       |                  |  |                             |    |                   |             |
| Class Information   |  |                             |     |          |            |             |      |       |                  |  |                             |    |                   |             |
| <table border="1"> <tbody> <tr> <td>Policy Name</td> <td>internet_access</td> </tr> <tr> <td>Policy Type</td> <td>In</td> </tr> <tr> <td>Member Class Name</td> <td>Development</td> </tr> </tbody> </table>  |  |                             |     |          |            |             |      |       | Policy Name      | internet_access  | Policy Type                 | In | Member Class Name | Development |
| Policy Name   | internet_access  |                             |     |          |            |             |      |       |                  |  |                             |    |                   |             |
| Policy Type   | In   |                             |     |          |            |             |      |       |                  |  |                             |    |                   |             |
| Member Class Name   | Development  |                             |     |          |            |             |      |       |                  |  |                             |    |                   |             |
| Policy Attribute  |  |                             |     |          |            |             |      |       |                  |  |                             |    |                   |             |
| <table border="1"> <tbody> <tr> <td>Policy Attribute</td> <td> <input checked="" type="radio"/> Assign Queue           <input type="radio"/> Drop           <input type="radio"/> Mark VLAN CoS           <input type="radio"/> Mark CoS As Secondary CoS           <input type="radio"/> Mark IP Precedence           <input type="radio"/> Mirror           <input type="radio"/> Redirect           <input type="radio"/> Mark IP DSCP           <input type="radio"/> Simple Policy         </td> <td>           4           <br/>0           <br/>0           <br/> <br/> <br/>           af11         </td> </tr> </tbody> </table> |  |                             |     |          |            |             |      |       | Policy Attribute | <input checked="" type="radio"/> Assign Queue <input type="radio"/> Drop <input type="radio"/> Mark VLAN CoS <input type="radio"/> Mark CoS As Secondary CoS <input type="radio"/> Mark IP Precedence <input type="radio"/> Mirror <input type="radio"/> Redirect <input type="radio"/> Mark IP DSCP <input type="radio"/> Simple Policy | 4<br>0<br>0<br><br><br>af11 |    |                   |             |
| Policy Attribute  | <input checked="" type="radio"/> Assign Queue <input type="radio"/> Drop <input type="radio"/> Mark VLAN CoS <input type="radio"/> Mark CoS As Secondary CoS <input type="radio"/> Mark IP Precedence <input type="radio"/> Mirror <input type="radio"/> Redirect <input type="radio"/> Mark IP DSCP <input type="radio"/> Simple Policy | 4<br>0<br>0<br><br><br>af11 |     |          |            |             |      |       |                  |  |                             |    |                   |             |
| Color Mode Color Blind  |  |                             |     |          |            |             |      |       |                  |  |                             |    |                   |             |

- c. In the **Assign Queue** list, select **4**.

- d. Click **Apply**.

14. Attach the defined policy to interfaces 1/0/1 through 1/0/4 in the inbound direction.

- a. Select **QoS > DiffServ > Advanced > Service Configuration**.

A screen similar to the following displays.

| Interface                                 | Policy In Name  | Policy Out Name | Direction | Operational Status |
|---|-----------------|-----------------|-----------|--------------------|
| <input checked="" type="checkbox"/> 1/0/1 | internet_access |                 |           |                    |
| <input checked="" type="checkbox"/> 1/0/2 |                 |                 |           |                    |
| <input checked="" type="checkbox"/> 1/0/3 |                 |                 |           |                    |
| <input checked="" type="checkbox"/> 1/0/4 |                 |                 |           |                    |
| <input type="checkbox"/> 1/0/5            |                 |                 |           |                    |
| <input type="checkbox"/> 1/0/6            |                 |                 |           |                    |
| <input type="checkbox"/> 1/0/7            |                 |                 |           |                    |

- b. Scroll down and select the check boxes for interfaces **1/0/1**, **1/0/2**, **1/0/3**, and **1/0/4**.
- c. In the **Policy In** list, select **internet\_access**.
- d. Click **Apply**.

15. Set the CoS queue 1 configuration for interface 1/0/5.

- a. Select **QoS > CoS > Advanced > Interface Queue Configuration**.

A screen similar to the following displays.

| Interface                                 | Queue ID | Minimum Bandwidth | Queue Management Type |
|---|----------|-------------------|-----------------------|
| <input checked="" type="checkbox"/> 1/0/5 | 1        | 25                | TailDrop              |
| <input type="checkbox"/> 1/0/1            | 0        | 0                 | TailDrop              |
| <input type="checkbox"/> 1/0/2            | 0        | 0                 | TailDrop              |
| <input type="checkbox"/> 1/0/3            | 0        | 0                 | TailDrop              |
| <input type="checkbox"/> 1/0/4            | 0        | 0                 | TailDrop              |
| <input type="checkbox"/> 1/0/6            | 0        | 0                 | TailDrop              |

- b. Scroll down and select the Interface **1/0/5** check box.

Now 1/0/5 appears in the Interface field at the top.

- c. In the **Queue ID** list, select **1**.
- d. In the **Minimum Bandwidth** field, enter **25**.
- e. Click **Apply**.

16. Set the CoS queue 2 configuration for interface 1/0/5.

- a. Select **QoS > CoS > Advanced > Interface Queue Configuration**.



A screen similar to the following displays.

The screenshot shows the 'CoS' configuration page under the 'QoS' tab. The 'Interface Queue Configuration' section is active. A table lists configurations for various interfaces. Interface 1/0/5 is selected, showing Queue ID 2 and Minimum Bandwidth 25. The Queue Management Type is set to TailDrop.

| Interface                                 | Queue ID | Minimum Bandwidth | Queue Management Type |
|---|----------|-------------------|-----------------------|
| <input checked="" type="checkbox"/> 1/0/5 | 2        | 25                | TailDrop              |
| <input type="checkbox"/> 1/0/1            | 1        | 0                 | TailDrop              |
| <input type="checkbox"/> 1/0/2            | 1        | 0                 | TailDrop              |
| <input type="checkbox"/> 1/0/3            | 1        | 0                 | TailDrop              |
| <input type="checkbox"/> 1/0/4            | 1        | 0                 | TailDrop              |
| <input type="checkbox"/> 1/0/6            | 1        | 0                 | TailDrop              |

- b. Under Interface Queue Configuration, scroll down and select the interface **1/0/5** check box.

Now 1/0/5 appears in the Interface field at the top.

- c. In the **Queue ID** list, select **2**.  
d. In the **Minimum Bandwidth** field, enter **25**.  
e. Click **Apply**.

17. Set the CoS queue 3 configuration for interface 1/0/5.

- a. Select **QoS > CoS > Advanced > Interface Queue Configuration**.

A screen similar to the following displays.

The screenshot shows the 'CoS' configuration page under the 'QoS' tab. The 'Interface Queue Configuration' section is active. A table lists configurations for various interfaces. Interface 1/0/5 is selected, showing Queue ID 3 and Minimum Bandwidth 25. The Scheduler Type is set to Weighted and the Queue Management Type is set to TailDrop.

| Interface                                 | Queue ID | Minimum Bandwidth | Scheduler Type | Queue Management Type |
|---|----------|-------------------|----------------|-----------------------|
| <input checked="" type="checkbox"/> 1/0/5 | 3        | 25                | Weighted       | TailDrop              |
| <input type="checkbox"/> 1/0/1            | 2        | 0                 | Weighted       | TailDrop              |
| <input type="checkbox"/> 1/0/2            | 2        | 0                 | Weighted       | TailDrop              |
| <input type="checkbox"/> 1/0/3            | 2        | 0                 | Weighted       | TailDrop              |
| <input type="checkbox"/> 1/0/4            | 2        | 0                 | Weighted       | TailDrop              |
| <input type="checkbox"/> 1/0/6            | 2        | 0                 | Weighted       | TailDrop              |
| <input type="checkbox"/> 1/0/7            | 2        | 0                 | Weighted       | TailDrop              |
| <input type="checkbox"/> 1/0/8            | 2        | 0                 | Weighted       | TailDrop              |
| <input type="checkbox"/> 1/0/9            | 2        | 0                 | Weighted       | TailDrop              |
| <input type="checkbox"/> 1/0/10           | 2        | 0                 | Weighted       | TailDrop              |
| <input type="checkbox"/> 1/0/11           | 2        | 0                 | Weighted       | TailDrop              |

- b. Under Interface Queue Configuration, scroll down and select the interface **1/0/5** check box.

Now 1/0/5 appears in the Interface field at the top.

- c. In the **Queue ID** list, select **3**.  
d. In the **Minimum Bandwidth** field, enter **25**.  
e. Click **Apply**.

18. Set the CoS queue 4 configuration for interface 1/0/5.

- a. Select **QoS > CoS > Advanced > Interface Queue Configuration**.



A screen similar to the following displays.

| System   | Switching | Routing           | QoS            | Security              | Monitoring | Maintenance | Help | Index |           |          |                   |                |                       |   |   |    |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                 |   |   |          |          |                                 |   |   |          |          |
|--|-----------|-------------------|----------------|-----------------------|------------|-------------|------|-------|-----------|----------|-------------------|----------------|-----------------------|---|---|----|----------|----------|--------------------------------|---|---|----------|----------|--------------------------------|---|---|----------|----------|--------------------------------|---|---|----------|----------|--------------------------------|---|---|----------|----------|--------------------------------|---|---|----------|----------|--------------------------------|---|---|----------|----------|--------------------------------|---|---|----------|----------|--------------------------------|---|---|----------|----------|---------------------------------|---|---|----------|----------|---------------------------------|---|---|----------|----------|
| CoS DiffServ   |           |                   |                |                       |            |             |      |       |           |          |                   |                |                       |   |   |    |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                 |   |   |          |          |                                 |   |   |          |          |
| <div>CoS</div> <div>Interface Queue Configuration</div> <div>1 2 3 LAG All</div> <div>Go To Interface <input type="text"/> <input type="button" value="Go"/></div> <table> <thead> <tr> <th>Interface</th> <th>Queue ID</th> <th>Minimum Bandwidth</th> <th>Scheduler Type</th> <th>Queue Management Type</th> </tr> </thead> <tbody> <tr> <td><input checked="" type="checkbox"/> 1/0/5</td> <td>4</td> <td>25</td> <td>Weighted</td> <td>TailDrop</td> </tr> <tr> <td><input type="checkbox"/> 1/0/1</td> <td>3</td> <td>0</td> <td>Weighted</td> <td>TailDrop</td> </tr> <tr> <td><input type="checkbox"/> 1/0/2</td> <td>3</td> <td>0</td> <td>Weighted</td> <td>TailDrop</td> </tr> <tr> <td><input type="checkbox"/> 1/0/3</td> <td>3</td> <td>0</td> <td>Weighted</td> <td>TailDrop</td> </tr> <tr> <td><input type="checkbox"/> 1/0/4</td> <td>3</td> <td>0</td> <td>Weighted</td> <td>TailDrop</td> </tr> <tr> <td><input type="checkbox"/> 1/0/6</td> <td>3</td> <td>0</td> <td>Weighted</td> <td>TailDrop</td> </tr> <tr> <td><input type="checkbox"/> 1/0/7</td> <td>3</td> <td>0</td> <td>Weighted</td> <td>TailDrop</td> </tr> <tr> <td><input type="checkbox"/> 1/0/8</td> <td>3</td> <td>0</td> <td>Weighted</td> <td>TailDrop</td> </tr> <tr> <td><input type="checkbox"/> 1/0/9</td> <td>3</td> <td>0</td> <td>Weighted</td> <td>TailDrop</td> </tr> <tr> <td><input type="checkbox"/> 1/0/10</td> <td>3</td> <td>0</td> <td>Weighted</td> <td>TailDrop</td> </tr> <tr> <td><input type="checkbox"/> 1/0/11</td> <td>3</td> <td>0</td> <td>Weighted</td> <td>TailDrop</td> </tr> </tbody> </table> |           |                   |                |                       |            |             |      |       | Interface | Queue ID | Minimum Bandwidth | Scheduler Type | Queue Management Type | <input checked="" type="checkbox"/> 1/0/5 | 4 | 25 | Weighted | TailDrop | <input type="checkbox"/> 1/0/1 | 3 | 0 | Weighted | TailDrop | <input type="checkbox"/> 1/0/2 | 3 | 0 | Weighted | TailDrop | <input type="checkbox"/> 1/0/3 | 3 | 0 | Weighted | TailDrop | <input type="checkbox"/> 1/0/4 | 3 | 0 | Weighted | TailDrop | <input type="checkbox"/> 1/0/6 | 3 | 0 | Weighted | TailDrop | <input type="checkbox"/> 1/0/7 | 3 | 0 | Weighted | TailDrop | <input type="checkbox"/> 1/0/8 | 3 | 0 | Weighted | TailDrop | <input type="checkbox"/> 1/0/9 | 3 | 0 | Weighted | TailDrop | <input type="checkbox"/> 1/0/10 | 3 | 0 | Weighted | TailDrop | <input type="checkbox"/> 1/0/11 | 3 | 0 | Weighted | TailDrop |
| Interface  | Queue ID  | Minimum Bandwidth | Scheduler Type | Queue Management Type |            |             |      |       |           |          |                   |                |                       |   |   |    |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                 |   |   |          |          |                                 |   |   |          |          |
| <input checked="" type="checkbox"/> 1/0/5  | 4         | 25                | Weighted       | TailDrop              |            |             |      |       |           |          |                   |                |                       |   |   |    |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                 |   |   |          |          |                                 |   |   |          |          |
| <input type="checkbox"/> 1/0/1   | 3         | 0                 | Weighted       | TailDrop              |            |             |      |       |           |          |                   |                |                       |   |   |    |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                 |   |   |          |          |                                 |   |   |          |          |
| <input type="checkbox"/> 1/0/2   | 3         | 0                 | Weighted       | TailDrop              |            |             |      |       |           |          |                   |                |                       |   |   |    |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                 |   |   |          |          |                                 |   |   |          |          |
| <input type="checkbox"/> 1/0/3   | 3         | 0                 | Weighted       | TailDrop              |            |             |      |       |           |          |                   |                |                       |   |   |    |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                 |   |   |          |          |                                 |   |   |          |          |
| <input type="checkbox"/> 1/0/4   | 3         | 0                 | Weighted       | TailDrop              |            |             |      |       |           |          |                   |                |                       |   |   |    |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                 |   |   |          |          |                                 |   |   |          |          |
| <input type="checkbox"/> 1/0/6   | 3         | 0                 | Weighted       | TailDrop              |            |             |      |       |           |          |                   |                |                       |   |   |    |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                 |   |   |          |          |                                 |   |   |          |          |
| <input type="checkbox"/> 1/0/7   | 3         | 0                 | Weighted       | TailDrop              |            |             |      |       |           |          |                   |                |                       |   |   |    |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                 |   |   |          |          |                                 |   |   |          |          |
| <input type="checkbox"/> 1/0/8   | 3         | 0                 | Weighted       | TailDrop              |            |             |      |       |           |          |                   |                |                       |   |   |    |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                 |   |   |          |          |                                 |   |   |          |          |
| <input type="checkbox"/> 1/0/9   | 3         | 0                 | Weighted       | TailDrop              |            |             |      |       |           |          |                   |                |                       |   |   |    |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                 |   |   |          |          |                                 |   |   |          |          |
| <input type="checkbox"/> 1/0/10  | 3         | 0                 | Weighted       | TailDrop              |            |             |      |       |           |          |                   |                |                       |   |   |    |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                 |   |   |          |          |                                 |   |   |          |          |
| <input type="checkbox"/> 1/0/11  | 3         | 0                 | Weighted       | TailDrop              |            |             |      |       |           |          |                   |                |                       |   |   |    |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                 |   |   |          |          |                                 |   |   |          |          |

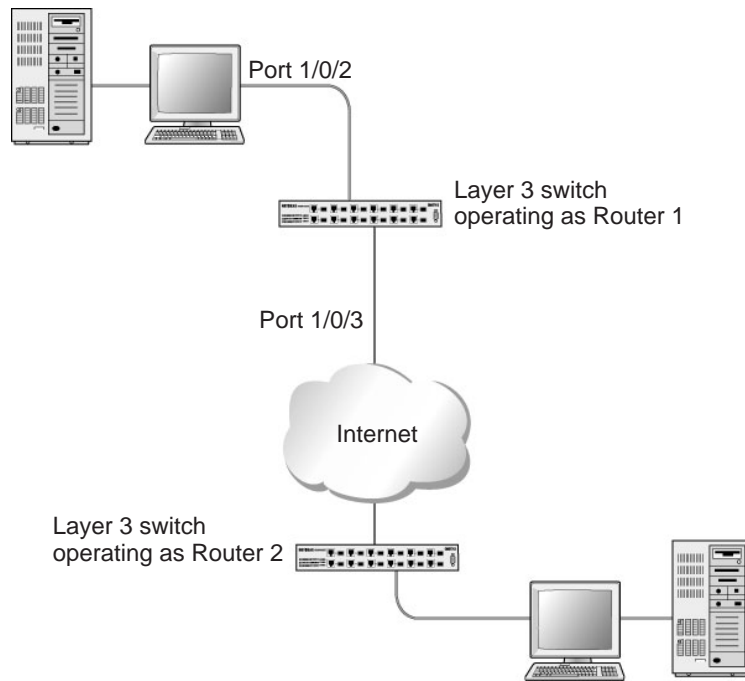
- b. Under Interface Queue Configuration, scroll down and select the Interface **1/0/5** check box.

Now 1/0/5 appears in the Interface field at the top.

- c. In the **Queue ID** list, select **4**.
- d. In the **Minimum Bandwidth** field, enter **25**.
- e. Click **Apply**.

## DiffServ for VoIP

One of the most valuable uses of DiffServ is to support Voice over IP (VoIP). VoIP traffic is inherently time sensitive: For a network to provide acceptable service, a guaranteed transmission rate is vital. This example shows one way to provide the necessary quality of service: how to set up a class for UDP traffic, have that traffic marked on the inbound side, and then expedite the traffic on the outbound side. The configuration script is for Router 1 in the accompanying diagram: A similar script should be applied to Router 2.



**Figure 28. Diffserv for VoIP in Router 1**

The example is shown as CLI commands and as a local browser interface procedure.

## CLI: Configure DiffServ for VoIP

1. Enter Global configuration mode. Set queue 5 on all ports to use strict priority mode. This queue will be used for all VoIP packets. Activate DiffServ for the switch.

```
(Netgear Switch) #config
(Netgear Switch) (Config)#cos-queue strict 5
(Netgear Switch) (Config)#diffserv
```

2. Create a DiffServ classifier named **class\_voip** and define a single match criterion to detect UDP packets. The class type **match-all** indicates that all match criteria defined for the class must be satisfied in order for a packet to be considered a match.

```
(Netgear Switch) (Config)#class-map match-all class_voip
(Netgear Switch) (Config class-map)#match protocol udp
(Netgear Switch) (Config class-map)#exit
```

3. Create a second DiffServ classifier named **class\_ef** and define a single match criterion to detect a DiffServ code point (DSCP) of **EF** (expedited forwarding). This handles incoming traffic that was previously marked as expedited somewhere in the network.

```
(Netgear Switch) (Config)#class-map match-all class_ef
(Netgear Switch) (Config class-map)#match ip dscp ef
(Netgear Switch) (Config class-map)#exit
```

4. Create a DiffServ policy for inbound traffic named **pol\_voip**, then add the previously created classes **class\_ef** and **class\_voip** as instances within this policy.

This policy handles incoming packets already marked with a DSCP value of **EF** (according to the **class\_ef** definition), or marks UDP packets according to the **class\_voip** definition) with a DSCP value of **EF**. In each case, the matching packets are assigned internally to use queue 5 of the egress port to which they are forwarded.

```
(Netgear Switch) (Config)#policy-map pol_voip in
(Netgear Switch) (Config policy-map)#class class_ef
(Netgear Switch) (Config policy-class-map)#assign-queue 5
(Netgear Switch) (Config policy-class-map)#exit
(Netgear Switch) (Config policy-map)#class class_voip
(Netgear Switch) (Config policy-class-map)#mark ip-dscp ef
(Netgear Switch) (Config policy-class-map)#assign-queue 5
(Netgear Switch) (Config policy-class-map)#exit
(Netgear Switch) (Config policy-map)#exit
```

5. Attach the defined policy to an inbound service interface.

```
(Netgear Switch) (Config)#interface 1/0/2
(Netgear Switch) (Interface 1/0/2)#service-policy in pol_voip
(Netgear Switch) (Interface 1/0/2)#exit
(Netgear Switch) (Config)#exit
```

## Local Browser Interface: Diffserv for VoIP

1. Set queue 5 on all interfaces to use strict mode.
  - a. Select **QoS > CoS > Advanced > CoS Interface Configuration**.

A screen similar to the following displays.

| System   | Switching | Routing           | QoS            | Security              | Monitoring | Maintenance | Help | Index |           |          |                   |                |                       |                                |   |   |        |          |   |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                 |   |   |          |          |                                 |   |   |          |          |
|--|-----------|-------------------|----------------|-----------------------|------------|-------------|------|-------|-----------|----------|-------------------|----------------|-----------------------|--------------------------------|---|---|--------|----------|---|---|---|----------|----------|--------------------------------|---|---|----------|----------|--------------------------------|---|---|----------|----------|--------------------------------|---|---|----------|----------|--------------------------------|---|---|----------|----------|--------------------------------|---|---|----------|----------|--------------------------------|---|---|----------|----------|--------------------------------|---|---|----------|----------|---------------------------------|---|---|----------|----------|---------------------------------|---|---|----------|----------|
| CoS DiffServ   |           |                   |                |                       |            |             |      |       |           |          |                   |                |                       |                                |   |   |        |          |   |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                 |   |   |          |          |                                 |   |   |          |          |
| <div>CoS</div> <div>Interface Queue Configuration</div> <div>1 2 3 LAG All</div> <div>Go To Interface <input type="text"/> <input type="button" value="Go"/></div> <table border="1"> <thead> <tr> <th>Interface</th> <th>Queue ID</th> <th>Minimum Bandwidth</th> <th>Scheduler Type</th> <th>Queue Management Type</th> </tr> </thead> <tbody> <tr> <td><input type="checkbox"/> 1/0/1</td> <td>5</td> <td>0</td> <td>Strict</td> <td>TailDrop</td> </tr> <tr> <td><input checked="" type="checkbox"/> 1/0/2</td> <td>0</td> <td>0</td> <td>Weighted</td> <td>TailDrop</td> </tr> <tr> <td><input type="checkbox"/> 1/0/3</td> <td>0</td> <td>0</td> <td>Weighted</td> <td>TailDrop</td> </tr> <tr> <td><input type="checkbox"/> 1/0/4</td> <td>0</td> <td>0</td> <td>Weighted</td> <td>TailDrop</td> </tr> <tr> <td><input type="checkbox"/> 1/0/5</td> <td>0</td> <td>0</td> <td>Weighted</td> <td>TailDrop</td> </tr> <tr> <td><input type="checkbox"/> 1/0/6</td> <td>0</td> <td>0</td> <td>Weighted</td> <td>TailDrop</td> </tr> <tr> <td><input type="checkbox"/> 1/0/7</td> <td>0</td> <td>0</td> <td>Weighted</td> <td>TailDrop</td> </tr> <tr> <td><input type="checkbox"/> 1/0/8</td> <td>0</td> <td>0</td> <td>Weighted</td> <td>TailDrop</td> </tr> <tr> <td><input type="checkbox"/> 1/0/9</td> <td>0</td> <td>0</td> <td>Weighted</td> <td>TailDrop</td> </tr> <tr> <td><input type="checkbox"/> 1/0/10</td> <td>0</td> <td>0</td> <td>Weighted</td> <td>TailDrop</td> </tr> <tr> <td><input type="checkbox"/> 1/0/11</td> <td>0</td> <td>0</td> <td>Weighted</td> <td>TailDrop</td> </tr> </tbody> </table> |           |                   |                |                       |            |             |      |       | Interface | Queue ID | Minimum Bandwidth | Scheduler Type | Queue Management Type | <input type="checkbox"/> 1/0/1 | 5 | 0 | Strict | TailDrop | <input checked="" type="checkbox"/> 1/0/2 | 0 | 0 | Weighted | TailDrop | <input type="checkbox"/> 1/0/3 | 0 | 0 | Weighted | TailDrop | <input type="checkbox"/> 1/0/4 | 0 | 0 | Weighted | TailDrop | <input type="checkbox"/> 1/0/5 | 0 | 0 | Weighted | TailDrop | <input type="checkbox"/> 1/0/6 | 0 | 0 | Weighted | TailDrop | <input type="checkbox"/> 1/0/7 | 0 | 0 | Weighted | TailDrop | <input type="checkbox"/> 1/0/8 | 0 | 0 | Weighted | TailDrop | <input type="checkbox"/> 1/0/9 | 0 | 0 | Weighted | TailDrop | <input type="checkbox"/> 1/0/10 | 0 | 0 | Weighted | TailDrop | <input type="checkbox"/> 1/0/11 | 0 | 0 | Weighted | TailDrop |
| Interface  | Queue ID  | Minimum Bandwidth | Scheduler Type | Queue Management Type |            |             |      |       |           |          |                   |                |                       |                                |   |   |        |          |   |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                 |   |   |          |          |                                 |   |   |          |          |
| <input type="checkbox"/> 1/0/1   | 5         | 0                 | Strict         | TailDrop              |            |             |      |       |           |          |                   |                |                       |                                |   |   |        |          |   |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                 |   |   |          |          |                                 |   |   |          |          |
| <input checked="" type="checkbox"/> 1/0/2  | 0         | 0                 | Weighted       | TailDrop              |            |             |      |       |           |          |                   |                |                       |                                |   |   |        |          |   |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                 |   |   |          |          |                                 |   |   |          |          |
| <input type="checkbox"/> 1/0/3   | 0         | 0                 | Weighted       | TailDrop              |            |             |      |       |           |          |                   |                |                       |                                |   |   |        |          |   |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                 |   |   |          |          |                                 |   |   |          |          |
| <input type="checkbox"/> 1/0/4   | 0         | 0                 | Weighted       | TailDrop              |            |             |      |       |           |          |                   |                |                       |                                |   |   |        |          |   |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                 |   |   |          |          |                                 |   |   |          |          |
| <input type="checkbox"/> 1/0/5   | 0         | 0                 | Weighted       | TailDrop              |            |             |      |       |           |          |                   |                |                       |                                |   |   |        |          |   |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                 |   |   |          |          |                                 |   |   |          |          |
| <input type="checkbox"/> 1/0/6   | 0         | 0                 | Weighted       | TailDrop              |            |             |      |       |           |          |                   |                |                       |                                |   |   |        |          |   |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                 |   |   |          |          |                                 |   |   |          |          |
| <input type="checkbox"/> 1/0/7   | 0         | 0                 | Weighted       | TailDrop              |            |             |      |       |           |          |                   |                |                       |                                |   |   |        |          |   |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                 |   |   |          |          |                                 |   |   |          |          |
| <input type="checkbox"/> 1/0/8   | 0         | 0                 | Weighted       | TailDrop              |            |             |      |       |           |          |                   |                |                       |                                |   |   |        |          |   |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                 |   |   |          |          |                                 |   |   |          |          |
| <input type="checkbox"/> 1/0/9   | 0         | 0                 | Weighted       | TailDrop              |            |             |      |       |           |          |                   |                |                       |                                |   |   |        |          |   |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                 |   |   |          |          |                                 |   |   |          |          |
| <input type="checkbox"/> 1/0/10  | 0         | 0                 | Weighted       | TailDrop              |            |             |      |       |           |          |                   |                |                       |                                |   |   |        |          |   |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                 |   |   |          |          |                                 |   |   |          |          |
| <input type="checkbox"/> 1/0/11  | 0         | 0                 | Weighted       | TailDrop              |            |             |      |       |           |          |                   |                |                       |                                |   |   |        |          |   |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                |   |   |          |          |                                 |   |   |          |          |                                 |   |   |          |          |

- b. Under Interface Queue Configuration, select all the interfaces.
  - c. In the **Queue ID** list, select **5**.
  - d. In the **Scheduler Type** list, select **Strict**.
  - e. Click **Apply** to save the settings.
2. Enable DiffServ.
  - a. Select **QoS > DiffServ > Basic > DiffServ Configuration**.

A screen similar to the following displays.

| System   | Switching | Routing | QoS | Security | Monitoring | Maintenance | Help | Index |
|--|-----------|---------|-----|----------|------------|-------------|------|-------|
| CoS DiffServ   |           |         |     |          |            |             |      |       |
| <div>DiffServ</div> <div>DiffServ Configuration</div> <div>DiffServ Admin Mode <input type="radio"/> Disable <input checked="" type="radio"/> Enable</div> |           |         |     |          |            |             |      |       |

- b. For Diffserv Admin Mode, select the **Enable** radio button.
  - c. Click **Apply** to save the settings.
3. Create a class class\_voip.
  - a. Select **QoS > DiffServ > Advanced > DiffServ Configuration**.

A screen similar to the following displays.

- b. In the **Class Name** field, enter **class\_voip**.
- c. In the **Class Type** list, select **All**.
- d. Click **Add** to create a new class.
- e. Click **class\_voip**.

A screen similar to the following displays.

- f. In the **Protocol Type** list, select **UDP**.
  - g. Click **Apply** to create a new class.
4. Create a class class\_ef:
- a. Select **QoS > DiffServ > Advanced > DiffServ Configuration**.

A screen similar to the following displays.

| Class Name | Class Type |
|------------|------------|
| class_ef   | All        |
| class_voip | All        |

- b. In the **Class Name** field, enter **class\_ef**.
- c. In the **Class Type** list, select **All**.
- d. Click **Add** to create a new class.
- e. Click **class\_ef**.

A screen similar to the following displays.

| Reference Class | Class Of Service | VLAN        | Secondary Class of Service | Secondary VLAN | Ethernet Type | Source MAC | Destination MAC | Protocol Type | Source IP  | Source L4 Port | Destination IP | Destination L4 Port | IP DSCP | Precedence Value | IP ToS   |
|-----------------|------------------|-------------|----------------------------|----------------|---------------|------------|-----------------|---------------|------------|----------------|----------------|---------------------|---------|------------------|----------|
| class_voip      | (1 to 4093)      | (1 to 4093) | (1 to 4093)                | (1 to 4093)    | (0 to 255)    | (0 to 255) | (0 to 255)      | (0 to 255)    | (0 to 255) | (0 to 65535)   | (0 to 65535)   | (0 to 65535)        | EF      | (0 to 7)         | Bit Mask |

- f. In the **IP DSCP** list, select **ef**.
  - g. Click **Apply** to create a new class.
5. Create a policy **pol\_voip**. and add **class\_voip** to this policy.
- a. Select **QoS > DiffServ > Advanced > Policy Configuration**.

A screen similar to the following displays.

| System   | Switching   | Routing      | QoS | Security | Monitoring | Maintenance | Help | Index |             |             |              |          |  |            |
|--|-------------|--------------|-----|----------|------------|-------------|------|-------|-------------|-------------|--------------|----------|--|------------|
| CoS DiffServ   |             |              |     |          |            |             |      |       |             |             |              |          |  |            |
| DiffServ   |             |              |     |          |            |             |      |       |             |             |              |          |  |            |
| Policy Configuration   |             |              |     |          |            |             |      |       |             |             |              |          |  |            |
| <div> <div> DiffServ Wizard Basic Advanced DiffServ Configuration Class Configuration IPv6 Class Configuration Policy Configuration </div> <div> <table border="1"> <thead> <tr> <th>Policy Name</th> <th>Policy Type</th> <th>Member Class</th> </tr> </thead> <tbody> <tr> <td>pol_voip</td> <td></td> <td>class_voip</td> </tr> </tbody> </table> </div> </div> |             |              |     |          |            |             |      |       | Policy Name | Policy Type | Member Class | pol_voip |  | class_voip |
| Policy Name  | Policy Type | Member Class |     |          |            |             |      |       |             |             |              |          |  |            |
| pol_voip   |             | class_voip   |     |          |            |             |      |       |             |             |              |          |  |            |

- b. In the **Policy Selector** field, enter **pol\_voip**.
- c. In the **Member Class** list, select **class\_voip**.
- d. Click **Add** to create a new policy.
- e. Click the **pol\_voip** whose class member is class\_voip.

A screen similar to the following displays.

| System  | Switching                                       | Routing | QoS | Security | Monitoring | Maintenance | Help | Index |                  |   |             |    |                            |            |  |                                     |   |  |   |  |  |  |   |  |                              |  |  |                                |  |  |   |    |  |                                     |  |
|---|---|---------|-----|----------|------------|-------------|------|-------|------------------|---|-------------|----|----------------------------|------------|--|-------------------------------------|---|--|---|--|--|--|---|--|------------------------------|--|--|--------------------------------|--|--|---|----|--|-------------------------------------|--|
| CoS DiffServ  |   |         |     |          |            |             |      |       |                  |   |             |    |                            |            |  |                                     |   |  |   |  |  |  |   |  |                              |  |  |                                |  |  |   |    |  |                                     |  |
| DiffServ  |   |         |     |          |            |             |      |       |                  |   |             |    |                            |            |  |                                     |   |  |   |  |  |  |   |  |                              |  |  |                                |  |  |   |    |  |                                     |  |
| Class Information   |   |         |     |          |            |             |      |       |                  |   |             |    |                            |            |  |                                     |   |  |   |  |  |  |   |  |                              |  |  |                                |  |  |   |    |  |                                     |  |
| <div> <div> DiffServ Wizard Basic Advanced DiffServ Configuration Class Configuration IPv6 Class Configuration Policy Configuration Service Interface Configuration Service Statistics </div> <div> <table border="1"> <tbody> <tr> <td>Policy Name</td> <td>pol_voip</td> </tr> <tr> <td>Policy Type</td> <td>in</td> </tr> <tr> <td>Member Class Name</td> <td>class_voip</td> </tr> </tbody> </table> </div> </div>  |   |         |     |          |            |             |      |       | Policy Name      | pol_voip                                      | Policy Type | in | Member Class Name          | class_voip |  |                                     |   |  |   |  |  |  |   |  |                              |  |  |                                |  |  |   |    |  |                                     |  |
| Policy Name   | pol_voip  |         |     |          |            |             |      |       |                  |   |             |    |                            |            |  |                                     |   |  |   |  |  |  |   |  |                              |  |  |                                |  |  |   |    |  |                                     |  |
| Policy Type   | in  |         |     |          |            |             |      |       |                  |   |             |    |                            |            |  |                                     |   |  |   |  |  |  |   |  |                              |  |  |                                |  |  |   |    |  |                                     |  |
| Member Class Name   | class_voip                                      |         |     |          |            |             |      |       |                  |   |             |    |                            |            |  |                                     |   |  |   |  |  |  |   |  |                              |  |  |                                |  |  |   |    |  |                                     |  |
| Policy Attribute  |   |         |     |          |            |             |      |       |                  |   |             |    |                            |            |  |                                     |   |  |   |  |  |  |   |  |                              |  |  |                                |  |  |   |    |  |                                     |  |
| <table border="1"> <tbody> <tr> <td>Policy Attribute</td> <td> <input checked="" type="radio"/> Assign Queue </td> <td>5</td> </tr> <tr> <td></td> <td><input type="radio"/> Drop</td> <td></td> </tr> <tr> <td></td> <td><input type="radio"/> Mark VLAN CoS</td> <td>0</td> </tr> <tr> <td></td> <td><input type="radio"/> Mark CoS As Secondary CoS</td> <td></td> </tr> <tr> <td></td> <td><input type="radio"/> Mark IP Precedence</td> <td>0</td> </tr> <tr> <td></td> <td><input type="radio"/> Mirror</td> <td></td> </tr> <tr> <td></td> <td><input type="radio"/> Redirect</td> <td></td> </tr> <tr> <td></td> <td><input checked="" type="radio"/> Mark IP DSCP</td> <td>EF</td> </tr> <tr> <td></td> <td><input type="radio"/> Simple Policy</td> <td></td> </tr> </tbody> </table> |   |         |     |          |            |             |      |       | Policy Attribute | <input checked="" type="radio"/> Assign Queue | 5           |    | <input type="radio"/> Drop |            |  | <input type="radio"/> Mark VLAN CoS | 0 |  | <input type="radio"/> Mark CoS As Secondary CoS |  |  | <input type="radio"/> Mark IP Precedence | 0 |  | <input type="radio"/> Mirror |  |  | <input type="radio"/> Redirect |  |  | <input checked="" type="radio"/> Mark IP DSCP | EF |  | <input type="radio"/> Simple Policy |  |
| Policy Attribute  | <input checked="" type="radio"/> Assign Queue   | 5       |     |          |            |             |      |       |                  |   |             |    |                            |            |  |                                     |   |  |   |  |  |  |   |  |                              |  |  |                                |  |  |   |    |  |                                     |  |
|   | <input type="radio"/> Drop                      |         |     |          |            |             |      |       |                  |   |             |    |                            |            |  |                                     |   |  |   |  |  |  |   |  |                              |  |  |                                |  |  |   |    |  |                                     |  |
|   | <input type="radio"/> Mark VLAN CoS             | 0       |     |          |            |             |      |       |                  |   |             |    |                            |            |  |                                     |   |  |   |  |  |  |   |  |                              |  |  |                                |  |  |   |    |  |                                     |  |
|   | <input type="radio"/> Mark CoS As Secondary CoS |         |     |          |            |             |      |       |                  |   |             |    |                            |            |  |                                     |   |  |   |  |  |  |   |  |                              |  |  |                                |  |  |   |    |  |                                     |  |
|   | <input type="radio"/> Mark IP Precedence        | 0       |     |          |            |             |      |       |                  |   |             |    |                            |            |  |                                     |   |  |   |  |  |  |   |  |                              |  |  |                                |  |  |   |    |  |                                     |  |
|   | <input type="radio"/> Mirror                    |         |     |          |            |             |      |       |                  |   |             |    |                            |            |  |                                     |   |  |   |  |  |  |   |  |                              |  |  |                                |  |  |   |    |  |                                     |  |
|   | <input type="radio"/> Redirect                  |         |     |          |            |             |      |       |                  |   |             |    |                            |            |  |                                     |   |  |   |  |  |  |   |  |                              |  |  |                                |  |  |   |    |  |                                     |  |
|   | <input checked="" type="radio"/> Mark IP DSCP   | EF      |     |          |            |             |      |       |                  |   |             |    |                            |            |  |                                     |   |  |   |  |  |  |   |  |                              |  |  |                                |  |  |   |    |  |                                     |  |
|   | <input type="radio"/> Simple Policy             |         |     |          |            |             |      |       |                  |   |             |    |                            |            |  |                                     |   |  |   |  |  |  |   |  |                              |  |  |                                |  |  |   |    |  |                                     |  |

- f. In the **Assign Queue** list, select **5**.
  - g. For Policy Attribute, select the **Mark IP DSCP** radio button, and select **ef**.
  - h. Click **Apply** to create a new policy.
6. Add class\_ef to the policy pol\_voip.
- a. Select **QoS > DiffServ > Advanced > Policy Configuration**.



A screen similar to the following displays.

| Policy Name | Policy Type | Member Class |
|-------------|-------------|--------------|
| pol_voip    | In          | class_ef     |
| pol_voip    | In          | class_voip   |

- b. Under Policy Configuration, scroll down and select the **pol\_voip** check box.  
Pol\_voip now appears in the Policy Selector field at the top.
- c. In the **Member Class** list, select **class\_ef** in.
- d. Click **Apply** to add the class class\_ef to the policy pol\_voip.
- e. Click the **pol\_voip** whose class member is class\_ef.

A screen similar to the following displays.

| Class Information |          |  |
|-------------------|----------|--|
| Policy Name       | pol_voip |  |
| Policy Type       | In       |  |
| Member Class Name | class_ef |  |

| Policy Attribute |                           |    |
|------------------|---------------------------|----|
| Policy Attribute | Assign Queue              | 5  |
|                  | Drop                      |    |
|                  | Mark VLAN CoS             | 0  |
|                  | Mark CoS As Secondary CoS |    |
|                  | Mark IP Precedence        | 0  |
|                  | Mirror                    |    |
|                  | Redirect                  |    |
|                  | Mark IP DSCP              | EF |
|                  | Simple Policy             |    |

- f. In the **Assign Queue** list, select **5**.
  - g. Click **Apply** to create a new policy.
7. Attach the defined policy to interface 1/0/2 in the inbound direction.
- a. Select **QoS > DiffServ > Advanced > Service Configuration**.

A screen similar to the following displays.

The screenshot shows the 'DiffServ' configuration page, specifically the 'Service Interface Configuration' section. On the left, a sidebar lists various configuration options, with 'Service Interface Configuration' selected. The main area displays a table of interfaces. The table has columns for 'Interface', 'Policy In Name', 'Policy Out Name', 'Direction', and 'Operational Status'. The '1/0/2' interface is selected, and the 'pol\_voip' policy is chosen in the 'Policy In Name' dropdown. A 'Go To Interface' field and a 'Go' button are also visible.

| Interface                                 | Policy In Name | Policy Out Name | Direction | Operational Status |
|---|----------------|-----------------|-----------|--------------------|
| <input type="checkbox"/> 1/0/1            |                |                 |           |                    |
| <input checked="" type="checkbox"/> 1/0/2 | pol_voip       |                 |           |                    |
| <input type="checkbox"/> 1/0/3            |                |                 |           |                    |
| <input type="checkbox"/> 1/0/4            |                |                 |           |                    |
| <input type="checkbox"/> 1/0/5            |                |                 |           |                    |
| <input type="checkbox"/> 1/0/6            |                |                 |           |                    |

b. Scroll down and select the Interface **1/0/2** check box.

Now 1/0/2 appears in the Interface field at the top.

c. In the **Policy In** list, select **pol\_voip**.

d. Click **Apply** to create a new policy.

## Auto VoIP

The Auto VoIP feature makes it easy to set up voice over IP (VoIP) for IP phones on a switch. From software release 10.0.0 on, the switch supports both protocol-based and OUI-based Auto-VoIP configurations.

### Protocol-Based Auto VoIP

In a VoIP system, various signaling protocols are used to establish the connection between two VoIP devices. Protocol-based Auto VoIP provides a better class of service (CoS) to data and signaling VoIP streams than to other traffic. The supported signaling protocols are Session Initiation Protocol (SIP), H.323, and Skinny Call Control Protocol (SCCP). Depending on your configuration, after VoIP packets are identified, the switch takes the following actions:

- If you enable remarking, the switch remarks the voice traffic 802.1p priority with the configured priority at the ingress port to ensure that voice traffic always receives the highest priority throughout the network. You must enable egress tagging on the appropriate uplink port to let the switch carry the remarked priority to the egress port.
- If you assign a queue, make sure that you allocate sufficient bandwidth to the queue to fulfill the priority treatment for VoIP traffic.

---

**Note:** Queue assignment and remark 802.1p priority are mutually exclusive configurations. You can configure each configuration on a per-port basis.

---

After a call session completes and the call is disconnected, the QoS rules are removed.

The ports on which you configure protocol-based Auto VoIP are made members of the voice VLAN automatically. By default, no VLAN is used for the voice VLAN. You must create a voice VLAN first.

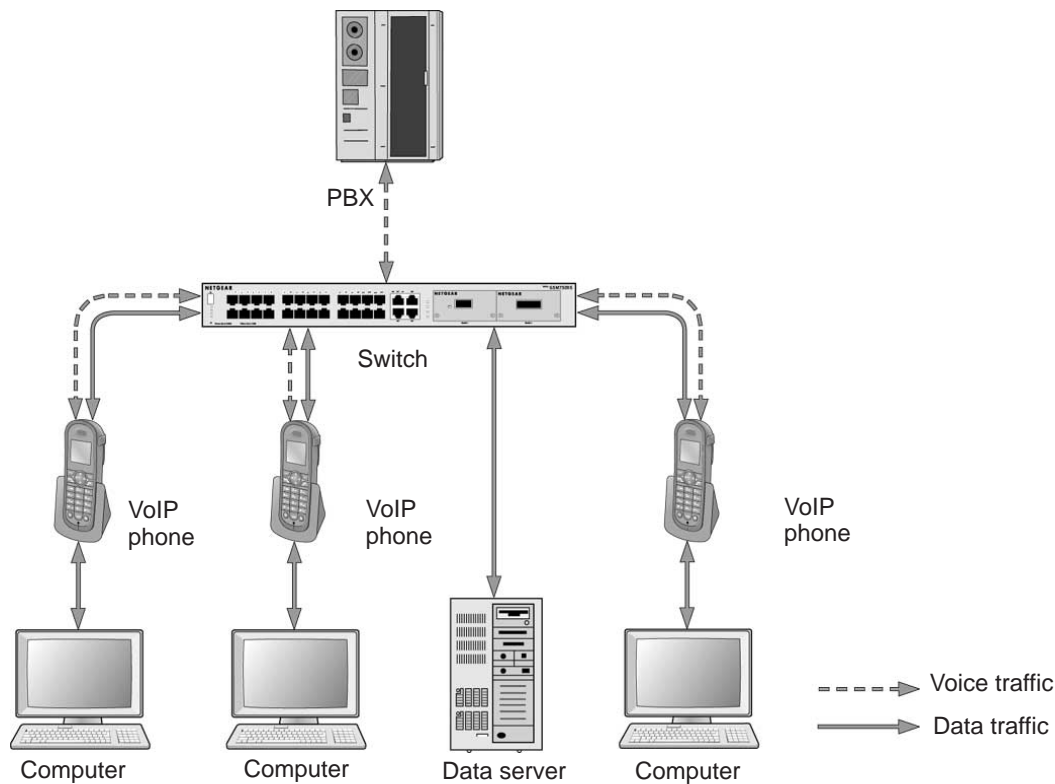
## OUI-Based Auto VoIP

OUI-based Auto VoIP prioritizes VoIP packets based on the bytes of the organizationally unique identifiers (OUIs) in the source MAC address. The switch is preconfigured with a default list of OUIs. You can also add OUIs that need prioritization. The switch can support up to 128 OUIs, including the default OUIs.

By default, the switch uses the highest available priority for all frames that match OUIs on the OUI list. You can override the default priority and configure a different priority. You need to map the priority to a traffic class to achieve the desired egress queuing for VoIP traffic.

The switch assigns all VoIP traffic that matches a known OUI list to the VoIP VLAN. If you modify the VoIP VLAN, all existing MAC VLAN entries are removed. The MAC entries are deleted from the forwarding database and relearned with the new VLAN as the devices transmit packets. The port VLAN membership also changes.

The switch assigns untagged VoIP traffic only to the VoIP VLAN and uses the associated priority for egress queuing. If you enable port mirroring on a port that is configured for Auto VoIP, the port remains nonoperational.



**Figure 29. OUI-based Auto VoIP topology**

## Example 1: Enable Protocol-Based Auto VoIP

This example is provided as CLI commands and as a local browser interface procedure.

### CLI: Protocol-Based Auto VoIP

This script in this section shows how to set up Auto VoIP per port.

1. Enable protocol-based Auto VoIP on a specific port of the switch.

```
(Netgear Switch)(Configure)#interface 2/0/1
(Netgear Switch)(Interface 2/0/1)#auto-voip protocol-based
```

## 2. Display the Auto VoIP information.

```
(Netgear Switch) #show auto-voip protocol-based interface 2/0/1
VoIP VLAN Id..... 2
Prioritization Type..... traffic-class
Class Value..... 6
Interface  Auto VoIP Mode Operational Status
-----  -
2/0/1      Enabled      Up
```

## Local Browser Interface: Configure Protocol-Based Auto VoIP

### 1. Enable protocol-based Auto VoIP on a specific port of the switch:

#### a. Select **Switching > Auto-VoIP > Protocol-based > Port Settings**.

A screen similar to the following displays.

The screenshot shows the Netgear web interface. The top navigation bar includes System, Switching, Routing, QoS, Security, Monitoring, Maintenance, Help, and Index. Under 'Switching', there are links for VLAN, Auto-VoIP, iSCSI, STP, Multicast, MVR, Address Table, Ports, LAG, and MLAG. The 'Auto-VoIP' section is expanded, showing 'Protocol-based' settings. The 'Port Settings' sub-section is selected, displaying 'Protocol Based Port Settings'. A table lists interfaces 2/0/1 through 2/0/4. Interface 2/0/1 is selected with a checkmark, and its 'Auto VoIP Mode' is set to 'Enable' and 'Operational Status' is 'Down'.

| Interface | Auto VoIP Mode | Operational Status |
|-----------|----------------|--------------------|
| 2/0/1     | Enable         | Down               |
| 2/0/2     | Disable        | Down               |
| 2/0/3     | Disable        | Down               |
| 2/0/4     | Disable        | Down               |

#### b. Scroll down and select the interface **2/0/1** check box.

The Interface field in the table heading displays 2/0/1.

#### c. From the Auto VoIP Mode mode, select **Enable**.

#### d. Click **Apply**.

## Example 2: Change the Queue of Protocol-Based Auto VoIP

This example is provided as CLI commands and as a local browser interface procedure.

### CLI: Change the Queue of Protocol-Based Auto VoIP

Protocol-based VoIP classifies and prioritizes packets and places them in the higher-priority queue. By default, the packets are placed in egress queue 6. However, you can override the egress queue setting. The following example shows how to assign the protocol-based Auto VoIP to egress queue 4.

## 1. Change the egress queue of protocol-based Auto VoIP.

```
(Netgear Switch) (Config)#auto-voip protocol-based traffic-class 4
```

## 2. Display the Auto VoIP information.

```
(Netgear Switch) #show auto-voip protocol-based interface 2/0/1
VoIP VLAN Id..... 2
Prioritization Type..... traffic-class
Class Value..... 4
Interface  Auto VoIP Mode Operational Status
-----
2/0/1      Enabled      Up
```

## Local Browser Interface: Configure Protocol-Based Auto VoIP

### 1. Change the queue of protocol-based Auto VoIP.

#### a. Select **Switching > Auto-VoIP > Protocol-based > Port Settings**.

A screen similar to the following displays.

The screenshot shows the Netgear web interface with the following structure:

- System** | **Switching** | **Routing** | **QoS** | **Security** | **Monitoring** | **Maintenance** | **Help** | **Index**
- VLAN** | **Auto-VoIP** | **iSCSI** | **STP** | **Multicast** | **MVR** | **Address Table** | **Ports** | **LAG** | **MLAG**
- Auto-VoIP**
  - Protocol Based Global Settings
    - Prioritization Type: Traffic Class
    - Class Value: 4
  - Protocol Based Port Settings
    - 1 2 LAG All Go To Interface  **Go**
    - Table:
 

| Interface                      | Auto VoIP Mode | Operational Status |
|--------------------------------|----------------|--------------------|
| <input type="checkbox"/> 2/0/1 | Enable         | Up                 |
| <input type="checkbox"/> 2/0/2 | Disable        | Down               |
| <input type="checkbox"/> 2/0/3 | Disable        | Down               |
| <input type="checkbox"/> 2/0/4 | Disable        | Down               |

#### b. From the Class Value menu, select **4**.

#### c. Click **Apply**.

## Example 3: Create an Auto VoIP VLAN

This example is provided as CLI commands and as a local browser interface procedure.

### CLI: Create an Auto VoIP VLAN

Since no default VoIP VLAN is specified, you must create a VLAN first to use auto VoIP.

**1. Create VLAN 5.**

```
(Netgear Switch) #vlan database
(Netgear Switch) (Vlan)#vlan 5
(Netgear Switch) (Vlan)#exit
```

**2. Assign the VoIP traffic to VLAN 5, which becomes the VoIP VLAN.**

```
(Netgear Switch) (Config)#auto-voip vlan 5
```

**3. Display the protocol-based Auto VoIP information.**

```
(Netgear Switch) #show auto-voip protocol-based interface 2/0/1

VoIP VLAN Id..... 5
Prioritization Type..... traffic-class
Class Value..... 6

Interface  Auto VoIP Mode Operational Status
-----  -
2/0/1      Enabled          Up
```

**4. Display the OUI-based Auto VoIP information.**

```
(Netgear Switch) #show auto-voip oui-based interface 2/0/1

VoIP VLAN Id..... 5
Priority..... 7
Interface  Auto VoIP Mode Operational Status
-----  -
2/0/1      Disabled         Down
```

**Local Browser Interface: Change the Auto VoIP VLAN****1. Create a VLAN 5:**

- a. Select **Switching > VLAN > Basic > Vlan Configuration**.



A screen similar to the following displays.

The screenshot shows the 'VLAN' configuration page. The left sidebar has a tree view with 'VLAN' selected, and 'VLAN Configuration' is highlighted under the 'Advanced' section. The main content area has a 'Reset' button at the top. Below it, the 'Internal VLAN Configuration' section includes a text field for 'Internal VLAN Allocation Base' set to '4093' and a radio button selection for 'Internal VLAN Allocation Policy' with 'Ascending' selected. At the bottom, the 'VLAN Configuration' table is visible:

| VLAN ID | VLAN Name | VLAN Type | Make Static |
|---------|-----------|-----------|-------------|
| 5       |           |           | Disable     |
| 1       | default   | Default   | Disable     |

- b. In the VLAN ID field, enter **5**.
  - c. Click **Add**.
2. Assign the VoIP traffic to VLAN 5.
  - a. Select **Switching > Auto-VoIP > Protocol-based > Port Settings**.

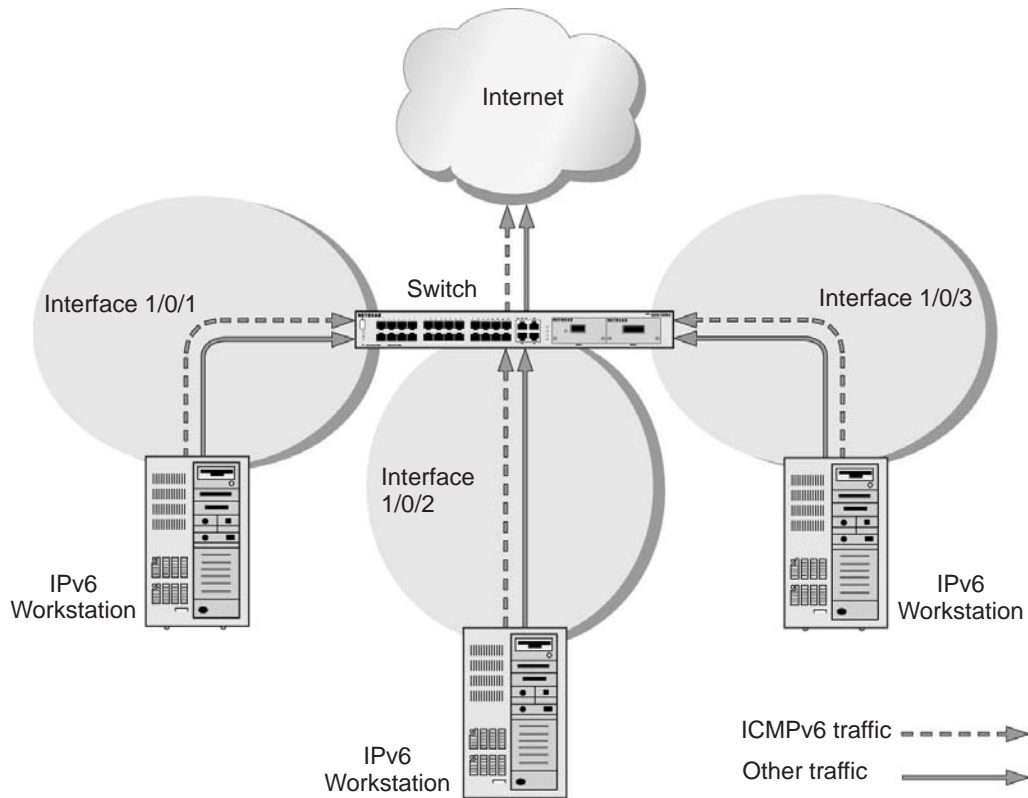
A screen similar to the following displays.

The screenshot shows the 'Auto-VoIP' configuration page. The left sidebar has a tree view with 'Auto-VoIP' selected, and 'Properties' is highlighted under the 'Protocol-based' section. The main content area has a 'OUI Based Properties' section. Below it, the 'Auto-VoIP VLAN ID' is set to '5' (with a range of '1 to 4093') and the 'OUI-based priority' is set to '7'.

- b. From the **VoIP VLAN Id** menu, select **5**.
  - c. Click **Apply**.

# DiffServ for IPv6

This feature extends the existing QoS ACL and DiffServ functionality by providing support for IPv6 packet classification.



**Figure 30. DiffServ for IPv6**

The example is shown as CLI commands and as a local browser interface procedure.

## CLI: Configure DiffServ for IPv6

The script in this section shows how to prioritize ICMPv6 traffic over other IPv6 traffic.

1. Create the IPv6 class classicmpv6.

```
(Netgear Switch) (Config)# class-map match-all classicmpv6 ipv6
```

2. Define matching criteria as protocol ICMPv6.

```
(Netgear Switch) (Config-classmap) # match protocol 58
(Netgear Switch) (Config-classmap) # exit
```

### 3. Create the policy policyicmpv6.

```
(Netgear Switch) (Config)# policy-map policyicmpv6 in
```

### 4. Associate the previously created class classicmpv6.

```
(Netgear Switch) (Config-policy-map)# class classicmpv6
```

### 5. Set the attribute as assign queue 6.

```
(Netgear Switch) (Config-policy-classmap)# assign-queue 6
(Netgear Switch) (Config-policy-map)# exit
```

### 6. Attach the policy policy\_icmpv6 to interfaces 1/0/1, 1/0/2 and 1/0/3:

```
(Netgear Switch) (Config)# interface 1/0/1
(Netgear Switch) (Interface 1/0/1)# service-policy in policyicmpv6
(Netgear Switch) (Interface 1/0/1)# exit

(Netgear Switch) (Config)# interface 1/0/2
(Netgear Switch) (Interface 1/0/2)# service-policy in policyicmpv6
(Netgear Switch) (Interface 1/0/2)# exit

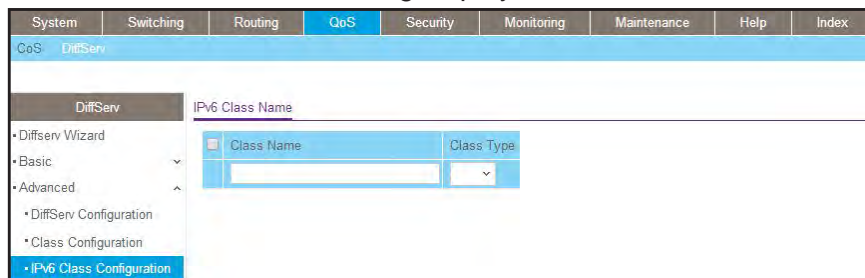
(Netgear Switch) (Config)# interface 1/0/3
(Netgear Switch) (Interface 1/0/3)# service-policy in policyicmpv6
(Netgear Switch) (Interface 1/0/3)# exit
```

## Local Browser Interface: Configure DiffServ for IPv6

### 1. Create the IPv6 class classicmpv6.

#### a. Select **QoS > DiffServ > Advanced > IPv6 Class Configuration**.

A screen similar to the following displays.



#### b. In the **Class Name** field, enter **classicmpv6**.

#### c. In the **Class Type** list, select **All**.

A screen similar to the following displays.

| System   | Switching  | Routing | QoS | Security | Monitoring | Maintenance | Help | Index |            |            |             |     |
|--|------------|---------|-----|----------|------------|-------------|------|-------|------------|------------|-------------|-----|
| CoS DiffServ   |            |         |     |          |            |             |      |       |            |            |             |     |
| DiffServ   |            |         |     |          |            |             |      |       |            |            |             |     |
| IPv6 Class Name  |            |         |     |          |            |             |      |       |            |            |             |     |
| <div> <div> <ul style="list-style-type: none"> <li>DiffServ Wizard</li> <li>Basic</li> <li>Advanced               <ul style="list-style-type: none"> <li>DiffServ Configuration</li> <li>Class Configuration</li> <li>IPv6 Class Configuration</li> </ul> </li> </ul> </div> <div> <table border="1"> <thead> <tr> <th>Class Name</th> <th>Class Type</th> </tr> </thead> <tbody> <tr> <td>classicmpv6</td> <td>All</td> </tr> </tbody> </table> </div> </div> |            |         |     |          |            |             |      |       | Class Name | Class Type | classicmpv6 | All |
| Class Name   | Class Type |         |     |          |            |             |      |       |            |            |             |     |
| classicmpv6  | All        |         |     |          |            |             |      |       |            |            |             |     |

- d. Click **Add** to create the IPv6 class.

A screen similar to the following displays.

| System  | Switching  | Routing | QoS | Security | Monitoring | Maintenance | Help | Index |            |            |  |  |             |     |
|---|------------|---------|-----|----------|------------|-------------|------|-------|------------|------------|--|--|-------------|-----|
| CoS DiffServ  |            |         |     |          |            |             |      |       |            |            |  |  |             |     |
| DiffServ  |            |         |     |          |            |             |      |       |            |            |  |  |             |     |
| IPv6 Class Name   |            |         |     |          |            |             |      |       |            |            |  |  |             |     |
| <div> <div> <ul style="list-style-type: none"> <li>DiffServ Wizard</li> <li>Basic</li> <li>Advanced               <ul style="list-style-type: none"> <li>DiffServ Configuration</li> <li>Class Configuration</li> <li>IPv6 Class Configuration</li> <li>Policy Configuration</li> </ul> </li> </ul> </div> <div> <table border="1"> <thead> <tr> <th>Class Name</th> <th>Class Type</th> </tr> </thead> <tbody> <tr> <td></td> <td></td> </tr> <tr> <td>classicmpv6</td> <td>All</td> </tr> </tbody> </table> </div> </div> |            |         |     |          |            |             |      |       | Class Name | Class Type |  |  | classicmpv6 | All |
| Class Name  | Class Type |         |     |          |            |             |      |       |            |            |  |  |             |     |
|   |            |         |     |          |            |             |      |       |            |            |  |  |             |     |
| classicmpv6   | All        |         |     |          |            |             |      |       |            |            |  |  |             |     |

2. Define matching criteria as protocol ICMPv6.

- a. Select **QoS > DiffServ > Advanced > IPv6 Class Configuration**.

A screen similar to the following displays.

| System  | Switching  | Routing | QoS | Security | Monitoring | Maintenance | Help | Index |            |            |  |  |             |     |
|---|------------|---------|-----|----------|------------|-------------|------|-------|------------|------------|--|--|-------------|-----|
| CoS DiffServ  |            |         |     |          |            |             |      |       |            |            |  |  |             |     |
| DiffServ  |            |         |     |          |            |             |      |       |            |            |  |  |             |     |
| IPv6 Class Name   |            |         |     |          |            |             |      |       |            |            |  |  |             |     |
| <div> <div> <ul style="list-style-type: none"> <li>DiffServ Wizard</li> <li>Basic</li> <li>Advanced               <ul style="list-style-type: none"> <li>DiffServ Configuration</li> <li>Class Configuration</li> <li>IPv6 Class Configuration</li> </ul> </li> </ul> </div> <div> <table border="1"> <thead> <tr> <th>Class Name</th> <th>Class Type</th> </tr> </thead> <tbody> <tr> <td></td> <td></td> </tr> <tr> <td>classicmpv6</td> <td>All</td> </tr> </tbody> </table> </div> </div> |            |         |     |          |            |             |      |       | Class Name | Class Type |  |  | classicmpv6 | All |
| Class Name  | Class Type |         |     |          |            |             |      |       |            |            |  |  |             |     |
|   |            |         |     |          |            |             |      |       |            |            |  |  |             |     |
| classicmpv6   | All        |         |     |          |            |             |      |       |            |            |  |  |             |     |

- b. Click the class **classicmpv6**.

A screen similar to the following displays.

| System                            | Switching | Routing  | QoS | Security | Monitoring | Maintenance | Help | Index |
|-----------------------------------|-----------|--|-----|----------|------------|-------------|------|-------|
| CoS DiffServ                      |           |  |     |          |            |             |      |       |
| DiffServ                          |           | IPv6 Class Information   |     |          |            |             |      |       |
| • DiffServ Wizard                 |           | Class Name <input type="text" value="classicmpv6"/>  |     |          |            |             |      |       |
| • Basic                           |           | Class Type <input type="text" value="All"/>  |     |          |            |             |      |       |
| • Advanced                        |           | IPv6 DiffServ Class Configuration  |     |          |            |             |      |       |
| • DiffServ Configuration          |           | <input checked="" type="radio"/> Match Every <input type="text" value="Any"/>              |     |          |            |             |      |       |
| • Class Configuration             |           | <input type="radio"/> Reference Class <input type="text" value="class_ef"/>                |     |          |            |             |      |       |
| • IPv6 Class Configuration        |           | <input type="radio"/> Protocol Type <input type="text" value="ICMPv6"/> (0 to 255)         |     |          |            |             |      |       |
| • Policy Configuration            |           | <input type="radio"/> Source Prefix/Length <input type="text"/>                            |     |          |            |             |      |       |
| • Service Interface Configuration |           | <input type="radio"/> Source L4 Port <input type="text" value="domain"/> (0 to 65535)      |     |          |            |             |      |       |
| • Service Statistics              |           | <input type="radio"/> Destination Prefix/Length <input type="text"/>                       |     |          |            |             |      |       |
|                                   |           | <input type="radio"/> Destination L4 Port <input type="text" value="domain"/> (0 to 65535) |     |          |            |             |      |       |
|                                   |           | <input type="radio"/> Flow Label <input type="text"/> (0 to 1048575)                       |     |          |            |             |      |       |
|                                   |           | <input type="radio"/> IP DSCP <input type="text" value="af11"/> (0 to 63)                  |     |          |            |             |      |       |

- c. Select the **Protocol Type** radio button, select **Other**, and enter **58**.

A screen similar to the following displays.

| System                            | Switching | Routing  | QoS | Security | Monitoring | Maintenance | Help | Index |
|-----------------------------------|-----------|--|-----|----------|------------|-------------|------|-------|
| CoS DiffServ                      |           |  |     |          |            |             |      |       |
| DiffServ                          |           | IPv6 Class Information   |     |          |            |             |      |       |
| • DiffServ Wizard                 |           | Class Name <input type="text" value="classicmpv6"/>  |     |          |            |             |      |       |
| • Basic                           |           | Class Type <input type="text" value="All"/>  |     |          |            |             |      |       |
| • Advanced                        |           | IPv6 DiffServ Class Configuration  |     |          |            |             |      |       |
| • DiffServ Configuration          |           | <input type="radio"/> Match Every <input type="text" value="Any"/>                           |     |          |            |             |      |       |
| • Class Configuration             |           | <input type="radio"/> Reference Class <input type="text" value="class_ef"/>                  |     |          |            |             |      |       |
| • IPv6 Class Configuration        |           | <input checked="" type="radio"/> Protocol Type <input type="text" value="Other"/> (0 to 255) |     |          |            |             |      |       |
| • Policy Configuration            |           | <input type="radio"/> Source Prefix/Length <input type="text"/>                              |     |          |            |             |      |       |
| • Service Interface Configuration |           | <input type="radio"/> Source L4 Port <input type="text" value="domain"/> (0 to 65535)        |     |          |            |             |      |       |
| • Service Statistics              |           | <input type="radio"/> Destination Prefix/Length <input type="text"/>                         |     |          |            |             |      |       |
|                                   |           | <input type="radio"/> Destination L4 Port <input type="text" value="domain"/> (0 to 65535)   |     |          |            |             |      |       |
|                                   |           | <input type="radio"/> Flow Label <input type="text"/> (0 to 1048575)                         |     |          |            |             |      |       |
|                                   |           | <input type="radio"/> IP DSCP <input type="text" value="af11"/> (0 to 63)                    |     |          |            |             |      |       |

d. Click the **Apply** button.

The screenshot shows the 'IPv6 DiffServ Class Configuration' page. The left sidebar has a tree view with 'DiffServ' expanded, and 'IPv6 Class Configuration' selected. The main content area has two tabs: 'IPv6 Class Information' and 'IPv6 DiffServ Class Configuration'. The 'IPv6 DiffServ Class Configuration' tab is active, showing a list of configuration options with radio buttons and input fields. The 'Match Every' option is selected. The 'Reference Class' is set to 'class\_ef'. The 'Protocol Type' is set to 'ICMPv6'. The 'Source Prefix/Length' is set to 'domain'. The 'Source L4 Port' is set to 'domain'. The 'Destination Prefix/Length' is set to 'domain'. The 'Destination L4 Port' is set to 'domain'. The 'Flow Label' is set to 'domain'. The 'IP DSCP' is set to 'af11'.

3. Create the policy `policyicmpv6`, and associate the previously created class `classicmpv6`.

a. Select **QoS > DiffServ > Advanced > Policy Configuration**.

A screen similar to the following displays.

The screenshot shows the 'Policy Configuration' page. The left sidebar has a tree view with 'DiffServ' expanded, and 'Policy Configuration' selected. The main content area has a table with three columns: 'Policy Name', 'Policy Type', and 'Member Class'. The 'Policy Name' field is empty. The 'Policy Type' dropdown is set to 'In'. The 'Member Class' dropdown is set to 'classicmpv6'.

b. In the **Policy Name** field, enter `policyicmpv6`.

c. In the **Policy Type** list, select **In**.

d. In the **Member Class** list, select `classicmpv6`.

A screen similar to the following displays.

| Policy Name  | Policy Type | Member Class |
|--------------|-------------|--------------|
| policyicmpv6 | In          | classicmpv6  |

e. Click **Add**.

4. Set the attribute as assign queue 6.

a. Select **QoS > DiffServ > Advanced > Policy Configuration**.

A screen similar to the following displays.

| Policy Name  | Policy Type | Member Class |
|--------------|-------------|--------------|
| policyicmpv6 | In          | classicmpv6  |

b. Click the policy **policyicmpv6**.

c. In the **Assign Queue** list, select **6**.



A screen similar to the following displays.

The screenshot shows the 'DiffServ' configuration page. The left sidebar has a tree view with 'Policy Configuration' selected. The main content area has two tabs: 'Class Information' and 'Policy Attribute'. Under 'Class Information', there are three input fields: 'Policy Name' (policyicmpv6), 'Policy Type' (in), and 'Member Class Name' (classicmpv6). Under 'Policy Attribute', there are several radio buttons and dropdown menus: 'Assign Queue' (selected, dropdown 6), 'Drop' (dropdown 0), 'Mark VLAN CoS' (dropdown 0), 'Mark CoS As Secondary CoS' (dropdown 0), 'Mark IP Precedence' (dropdown 0), 'Mirror' (dropdown), 'Redirect' (dropdown), 'Mark IP DSCP' (dropdown af11), and 'Simple Policy' (dropdown). At the bottom right, there are 'Color Mode' and 'Color Blind' checkboxes.

d. Click **Apply**.

5. Attach the policy policyicmpv6 to interfaces 1/0/1, 1/0/2 and 1/0/3.

a. Select **QoS > DiffServ > Advanced > Service Interface Configuration**.

A screen similar to the following displays.

The screenshot shows the 'Service Interface Configuration' page. The left sidebar has a tree view with 'Service Interface Configuration' selected. The main content area has a 'Go To Interface' dropdown and a 'Go' button. Below is a table with the following columns: Interface, Policy In Name, Policy Out Name, Direction, and Operational Status. The table lists interfaces 1/0/1 through 1/0/8. The 'Policy In Name' and 'Policy Out Name' columns have dropdown menus. The 'Direction' column has a dropdown menu. The 'Operational Status' column has a checkbox.

b. In the **Policy Name** list, select **policyicmpv6**.

c. Select the Interface **1/0/1**, **1/0/2**, and **1/0/3** check boxes.

A screen similar to the following displays.

The screenshot shows the 'DiffServ' configuration page with the 'Service Interface Configuration' tab selected. The left sidebar lists various configuration options, with 'Service Interface Configuration' highlighted. The main area displays a table for LAG 1 configuration. The table has columns for Interface, Policy In Name, Policy Out Name, Direction, and Operational Status. The first three rows (1/0/1, 1/0/2, 1/0/3) are checked and highlighted in yellow, while the remaining rows (1/0/4, 1/0/5, 1/0/6, 1/0/7) are unchecked.

| Interface                                 | Policy In Name | Policy Out Name | Direction | Operational Status |
|---|----------------|-----------------|-----------|--------------------|
| <input checked="" type="checkbox"/> 1/0/1 | policyicmpv6   |                 |           |                    |
| <input checked="" type="checkbox"/> 1/0/2 |                |                 |           |                    |
| <input checked="" type="checkbox"/> 1/0/3 |                |                 |           |                    |
| <input type="checkbox"/> 1/0/4            |                |                 |           |                    |
| <input type="checkbox"/> 1/0/5            |                |                 |           |                    |
| <input type="checkbox"/> 1/0/6            |                |                 |           |                    |
| <input type="checkbox"/> 1/0/7            |                |                 |           |                    |

d. Click **Apply**.

A screen similar to the following displays.

The screenshot shows the 'DiffServ' configuration page with the 'Service Interface Configuration' tab selected. The left sidebar lists various configuration options, with 'Service Interface Configuration' highlighted. The main area displays a table for LAG 3 configuration. The table has columns for Interface, Policy In Name, Policy Out Name, Direction, and Operational Status. The first three rows (1/0/1, 1/0/2, 1/0/3) are checked and show 'policyicmpv6' in the Policy In Name column and 'In' in the Direction column. The remaining rows (1/0/4, 1/0/5, 1/0/6) are unchecked and show 'Down' in the Operational Status column.

| Interface                                 | Policy In Name | Policy Out Name | Direction | Operational Status |
|---|----------------|-----------------|-----------|--------------------|
| <input checked="" type="checkbox"/> 1/0/1 | policyicmpv6   |                 | In        | Down               |
| <input checked="" type="checkbox"/> 1/0/2 | policyicmpv6   |                 | In        | Down               |
| <input checked="" type="checkbox"/> 1/0/3 | policyicmpv6   |                 | In        | Down               |
| <input type="checkbox"/> 1/0/4            |                |                 |           |                    |
| <input type="checkbox"/> 1/0/5            |                |                 |           |                    |
| <input type="checkbox"/> 1/0/6            |                |                 |           |                    |

## Color Conform Policy

This example shows how to create a policy to police the traffic to a committed rate. The packets with IP precedence value of 7 are colored green to ensure that these packets are the last to be dropped when there is congestion. The example is shown as CLI commands and as a local browser interface procedure.

## CLI: Configure a Color Conform Policy

1. Create a VLAN 5 and configure ports 1/0/13 and 1/0/25 as its members.

```
(Netgear Switch) #vlan database
(Netgear Switch) (Vlan)#vlan 5
(Netgear Switch) (Vlan)#exit
(Netgear Switch) #config
(Netgear Switch) (Config)#interface 1/0/13
(Netgear Switch) (Interface 1/0/13)#vlan participation include 5
(Netgear Switch) (Interface 1/0/13)#vlan tagging 5
(Netgear Switch) (Interface 1/0/13)#exit
(Netgear Switch) (Config)#interface 1/0/25
(Netgear Switch) (Interface 1/0/25)#vlan participation include 5
(Netgear Switch) (Interface 1/0/25)#vlan tagging 5
(Netgear Switch) (Interface 1/0/25)#exit
```

2. Create classes class\_vlan and class\_color.

---

**Note:** DiffServ service is enabled by default.

---

```
(Netgear Switch) (Config)#class-map match-all class_vlan
(Netgear Switch) (Config-classmap)#match vlan 5
(Netgear Switch) (Config-classmap)#exit
(Netgear Switch) (Config)#class-map match-all class_color
(Netgear Switch) (Config-classmap)#match ip precedence 7
(Netgear Switch) (Config-classmap)#exit
```

3. Create a policy to police the traffic to a rate of 1000 kbps with an allowed burst size of 64 KB. Furthermore, the packets with IP precedence value of 7 will be colored green. That means these packets will be the last packets to be dropped in the event of congestion beyond the policed rate.

```
(Netgear Switch) (Config)#policy-map policy_vlan in
(Netgear Switch) (Config-policy-map)#class class_vlan
(Netgear Switch) (Config-policy-classmap)#police-simple 1000 64 conform-action
transmit violate-action drop
(Netgear Switch) (Config-policy-classmap)#conform-color class_color
(Netgear Switch) (Config-policy-classmap)#exit
(Netgear Switch) (Config-policy-map)#exit
```

#### 4. Apply this policy to port 1/0/13.

```
(Netgear Switch) (Config)#interface 1/0/13
(Netgear Switch) (Interface 1/0/13)#service-policy in policy_vlan
(Netgear Switch) (Interface 1/0/13)#exit
(Netgear Switch) (Config)#exit
```

## Local Browser Interface: Configure a Color Conform Policy

### 1. Create a VLAN.

#### a. Select **Switching > VLAN > Basic > VLAN Configuration**.

A screen similar to the following displays.

#### b. In the **VLAN ID** field, enter 5.

#### c. Click **Add**.

### 2. Add ports 1/0/13 and 1/0/25 to VLAN 5.

#### a. Select **Switching > VLAN > Advanced > VLAN Membership**.

A screen similar to the following displays.

#### b. In the **VLAN ID** list, select 5.

#### c. Click **Unit 1**. The ports display.

- d. Click the gray boxes under ports **13** and **25** until **T** displays.

The T specifies that the egress packet is tagged for the port.

- e. Click **Apply**.

3. Create a class class\_vlan:

- a. Select **QoS > DiffServ > Advanced > Class Configuration**.

A screen similar to the following displays.

| DiffServ                          |  |
|-----------------------------------|--|
| • Diffserv Wizard                 |  |
| • Basic                           |  |
| • Advanced                        |  |
| • DiffServ Configuration          |  |
| • <b>Class Configuration</b>      |  |
| • IPv6 Class Configuration        |  |
| • Policy Configuration            |  |
| • Service Interface Configuration |  |
| • Service Statistics              |  |

| Class Name |            |
|------------|------------|
| Class Name | Class Type |
| class_vlan | All        |

- b. Enter the following information:

- In the **Class Name** field, enter **class\_vlan**.
- In the **Class Type** list, select **All**.

- c. Click **Add** to create a new class class\_vlan.

A screen similar to the following displays.

| DiffServ                          |  |
|-----------------------------------|--|
| • Diffserv Wizard                 |  |
| • Basic                           |  |
| • Advanced                        |  |
| • DiffServ Configuration          |  |
| • <b>Class Configuration</b>      |  |
| • IPv6 Class Configuration        |  |
| • Policy Configuration            |  |
| • Service Interface Configuration |  |
| • Service Statistics              |  |

| Class Name |            |
|------------|------------|
| Class Name | Class Type |
| class_VLAN | All        |

- d. Click **class\_vlan** to configure this class.

A screen similar to the following displays.

e. Under Diffserv Class Configuration, in the **VLAN** field, enter **5**.

f. Click **Apply**.

4. Create a class class\_color.

a. Select **QoS > DiffServ > Advanced > Class Configuration**.

A screen similar to the following displays.

b. Enter the following information:

- In the **Class Name** field, enter **class\_color**.
- In the **Class Type** list, select **All**.

c. Click **Add** to create a new class class\_color.

A screen similar to the following displays.

d. Click **class\_color** to configure this class.



A screen similar to the following displays.

| System   | Switching | Routing | QoS | Security | Monitoring | Maintenance | Help | Index |
|--|-----------|---------|-----|----------|------------|-------------|------|-------|
| CoS DiffServ   |           |         |     |          |            |             |      |       |
| <div> <div>DiffServ</div> <div> <div>Class Information</div> <div> <div>Class Name</div> <div>class_color</div> </div> <div>Class Type</div> <div>All</div> </div> </div>  |           |         |     |          |            |             |      |       |
| <div> <div>DiffServ Configuration</div> <div> <div>Class Configuration</div> <div> <div>DiffServ Class Configuration</div> <div> <div>Match Every</div> <div>Any</div> </div> <div>Reference Class</div> <div>class_VLAN</div> </div> <div>Class Of Service</div> <div>0</div> </div> <div>VLAN</div> <div>(1 to 4093)</div> <div>Secondary Class of Service</div> <div>0</div> </div> <div>Secondary VLAN</div> <div>(1 to 4093)</div> <div>Ethernet Type</div> <div>AppleTalk</div> <div>Source MAC</div> <div>Address</div> <div>Destination MAC</div> <div>Address</div> |           |         |     |          |            |             |      |       |

e. Under Diffserv Class Configuration, in the **Precedence Value** list, select **7**.

f. Click **Apply**.

5. Create a policy policy\_vlan.

a. Select **QoS > DiffServ > Advanced > Policy Configuration**.

A screen similar to the following displays.

| System  | Switching | Routing | QoS | Security | Monitoring | Maintenance | Help | Index |
|---|-----------|---------|-----|----------|------------|-------------|------|-------|
| CoS DiffServ  |           |         |     |          |            |             |      |       |
| <div> <div>DiffServ</div> <div> <div>Policy Configuration</div> <div> <div>Policy Name</div> <div>policy_vlan</div> </div> <div>Policy Type</div> <div>In</div> <div>Member Class</div> <div></div> </div> </div> |           |         |     |          |            |             |      |       |

b. In the **Policy Name** field, enter **policy\_vlan**.

c. In the **Policy Type** list, select **In**.

d. Click **Add**.

6. Associate policy\_vlan with class\_vlan.

a. Select **QoS > DiffServ > Advanced > Policy Configuration**.



A screen similar to the following displays.

| System  | Switching   | Routing      | QoS | Security | Monitoring | Maintenance | Help | Index |             |             |              |             |    |            |   |    |  |
|---|-------------|--------------|-----|----------|------------|-------------|------|-------|-------------|-------------|--------------|-------------|----|------------|---|----|--|
| CoS DiffServ  |             |              |     |          |            |             |      |       |             |             |              |             |    |            |   |    |  |
| DiffServ Policy Configuration   |             |              |     |          |            |             |      |       |             |             |              |             |    |            |   |    |  |
| <ul style="list-style-type: none"> <li>DiffServ Wizard</li> <li>Basic</li> <li>Advanced               <ul style="list-style-type: none"> <li>DiffServ Configuration</li> <li>Class Configuration</li> <li>IPv6 Class Configuration</li> <li><b>Policy Configuration</b></li> <li>Service Interface Configuration</li> <li>Service Statistics</li> </ul> </li> </ul> |             |              |     |          |            |             |      |       |             |             |              |             |    |            |   |    |  |
| <table border="1"> <thead> <tr> <th>Policy Name</th> <th>Policy Type</th> <th>Member Class</th> </tr> </thead> <tbody> <tr> <td>policy_vlan</td> <td>In</td> <td>class_vlan</td> </tr> <tr> <td><input checked="" type="checkbox"/> policy_vlan</td> <td>In</td> <td></td> </tr> </tbody> </table>  |             |              |     |          |            |             |      |       | Policy Name | Policy Type | Member Class | policy_vlan | In | class_vlan | <input checked="" type="checkbox"/> policy_vlan | In |  |
| Policy Name   | Policy Type | Member Class |     |          |            |             |      |       |             |             |              |             |    |            |   |    |  |
| policy_vlan   | In          | class_vlan   |     |          |            |             |      |       |             |             |              |             |    |            |   |    |  |
| <input checked="" type="checkbox"/> policy_vlan   | In          |              |     |          |            |             |      |       |             |             |              |             |    |            |   |    |  |

- b. Under Policy Configuration, scroll down and select the **policy\_vlan** check box.
  - c. In the **Member Class** field, enter **class\_vlan**.
  - d. Click **Apply**.
7. Configure policy\_vlan.
- a. Select **QoS > DiffServ > Advanced > Policy Configuration**.
  - b. Click **policy\_vlan**.

A screen similar to the following displays.

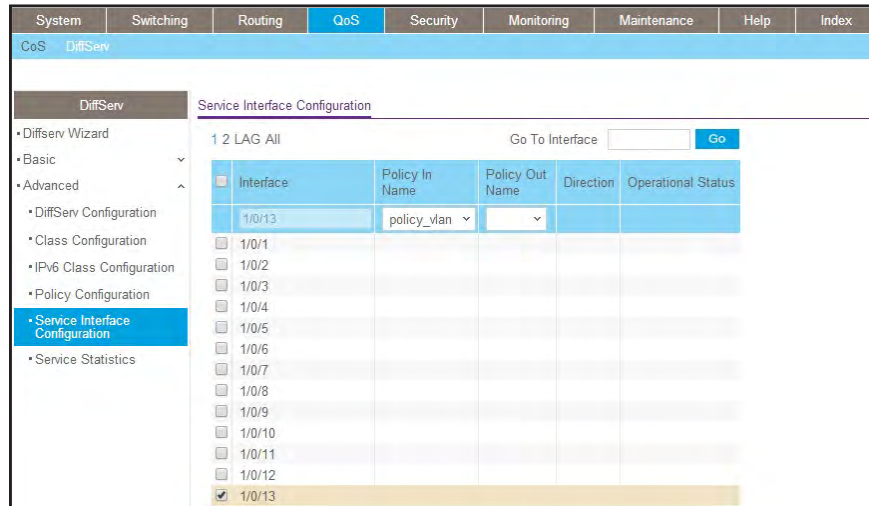
| System   | Switching | Routing | QoS | Security | Monitoring | Maintenance | Help | Index |
|--|-----------|---------|-----|----------|------------|-------------|------|-------|
| CoS DiffServ   |           |         |     |          |            |             |      |       |
| DiffServ Policy Attribute  |           |         |     |          |            |             |      |       |
| <ul style="list-style-type: none"> <li>DiffServ Wizard</li> <li>Basic</li> <li>Advanced               <ul style="list-style-type: none"> <li>DiffServ Configuration</li> <li>Class Configuration</li> <li>IPv6 Class Configuration</li> <li><b>Policy Configuration</b></li> <li>Service Interface Configuration</li> <li>Service Statistics</li> </ul> </li> </ul>  |           |         |     |          |            |             |      |       |
| <div> <input checked="" type="radio"/> Assign Queue         </div> <div> <input type="radio"/> Drop         </div> <div> <input type="radio"/> Mark VLAN CoS         </div> <div> <input type="radio"/> Mark CoS As Secondary CoS         </div> <div> <input type="radio"/> Mark IP Precedence         </div> <div> <input type="radio"/> Mirror         </div> <div> <input type="radio"/> Redirect         </div> <div> <input type="radio"/> Mark IP DSCP         </div> <div> <input checked="" type="radio"/> Simple Policy         </div> |           |         |     |          |            |             |      |       |
| <div>         Color Conform Class: class_color       </div> <div>         Committed Rate: 1000       </div> <div>         Committed Burst Size: 64       </div> <div>         Conform Action: Send       </div> <div>         Violate Action: Drop       </div> <div>         Color Mode: Color Aware       </div>   |           |         |     |          |            |             |      |       |

- c. Select the **Simple Policy** radio button.
- d. In the **Color Mode** list, select **Color Aware**.
- e. In the **Color Conform Class** list, select **class\_color**.
- f. In the **Committed Rates** field, enter **1000**.
- g. In the **Committed Burst Size** field, enter **64**.
- h. For Conform Action, select the **Send** radio button.
- i. For Violate Action, select the **Drop** radio button.
- j. Click **Apply**.

## 8. Apply policy\_vlan to interface 1/0/13.

a. Select **QoS > DiffServ > Advanced > Service Interface Configuration**.

A screen similar to the following displays.

b. Under Service Interface Configuration, scroll down and select the Interface **1/0/13** check box.c. In the **Policy Name** list, select **policy\_vlan**.d. Click **Apply** to save the settings.

## WRED Explicit Congestion Notification

Explicit Congestion Notification (ECN) is defined in RFC 3168. Conventional TCP networks address congestion by dropping packets using the tail drop algorithm. Random early discard (RED, also referred to as random early detection) provides earlier notification than the tail drop algorithm and can drop packets that are already queued for transmission. ECN marks congested packets that would otherwise be dropped and sends a message to the transmitter so that the packets are not retransmitted. That is, the receiver advertises a reduced window size to the transmitter but does not request retransmission of the CE-marked packets.

ECN uses the two least significant bits of the Diffserv field (that is, the ToS octet in IPv4 and the Traffic Class octet in IPv6) and codes them as follows:

- 00. Non ECN-Capable Transport, Non-ECT
- 10. ECN Capable Transport, ECT (0)
- 01. ECN Capable Transport, ECT (1)
- 11. Congestion Encountered, CE

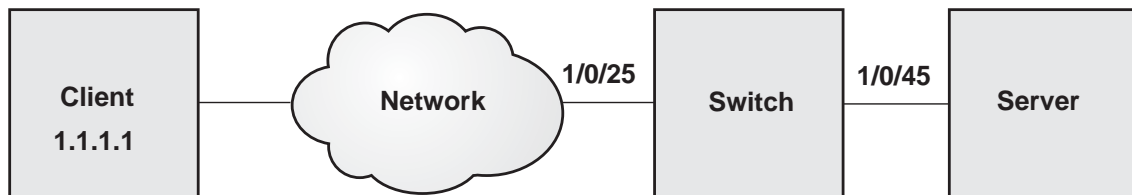
TCP also supports ECN through two flags in the TCP header:

- ECN-Echo (ECE)
- Congestion Window Reduced (CWR)

Weighted random early discard (WRED, also referred to as weighted random early detection) considers packets for early discard only when the number of packets that are queued for transmission on a port exceeds the relevant minimum WRED threshold. The green, yellow, and red thresholds operate on TCP packets. A fourth threshold operates on non-TCP packets.

If ECN is enabled and congestion occurs, ECN-capable TCP packets that are queued for transmission and that are selected to be discarded by WRED are instead CE-marked and transmitted. Packets that exceed the WRED upper threshold are also transmitted. If severe congestion occurs on the switch (that is, no buffers are available), the packets are discarded.

On managed switches, ECN is implemented as part of the WRED configuration process. You can configure any CoS queue to operate in ECN marking mode and you can configure different discard thresholds for each color.



**Figure 31. WRED Explicit Congestion Notification configuration**

To configure WRED Explicit Congestion Notification configuration:

1. Create class 1 and class 2.

```

(Netgear Switch) (Config)#class-map
(Netgear Switch) (Config)#class-map match-all class1
(Netgear Switch) (Config-classmap)#match srcip 1.1.1.1 255.255.255.255
(Netgear Switch) (Config-classmap)#exit
(Netgear Switch) (Config)#class-map match-all class2
(Netgear Switch) (Config-classmap)#match ip dscp 46
(Netgear Switch) (Config-classmap)#exit
  
```

2. Create a policy and configure the conform color for class 2.

```

(Netgear Switch) (Config)#policy-map p1 in
(Netgear Switch) (Config-policy-map)#class class1
(Netgear Switch) (Config-policy-classmap)#police-single-rate 1000000 128 128
conform-action transmit exceed-action transmit violate-action transmit
(Netgear Switch) (Config-policy-classmap)#conform-color class2
(Netgear Switch) (Config-policy-classmap)#exit
  
```

**3. Apply the policy on port 1/0/25.**

```
(Netgear Switch) (Config)#interface 1/0/25
(Netgear Switch) (Interface 1/0/25)#service-policy in p1
```

**4. Let the packets with dot1p priority 3 be placed in queue 3.**

```
(Netgear Switch) (Config)#classofservice dot1p-mapping 3 3
(Netgear Switch) #show classofservice dot1p-mapping
```

| User Priority | Traffic Class |
|---------------|---------------|
| -----         | -----         |
| 0             | 1             |
| 1             | 0             |
| 2             | 0             |
| 3             | 3             |
| 4             | 2             |
| 5             | 2             |
| 6             | 3             |
| 7             | 3             |

**5. Enable WRED on queue 3.**

```
(Netgear Switch) (Config)#cos-queue random-detect 3
(Netgear Switch) #show interfaces cos-queue
```

## Global Configuration

Interface Shaping Rate..... 0

WRED Decay Exponent..... 9

| Queue ID | Min. Bandwidth | Scheduler Type | Queue Management Type |
|----------|----------------|----------------|-----------------------|
| -----    | -----          | -----          | -----                 |
| 0        | 0              | Weighted       | Tail Drop             |
| 1        | 0              | Weighted       | Tail Drop             |
| 2        | 0              | Weighted       | Tail Drop             |
| 3        | 0              | Weighted       | WRED                  |
| 4        | 0              | Weighted       | Tail Drop             |
| 5        | 0              | Weighted       | Tail Drop             |
| 6        | 0              | Weighted       | Tail Drop             |

**6. Configure the queue threshold and enable ECN on queue 3.**

```
(Netgear Switch) (Config)#random-detect queue-parms 3 min-thresh 60 20 10 10
max-thresh 100 80 70 60 drop-prob 10 10 10 10 ecn
```

# 14

## IGMP Snooping and Querier

---

### Internet Group Management Protocol features

This chapter includes the following sections:

- [Internet Group Management Protocol Concepts](#)
- [IGMP Snooping](#)
- [Show igmpsnooping](#)
- [Show mac-address-table igmpsnooping](#)
- [External Multicast Router](#)
- [Multicast Router Using VLAN](#)
- [IGMP Querier Concepts](#)
- [Enable IGMP Querier](#)
- [Show IGMP Querier Status](#)

# Internet Group Management Protocol Concepts

NETGEAR implements Internet Group Management Protocol (IGMP) in the following way:

- IGMP uses version 1, version 2, or version 3.
- IGMP includes snooping.
- By default, IGMP snooping is enabled on VLAN 1.

## IGMP Snooping

The following are examples of the commands used for the IGMP snooping feature.

### CLI: Enable IGMP Snooping

1. Globally enable IGMP snooping:

```
(Netgear Switch) #config
(Netgear Switch) (Config)#set igmp
(Netgear Switch) (Config)#exit
```

2. Enable IGMP snooping on a VLAN (in this example, on VLAN 300):

```
(Netgear Switch) #vlan database
(Netgear Switch) (Vlan)#set igmp 300
(Netgear Switch) (Vlan)#exit
```

## Local Browser Interface: Enable IGMP Snooping

Configure IGMP snooping:

1. Select **Switching > Multicast > IGMP Snooping Configuration**.

A screen similar to the following displays.

| System | Switching | Routing | QoS | Security  | Monitoring | Maintenance   | Help  | Index |      |
|--------|-----------|---------|-----|-----------|------------|---------------|-------|-------|------|
| VLAN   | Auto-VoIP | iSCSI   | STP | Multicast | MVR        | Address Table | Ports | LAG   | MLAG |

Multicast

- MFDB
- IGMP Snooping
- Configuration**
- Interface Configuration
- IGMP VLAN Configuration
- Multicast Router Configuration
- Multicast Router VLAN Configuration
- Querier Configuration
- Querier VLAN Configuration
- MLD Snooping

### IGMP Snooping Configuration

Admin Mode: ☐ Disable ☒ Enable

Multicast Control Frame Count: 0

Validate IGMP IP header: ☐ Disable ☒ Enable

Interfaces Enabled for IGMP Snooping: ☐ Disable ☒ Enable

Proxy Querier Mode: ☐ Disable ☒ Enable

### VLAN IDs Enabled for IGMP Snooping

2. For Admin Mode select the **Enable** radio button.
3. For Unknown Multicast Filtering, select the **Enable** radio button.
4. Click **Apply**.

## Show igmpsnooping

The example is shown as CLI commands and as a local browser interface procedure.

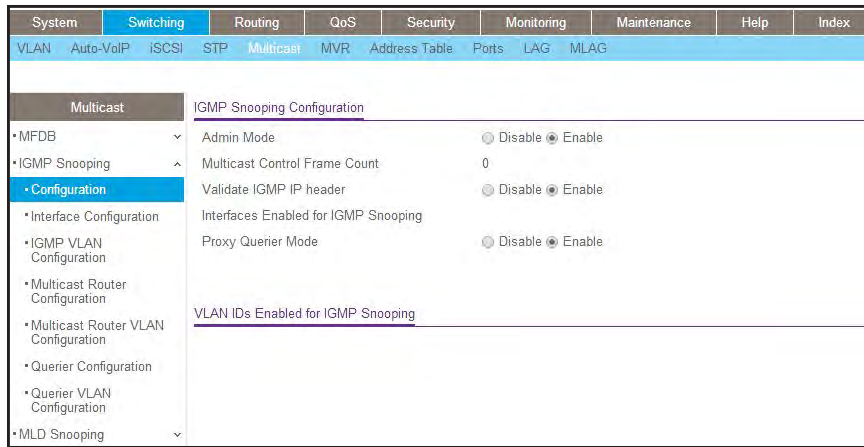
### CLI: Show igmpsnooping

```
(Netgear Switch) #show igmpsnooping
Admin Mode..... Disable
Multicast Control Frame Count..... 0
Interfaces Enabled for IGMP Snooping..... None
VLANs enabled for IGMP snooping..... None
```



## Local Browser Interface: Show igmpsnooping

Select **Switching > Multicast > IGMP Snooping Configuration**. A screen similar to the following displays.



## Show mac-address-table igmpsnooping

The example is shown as CLI commands and as a local browser interface procedure.

### CLI for IGMPv1 and IGMPv2: Show mac-address-table igmpsnooping

```
(Netgear Switch) #show mac-address-table igmpsnooping ?

<cr>                                     Press Enter to execute the command.

(Netgear Switch) #show mac-address-table igmpsnooping

Type      Description      Interfaces
-----
00:01:01:00:5E:00:01:16  Dynamic      Network Assist  Fwd: 1/0/47
00:01:01:00:5E:00:01:18  Dynamic      Network Assist  Fwd: 1/0/47
00:01:01:00:5E:37:96:D0  Dynamic      Network Assist  Fwd: 1/0/47
00:01:01:00:5E:7F:FF:FA  Dynamic      Network Assist  Fwd: 1/0/47
00:01:01:00:5E:7F:FF:FE  Dynamic      Network Assist  Fwd: 1/0/47
```

## CLI for IGMPv3: show igmpsnooping ssm entries

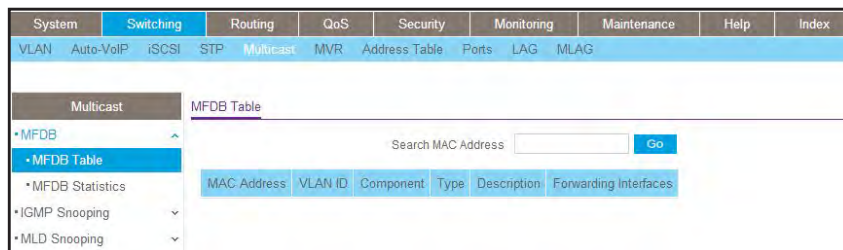
```
(Netgear Switch) #show igmpsnooping ssm entries
```

| VLAN ID | Group     | Source Ip | Source Filter Mode | Interfaces |
|---------|-----------|-----------|--------------------|------------|
| 1000    | 224.1.1.1 | 1.1.1.1   | include            | 1/0/2      |

## Local Browser Interface: Show mac-address-table igmpsnooping

Select **Switching > Multicast > IGMP Snooping Table**.

A screen similar to the following displays.



## External Multicast Router

The example is shown as CLI commands and as a local browser interface procedure.

## CLI: Configure the Switch with an External Multicast Router

This example configures the interface as the one the multicast router is attached to. All IGMP packets that are snooped by the switch are forwarded to the multicast router that is reachable from this interface.

```
(Netgear Switch)(Interface 1/0/3)# set igmp mrouter interface
```

## Local Browser Interface: Configure the Switch with an External Multicast Router

1. Select **Switching > Multicast > Multicast Router Configuration**.

A screen similar to the following displays.

| Interface | Admin Mode | Membership Interval | Max Response Time | Expiration Time | Fast Leave | Proxy Querier |
|-----------|------------|---------------------|-------------------|-----------------|------------|---------------|
| 1/0/3     | Enable     | 260                 | 10                | 0               | Disable    | Enable        |
| 1/0/1     | Disable    | 260                 | 10                | 0               | Disable    | Enable        |
| 1/0/2     | Disable    | 260                 | 10                | 0               | Disable    | Enable        |
| 1/0/3     | Disable    | 260                 | 10                | 0               | Disable    | Enable        |
| 1/0/4     | Disable    | 260                 | 10                | 0               | Disable    | Enable        |

2. Under Multicast Router Configuration, scroll down and select the Interface **1/0/3** check box. Now 1/0/3 appears in the Interface field at the top.
3. In the Admin Mode field, select **Enable**.
4. Click **Apply**.

## Multicast Router Using VLAN

The example is shown as CLI commands and as a local browser interface procedure.

### CLI: Configure the Switch with a Multicast Router Using VLAN

This example configures the interface to forward only the snooped IGMP packets that come from VLAN ID (<VLAN Id>) to the multicast router attached to this interface.

```
(Netgear Switch)(Interface 1/0/3)# set igmp mrouter 2
```

## Local Browser Interface: Configure the Switch with a Multicast Router Using VLAN

1. Select **Switching > Multicast > Multicast Router VLAN Configuration**.

A screen similar to the following displays.

The screenshot shows the 'Multicast Router VLAN Configuration' page. The left sidebar has a tree view with 'Multicast Router VLAN Configuration' selected. The main content area has a title bar 'Multicast Router VLAN Configuration' and a sub-header 'Interface' with a dropdown menu showing '1/0/3'. Below this, there is a table with two columns: 'VLAN ID' and 'Multicast Router'. The 'VLAN ID' row has a value of '2' and the 'Multicast Router' row has a value of 'Enable'.

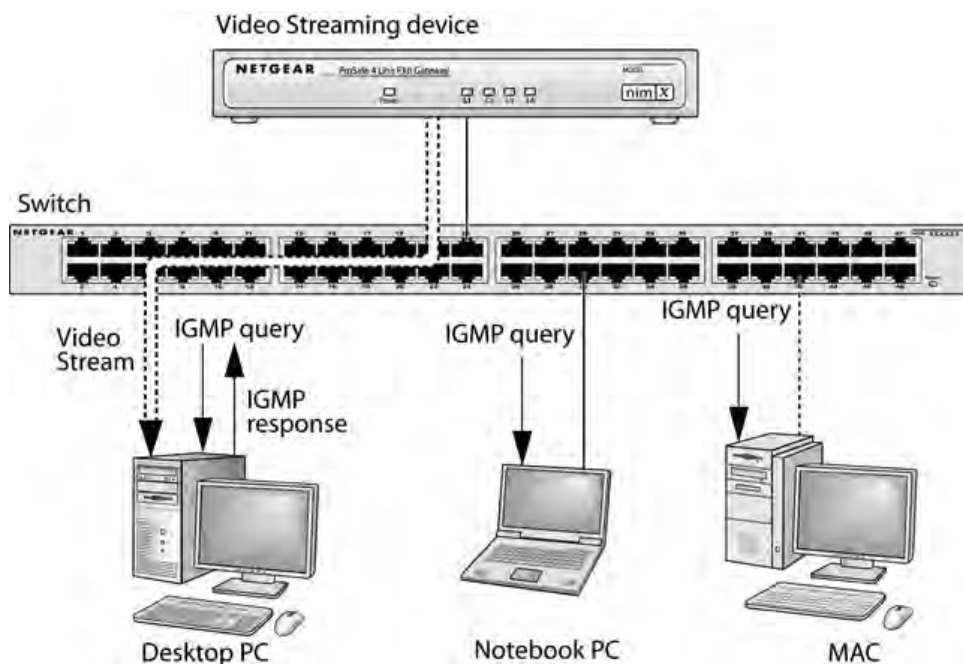
| VLAN ID | Multicast Router |
|---------|------------------|
| 2       | Enable           |

2. Under Multicast Router VLAN Configuration, scroll down and select the Interface **1/0/3** check box.
3. Enter the following information in the Multicast Router VLAN Configuration.
  - In the **VLAN ID** field, enter **2**.
  - In the **Multicast Router** field, select **Enable**.
4. Click **Apply**.

## IGMP Querier Concepts

When the switch is used in network applications where video services such as IPTV, video streaming, and gaming are deployed, the video traffic is normally flooded to all connected ports because such traffic packets usually have multicast Ethernet addresses. IGMP snooping can be enabled to create a multicast group to direct that traffic only to those users that require it.

However, the IGMP snooping operation usually requires an extra network device—usually a router—that can generate an IGMP membership query and solicit interested nodes to respond. With the built-in IGMP querier feature inside the switch, such an external device is no longer needed.



**Figure 32. IGMP querier**

Since the IGMP querier is designed to work with IGMP snooping, it is necessary to enable IGMP snooping when using it. The following figure shows a network application for video streaming service using the IGMP querier feature.

## Enable IGMP Querier

The example is shown as CLI commands and as a local browser interface procedure.

### CLI: Enable IGMP Querier

Use the following CLI commands to set up the switch to generate an IGMP querier packet for a designated VLAN. The IGMP packet will be transmitted to every port on the VLAN. The following example enables the querier for VLAN 1 and uses 10.10.10.1 as the source IP address in querier packets. See the *Command Line Reference* for more details about other IGMP querier command options.

```
(Netgear switch) #vlan database
(Netgear switch) (vlan)#set igmp 1
(Netgear switch) (vlan)#set igmp querier 1
(Netgear switch) (vlan)#exit
(Netgear switch) #config
(Netgear switch) (config)#set igmp querier
(Netgear switch) (config)#set igmp querier address 10.10.10.1
(Netgear switch) (config)#exit
```

## Local Browser Interface: Enable IGMP Querier

### 1. Select **Switching > Multicast > IGMP VLAN Configuration**.

A screen similar to the following displays.

| System   | Switching | Routing                              | QoS | Security  | Monitoring | Maintenance   | Help  | Index |
|--|-----------|--------------------------------------|-----|---|------------|---------------|-------|-------|
| VLAN   | Auto-VoIP | iSCSI                                | STP | Multicast   | MVR        | Address Table | Ports | LAG   |
| <div> <div>Multicast</div> <div>IGMP Snooping Configuration</div> </div> |           |                                      |     |   |            |               |       |       |
| • MFDB   |           | Admin Mode                           |     | <input checked="" type="radio"/> Disable <input type="radio"/> Enable |            |               |       |       |
| • IGMP Snooping  |           | Multicast Control Frame Count        |     | 0   |            |               |       |       |
| • Configuration  |           | Validate IGMP IP header              |     | <input checked="" type="radio"/> Disable <input type="radio"/> Enable |            |               |       |       |
| • Interface Configuration  |           | Interfaces Enabled for IGMP Snooping |     |   |            |               |       |       |
| • IGMP VLAN Configuration  |           | Proxy Querier Mode                   |     | <input type="radio"/> Disable <input checked="" type="radio"/> Enable |            |               |       |       |
| • Multicast Router Configuration   |           | VLAN IDs Enabled for IGMP Snooping   |     |   |            |               |       |       |
| • Multicast Router VLAN Configuration                                    |           |                                      |     |   |            |               |       |       |

### 2. Enable IGMP snooping on VLAN 1.

#### a. Select **Switching > Multicast > IGMP Snooping > IGMP VLAN Configuration**.

A screen similar to the following displays.

| System   | Switching | Routing | QoS | Security  | Monitoring | Maintenance   | Help  | Index |
|--|-----------|---------|-----|-----------|------------|---------------|-------|-------|
| VLAN   | Auto-VoIP | iSCSI   | STP | Multicast | MVR        | Address Table | Ports | LAG   |
| <div> <div>Multicast</div> <div>IGMP VLAN Configuration</div> </div> |           |         |     |           |            |               |       |       |
| • MFDB   |           |         |     |           |            |               |       |       |
| • IGMP Snooping  |           |         |     |           |            |               |       |       |
| • Configuration  |           |         |     |           |            |               |       |       |
| • Interface Configuration  |           |         |     |           |            |               |       |       |
| • IGMP VLAN Configuration  |           |         |     |           |            |               |       |       |

| VLAN ID | Admin Mode | Fast Leave | Membership Interval | Maximum Response Time | Multicast Router Expiry Time | Report Suppression | Proxy Querier |
|---------|------------|------------|---------------------|-----------------------|------------------------------|--------------------|---------------|
| 1       | Enable     |            |                     |                       |                              |                    |               |

#### b. Enter the following information:

- In the **VLAN ID** field, enter 1.
- In the **Admin Mode** field, select **Enable**.

#### c. Click **Add**.

### 3. Enable the IGMP snooping querier globally.

#### a. Select **Switching > Multicast > IGMP Snooping > IGMP VLAN Configuration**.

A screen similar to the following displays.

| System   | Switching | Routing | QoS | Security  | Monitoring | Maintenance   | Help  | Index |
|--|-----------|---------|-----|-----------|------------|---------------|-------|-------|
| VLAN   | Auto-VoIP | iSCSI   | STP | Multicast | MVR        | Address Table | Ports | LAG   |
| <div> <div>Multicast</div> <div> <div>Querier Configuration</div> <div> <div>Querier Admin Mode</div> <div> <input type="radio"/> Disable <input checked="" type="radio"/> Enable </div> </div> <div> <div>Snooping Querier Address</div> <div>10.10.10.1</div> </div> <div> <div>IGMP Version</div> <div>2</div> <div>(1 to 2)</div> </div> <div> <div>Query Interval(secs)</div> <div>60</div> <div>(1 to 1800)</div> </div> <div> <div>Querier Expiry Interval(secs)</div> <div>60</div> <div>(60 to 300)</div> </div> <div> <div>VLAN IDs Enabled for IGMP Snooping Querier</div> <div></div> </div> </div> </div> |           |         |     |           |            |               |       |       |

b. Enter the following information:

- For Querier Admin Mode, select the **Enable** radio button.
- In the **Querier IP Address** field, enter **10.10.10.1**.

c. Click **Apply**.

4. Enable the IGMP snooping querier on VLAN 1.

a. Select **Switching > Multicast > IGMP Snooping Querier VLAN Configuration**.

A screen similar to the following displays.

| System   | Switching                         | Routing              | QoS               | Security            | Monitoring           | Maintenance          | Help                          | Index |         |                                   |                      |                   |                     |                      |                      |                               |   |  |  |  |  |  |  |  |
|--|-----------------------------------|----------------------|-------------------|---------------------|----------------------|----------------------|-------------------------------|-------|---------|-----------------------------------|----------------------|-------------------|---------------------|----------------------|----------------------|-------------------------------|---|--|--|--|--|--|--|--|
| VLAN   | Auto-VoIP                         | iSCSI                | STP               | Multicast           | MVR                  | Address Table        | Ports                         | LAG   |         |                                   |                      |                   |                     |                      |                      |                               |   |  |  |  |  |  |  |  |
| <div> <div>Multicast</div> <div> <div>IGMP Snooping Querier VLAN Configuration</div> <table border="1"> <thead> <tr> <th>VLAN ID</th> <th>Querier Election Participate Mode</th> <th>Querier VLAN Address</th> <th>Operational State</th> <th>Operational Version</th> <th>Last Querier Address</th> <th>Last Querier Version</th> <th>Operational Max Response Time</th> </tr> </thead> <tbody> <tr> <td>1</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> </tbody> </table> </div> </div> |                                   |                      |                   |                     |                      |                      |                               |       | VLAN ID | Querier Election Participate Mode | Querier VLAN Address | Operational State | Operational Version | Last Querier Address | Last Querier Version | Operational Max Response Time | 1 |  |  |  |  |  |  |  |
| VLAN ID  | Querier Election Participate Mode | Querier VLAN Address | Operational State | Operational Version | Last Querier Address | Last Querier Version | Operational Max Response Time |       |         |                                   |                      |                   |                     |                      |                      |                               |   |  |  |  |  |  |  |  |
| 1  |                                   |                      |                   |                     |                      |                      |                               |       |         |                                   |                      |                   |                     |                      |                      |                               |   |  |  |  |  |  |  |  |

b. In the **VLAN ID** field, enter **1**.

5. Click **Add**.



# Show IGMP Querier Status

The example is shown as CLI commands and as a local browser interface procedure.

## CLI: Show IGMP Querier Status

To see the IGMP querier status, use the following command.

```
(Netgear Switch) #show igmpsnooping querier vlan 1
VLAN 1 : IGMP Snooping querier status
-----
IGMP Snooping Querier VLAN Mode..... Enable
Querier Election Participate Mode..... Disable
Querier VLAN Address..... 0.0.0.0
Operational State..... Disabled
Operational version..... 2
```

The command shows that the IGMP admin mode is Active. The mode is controlled by the **set igmp** command. If the mode is inactive, no query packet is sent.

## Local Browser Interface: Show IGMP Querier Status

1. Select **Switching > Multicast > IGMP Snooping > Querier Configuration**.

A screen similar to the following displays.

| System | Switching | Routing | QoS | Security  | Monitoring | Maintenance   | Help  | Index |      |
|--------|-----------|---------|-----|-----------|------------|---------------|-------|-------|------|
| VLAN   | Auto-VoIP | iSCSI   | STP | Multicast | MVR        | Address Table | Ports | LAG   | MLAG |

- Multicast
  - Querier Configuration
- IGMP Snooping
  - Configuration
  - Interface Configuration
  - IGMP VLAN Configuration
  - Multicast Router Configuration
  - Multicast Router VLAN Configuration
  - Querier Configuration
  - Querier VLAN Configuration
- MLD Snooping

### Querier Configuration

Querier Admin Mode: ☒ Disable ☐ Enable

Snooping Querier Address:

IGMP Version:  (1 to 2)

Query Interval(secs):  (1 to 1800)

Querier Expiry Interval(secs):  (60 to 300)

VLAN IDs Enabled for IGMP Snooping Querier

2. Click **Refresh**.

# 15

## 15 MVR

---

### Multicast VLAN registration

This chapter includes the following sections:

- [Multicast VLAN Registration](#)
- [Configure MVR in Compatible Mode](#)
- [Configure MVR in Dynamic Mode](#)

# Multicast VLAN Registration

The IGMP Layer 3 protocol is widely used for IPv4 network multicasting. In Layer 2 networks, the IGMP protocol uses resources inefficiently. For example, a Layer 2 switch multicast traffic to all ports even if there are receivers connected to only a few ports.

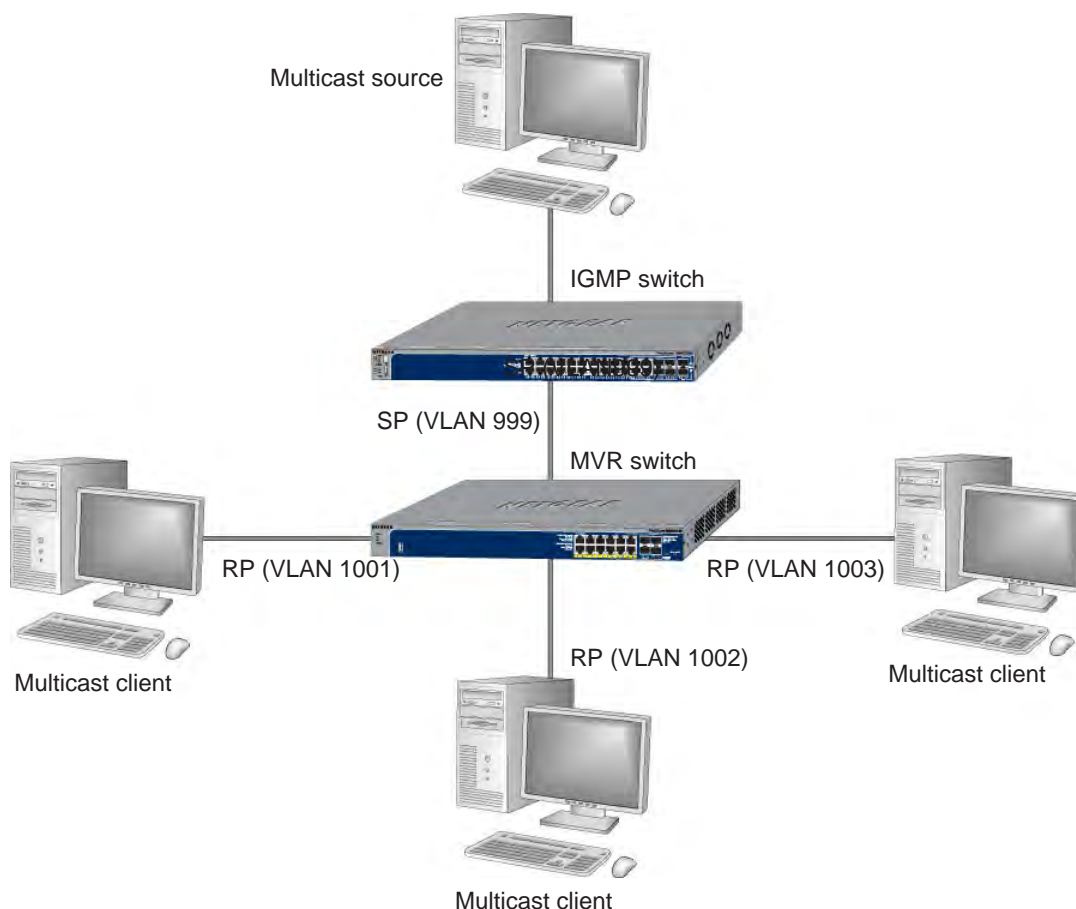
To fix this problem, the IGMP snooping protocol was developed. But the problem reappears when receivers are in different VLANs. Multicast VLAN registration (MVR) is intended to solve the problem of receivers in different VLANs. It uses a dedicated manually configured VLAN, called the multicast VLAN, to forward multicast traffic over Layer 2 network in conjunction with IGMP snooping.

MVR, like the IGMP Snooping protocol, allows a Layer 2 switch to snoop on the IGMP control protocol. Both protocols operate independently of each other. Both protocols can be enabled on the switch interfaces at the same time. In such a case, MVR listens to the join and report messages only for groups configured statically. All other groups are managed by IGMP snooping.

There are two types of MVR ports: source and receiver.

- The source port is the port to which the multicast traffic flows using the multicast VLAN.
- The receiver port is the port where a listening host is connected to the switch. It can utilize any (or no) VLAN, except the multicast VLAN. This implies that the MVR switch performs VLAN tag substitution from the multicast VLAN source port to the VLAN tag used by the receiver port.

The multicast VLAN is the VLAN that you configure in the specific network for MVR purposes. The multicast VLAN is used to transfer multicast traffic over the network to avoid duplication of multicast streams for clients in different VLANs. The operator must configure the multicast VLAN manually for all source ports in the network. A diagram of a network configured for MVR is shown in the following illustration. SP is the source port and RP is the receiver port.



**Figure 33. Network configured for MVR**

---

**Note:** The following examples show how to configure the MVR on the MVR switch.

---

## Configure MVR in Compatible Mode

In compatible mode, the MVR switch does not learn multicast groups; the groups have to be configured by the operator as the MVR does not forward IGMP reports from the hosts (RP port) to the IGMP router (SP port). To operate in this mode, the IGMP router has to be statically configured to transmit all required multicast streams to the MVR switch.

## CLI: Configure MVR in Compatible Mode

### 1. Create MVLAN, VLAN1, VLAN2, and VLAN3.

```
(Netgear Switch) #vlan database
(Netgear Switch) (Vlan)#vlan 999,1001, 1002, 1003
(Netgear Switch) (Vlan)#vlan name 999 mVlan
(Netgear Switch) (Vlan)#vlan name 1001 Vlan1
(Netgear Switch) (Vlan)#vlan name 1002 Vlan2
(Netgear Switch) (Vlan)#vlan name 1003 Vlan3
(Netgear Switch) (Vlan)#exit
```

### 2. Enable MVR, configure VLAN 999 as a multicast VLAN, and add group 224.1.2.3 to MVR.

```
(Netgear Switch) #config
(Netgear Switch) (Config)#mvr
(Netgear Switch) (Config)#mvr vlan 999
(Netgear Switch) (Config)#mvr group 224.1.2.3
```

### 3. Configure multicast VLAN on the source port.

```
(Netgear Switch) (Config)#interface 0/9
(Netgear Switch) (Interface 0/9)#vlan participation include 999
(Netgear Switch) (Interface 0/9)#vlan tagging 999
(Netgear Switch) (Interface 0/9)#mvr
(Netgear Switch) (Interface 0/9)#mvr type source
(Netgear Switch) (Interface 0/9)#exit
```

### 4. Configure the receive ports.

---

**Note:** The receive port can participate in only one VLAN.

---

```

(Netgear Switch) (Config)#interface 0/1
(Netgear Switch) (Interface 0/1)#vlan participation include 1001
(Netgear Switch) (Interface 0/1)#vlan pvid 1001
(Netgear Switch) (Interface 0/1)#vlan participation exclude 1
(Netgear Switch) (Interface 0/1)#mvr
(Netgear Switch) (Interface 0/1)#mvr type receiver
(Netgear Switch) (Interface 0/1)#mvr vlan 999 group 224.1.2.3
(Netgear Switch) (Interface 0/1)#exit

(Netgear Switch) (Config)#interface 0/5
(Netgear Switch) (Interface 0/5)#vlan participation include 1002
(Netgear Switch) (Interface 0/5)#vlan pvid 1002
(Netgear Switch) (Interface 0/5)#vlan participation exclude 1
(Netgear Switch) (Interface 0/5)#mvr
(Netgear Switch) (Interface 0/5)#mvr stype receiver
(Netgear Switch) (Interface 0/5)#mvr vlan 999 group 224.1.2.3
(Netgear Switch) (Interface 0/5)#exit

(Netgear Switch) (Config)#interface 0/7
(Netgear Switch) (Interface 0/7)#vlan participation include1003
(Netgear Switch) (Interface 0/7)#vlan pvid 1003
(Netgear Switch) (Interface 0/7)#vlan participation exclude 1
(Netgear Switch) (Interface 0/7)#mvr
(Netgear Switch) (Interface 0/7)#mvr type receiver
(Netgear Switch) (Interface 0/7)#mvr vlan 999 group 224.1.2.3
(Netgear Switch) (Interface 0/7)#exit

```

## 5. Display the MVR status.

```

(Netgear Switch) #show mvr
MVR Running..... TRUE
MVR multicast VLAN..... 999
MVR Max Multicast Groups..... 256
MVR Current multicast groups..... 1
MVR Global query response time.... 5 (tenths of sec)
MVR Mode..... compatible
(Netgear Switch) #show mvr interface

```

| Port | Type     | Status        | Immediate Leave |
|------|----------|---------------|-----------------|
| 0/1  | RECEIVER | ACTIVE/InVLAN | DISABLED        |
| 0/5  | RECEIVER | ACTIVE/InVLAN | DISABLED        |
| 0/7  | RECEIVER | ACTIVE/InVLAN | DISABLED        |
| 0/9  | SOURCE   | ACTIVE/InVLAN | DISABLED        |

## Local Browser Interface: Configure MVR in Compatible Mode

1. Create MVLAN 999, VLAN1 1001, VLAN2 1002 and VLAN3 1003.

- a. Select **Switching > VLAN > Basic > VLAN Configuration**.

A screen similar to the following displays.

| VLAN ID | VLAN Name | VLAN Type | Make Static |
|---------|-----------|-----------|-------------|
| 999     | mVlan     | Static    | Disable     |
| 1       | default   | Default   | Disable     |
| 3       | VLAN0003  | Static    | Disable     |
| 10      | VLAN0010  | Static    | Disable     |

- b. In the VLAN ID field, enter **999**, and in the VLAN Name field, enter **mVlan**.

- c. Click **Add**.

- d. Repeat step b and c to create VLAN1 1001, VLAN2 1002, and VLAN3 1003.

2. Add port 9 into MVLAN 999 with tagged mode.

- a. Select **Switching > VLAN > Advanced > VLAN Membership**.

A screen similar to the following displays.

| Unit 1 | 1 | 3 | 5 | 7 | 9 | 11 | 13 | 15 | 17 | 19 | 21 | 23 | 25 | 27 | 29 | 31 | 33 | 35 | 37 | 39 | 41 | 43 | 45 | 47 |
|--------|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Ports  |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|        |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |

- b. In the VLAN ID list, select **999**.

- c. Click **Unit 1**. The ports display.

- d. Click the gray box under port 9 until T displays. The T specifies that the egress packet is tagged for the ports.

- e. Click **Apply** to save the settings.



- f. Repeat steps from b to e, add port 0/1 to VLAN1 1001, add port 0/5 to VLAN2 1002, and add port 0/7 to VLAN3 1003.
3. Enable MVR and multicast VLAN
  - a. Select **Switching > MVR > Basic > MVR Configuration**.

A screen similar to the following displays.

| System   | Switching | Routing | QoS | Security  | Monitoring | Maintenance   | Help  | Index |      |
|--|-----------|---------|-----|-----------|------------|---------------|-------|-------|------|
| VLAN   | Auto-VoIP | iSCSI   | STP | Multicast | MVR        | Address Table | Ports | LAG   | MLAG |
| <div>MVR</div> <div>MVR Configuration</div> <div> <div>• Basic</div> <div>• MVR Configuration</div> <div>• Advanced</div> </div> <div> <div>MVR Running</div> <div>MVR Multicast Vlan</div> <div>MVR Max Multicast Groups</div> <div>MVR Current Multicast Groups</div> <div>MVR Global query response time</div> <div>MVR Mode</div> </div> <div> <div>Disable <input checked="" type="radio"/> Enable <input type="radio"/></div> <div>999 (1 to 4093)</div> <div>256</div> <div>0</div> <div>5 (1 to 100)</div> <div>compatible <input checked="" type="radio"/> dynamic <input type="radio"/></div> </div> |           |         |     |           |            |               |       |       |      |

- b. For MVR Running, select **Enable**.
- c. In the MVR Multicast VLAN field, enter **999**.
- d. Click **Apply**.
4. Add multicast group 224.1.2.3 to MVR.
  - a. Select **Switching > MVR > Basic > MVR Group Configuration**.

A screen similar to the following displays.

| System  | Switching | Routing | QoS | Security  | Monitoring | Maintenance   | Help  | Index |      |
|---|-----------|---------|-----|-----------|------------|---------------|-------|-------|------|
| VLAN  | Auto-VoIP | iSCSI   | STP | Multicast | MVR        | Address Table | Ports | LAG   | MLAG |
| <div>MVR</div> <div>MVR Group Configuration</div> <div> <div>• Basic</div> <div>• Advanced</div> <div>• MVR Configuration</div> <div>• MVR Group Configuration</div> <div>• MVR Interface Configuration</div> <div>• MVR Group Membership</div> <div>• MVR Statistics</div> </div> <div> <div><input type="checkbox"/> MVR Group IP</div> <div>224.1.2.3</div> <div>Status</div> <div>Members</div> <div>Count</div> </div> |           |         |     |           |            |               |       |       |      |

- b. In the MVR Group IP field, enter **224.1.2.3**.
- c. Click **Add**.
5. Configure a receiver on interface 0/1, 0/5, and 0/7.
  - a. Select **Switching > MVR > Basic > MVR Interface Configuration**.

A screen similar to the following displays.

| Interface                                 | Admin Mode | Type | Immediate Leave | Status          |
|---|------------|------|-----------------|-----------------|
| <input checked="" type="checkbox"/> 1/0/1 | Disable    | none | Disable         | Active/InVLAN   |
| <input type="checkbox"/> 1/0/2            | Disable    | none | Disable         | Inactive/InVLAN |
| <input type="checkbox"/> 1/0/3            | Disable    | none | Disable         | Inactive/InVLAN |
| <input type="checkbox"/> 1/0/4            | Disable    | none | Disable         | Inactive/InVLAN |
| <input checked="" type="checkbox"/> 1/0/5 | Disable    | none | Disable         | Inactive/InVLAN |
| <input type="checkbox"/> 1/0/6            | Disable    | none | Disable         | Inactive/InVLAN |
| <input checked="" type="checkbox"/> 1/0/7 | Disable    | none | Disable         | Inactive/InVLAN |

- b. Under MVR Interface Configuration, scroll down and select the Interface **0/1**, **0/5** and **0/7** check boxes.
  - c. Enter the following information:
    - In the Admin Mode list, select **Enable**.
    - In the Type list, select **Receiver**.
  - d. Click **Apply** to save the settings.
6. Configure source interface.
- a. Select **Switching > MVR > Basic > MVR Interface Configuration**.

A screen similar to the following displays.

| Interface                                 | Admin Mode | Type   | Immediate Leave | Status          |
|---|------------|--------|-----------------|-----------------|
| <input checked="" type="checkbox"/> 1/0/9 | Disable    | source | Disable         | Inactive/InVLAN |
| <input type="checkbox"/> 1/0/1            | Disable    | none   | Disable         | Active/InVLAN   |
| <input type="checkbox"/> 1/0/2            | Disable    | none   | Disable         | Inactive/InVLAN |
| <input type="checkbox"/> 1/0/3            | Disable    | none   | Disable         | Inactive/InVLAN |
| <input type="checkbox"/> 1/0/4            | Disable    | none   | Disable         | Inactive/InVLAN |
| <input type="checkbox"/> 1/0/5            | Disable    | none   | Disable         | Inactive/InVLAN |
| <input type="checkbox"/> 1/0/6            | Disable    | none   | Disable         | Inactive/InVLAN |
| <input type="checkbox"/> 1/0/7            | Disable    | none   | Disable         | Inactive/InVLAN |
| <input type="checkbox"/> 1/0/8            | Disable    | none   | Disable         | Inactive/InVLAN |
| <input checked="" type="checkbox"/> 1/0/9 | Disable    | none   | Disable         | Inactive/InVLAN |

- b. Under MVR Interface Configuration, scroll down and select the Interface **0/9** check box.
  - c. Enter the following information:
    - In the Admin Mode list, select **Enable**.
    - In the Type list, select **source**.
  - d. Click **Apply** to save the settings.
7. Configure MVR Group Membership.
- a. Select **Switching > MVR > Advanced > MVR Membership**.

A screen similar to the following displays.

- b.** In the Group IP list, select **224.1.2.3**.
- c.** Click **Unit 1**. The ports display.
- d.** Click the gray boxes under ports **1**, **5**, and **7**. (Port 9 is already in MVR group 224.1.2.3 because it is configured as the source port.)
- e.** Click **Apply** to save the settings.

## Configure MVR in Dynamic Mode

### CLI: Configure MVR in Dynamic Mode

In dynamic mode, the MVR switch learns existing multicast groups by snooping the IGMP queries from router on source ports and forwarding the IGMP reports from the hosts to the IGMP router on the Multicast VLAN (with appropriate translation of the VLAN ID).

- 1.** Create MVLAN, VLAN1, VLAN2, and VLAN3.

```
(Netgear Switch) #vlan database
(Netgear Switch) (Vlan)#vlan 999,1001, 1002, 1003
(Netgear Switch) (Vlan)#vlan name 999 mVlan
(Netgear Switch) (Vlan)#vlan name 1001 Vlan1
(Netgear Switch) (Vlan)#vlan name 1002 Vlan2
(Netgear Switch) (Vlan)#vlan name 1003 Vlan3
(Netgear Switch) (Vlan)#exit
```

**2. Enable MVR, configure VLAN 999 as a multicast VLAN, and add group 224.1.2.3 to MVR.**

```
(Netgear Switch) #config
(Netgear Switch) (Config)#mvr
(Netgear Switch) (Config)#mvr vlan 999
(Netgear Switch) (Config)#mvr group 224.1.2.3
```

**3. Configure MVR in dynamic mode.**

```
(Netgear Switch) (Config)#mvr mode dynamic
```

**4. Configure multicast VLAN on the source port.**

```
(Netgear Switch) (Config)#interface 0/9
(Netgear Switch) (Interface 0/9)#vlan participation include 999
(Netgear Switch) (Interface 0/9)#vlan tagging 999
(Netgear Switch) (Interface 0/9)#mvr
(Netgear Switch) (Interface 0/9)#mvr type source
(Netgear Switch) (Interface 0/9)#exit
```

**5. Configure the receive ports.**

---

**Note:** A receive port can participate in only one VLAN.

---

```

(Netgear Switch) (Config)#interface 0/1
(Netgear Switch) (Interface 0/1)#vlan participation include 1001
(Netgear Switch) (Interface 0/1)#vlan pvid 1001
(Netgear Switch) (Interface 0/1)#vlan participation exclude 1
(Netgear Switch) (Interface 0/5)#mvr
(Netgear Switch) (Interface 0/1)#mvr type receiver
(Netgear Switch) (Interface 0/1)#exit

(Netgear Switch) (Config)#interface 0/5
(Netgear Switch) (Interface 0/5)#vlan participation include 1002
(Netgear Switch) (Interface 0/5)#vlan pvid 1002
(Netgear Switch) (Interface 0/5)#vlan participation exclude 1
(Netgear Switch) (Interface 0/5)#mvr
(Netgear Switch) (Interface 0/5)#mvr stype receiver
(Netgear Switch) (Interface 0/5)#exit

(Netgear Switch) (Config)#interface 0/7
(Netgear Switch) (Interface 0/7)#vlan participation include1003
(Netgear Switch) (Interface 0/7)#vlan pvid 1003
(Netgear Switch) (Interface 0/7)#vlan participation exclude 1
(Netgear Switch) (Interface 0/7)#mvr
(Netgear Switch) (Interface 0/7)#mvr type receiver
(Netgear Switch) (Interface 0/7)#exit

```

## 6. Show the MVR status.

```

(Netgear Switch) #show mvr
MVR Running..... TRUE
MVR multicast VLAN..... 999
MVR Max Multicast Groups..... 256
MVR Current multicast groups..... 1
MVR Global query response time.... 5 (tenths of sec)
MVR Mode..... compatible
  (Netgear Switch) #show mvr interface

```

| Port  | Type     | Status        | Immediate Leave |
|-------|----------|---------------|-----------------|
| ----- | -----    | -----         | -----           |
| 0/1   | RECEIVER | ACTIVE/InVLAN | DISABLED        |
| 0/5   | RECEIVER | ACTIVE/InVLAN | DISABLED        |
| 0/7   | RECEIVER | ACTIVE/InVLAN | DISABLED        |
| 0/9   | SOURCE   | ACTIVE/InVLAN | DISABLED        |

7. After port 0/1 receive IGMP report for Multicast Group 224.1.2.3, it will be added to the MVR Group 224.1.2.3.

```
(Netgear Switch) #show mvr members
```

| MVR Group IP | Status | Members |
|--------------|--------|---------|
| -----        | -----  | -----   |
| 224.1.2.3    | ACTIVE | 0/1 (d) |

## Local Browser Interface: Configure MVR in Dynamic Mode

1. Create MVLAN 999, VLAN1 1001, VLAN2 1002, and VLAN3 1003.
  - a. Select **Switching > VLAN > Basic > VLAN Configuration**.

A screen similar to the following displays.

- b. In the VLAN ID field, enter **999**, and in the VLAN Name field, enter **mVlan**.
  - c. Click **Add**.
  - d. Repeat step b and c to create VLAN1 1001, VLAN2 1002, and VLAN3 1003.
  - e. Add port 9 into MVLAN 999 with tagged mode.
  - f. Select **Switching > VLAN > Advanced > VLAN Membership**.

A screen similar to the following displays.

- g. In the VLAN ID list, select **999**.
  - h. Click **Unit 1**. The ports display.
  - i. Click the gray boxes under port **9** until T displays. The T specifies that the egress packet is tagged for the ports.
  - j. Click **Apply** to save the settings.
  - k. Repeat steps from b to e, add port 0/1 to VLAN1 1001, add port 0/5 to VLAN2 1002, and add port 0/7 to VLAN3 1003.
2. Enable MVR and multicast VLAN.
    - a. Select **Switching > MVR > Basic > MVR Configuration**.

A screen similar to the following displays.

- b. From the MVR Running list, select **Enable**.
  - c. In the MVR Multicast Vlan field, enter **999**.
  - d. From the MVR mode list, select **dynamic**.
  - e. Click **Apply**.
3. Add multicast group 224.1.2.3 to the MVR.



- a. Select **Switching > MVR > Basic > MVR Group Configuration**.

A screen similar to the following displays.

| MVR Group IP | Status | Members | Count |
|--------------|--------|---------|-------|
| 224.1.2.3    |        |         |       |

- b. In the MVR Group IP field, enter **224.1.2.3**.

- c. Click **Add**.

4. Configure a receiver on interface 0/1, 0/5 and 0/7.

- a. Select **Switching > MVR > Basic > MVR Interface Configuration**.

A screen similar to the following displays.

| Interface                                 | Admin Mode | Type | Immediate Leave | Status          |
|---|------------|------|-----------------|-----------------|
| <input checked="" type="checkbox"/> 1/0/1 | Disable    | none | Disable         | Active/InVLAN   |
| <input type="checkbox"/> 1/0/2            | Disable    | none | Disable         | Inactive/InVLAN |
| <input type="checkbox"/> 1/0/3            | Disable    | none | Disable         | Inactive/InVLAN |
| <input type="checkbox"/> 1/0/4            | Disable    | none | Disable         | Inactive/InVLAN |
| <input checked="" type="checkbox"/> 1/0/5 | Disable    | none | Disable         | Inactive/InVLAN |
| <input type="checkbox"/> 1/0/6            | Disable    | none | Disable         | Inactive/InVLAN |
| <input checked="" type="checkbox"/> 1/0/7 | Disable    | none | Disable         | Inactive/InVLAN |

- b. Under MVR Interface Configuration, scroll down and select the Interface **0/1**, **0/5** and **0/7** check boxes

- c. Enter the following information:

- In the Admin Mode list, select **Enable**.
- In the Type list, select **Receiver**.

- d. Click **Apply** to save the settings.

5. Configure a source interface.

- a. Select **Switching > MVR > Basic > MVR Interface Configuration**.

A screen similar to the following displays.

The screenshot shows the 'MVR Interface Configuration' page. The left sidebar has a tree view with 'MVR' expanded, and 'MVR Interface Configuration' selected. The main area shows a table of interfaces with columns: Interface, Admin Mode, Type, Immediate Leave, and Status. Interface 1/0/9 is selected and highlighted in orange.

| Interface | Admin Mode | Type     | Immediate Leave | Status             |
|-----------|------------|----------|-----------------|--------------------|
| 1/0/9     | Enable     | source   | Disable         | Inactive/InVLAN    |
| 1/0/1     | Enable     | receiver | Disable         | Inactive/InVLAN    |
| 1/0/2     | Disable    | none     | Disable         | Inactive/InVLAN    |
| 1/0/3     | Disable    | none     | Disable         | Inactive/InVLAN    |
| 1/0/4     | Disable    | none     | Disable         | Inactive/NotInVLAN |
| 1/0/5     | Enable     | receiver | Disable         | Inactive/InVLAN    |
| 1/0/6     | Disable    | none     | Disable         | Inactive/InVLAN    |
| 1/0/7     | Enable     | receiver | Disable         | Inactive/InVLAN    |
| 1/0/8     | Disable    | none     | Disable         | Inactive/InVLAN    |
| 1/0/9     | Enable     | none     | Disable         | Inactive/InVLAN    |

- b. Under MVR Interface Configuration, scroll down and select the Interface **0/9** check box.
  - c. Enter the following information:
    - In the Admin Mode list, select **Enable**.
    - In the Type list, select **source**.
  - d. Click **Apply** to save the settings.
6. After port 1 receives an IGMP report for multicast group 224.1.2.3, it is added into MVR group 224.1.2.3.
- a. Select **Switching > MVR > Advanced > MVR Group Membership**.

A screen similar to the following displays.

The screenshot shows the 'MVR Group Membership' page. The left sidebar has 'MVR Group Membership' selected. The main area shows a form for 'Group IP' with the value '224.1.2.3'. Below the form, there are two sections for 'Unit 1' and 'Unit 2', each with a grid of ports. In the 'Unit 1' grid, port 1 is checked.

| Unit   | Port | Status  |
|--------|------|---------|
| Unit 1 | 1    | Checked |
|        | 2    |         |
|        | 3    |         |
|        | 4    |         |
|        | 5    |         |
|        | 6    |         |
|        | 7    |         |
|        | 8    |         |
|        | 9    |         |
|        | 10   |         |
|        | 11   |         |
|        | 12   |         |
|        | 13   |         |
|        | 14   |         |
|        | 15   |         |
|        | 16   |         |
| Unit 2 | 1    |         |
|        | 2    |         |
|        | 3    |         |
|        | 4    |         |
|        | 5    |         |
|        | 6    |         |
|        | 7    |         |
|        | 8    |         |

# 16

## Security Management

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### Port security features

This chapter includes the following sections:

- [Port Security Concepts](#)
- [Set the Dynamic and Static Limit on Port 1/0/1](#)
- [Convert the Dynamic Address Learned from 1/0/1 to a Static Address](#)
- [Create a Static Address](#)
- [Protected Ports](#)
- [802.1x Port Security](#)
- [Create a Guest VLAN](#)
- [Assign VLANs Using RADIUS](#)
- [Dynamic ARP Inspection](#)
- [Static Mapping](#)
- [DHCP Snooping](#)
- [Find a Rogue DHCP Server](#)
- [Enter Static Binding into the Binding Database](#)
- [Maximum Rate of DHCP Messages](#)
- [IP Source Guard](#)
- [Command Authorization](#)
- [Privileged Exec Command Mode Authorization](#)
- [Accounting](#)
- [Use the Authentication Manager to Set Up an Authentication Method List](#)
- [RADIUS Change of Authorization](#)
- [IPv6 Stateless RA Guard](#)
- [Changing the SSH/Telnet Login Method to Radius](#)

# Port Security Concepts

Port security helps to secure the network by preventing unknown devices from forwarding packets. When a link goes down, all dynamically locked addresses are freed. The port security feature offers the following benefits:

- You can limit the number of MAC addresses on a given port. Packets that have a matching MAC address (secure packets) are forwarded; all other packets (unsecure packets) are restricted.
- You can enable port security on a per port basis.

Port security implements two traffic filtering methods, dynamic locking and static locking. These methods can be used concurrently.

- **Dynamic locking.** You can specify the maximum number of MAC addresses that can be learned on a port. The maximum number of MAC addresses is platform-dependent and is listed in the software release notes. After the limit is reached, additional MAC addresses are not learned. Only frames with allowable source MAC addresses are forwarded.

---

**Note:** If you want to set a specific MAC address for a port, set the dynamic entries to 0, then allow only packets with a MAC address matching the MAC address in the static list.

---

Dynamically locked addresses can be converted to statically locked addresses. Dynamically locked MAC addresses are aged out if another packet with that address is not seen within the age-out time. You can set the time-out value. Dynamically locked MAC addresses are eligible to be learned by another port. Static MAC addresses are not eligible for aging.

- **Static locking.** You can manually specify a list of static MAC addresses for a port. Dynamically locked addresses can be converted to statically locked addresses.

# Set the Dynamic and Static Limit on Port 1/0/1

The example is shown as CLI commands and as a local browser interface procedure.

## CLI: Set the Dynamic and Static Limit on Port 1/0/1

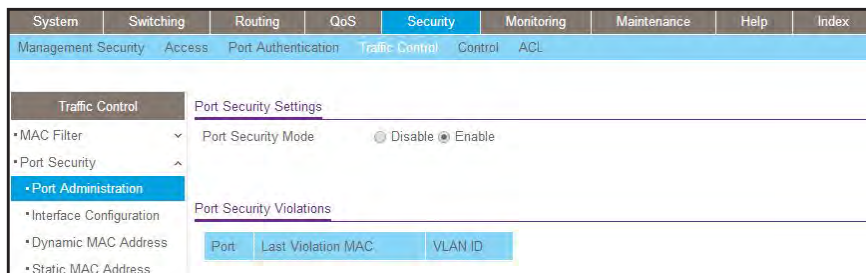
```
(Netgear Switch) (Config)#port-security
Enable port-security globally
(Netgear Switch) (Config)#interface 1/0/1
(Netgear Switch) (Interface 1/0/1)#port-security
Enable port-security on port 1/0/1
(Netgear Switch) (Interface 1/0/1)#port-security max-dynamic 10
Set the dynamic limit to 10
(Netgear Switch) (Interface 1/0/1)#port-security max-static 3
Set the static limit to 3
(Netgear Switch) (Interface 1/0/1)#ex
(Netgear Switch) (Config)#ex
(Netgear Switch) #show port-security 1/0/1
```

|       | Admin    | Dynamic | Static | Violation |
|-------|----------|---------|--------|-----------|
| Intf  | Mode     | Limit   | Limit  | Trap Mode |
| ----- | -----    | -----   | -----  | -----     |
| 1/0/1 | Disabled | 10      | 3      | Disabled  |

## Local Browser Interface: Set the Dynamic and Static Limit on Port 1/0/1

1. Select **Security > Traffic Control > Port Security >Port Administrator**.

A screen similar to the following displays.



- b. Under Port Security Configuration, next to Port Security Mode, select the **Enable** radio button.
- c. Click **Apply** to save the settings.

2. Set the dynamic and static limit on the port 1/0/1:

a. Select **Security > Traffic Control > Port Security > Interface Configuration**.

A screen similar to the following displays.

| Port   | Security Mode | Max Learned MAC Address | Max Static MAC Address | Violation Trap |
|--------|---------------|-------------------------|------------------------|----------------|
| 1/0/1  | Enable        | 10                      | 3                      | Disable        |
| 1/0/2  | Disable       | 4096                    | 48                     | Disable        |
| 1/0/3  | Disable       | 4096                    | 48                     | Disable        |
| 1/0/4  | Disable       | 4096                    | 48                     | Disable        |
| 1/0/5  | Disable       | 4096                    | 48                     | Disable        |
| 1/0/6  | Disable       | 4096                    | 48                     | Disable        |
| 1/0/7  | Disable       | 4096                    | 48                     | Disable        |
| 1/0/8  | Disable       | 4096                    | 48                     | Disable        |
| 1/0/9  | Disable       | 4096                    | 48                     | Disable        |
| 1/0/10 | Disable       | 4096                    | 48                     | Disable        |

b. Scroll down and select the Interface **1/0/1** check box.

Now 1/0/1 appears in the Interface field at the top.

c. Enter the following information:

- In the **Port Security** field, select **Enable**.
- In the **Max Allowed Dynamically Learned MAC** field, enter **10**.
- In the **Max Allowed Statically Locked MAC** field, enter **3**.

d. Click **Apply** to save the settings.

# Convert the Dynamic Address Learned from 1/0/1 to a Static Address

The example is shown as CLI commands and as a local browser interface procedure.

## CLI: Convert the Dynamic Address Learned from 1/0/1 to the Static Address

```
(Netgear Switch)(Interface 1/0/1)#port-security mac-address move
Convert the dynamic address learned from 1/0/1 to the static address
(Netgear Switch)(Interface 1/0/1)#exit
(Netgear Switch)(Config)#exit
(Netgear Switch)#show port-security static 1/0/1
Number of static MAC addresses configured: 3
Statically configured MAC Address VLAN ID
-----
00:0E:45:30:15:F3 1
00:13:46:EC:2F:62 1
00:14:6C:E8:81:23 1
```

## Local Browser Interface: Convert the Dynamic Address Learned from 1/0/1 to the Static Address

1. Select **Security > Traffic Control > Port Security > Dynamic MAC Address**.

A screen similar to the following displays.



2. Under Port Security Configuration, in the **Port List** field, select **1/0/1**.
3. Select the **Convert Dynamic Address to Static** check box.
4. Click **Apply** to save the settings.



# Create a Static Address

The example is shown as CLI commands and as a local browser interface procedure.

## CLI: Create a Static Address

```
(Netgear Switch) (Interface 1/0/1)#port-security mac-address 00:13:00:01:02:03
```

## Local Browser Interface: Create a Static Address

1. Select **Security > Traffic Control > Port Security > Static MAC address**.

A screen similar to the following displays.

The screenshot shows the Netgear web interface. The top navigation bar includes System, Switching, Routing, QoS, Security, Monitoring, Maintenance, Help, and Index. The Security section is expanded, showing Management, Security, Access, Port Authentication, Traffic Control, Control, and ACL. Under Traffic Control, Port List is selected. The Port List table shows Interface 1/0/1. Below this, the Static MAC Address Table is displayed with a table containing two columns: Static MAC Address and VLAN ID. The first row shows 00:13:00:01:02:03 and 3. The Static MAC Address field is highlighted in blue.

| Static MAC Address | VLAN ID |
|--------------------|---------|
| 00:13:00:01:02:03  | 3       |

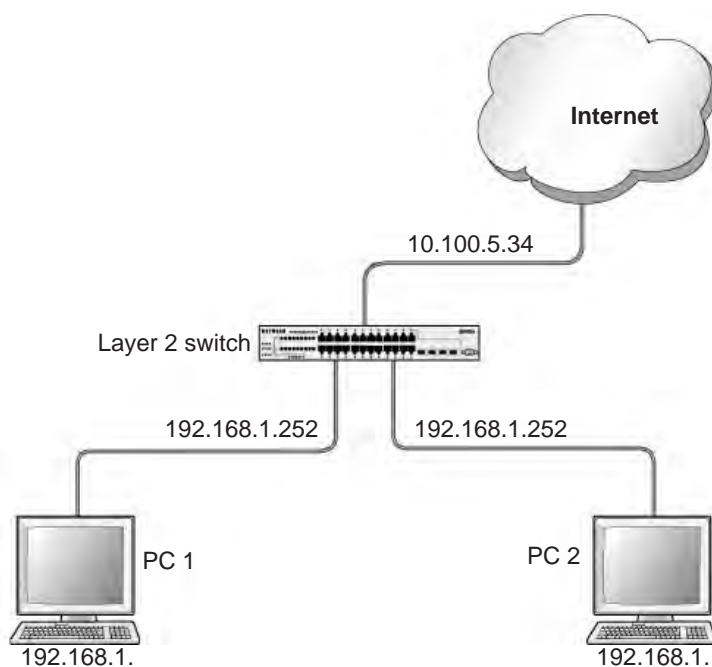
2. Under Port List, in the **Interface** list, select **1/0/1**.
3. In the Static MAC Address section of the screen, enter the following information:
  - In the **Static MAC Address** field, enter **00:13:00:01:02:03**.
  - In the **Vlan ID** list, select **3**.
4. Click **Add**.

## Protected Ports

This section describes how to set up protected ports on the switch. Some situations might require that traffic is prevented from being forwarded between any ports at Layer 2 so that one user cannot see the traffic of another user on the same switch. Protected ports can:

- Prevent traffic from being forwarded between protected ports.
- Allow traffic to be forwarded between a protected port and a non-protected port.

In following example, PC 1 and PC 2 can access the Internet as usual, but PC 1 cannot see the traffic that is generated by PC 2, that is, no traffic is forwarded between PC 1 and PC 2.



**Figure 34. Protected ports**

## CLI: Configure a Protected Port to Isolate Ports on the Switch

1. Create one VLAN 192 including PC 1 and PC 2.

```
(Netgear Switch) #vlan database
(Netgear Switch) #vlan 192
(Netgear Switch) #vlan routing 192
(Netgear Switch) #exit
(Netgear Switch) #configure
(Netgear Switch) (Config)#interface 1/0/23
(Netgear Switch) (Interface 1/0/23)#vlan pvid 192
(Netgear Switch) (Interface 1/0/23)#vlan participation include 192
(Netgear Switch) (Interface 1/0/23)#exit
(Netgear Switch) (Config)#interface 1/0/24
(Netgear Switch) (Interface 1/0/24)#vlan pvid 192
(Netgear Switch) (Interface 1/0/24)#vlan participation include 192
(Netgear Switch) (Interface 1/0/24)#exit
(Netgear Switch) (Interface-vlan 192)#interface vlan 192
(Netgear Switch) (Interface-vlan 192)#routing
(Netgear Switch) (Interface-vlan 192)#ip address 192.168.1.254 255.255.255.0
(Netgear Switch) (Interface-vlan 192)#exit
```

**2. Create one VLAN 202 connected to the Internet.**

```
(Netgear Switch) #vlan database
(Netgear Switch) (Vlan)#vlan 202
(Netgear Switch) (Vlan)#vlan routing 202
(Netgear Switch) (Vlan)#exit
(Netgear Switch) #configure
(Netgear Switch) (Config)#interface 1/0/48
(Netgear Switch) (Interface 1/0/48)#vlan pvid 202
(Netgear Switch) (Interface 1/0/48)#vlan participation include 202
(Netgear Switch) (Interface 1/0/48)#exit
(Netgear Switch) (Config)#interface vlan 202
(Netgear Switch) (Interface-vlan 202)#routing
(Netgear Switch) (Interface-vlan 202)ip address 10.100.5.34 255.255.255.0
(Netgear Switch) (Interface-vlan 202)#exit
```

**3. Create a DHCP pool to allocated IP addresses to PCs.**

```
(Netgear Switch) (config)#service dhcp
(Netgear Switch) (config)#ip dhcp pool pool-a
(Netgear Switch) (Config-dhcp-pool)#dns-server 12.7.210.170
(Netgear Switch) (Config-dhcp-pool)#default-router 192.168.1.254
(Netgear Switch) (Config-dhcp-pool)#network 192.168.1.0 255.255.255.0
(Netgear Switch) (Config-dhcp-pool)#exit
```

**4. Enable IP routing and configure a default route.**

```
(Netgear Switch)(config)#ip routing
(Netgear Switch)(config)#ip route 0.0.0.0 0.0.0.0 10.100.5.252
```

**5. Enable a protected port on 1/0/23 and 1/0/24.**

```
(Netgear Switch) (Config)#interface 1/0/23
(Netgear Switch) (Interface 1/0/23)#switchport protected
(Netgear Switch) (Interface 1/0/23)#exit
(Netgear Switch) (Config)#interface 1/0/24
(Netgear Switch) (Interface 1/0/24)#switchport protected
(Netgear Switch) (Interface 1/0/24)#exit
```

# Local Browser Interface: Configure a Protected Port to Isolate Ports on the Switch

## 1. Create a DHCP pool:

**Note:** This example assumes that the DHCP service is enabled. For information about how to enable the DHCP service, see the local browser interface procedure in [Configure a DHCP Server in Dynamic Mode on page 485](#).

### a. Select **System > Services > DHCP Server > DHCP Server Configuration**.

A screen similar to the following displays.

| System   | Switching   | Routing  | QoS     | Security | Monitoring | Maintenance | Help           | Index |
|--|-------------|----------|---------|----------|------------|-------------|----------------|-------|
| Management   | Device View | Services | Chassis | SNMP     | LLDP       | ISDP        | Timer Schedule |       |
| <div> <div> <div>Services</div> <div> <div>• DHCP Server</div> <div>• DHCP Server Configuration</div> <div>• DHCP Pool Configuration</div> <div>• DHCP Pool Options</div> <div>• DHCP Server Statistics</div> <div>• DHCP Bindings Information</div> <div>• DHCP Conflicts Information</div> <div>• DHCP Relay</div> <div>• DHCP L2 Relay</div> <div>• UDP Relay</div> <div>• DHCPv6 Server</div> <div>• DHCPv6 Relay</div> </div> </div> <div> <div>DHCP Pool Configuration</div> <div> <div>Pool Name</div> <div>Pool Name</div> <div>Type of Binding</div> <div>Network Address</div> <div>Network Mask</div> <div>Network Prefix Length</div> <div>Client Name</div> <div>Hardware Address</div> <div>Hardware Address Type</div> <div>Client ID</div> <div>Host Number</div> <div>Host Mask</div> <div>Host Prefix Length</div> <div>Lease Time</div> <div>Days</div> <div>Hours</div> </div> </div> </div> |             |          |         |          |            |             |                |       |

### b. Under DHCP Pool Configuration, enter the following information:

- In the **Pool Name** field, select **Create**.
- In the **Pool Name** field, enter **pool-a**.
- In the **Type of Binding** field, select **Dynamic**.
- In the **Network Number** field, enter **192.168.1.0**.
- In the **Network Mask** field, enter **255.255.255.0**.
- In the **Days** field, enter **1**.
- Click **Default Router Addresses**. The DNS server address fields display. In the first **Router Address** field, enter **192.168.1.254**.
- Click **DNS Server Addresses**. The router address fields display. In the first **DNS Server Address** field, enter **12.7.210.170**.

### c. Click **Add**.

2. Configure a VLAN and include ports 1/0/23 and 1/0/24 in the VLAN:
  - a. Select **Routing > VLAN > VLAN Routing Wizard**.

A screen similar to the following displays.

The screenshot shows the 'VLAN Routing Wizard' configuration page. The 'Vlan ID' field is set to 192, the 'IP Address' field is set to 192.168.1.254, and the 'Network Mask' field is set to 255.255.255.0. Under the 'Unit 1' section, there is a grid of 48 ports. Ports 23 and 24 are selected, indicated by a 'U' in their respective boxes.

- b. Enter the following information:
    - In the **Vlan ID** field, enter **192**.
    - In the **IP Address** field, enter **192.168.1.254**.
    - In the **Network Mask** field, enter **255.255.255.0**.
  - c. Click **Unit 1**. The ports display:
    - Click the gray box under port **23** twice until **U** displays.
    - Click the gray box under port **24** twice until **U** displays.

The U specifies that the egress packet is untagged for the port.

- d. Click **Apply** to save the VLAN that includes ports 23 and 24.
3. Configure a VLAN and include port 1/0/48 in the VLAN:

- a. Select **Routing > VLAN > VLAN Routing Wizard**.

A screen similar to the following displays.

The screenshot shows the 'VLAN Routing Wizard' configuration page. The 'Vlan ID' field is set to 202, the 'IP Address' field is set to 10.100.5.34, and the 'Network Mask' field is set to 255.255.255.0. Under the 'Unit 1' section, there is a grid of 48 ports. Port 48 is selected, indicated by a 'U' in its box.

- b. Enter the following information:
    - In the **Vlan ID** field, enter **202**.
    - In the **IP Address** field, enter **10.100.5.34**.
    - In the **Network Mask** field, enter **255.255.255.0**.
  - c. Click **Unit 1**. The ports display:

- d. Click the gray box under port **48** twice until **U** displays. The U specifies that the egress packet is untagged for the port.
  - e. Click **Apply** to save the VLAN that includes port 48.
4. Enable IP routing:
    - a. Select **Routing > IP > Basic > IP Configuration**.

A screen similar to the following displays.

| System  | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table   | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |
| <div> <div>IP</div> <div>IP Configuration</div> </div> <div> <div> <ul style="list-style-type: none"> <li>Basic</li> <li><b>IP Configuration</b></li> <li>Statistics</li> <li>Advanced</li> </ul> </div> <div> <p>Default Time to Live: 64</p> <p>Routing Mode: <input checked="" type="radio"/> Enable <input type="radio"/> Disable</p> <p>ICMP Echo Replies: <input checked="" type="radio"/> Enable <input type="radio"/> Disable</p> <p>ICMP Redirects: <input checked="" type="radio"/> Enable <input type="radio"/> Disable</p> <p>ICMP Rate Limit Interval: 1000 (0 to 2147483647 ms)</p> <p>ICMP Rate Limit Burst Size: 100 (1 to 200)</p> <p>Maximum Next Hops: 4</p> <p>Maximum Routes: 8160</p> </div> </div> |           |         |      |          |            |             |        |                  |      |           |                |

- b. Under IP Configuration, make the following selections:
    - For Routing Mode, select the **Enable** radio button.
    - For IP Forwarding Mode, select the **Enable** radio button.
  - c. Click **Apply** to enable IP routing.
5. Configure default route for VLAN 202:
    - a. Select **Routing > Routing Table > Basic > Route Configuration**.

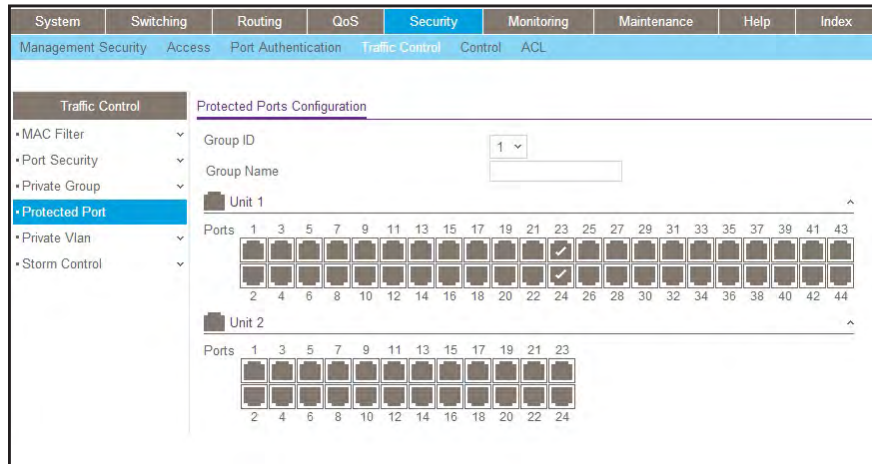
A screen similar to the following displays.

| System  | Switching       | Routing       | QoS              | Security           | Monitoring       | Maintenance | Help   | Index            |      |           |                |            |                 |             |                  |            |        |              |               |               |  |         |         |         |              |     |                 |             |          |            |                    |                  |            |        |         |         |         |        |        |              |     |   |              |               |       |           |        |                |   |   |
|---|-----------------|---------------|------------------|--------------------|------------------|-------------|--------|------------------|------|-----------|----------------|------------|-----------------|-------------|------------------|------------|--------|--------------|---------------|---------------|--|---------|---------|---------|--------------|-----|-----------------|-------------|----------|------------|--------------------|------------------|------------|--------|---------|---------|---------|--------|--------|--------------|-----|---|--------------|---------------|-------|-----------|--------|----------------|---|---|
| Routing Table   | IP              | IPv6          | VLAN             | ARP                | RIP              | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |            |                 |             |                  |            |        |              |               |               |  |         |         |         |              |     |                 |             |          |            |                    |                  |            |        |         |         |         |        |        |              |     |   |              |               |       |           |        |                |   |   |
| <div> <div>Routing Table</div> <div>Configure Routes</div> </div> <div> <div> <ul style="list-style-type: none"> <li>Basic</li> <li><b>Route Configuration</b></li> <li>Advanced</li> </ul> </div> <div> <table border="1"> <thead> <tr> <th>Route Type</th> <th>Network Address</th> <th>Subnet Mask</th> <th>Next Hop Address</th> <th>Preference</th> </tr> </thead> <tbody> <tr> <td>Static</td> <td>192.168.40.0</td> <td>255.255.255.0</td> <td>192.168.200.2</td> <td></td> </tr> <tr> <td>Default</td> <td>0.0.0.0</td> <td>0.0.0.0</td> <td>192.168.10.1</td> <td>253</td> </tr> </tbody> </table> </div> </div> <div> <p>Learned Routes</p> <table border="1"> <thead> <tr> <th>Network Address</th> <th>Subnet Mask</th> <th>Protocol</th> <th>Route Type</th> <th>Next Hop Interface</th> <th>Next Hop Address</th> <th>Preference</th> <th>Metric</th> </tr> </thead> <tbody> <tr> <td>0.0.0.0</td> <td>0.0.0.0</td> <td>Default</td> <td>Static</td> <td>vlan 1</td> <td>192.168.10.1</td> <td>253</td> <td>0</td> </tr> <tr> <td>192.168.10.0</td> <td>255.255.255.0</td> <td>Local</td> <td>Connected</td> <td>vlan 1</td> <td>192.168.10.138</td> <td>0</td> <td>1</td> </tr> </tbody> </table> </div> |                 |               |                  |                    |                  |             |        |                  |      |           |                | Route Type | Network Address | Subnet Mask | Next Hop Address | Preference | Static | 192.168.40.0 | 255.255.255.0 | 192.168.200.2 |  | Default | 0.0.0.0 | 0.0.0.0 | 192.168.10.1 | 253 | Network Address | Subnet Mask | Protocol | Route Type | Next Hop Interface | Next Hop Address | Preference | Metric | 0.0.0.0 | 0.0.0.0 | Default | Static | vlan 1 | 192.168.10.1 | 253 | 0 | 192.168.10.0 | 255.255.255.0 | Local | Connected | vlan 1 | 192.168.10.138 | 0 | 1 |
| Route Type  | Network Address | Subnet Mask   | Next Hop Address | Preference         |                  |             |        |                  |      |           |                |            |                 |             |                  |            |        |              |               |               |  |         |         |         |              |     |                 |             |          |            |                    |                  |            |        |         |         |         |        |        |              |     |   |              |               |       |           |        |                |   |   |
| Static  | 192.168.40.0    | 255.255.255.0 | 192.168.200.2    |                    |                  |             |        |                  |      |           |                |            |                 |             |                  |            |        |              |               |               |  |         |         |         |              |     |                 |             |          |            |                    |                  |            |        |         |         |         |        |        |              |     |   |              |               |       |           |        |                |   |   |
| Default   | 0.0.0.0         | 0.0.0.0       | 192.168.10.1     | 253                |                  |             |        |                  |      |           |                |            |                 |             |                  |            |        |              |               |               |  |         |         |         |              |     |                 |             |          |            |                    |                  |            |        |         |         |         |        |        |              |     |   |              |               |       |           |        |                |   |   |
| Network Address   | Subnet Mask     | Protocol      | Route Type       | Next Hop Interface | Next Hop Address | Preference  | Metric |                  |      |           |                |            |                 |             |                  |            |        |              |               |               |  |         |         |         |              |     |                 |             |          |            |                    |                  |            |        |         |         |         |        |        |              |     |   |              |               |       |           |        |                |   |   |
| 0.0.0.0   | 0.0.0.0         | Default       | Static           | vlan 1             | 192.168.10.1     | 253         | 0      |                  |      |           |                |            |                 |             |                  |            |        |              |               |               |  |         |         |         |              |     |                 |             |          |            |                    |                  |            |        |         |         |         |        |        |              |     |   |              |               |       |           |        |                |   |   |
| 192.168.10.0  | 255.255.255.0   | Local         | Connected        | vlan 1             | 192.168.10.138   | 0           | 1      |                  |      |           |                |            |                 |             |                  |            |        |              |               |               |  |         |         |         |              |     |                 |             |          |            |                    |                  |            |        |         |         |         |        |        |              |     |   |              |               |       |           |        |                |   |   |

- b. Under Configure Routes, in the **Route Type** list, select **Default Route**.
  - c. In the **Next Hop IP Address** field, enter **10.100.5.252**.
  - d. Click **Add** to add the route that is associated to VLAN 202 to the Learned Routes table.
6. Configure port 23 and port 24 as protected ports:
    - a. Select **Security > Traffic Control > Protected Port**.



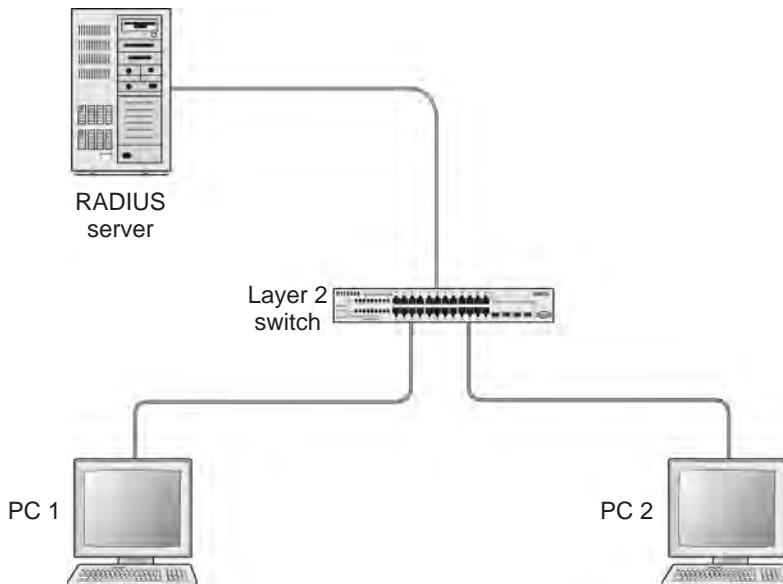
A screen similar to the following displays.



- b. Under Protected Ports Configuration, click **Unit 1**. The ports display.
  - Click the gray box under port **23**. A check mark displays in the box.
  - Click the gray box under port **24**. A check mark displays in the box.
- c. Click **Apply** to activate ports 23 and 24 as protected ports.

## 802.1x Port Security

This section describes how to configure the 802.1x port security feature on a switch port. IEEE 802.1x authentication prevents unauthorized clients from connecting to a VLAN unless these clients are authorized by the server. 802.1x port security prevents unauthorized clients from connecting to a VLAN. It can be configured on a per-port basis.



**Figure 35. Using 802.1x port security**



The following example shows how to authenticate the dot1x users by a RADIUS server. The management IP address is 10.100.5.33/24. The example is shown as CLI commands and as a local browser interface procedure.

## CLI: Authenticating dot1x Users by a RADIUS Server

1. Assign an IP address to 1/0/19, and set force authorized mode to this port, and create a user name list dot1xList.

```
(Netgear Switch) #config
(Netgear Switch) (Config)#ip routing
(Netgear Switch) (Config)#interface 1/0/1
(Netgear Switch) (Interface 1/0/1)#routing
(Netgear Switch) (Interface 1/0/1)#ip address 192.168.1.1 255.255.255.0
(Netgear Switch) (Config)#dot1x system-auth-control
(Netgear Switch) (Config)#interface 1/0/19
(Netgear Switch) (Interface 1/0/19)#routing
(Netgear Switch) (Interface 1/0/19)#ip address 10.100.5.33 255.255.255.0
(Netgear Switch) (Interface 1/0/19)#dot1x port-control force-authorized
```

2. Use RADIUS to authenticate the dot1x users.

```
(Netgear Switch) (Config)#aaa authentication dot1x default radius
```

3. Configure a RADIUS authentication server.

```
(Netgear Switch) (Config)#radius server host auth 10.100.5.17
```

4. Configure the shared secret between the RADIUS client and the server.

```
Netgear Switch) (Config)#radius server key auth 10.100.5.17
Enter secret (16 characters max):123456
Re-enter secret:123456
```

5. Set the RADIUS server as a primary server.

```
(Netgear Switch) (Config)#radius server msgauth 10.100.5.17
(Netgear Switch) (Config)# radius server primary 10.100.5.17
```

## 6. Configure an accounting server.

```
(Netgear Switch) (Config)#radius accounting mode
(Netgear Switch) (Config)#radius server host acct 10.100.5.17
```

## 7. Configure the shared secret between the accounting server and the client.

```
(Netgear Switch) (Config)#radius server key acct 10.100.5.17
Enter secret (16 characters max):123456
Re-enter secret:123456
```

# Local Browser Interface: Authenticating dot1x Users by a RADIUS Server

## 1. Enable routing for the switch.

### a. Select **Routing > Basic > IP Configuration**.

A screen similar to the following displays.

| System   | Switching  | Routing | QoS | Security | Monitoring | Maintenance | Help | Index |
|--|--|---------|-----|----------|------------|-------------|------|-------|
| Routing Table  | IP* IPv6 VLAN ARP RIP OSPF OSPFv3 Router Discovery VRRP Multicast IPv6 Multicast |         |     |          |            |             |      |       |
| <div> <div>IP</div> <div>IP Configuration</div> </div> <div> <div>• Basic</div> <div>• IP Configuration</div> <div>• Statistics</div> <div>• Advanced</div> </div> <div> <div>Default Time to Live</div> <div>64</div> </div> <div> <div>Routing Mode</div> <div> <input type="radio"/> Enable           <input checked="" type="radio"/> Disable         </div> </div> <div> <div>ICMP Echo Replies</div> <div> <input type="radio"/> Enable           <input checked="" type="radio"/> Disable         </div> </div> <div> <div>ICMP Redirects</div> <div> <input type="radio"/> Enable           <input checked="" type="radio"/> Disable         </div> </div> <div> <div>ICMP Rate Limit Interval</div> <div> <input type="text" value="1000"/> (0 to 2147483647 ms)         </div> </div> <div> <div>ICMP Rate Limit Burst Size</div> <div> <input type="text" value="100"/> (1 to 200)         </div> </div> <div> <div>Maximum Next Hops</div> <div>4</div> </div> |  |         |     |          |            |             |      |       |

### b. For Routing Mode, select the **Enable** radio button.

### c. Click **Apply** to save the settings.

## 2. Assign IP address 192.168.1.1/24 to the interface 1/0/1.

### a. Select **Routing > Advanced > IP Interface Configuration**.

A screen similar to the following displays.

| System   | Switching  | Routing | QoS                             | Security    | Monitoring    | Maintenance  | Help                | Index |      |             |         |                                 |            |             |              |                     |   |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
|--|--|---------|---------------------------------|-------------|---------------|--------------|---------------------|-------|------|-------------|---------|---------------------------------|------------|-------------|--------------|---------------------|---|--|--|--------|-------------|---------------|--------|--------|--------------------------------|--|--|------|---------|---------|---------|--------|--------------------------------|--|--|------|---------|---------|---------|--------|
| Routing Table  | IP* IPv6 VLAN ARP RIP OSPF OSPFv3 Router Discovery VRRP Multicast IPv6 Multicast |         |                                 |             |               |              |                     |       |      |             |         |                                 |            |             |              |                     |   |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <div> <div>IP</div> <div>IP Interface Configuration</div> </div> <div> <div>• Basic</div> <div>• Advanced</div> <div>• IP Configuration</div> <div>• Statistics</div> <div>• IP Interface Configuration</div> </div> <div> <div>1 2 3 VLANs All</div> </div> <table border="1"> <thead> <tr> <th>Port</th> <th>Description</th> <th>VLAN ID</th> <th>IP Address Configuration Method</th> <th>IP Address</th> <th>Subnet Mask</th> <th>Routing Mode</th> <th>Administrative Mode</th> </tr> </thead> <tbody> <tr> <td><input checked="" type="checkbox"/> 1/0/1</td> <td></td> <td></td> <td>Manual</td> <td>192.168.1.1</td> <td>255.255.255.0</td> <td>Enable</td> <td>Enable</td> </tr> <tr> <td><input type="checkbox"/> 1/0/1</td> <td></td> <td></td> <td>None</td> <td>0.0.0.0</td> <td>0.0.0.0</td> <td>Disable</td> <td>Enable</td> </tr> <tr> <td><input type="checkbox"/> 1/0/2</td> <td></td> <td></td> <td>None</td> <td>0.0.0.0</td> <td>0.0.0.0</td> <td>Disable</td> <td>Enable</td> </tr> </tbody> </table> |  |         |                                 |             |               |              |                     |       | Port | Description | VLAN ID | IP Address Configuration Method | IP Address | Subnet Mask | Routing Mode | Administrative Mode | <input checked="" type="checkbox"/> 1/0/1 |  |  | Manual | 192.168.1.1 | 255.255.255.0 | Enable | Enable | <input type="checkbox"/> 1/0/1 |  |  | None | 0.0.0.0 | 0.0.0.0 | Disable | Enable | <input type="checkbox"/> 1/0/2 |  |  | None | 0.0.0.0 | 0.0.0.0 | Disable | Enable |
| Port   | Description  | VLAN ID | IP Address Configuration Method | IP Address  | Subnet Mask   | Routing Mode | Administrative Mode |       |      |             |         |                                 |            |             |              |                     |   |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input checked="" type="checkbox"/> 1/0/1  |  |         | Manual                          | 192.168.1.1 | 255.255.255.0 | Enable       | Enable              |       |      |             |         |                                 |            |             |              |                     |   |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input type="checkbox"/> 1/0/1   |  |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |       |      |             |         |                                 |            |             |              |                     |   |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input type="checkbox"/> 1/0/2   |  |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |       |      |             |         |                                 |            |             |              |                     |   |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |

### b. Under IP Interface Configuration, scroll down and select the Interface **1/0/1** check box.

Now 1/0/1 appears in the Interface field at the top.

**c.** Enter the following information:

- In the **IP Address** field, enter **192.168.1.1**.
- In the **Subnet Mask** field, enter **255.255.255.0**.
- In the **Routing Mode** field, select **Enable**.

**d.** Click **Apply** to save the settings.

**3.** Assign IP address 10.100.5.33/24 to interface 1/0/19:

**a.** Select **Routing > Advanced > IP Interface Configuration**.

A screen similar to the following displays.

| System        | Switching |      | Routing |     | QoS |      | Security | Monitoring       |      | Maintenance | Help           | Index |
|---------------|-----------|------|---------|-----|-----|------|----------|------------------|------|-------------|----------------|-------|
| Routing Table | IP        | IPv6 | VLAN    | ARP | RIP | OSPF | OSPFv3   | Router Discovery | VRRP | Multicast   | IPv6 Multicast |       |

IP

• Basic

• Advanced

• IP Configuration

• Statistics

• IP Interface Configuration

• Secondary IP

IP Interface Configuration

1 2 3 VLANs All

| Port                           | Description | VLAN ID | IP Address Configuration Method | IP Address  | Subnet Mask   | Routing Mode | Administrative Mode |
|--------------------------------|-------------|---------|---------------------------------|-------------|---------------|--------------|---------------------|
| 1/0/19                         |             |         | Manual                          | 10.100.5.33 | 255.255.255.0 | Enable       | Enable              |
| <input type="checkbox"/> 1/0/1 |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 1/0/2 |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 1/0/3 |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |

**b.** Scroll down and select the interface **1/0/19** check box.

Now 1/0/19 appears in the Interface field at the top.

**c.** Enter the following information:

- In the **IP Address** field, enter **10.100.5.33**.
- In the **Subnet Mask** field, enter **255.255.255.0**.
- In the **Routing Mode** field, select **Enable**.

**d.** Click **Apply** to save the settings.

**4.** Create an authentication name list.

**a.** Select **Security > Management Security > Login > Authentication List**.

A screen similar to the following displays.

| System                      | Switching | Routing                                | QoS                 | Security        | Monitoring | Maintenance | Help  | Index |
|-----------------------------|-----------|--|---------------------|-----------------|------------|-------------|-------|-------|
| Management Security         |           | Access                                 | Port Authentication | Traffic Control | Control    | ACL         |       |       |
|                             |           |  |                     |                 |            |             |       |       |
| Management Security         |           | Login Authentication List              |                     |                 |            |             |       |       |
| • Local User                | ▼         | <input type="checkbox"/> List Name     | 1                   | 2               | 3          | 4           | 5     | 6     |
| • Enable Password           |           | <input type="text" value="dot1xList"/> | Radius ▼            | N/A ▼           | N/A ▼      | N/A ▼       | N/A ▼ | N/A ▼ |
| • Line Password             |           | <input type="checkbox"/> defaultList   | Local               | N/A             | N/A        | N/A         | N/A   | N/A   |
| • RADIUS                    | ▼         | <input type="checkbox"/> networkList   | Local               | N/A             | N/A        | N/A         | N/A   | N/A   |
| • TACACS                    |           |  |                     |                 |            |             |       |       |
| • Authentication List       | ▼         |  |                     |                 |            |             |       |       |
| • Login Authentication List |           |  |                     |                 |            |             |       |       |

**b.** Select the check box before **dot1xList**.

**c.** In the **1** list, select **RADIUS**.

**d.** Click **Apply**.

5. Set port 1/0/19 to force authorized mode. (In this case, the RADIUS server is connected to this interface.)

- a. Select **Security > Port Authentication > Advanced > Port Authentication**.

A screen similar to the following displays.

| System  | Switching        | Routing | QoS          | Security        | Monitoring    | Maintenance       | Help                    | Index |      |              |     |              |                 |               |                   |                         |        |                  |         |    |    |   |    |   |       |      |         |    |    |   |    |   |       |      |         |    |    |   |    |   |
|---|------------------|---------|--------------|-----------------|---------------|-------------------|-------------------------|-------|------|--------------|-----|--------------|-----------------|---------------|-------------------|-------------------------|--------|------------------|---------|----|----|---|----|---|-------|------|---------|----|----|---|----|---|-------|------|---------|----|----|---|----|---|
| Management Security Access Port Authentication Traffic Control Control ACL  |                  |         |              |                 |               |                   |                         |       |      |              |     |              |                 |               |                   |                         |        |                  |         |    |    |   |    |   |       |      |         |    |    |   |    |   |       |      |         |    |    |   |    |   |
| Port Authentication   |                  |         |              |                 |               |                   |                         |       |      |              |     |              |                 |               |                   |                         |        |                  |         |    |    |   |    |   |       |      |         |    |    |   |    |   |       |      |         |    |    |   |    |   |
| <div> <div> <div>Basic</div> <div>Advanced</div> <div>802.1X Configuration</div> <div>Port Authentication</div> <div>Port Summary</div> <div>Client Summary</div> </div> <div> <div>1</div> <div>2</div> <div>3</div> <div>All</div> </div> </div>  |                  |         |              |                 |               |                   |                         |       |      |              |     |              |                 |               |                   |                         |        |                  |         |    |    |   |    |   |       |      |         |    |    |   |    |   |       |      |         |    |    |   |    |   |
| <table border="1"> <thead> <tr> <th>Port</th> <th>Control Mode</th> <th>MAB</th> <th>Quiet Period</th> <th>Transmit Period</th> <th>Guest VLAN ID</th> <th>Guest VLAN Period</th> <th>Unauthenticated VLAN ID</th> </tr> </thead> <tbody> <tr> <td>1/0/19</td> <td>Force Authorized</td> <td>Disable</td> <td>60</td> <td>30</td> <td>0</td> <td>90</td> <td>0</td> </tr> <tr> <td>1/0/1</td> <td>Auto</td> <td>Disable</td> <td>60</td> <td>30</td> <td>0</td> <td>90</td> <td>0</td> </tr> <tr> <td>1/0/2</td> <td>Auto</td> <td>Disable</td> <td>60</td> <td>30</td> <td>0</td> <td>90</td> <td>0</td> </tr> </tbody> </table> |                  |         |              |                 |               |                   |                         |       | Port | Control Mode | MAB | Quiet Period | Transmit Period | Guest VLAN ID | Guest VLAN Period | Unauthenticated VLAN ID | 1/0/19 | Force Authorized | Disable | 60 | 30 | 0 | 90 | 0 | 1/0/1 | Auto | Disable | 60 | 30 | 0 | 90 | 0 | 1/0/2 | Auto | Disable | 60 | 30 | 0 | 90 | 0 |
| Port  | Control Mode     | MAB     | Quiet Period | Transmit Period | Guest VLAN ID | Guest VLAN Period | Unauthenticated VLAN ID |       |      |              |     |              |                 |               |                   |                         |        |                  |         |    |    |   |    |   |       |      |         |    |    |   |    |   |       |      |         |    |    |   |    |   |
| 1/0/19  | Force Authorized | Disable | 60           | 30              | 0             | 90                | 0                       |       |      |              |     |              |                 |               |                   |                         |        |                  |         |    |    |   |    |   |       |      |         |    |    |   |    |   |       |      |         |    |    |   |    |   |
| 1/0/1   | Auto             | Disable | 60           | 30              | 0             | 90                | 0                       |       |      |              |     |              |                 |               |                   |                         |        |                  |         |    |    |   |    |   |       |      |         |    |    |   |    |   |       |      |         |    |    |   |    |   |
| 1/0/2   | Auto             | Disable | 60           | 30              | 0             | 90                | 0                       |       |      |              |     |              |                 |               |                   |                         |        |                  |         |    |    |   |    |   |       |      |         |    |    |   |    |   |       |      |         |    |    |   |    |   |

- b. Scroll down and select the Interface **1/0/19** check box. Now 1/0/19 appears in the Interface field at the top.
    - c. In the **Control Mode** list, select **Force Authorized**.
    - d. Click **Apply** to save the settings.
6. Enable dot1x on the switch.

- a. Select **Security > Port Authentication > Server Configuration**.

A screen similar to the following displays.

| System   | Switching | Routing | QoS | Security | Monitoring | Maintenance | Help | Index |
|--|-----------|---------|-----|----------|------------|-------------|------|-------|
| Management Security Access Port Authentication Traffic Control Control ACL   |           |         |     |          |            |             |      |       |
| Port Authentication  |           |         |     |          |            |             |      |       |
| 802.1X Configuration   |           |         |     |          |            |             |      |       |
| <div> <div> <div>Basic</div> <div>802.1X Configuration</div> <div>Advanced</div> </div> <div> <div>Administrative Mode</div> <div>VLAN Assignment Mode</div> <div>EAPOL Flood Mode</div> <div>Dynamic VLAN Creation Mode</div> <div>Monitor Mode</div> <div>Users</div> <div>Login</div> <div>Authentication List</div> </div> <div> <div> <input type="radio"/> Disable           <input checked="" type="radio"/> Enable         </div> <div> <input checked="" type="radio"/> Disable           <input type="radio"/> Enable         </div> <div> <input checked="" type="radio"/> Disable           <input type="radio"/> Enable         </div> <div> <div>Disable</div> <div>Disable</div> </div> <div> <div>Non-configured user</div> <div>defaultList</div> <div>dot1xList</div> </div> </div> </div> |           |         |     |          |            |             |      |       |

- b. For Administrative Mode, select the **Enable** radio button.
    - c. In the **Login** list, select **dot1xList**.
    - d. Click **Apply** to save settings.
7. Configure the RADIUS authentication server.

- a. Select **Security > Management Security > Server Configuration**.

A screen similar to the following displays.

| System   | Switching          | Routing         | QoS                    | Security          | Monitoring     | Maintenance       | Help                       | Index              |                          |                    |                 |                        |                   |                |                   |                            |                    |                  |          |               |                 |     |       |     |        |  |  |  |  |  |  |  |  |  |
|--|--------------------|-----------------|------------------------|-------------------|----------------|-------------------|----------------------------|--------------------|--------------------------|--------------------|-----------------|------------------------|-------------------|----------------|-------------------|----------------------------|--------------------|------------------|----------|---------------|-----------------|-----|-------|-----|--------|--|--|--|--|--|--|--|--|--|
| Management Security Access Port Authentication Traffic Control Control ACL   |                    |                 |                        |                   |                |                   |                            |                    |                          |                    |                 |                        |                   |                |                   |                            |                    |                  |          |               |                 |     |       |     |        |  |  |  |  |  |  |  |  |  |
| <div> <div> <div>Management Security</div> <div>Server Configuration</div> </div> <div> <div>Local User</div> <div>Enable Password</div> <div>Line Password</div> <div>RADIUS</div> <div>Radius Configuration</div> <div>Server Configuration</div> <div>Accounting Server Configuration</div> </div> </div>   |                    |                 |                        |                   |                |                   |                            |                    |                          |                    |                 |                        |                   |                |                   |                            |                    |                  |          |               |                 |     |       |     |        |  |  |  |  |  |  |  |  |  |
| <table border="1"> <thead> <tr> <th>Radius Server IP Address</th> <th>Radius Server Name</th> <th>Current</th> <th>Port</th> <th>Secret Configured</th> <th>Secret</th> <th>Primary Server</th> <th>Message Authentication</th> <th>Server Type</th> </tr> </thead> <tbody> <tr> <td>10.100.5.17</td> <td></td> <td></td> <td>1812</td> <td>Yes</td> <td>*****</td> <td>Yes</td> <td>Enable</td> <td></td> </tr> </tbody> </table>   |                    |                 |                        |                   |                |                   |                            |                    | Radius Server IP Address | Radius Server Name | Current         | Port                   | Secret Configured | Secret         | Primary Server    | Message Authentication     | Server Type        | 10.100.5.17      |          |               | 1812            | Yes | ***** | Yes | Enable |  |  |  |  |  |  |  |  |  |
| Radius Server IP Address   | Radius Server Name | Current         | Port                   | Secret Configured | Secret         | Primary Server    | Message Authentication     | Server Type        |                          |                    |                 |                        |                   |                |                   |                            |                    |                  |          |               |                 |     |       |     |        |  |  |  |  |  |  |  |  |  |
| 10.100.5.17  |                    |                 | 1812                   | Yes               | *****          | Yes               | Enable                     |                    |                          |                    |                 |                        |                   |                |                   |                            |                    |                  |          |               |                 |     |       |     |        |  |  |  |  |  |  |  |  |  |
| <div> <div>Statistics</div> <table border="1"> <thead> <tr> <th>Radius Server</th> <th>Round Trip Time</th> <th>Access Requests</th> <th>Access Retransmissions</th> <th>Access Accepts</th> <th>Access Rejects</th> <th>Access Challenges</th> <th>Malformed Access Responses</th> <th>Bad Authenticators</th> <th>Pending Requests</th> <th>Timeouts</th> <th>Unknown Types</th> <th>Packets Dropped</th> </tr> </thead> <tbody> <tr> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> </tbody> </table> </div> |                    |                 |                        |                   |                |                   |                            |                    | Radius Server            | Round Trip Time    | Access Requests | Access Retransmissions | Access Accepts    | Access Rejects | Access Challenges | Malformed Access Responses | Bad Authenticators | Pending Requests | Timeouts | Unknown Types | Packets Dropped |     |       |     |        |  |  |  |  |  |  |  |  |  |
| Radius Server  | Round Trip Time    | Access Requests | Access Retransmissions | Access Accepts    | Access Rejects | Access Challenges | Malformed Access Responses | Bad Authenticators | Pending Requests         | Timeouts           | Unknown Types   | Packets Dropped        |                   |                |                   |                            |                    |                  |          |               |                 |     |       |     |        |  |  |  |  |  |  |  |  |  |
|  |                    |                 |                        |                   |                |                   |                            |                    |                          |                    |                 |                        |                   |                |                   |                            |                    |                  |          |               |                 |     |       |     |        |  |  |  |  |  |  |  |  |  |

- b. In the **Server Address** field, enter **10.100.5.17**.
  - c. In the **Secret Configured** field, select **Yes**.
  - d. In the **Secret** field, enter **123456**.
  - e. In the **Primary Server** field, select **Yes**.
  - f. In the **Message Authenticator** field, select **Enable**.
  - g. Click **Add**.
8. Enable accounting.
- a. Select **Security > Management Security > RADIUS > Radius Configuration**.

A screen similar to the following displays.

The screenshot shows the 'Radius Configuration' screen under 'Management Security'. The 'Accounting Server Configuration' section is active. It contains a table with the following data:

| Accounting Server IP Address | Accounting Server Name | Port | Secret Configured | Secret | Accounting Mode |
|------------------------------|------------------------|------|-------------------|--------|-----------------|
| 10.100.5.17                  |                        | 1812 | Yes               | *****  | Enable          |

Below the table is a 'Statistics' section with a table showing various metrics:

| Accounting Server | Round Trip Time | Accounting Requests | Accounting Retransmissions | Accounting Responses | Malformed Accounting Responses | Bad Authenticators | Pending Requests | Timeouts | Unknown Types | Packets Dropped |
|-------------------|-----------------|---------------------|----------------------------|----------------------|--------------------------------|--------------------|------------------|----------|---------------|-----------------|
|                   |                 |                     |                            |                      |                                |                    |                  |          |               |                 |

- b. In the **Server Address** field, enter **10.100.5.17**.
  - c. In the **Accounting Mode** field, select **Enable**.
  - d. Click **Apply**.
9. Configure the accounting server.
- a. Select **Security > Management Security > RADIUS > Radius Accounting Server Configuration**.

A screen similar to the following displays.

The screenshot shows the 'Radius Accounting Server Configuration' screen under 'Management Security'. The 'Accounting Server Configuration' section is active. It contains a table with the following data:

| Accounting Server IP Address | Accounting Server Name | Port | Secret Configured | Secret | Accounting Mode |
|------------------------------|------------------------|------|-------------------|--------|-----------------|
| 10.100.5.17                  |                        |      | Yes               | *****  | Enable          |

Below the table is a 'Statistics' section with a table showing various metrics:

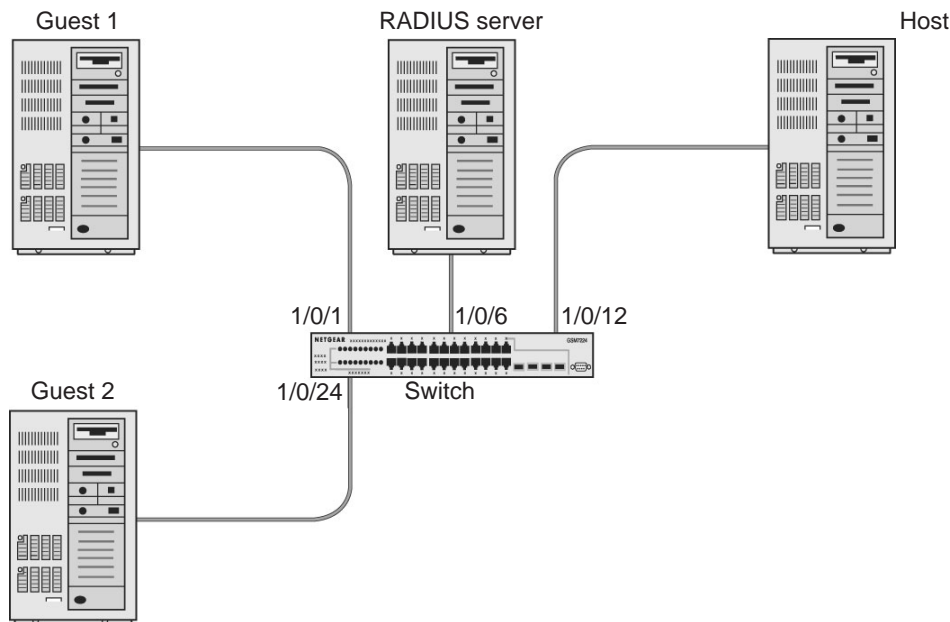
| Accounting Server | Round Trip Time | Accounting Requests | Accounting Retransmissions | Accounting Responses | Malformed Accounting Responses | Bad Authenticators | Pending Requests | Timeouts | Unknown Types | Packets Dropped |
|-------------------|-----------------|---------------------|----------------------------|----------------------|--------------------------------|--------------------|------------------|----------|---------------|-----------------|
|                   |                 |                     |                            |                      |                                |                    |                  |          |               |                 |

- b. In the **Accounting Server Address** field, enter **10.100.5.17**.
- c. In the **Accounting Mode** field, select **Enable**.
- d. Click **Apply**.



# Create a Guest VLAN

The guest VLAN feature allows a switch to provide a distinguished service to dot1x unaware clients (not rogue users who fail authentication). This feature provides a mechanism to allow visitors and contractors to have network access to reach an external network with no ability to surf the internal LAN.



**Figure 36. Guest VLAN**

If a port is in port-based mode, and a client that does not support 802.1X is connected to an unauthorized port that has 802.1X enabled, the client does not respond to the 802.1X requests from the switch. The port remains in the unauthorized state, and the client is not granted access to the network. If the guest VLAN is configured for that port, then the port is placed in the configured guest VLAN and the port is moved to the authorized state, allowing access to the client after a certain amount of time (determined by the guest VLAN period). If the client attached is 802.1x aware, then this allows the client to respond to 802.1X requests from the switch.

For a port in MAC-based mode, if a guest VLAN has been configured on the port and if traffic from an unauthenticated client is detected on the port, the guest VLAN timer is started for that client. If the client is 802.1x unaware and does not respond to any 802.1x requests, when the guest VLAN timer expires, the client is authenticated and associated with the guest VLAN. This ensures that traffic from the client is accepted and switched through the guest VLAN.

In this example, dot1x is enabled on all the ports so that all the hosts that are authorized are assigned to VLAN 1. On ports 1/0/1 and 1/0/24, guest VLAN is enabled. If guests connect to the port, they are assigned to VLAN 2000, so that guests cannot access the internal VLAN, but can access each other in the guest VLAN.

## CLI: Create a Guest VLAN

### 1. Enter the following commands:

```
(Netgear Switch) #vlan database
(Netgear Switch) (Vlan)#vlan 2000
(Netgear Switch) (Vlan)#exit
(Netgear Switch) (Config)#interface 1/0/1
(Netgear Switch) (Interface 1/0/1)#vlan participation include 2000
(Netgear Switch) (Interface 1/0/1)#exit
(Netgear Switch) (Config)#interface 1/0/24
(Netgear Switch) (Interface 1/0/24)#vlan participation include 2000
(Netgear Switch) (Interface 1/0/24)#exit
```

### 2. Create VLAN 2000, and have 1/0/1 and 1/0/24 as members of VLAN 2000.

```
(Netgear Switch) (Config)#aaa authentication dot1x default radius
(Netgear Switch) (Config)#dot1x system-auth-control
(Netgear Switch) (Config)#radius server host auth 192.168.0.1
(Netgear Switch) (Config)#radius server key auth 192.168.0.1
Enter secret (16 characters max):12345
Re-enter secret:12345
(Netgear Switch) (Config)#interface 1/0/6
(Netgear Switch) (Interface 1/0/6)#dot1x port-control force-authorized
(Netgear Switch) (Interface 1/0/6)#exit
(Netgear Switch) (Config)#interface 1/0/12
(Netgear Switch) (Interface 1/0/12)#dot1x port-control force-authorized
(Netgear Switch) (Interface 1/0/12)#exit
```

### 3. Enable dot1x and RADIUS on the switch.

```
(Netgear Switch) (Config)#interface 1/0/1
(Netgear Switch) (Interface 1/0/1)#dot1x guest-vlan 2000
(Netgear Switch) (Interface 1/0/1)#exit
(Netgear Switch) (Config)#interface 1/0/24
(Netgear Switch) (Interface 1/0/24)#dot1x guest-vlan 2000
(Netgear Switch) (Interface 1/0/24)#exit
```



#### 4. Enable the guest VLAN on ports 1/0/1 and 1/0/24.

```
(Netgear Switch) #show dot1x detail 1/0/1
Protocol Version..... 1
PAE Capabilities..... Authenticator
Control Mode..... auto
Authenticator PAE State..... Authenticated
Backend Authentication State..... Idle
Quiet Period (secs)..... 60
Transmit Period (secs)..... 30
Guest VLAN ID..... 2000
Guest VLAN Period (secs)..... 90
Supplicant Timeout (secs)..... 30
Server Timeout (secs)..... 30
Maximum Requests..... 2
VLAN Id..... 2000
VLAN Assigned Reason..... Guest
Reauthentication Period (secs)..... 3600
Reauthentication Enabled..... FALSE
Key Transmission Enabled..... FALSE
Control Direction..... both
Maximum Users..... 16
Unauthenticated VLAN ID..... 0
Session Timeout..... 0
Session Termination Action..... Default
```

## Local Browser Interface: Create a Guest VLAN

### 1. Create VLAN 2000.

#### a. Select **Switching > VLAN > Basic > VLAN Configuration**.

A screen similar to the following displays.

| VLAN ID | VLAN Name | VLAN Type | Make Static |
|---------|-----------|-----------|-------------|
| 2000    |           | Static    | Enable      |
| 1       | default   | Default   | Disable     |
| 3       | VLAN0003  | Static    | Disable     |

- b. In the **VLAN ID** field, enter **2000**.
  - c. In the **VLAN Type** field, select **Static**.
  - d. Click **Add**.
2. Add ports to VLAN 2000.
  - a. Select **Switching > VLAN > Advanced > VLAN Membership**.

A screen similar to the following displays.

The screenshot shows the 'VLAN Membership' configuration page. The left sidebar has a tree view with 'VLAN' expanded and 'VLAN Membership' selected. The main content area has the following fields:

- VLAN ID: 2000
- Group Operation: Untag All
- VLAN Name: VLAN2000
- VLAN Type: Static

Below these fields is a section for 'Unit 1' showing a grid of ports. Ports 1 and 24 are highlighted with a 'U' icon, indicating they are untagged.

- b. In the **VLAN ID** list, select **2000**.
  - c. Click **Unit 1**. The ports display.
  - d. Click the gray boxes under ports **1** and **24** until **U** displays.
- e. Click **Apply**.
3. Set force authorized mode on ports 1/0/6 and 1/0/12.
  - a. Select **Security > Port Authentication > Advanced > Port Authentication**.

A screen similar to the following displays.

The screenshot shows the 'Port Authentication' configuration page. The left sidebar has a tree view with 'Security' expanded and 'Port Authentication' selected. The main content area shows a table of ports with the following columns:

| Port  | Control Mode     | MAB     | Quiet Period | Transmit Period | Guest VLAN ID | Guest VLAN Period | Unauthenticated VLAN ID | Supplicant Timeout | Server Timeout | Maximum Requests |
|-------|------------------|---------|--------------|-----------------|---------------|-------------------|-------------------------|--------------------|----------------|------------------|
| 1/0/6 | Force Authorized | Disable | 60           | 30              | 0             | 90                | 0                       | 30                 | 30             | 2                |
| 1/0/1 | Auto             | Disable | 60           | 30              | 0             | 90                | 0                       | 30                 | 30             | 2                |
| 1/0/2 | Auto             | Disable | 60           | 30              | 0             | 90                | 0                       | 30                 | 30             | 2                |
| 1/0/3 | Auto             | Disable | 60           | 30              | 0             | 90                | 0                       | 30                 | 30             | 2                |
| 1/0/4 | Auto             | Disable | 60           | 30              | 0             | 90                | 0                       | 30                 | 30             | 2                |
| 1/0/5 | Auto             | Disable | 60           | 30              | 0             | 90                | 0                       | 30                 | 30             | 2                |
| 1/0/6 | Auto             | Disable | 60           | 30              | 0             | 90                | 0                       | 30                 | 30             | 2                |

- b. Scroll down and select the Interface **1/0/6** and **1/0/12**, check boxes.
  - c. In the **Control Mode** list, select **Force Authorized**.
  - d. Click **Apply** to save settings.
4. Enable dot1x on the switch.

Make sure that 1/0/12 and 1/0/6 are configured as force authorized before you perform this step; otherwise you cannot access the switch through the local browser interface.

- a. Select **Security > Port Authentication > Basic > 802.1x Configuration**.

A screen similar to the following displays.

The screenshot shows the '802.1X Configuration' page. The left sidebar has 'Port Authentication' expanded, with '802.1X Configuration' selected. The main area shows configuration options for Administrative Mode, VLAN Assignment Mode, EAPOL Flood Mode, Dynamic VLAN Creation Mode, Monitor Mode, Users, Login, and Authentication List. The 'Enable' radio button is selected for Administrative Mode. The 'Authentication List' dropdown is set to 'dot1xList'.

- b. For Administrative Mode, select the **Enable** radio button.
  - c. Click **Apply** to save settings.
5. Configure the dot1x authentication list.
- a. Select **Security > Management Security > Authentication List > Dot1x Authentication List**.

A screen similar to the following displays.

The screenshot shows the 'Login Authentication List' page. The left sidebar has 'Management Security' expanded, with 'Login Authentication List' selected. The main area shows a table with columns: List Name, 1, 2, 3, 4, 5, 6. The 'defaultList' row is selected, and the '1' column is set to 'Radius'.

| List Name   | 1      | 2   | 3   | 4   | 5   | 6   |
|-------------|--------|-----|-----|-----|-----|-----|
| defaultList | Radius | N/A | N/A | N/A | N/A | N/A |
| defaultList | Local  | N/A | N/A | N/A | N/A | N/A |
| networkList | Local  | N/A | N/A | N/A | N/A | N/A |

- b. Select the **defaultList** check box.
  - c. In the **1** list, select **RADIUS**.
  - d. Click **Add**.
6. Configure the RADIUS authentication server.
- a. Select **Security > Management Security > Radius > Server Configuration**.

A screen similar to the following displays.

The screenshot shows the 'Server Configuration' page. The left sidebar has 'Management Security' expanded, with 'Server Configuration' selected. The main area shows a table with columns: Radius Server IP Address, Radius Server Name, Current, Port, Secret Configured, Secret, Primary Server, Message Authenticator, and Server Type. The 'Radius Server IP Address' field is set to '192.168.0.1'. The 'Secret Configured' field is set to 'Yes'. The 'Secret' field is set to '12345'.

| Radius Server IP Address | Radius Server Name | Current | Port | Secret Configured | Secret | Primary Server | Message Authenticator | Server Type |
|--------------------------|--------------------|---------|------|-------------------|--------|----------------|-----------------------|-------------|
| 192.168.0.1              |                    |         |      | Yes               | 12345  |                |                       |             |

- b. In the **Radius Server IP Address** field, enter **192.168.0.1**.
- c. In the **Secret Configured** field, select **Yes**.
- d. In the **Secret** field, enter **12345**.

- e. Click **Add**.
7. Configure the guest VLAN.
  - a. Select **Security > Port Authentication > Advanced > Port Authentication**.

A screen similar to the following displays.

| Port   | Control Mode | MAB                                 | Quiet Period | Transmit Period | Guest VLAN ID | Guest VLAN Period | Unauthenticated VLAN ID |
|--------|--------------|-------------------------------------|--------------|-----------------|---------------|-------------------|-------------------------|
| 1/0/1  | Auto         | <input checked="" type="checkbox"/> | 60           | 30              | 2000          | 90                | 0                       |
| 1/0/24 | Auto         | <input checked="" type="checkbox"/> | 60           | 30              | 2000          | 90                | 0                       |

- b. Scroll down and select the port 1/0/1 and 1/0/24 check boxes.
- c. In the **Guest VLAN ID** field, enter **2000**.
- d. Click **Apply** to save your settings.

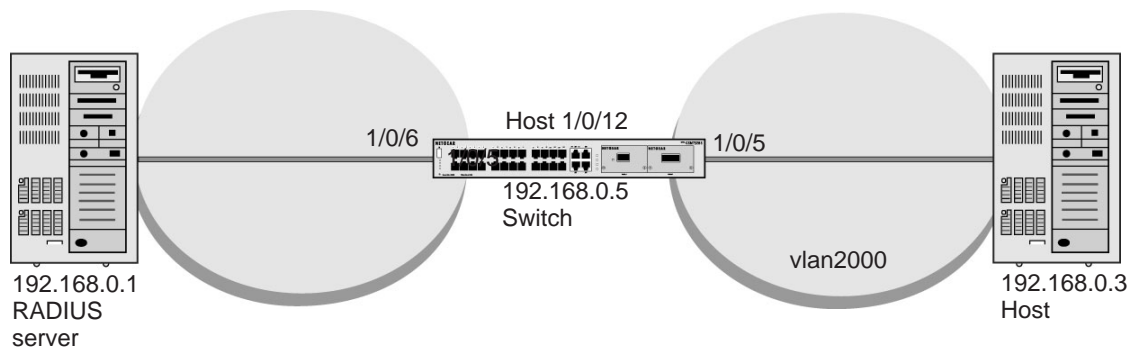
## Assign VLANs Using RADIUS

This feature allows the client to connect from any port and be assigned to the appropriate VLAN assigned by the RADIUS server. This gives flexibility for the clients to move around the network without requiring the administrator to do static VLAN configuration. When multiple hosts are connected to the switch on the same port, only one host uses authentication. If any VLAN information is applied on the port based on the authenticated host, the VLAN applies that information to all the hosts that are connected to that port.

- After a port is in an authorized state, if any client initiates dot1x authentication, the port clears authenticated clients' states, and in the process clears the VLAN assigned to the port (if any). Then the port continues with the new client authentication and authorization process.
- When a client authenticates itself initially on the network, the switch acts as the authenticator to the clients on the network and forwards the authentication request to the RADIUS server in the network.

For use in VLAN assignment, the following tunnel attributes are used:

- Tunnel-Type = VLAN (13)
- Tunnel-Medium-Type = 802
- Tunnel-Private-Group-ID = VLANID where VLANID is 12 bits, with a value between 1 and 4094.



**Figure 37. VLAN assignment using RADIUS**

In the previous figure, the switch has placed the host in the VLAN (vlan2000) based on the user details of the clients.

The configuration on a RADIUS server for a user logged in as admin is:

- Tunnel-Type = VLAN (13)
- Tunnel-Medium-Type = 802
- Tunnel-Private-Group-ID = 2000

## CLI: Assign VLANs Using RADIUS

### 1. Create VLAN 2000.

```
(Netgear Switch) #network protocol none
Changing protocol mode will reset ip configuration.
Are you sure you want to continue? (y/n) y
(Netgear Switch) #network parms 192.168.0.5 255.255.255.0
(Netgear Switch) #vlan database
(Netgear Switch) (Vlan)#vlan 2000
(Netgear Switch) #exit
```

### 2. Enable dot1x authentication on the switch

```
(Netgear Switch) (Config)#dot1x system-auth-control
```

### 3. Use the RADIUS as the authenticator.

```
(Netgear Switch) (Config)#aaa authentication dot1x default radius
```

**4. Enable the switch to accept VLAN assignment by the RADIUS server.**

```
(Netgear Switch) (Config)#authorization network radius
```

**5. Set the RADIUS server IP address.**

```
(Netgear Switch) (Config)#radius server host auth 192.168.0.1
```

**6. Set the NAS-IP address for the RADIUS server.**

```
(Netgear Switch) (Config)#radius server key auth 192.168.0.1
Enter secret (16 characters max):12345
Re-enter secret:12345
Set the radius server key.
(Netgear Switch) (Config)#radius server attribute 4 192.168.0.1
```

**7. Force 1/0/6 to be authorized for it to connect to the RADIUS server.**

```
(Netgear Switch) (Config)#interface 1/0/6
(Netgear Switch) (Interface 1/0/6)#dot1x port-control force-authorized
(Netgear Switch) (Interface 1/0/6)#exit
```

**8. Show the dot1x detail for 1/0/5.**

```
(Netgear Switch) #show dot1x detail 1/0/5
Port..... 1/0/5
Protocol Version..... 1
PAE Capabilities..... Authenticator
Control Mode..... auto
Authenticator PAE State..... Authenticated
Backend Authentication State..... Idle
Quiet Period (secs)..... 60
Transmit Period (secs)..... 30
Guest VLAN ID..... 0
Guest VLAN Period (secs)..... 90
Supplicant Timeout (secs)..... 30
Server Timeout (secs)..... 30
Maximum Requests..... 2
VLAN Id..... 2000
VLAN Assigned Reason..... RADIUS
Reauthentication Period (secs)..... 3600
Reauthentication Enabled..... FALSE
Key Transmission Enabled..... FALSE
Control Direction..... both
Maximum Users..... 16
Unauthenticated VLAN ID..... 0
Session Timeout..... 0
Session Termination Action..... Default
```



## Local Browser Interface: Assign VLANS Using RADIUS

1. Assign the IP address for the web management interface.
  - a. Select **System > Management > Network Interface > IPv4 Network Configuration**.

A screen similar to the following displays.

The screenshot shows the 'IPv4 Network Interface Configuration' page. The left sidebar has a tree view with 'Management' expanded and 'IPv4 Network Configuration' selected. The main content area has a tabbed interface with 'Management' selected. The configuration fields are as follows:

| Field                                  | Value  |
|--|--|
| IP Address                             | 192.168.0.5  |
| Subnet Mask                            | 255.255.255.0  |
| Default Gateway                        | 0.0.0.0  |
| Burned In MAC Address                  | 20:0C:C8:4D:95:72  |
| Locally Administered MAC Address       | 00:00:00:00:00:00  |
| MAC Address Type                       | <input checked="" type="radio"/> Burned In <input type="radio"/> Locally Administered        |
| Current Network Configuration Protocol | <input checked="" type="radio"/> None <input type="radio"/> Bootp <input type="radio"/> DHCP |
| DHCP Vendor Class Identifier           | <input type="text"/>   |
| DHCP Vendor Class Identifier String    | <input type="text"/>   |
| Management VLAN ID                     | 1 (1 to 4093)  |
| Interface Status                       | Up   |

- b. For Current Network Configuration Protocol, select the **None** radio button.
  - c. In the **IP Address** field, enter **192.168.0.5**.
  - d. In the **Subnet Mask** field, enter **255.255.255.0**.
  - e. Click **Apply**.
2. Create VLAN 2000.
  - a. Select **Switching > VLAN > Basic > VLAN Configuration**.

A screen similar to the following displays.

The screenshot shows the 'VLAN Configuration' page. The left sidebar has a tree view with 'Switching' expanded and 'VLAN Configuration' selected. The main content area has a tabbed interface with 'VLAN' selected. The configuration fields are as follows:

| Field                           | Value   |
|---------------------------------|---|
| Internal VLAN Allocation Base   | 4093  |
| Internal VLAN Allocation Policy | <input type="radio"/> Ascending <input checked="" type="radio"/> Descending |

Below the configuration fields is a table for VLAN configuration:

| VLAN ID | VLAN Name | VLAN Type | Make Static |
|---------|-----------|-----------|-------------|
| 2000    |           |           |             |
| 1       | default   | Default   | Disable     |

- b. In the **VLAN ID** field, enter **2000**.
  - c. In the **VLAN Type** field, select **Static**.
  - d. Click **Add**.
3. Set force authorized mode on ports 1/0/6 and 1/0/12.
  - a. Select **Security > Port Authentication > Advanced > Port Authentication**.

A screen similar to the following displays.

| System   | Switching        | Routing | QoS          | Security        | Monitoring    | Maintenance       | Help                    | Index |      |              |     |              |                 |               |                   |                         |   |                  |         |    |    |      |    |   |                                |      |         |    |    |   |    |   |                                |      |         |    |    |   |    |   |                                |      |         |    |    |   |    |   |                                |      |         |    |    |   |    |   |                                |      |         |    |    |   |    |   |   |      |         |    |    |   |    |   |
|--|------------------|---------|--------------|-----------------|---------------|-------------------|-------------------------|-------|------|--------------|-----|--------------|-----------------|---------------|-------------------|-------------------------|---|------------------|---------|----|----|------|----|---|--------------------------------|------|---------|----|----|---|----|---|--------------------------------|------|---------|----|----|---|----|---|--------------------------------|------|---------|----|----|---|----|---|--------------------------------|------|---------|----|----|---|----|---|--------------------------------|------|---------|----|----|---|----|---|---|------|---------|----|----|---|----|---|
| Management Security Access Port Authentication Traffic Control Control ACL   |                  |         |              |                 |               |                   |                         |       |      |              |     |              |                 |               |                   |                         |   |                  |         |    |    |      |    |   |                                |      |         |    |    |   |    |   |                                |      |         |    |    |   |    |   |                                |      |         |    |    |   |    |   |                                |      |         |    |    |   |    |   |                                |      |         |    |    |   |    |   |   |      |         |    |    |   |    |   |
| Port Authentication  |                  |         |              |                 |               |                   |                         |       |      |              |     |              |                 |               |                   |                         |   |                  |         |    |    |      |    |   |                                |      |         |    |    |   |    |   |                                |      |         |    |    |   |    |   |                                |      |         |    |    |   |    |   |                                |      |         |    |    |   |    |   |                                |      |         |    |    |   |    |   |   |      |         |    |    |   |    |   |
| <div> <div> <div>Basic</div> <div>Advanced</div> <div>802.1X Configuration</div> <div>Port Authentication</div> <div>Port Summary</div> <div>Client Summary</div> </div> <div> <div>1 2 3 All</div> <table border="1"> <thead> <tr> <th>Port</th> <th>Control Mode</th> <th>MAB</th> <th>Quiet Period</th> <th>Transmit Period</th> <th>Guest VLAN ID</th> <th>Guest VLAN Period</th> <th>Unauthenticated VLAN ID</th> </tr> </thead> <tbody> <tr> <td><input checked="" type="checkbox"/> 1/0/6</td> <td>Force Authorized</td> <td>Disable</td> <td>60</td> <td>30</td> <td>2000</td> <td>90</td> <td>0</td> </tr> <tr> <td><input type="checkbox"/> 1/0/1</td> <td>Auto</td> <td>Disable</td> <td>60</td> <td>30</td> <td>0</td> <td>90</td> <td>0</td> </tr> <tr> <td><input type="checkbox"/> 1/0/2</td> <td>Auto</td> <td>Disable</td> <td>60</td> <td>30</td> <td>0</td> <td>90</td> <td>0</td> </tr> <tr> <td><input type="checkbox"/> 1/0/3</td> <td>Auto</td> <td>Disable</td> <td>60</td> <td>30</td> <td>0</td> <td>90</td> <td>0</td> </tr> <tr> <td><input type="checkbox"/> 1/0/4</td> <td>Auto</td> <td>Disable</td> <td>60</td> <td>30</td> <td>0</td> <td>90</td> <td>0</td> </tr> <tr> <td><input type="checkbox"/> 1/0/5</td> <td>Auto</td> <td>Disable</td> <td>60</td> <td>30</td> <td>0</td> <td>90</td> <td>0</td> </tr> <tr> <td><input checked="" type="checkbox"/> 1/0/6</td> <td>Auto</td> <td>Disable</td> <td>60</td> <td>30</td> <td>0</td> <td>90</td> <td>0</td> </tr> </tbody> </table> </div> </div> |                  |         |              |                 |               |                   |                         |       | Port | Control Mode | MAB | Quiet Period | Transmit Period | Guest VLAN ID | Guest VLAN Period | Unauthenticated VLAN ID | <input checked="" type="checkbox"/> 1/0/6 | Force Authorized | Disable | 60 | 30 | 2000 | 90 | 0 | <input type="checkbox"/> 1/0/1 | Auto | Disable | 60 | 30 | 0 | 90 | 0 | <input type="checkbox"/> 1/0/2 | Auto | Disable | 60 | 30 | 0 | 90 | 0 | <input type="checkbox"/> 1/0/3 | Auto | Disable | 60 | 30 | 0 | 90 | 0 | <input type="checkbox"/> 1/0/4 | Auto | Disable | 60 | 30 | 0 | 90 | 0 | <input type="checkbox"/> 1/0/5 | Auto | Disable | 60 | 30 | 0 | 90 | 0 | <input checked="" type="checkbox"/> 1/0/6 | Auto | Disable | 60 | 30 | 0 | 90 | 0 |
| Port   | Control Mode     | MAB     | Quiet Period | Transmit Period | Guest VLAN ID | Guest VLAN Period | Unauthenticated VLAN ID |       |      |              |     |              |                 |               |                   |                         |   |                  |         |    |    |      |    |   |                                |      |         |    |    |   |    |   |                                |      |         |    |    |   |    |   |                                |      |         |    |    |   |    |   |                                |      |         |    |    |   |    |   |                                |      |         |    |    |   |    |   |   |      |         |    |    |   |    |   |
| <input checked="" type="checkbox"/> 1/0/6  | Force Authorized | Disable | 60           | 30              | 2000          | 90                | 0                       |       |      |              |     |              |                 |               |                   |                         |   |                  |         |    |    |      |    |   |                                |      |         |    |    |   |    |   |                                |      |         |    |    |   |    |   |                                |      |         |    |    |   |    |   |                                |      |         |    |    |   |    |   |                                |      |         |    |    |   |    |   |   |      |         |    |    |   |    |   |
| <input type="checkbox"/> 1/0/1   | Auto             | Disable | 60           | 30              | 0             | 90                | 0                       |       |      |              |     |              |                 |               |                   |                         |   |                  |         |    |    |      |    |   |                                |      |         |    |    |   |    |   |                                |      |         |    |    |   |    |   |                                |      |         |    |    |   |    |   |                                |      |         |    |    |   |    |   |                                |      |         |    |    |   |    |   |   |      |         |    |    |   |    |   |
| <input type="checkbox"/> 1/0/2   | Auto             | Disable | 60           | 30              | 0             | 90                | 0                       |       |      |              |     |              |                 |               |                   |                         |   |                  |         |    |    |      |    |   |                                |      |         |    |    |   |    |   |                                |      |         |    |    |   |    |   |                                |      |         |    |    |   |    |   |                                |      |         |    |    |   |    |   |                                |      |         |    |    |   |    |   |   |      |         |    |    |   |    |   |
| <input type="checkbox"/> 1/0/3   | Auto             | Disable | 60           | 30              | 0             | 90                | 0                       |       |      |              |     |              |                 |               |                   |                         |   |                  |         |    |    |      |    |   |                                |      |         |    |    |   |    |   |                                |      |         |    |    |   |    |   |                                |      |         |    |    |   |    |   |                                |      |         |    |    |   |    |   |                                |      |         |    |    |   |    |   |   |      |         |    |    |   |    |   |
| <input type="checkbox"/> 1/0/4   | Auto             | Disable | 60           | 30              | 0             | 90                | 0                       |       |      |              |     |              |                 |               |                   |                         |   |                  |         |    |    |      |    |   |                                |      |         |    |    |   |    |   |                                |      |         |    |    |   |    |   |                                |      |         |    |    |   |    |   |                                |      |         |    |    |   |    |   |                                |      |         |    |    |   |    |   |   |      |         |    |    |   |    |   |
| <input type="checkbox"/> 1/0/5   | Auto             | Disable | 60           | 30              | 0             | 90                | 0                       |       |      |              |     |              |                 |               |                   |                         |   |                  |         |    |    |      |    |   |                                |      |         |    |    |   |    |   |                                |      |         |    |    |   |    |   |                                |      |         |    |    |   |    |   |                                |      |         |    |    |   |    |   |                                |      |         |    |    |   |    |   |   |      |         |    |    |   |    |   |
| <input checked="" type="checkbox"/> 1/0/6  | Auto             | Disable | 60           | 30              | 0             | 90                | 0                       |       |      |              |     |              |                 |               |                   |                         |   |                  |         |    |    |      |    |   |                                |      |         |    |    |   |    |   |                                |      |         |    |    |   |    |   |                                |      |         |    |    |   |    |   |                                |      |         |    |    |   |    |   |                                |      |         |    |    |   |    |   |   |      |         |    |    |   |    |   |

b. Under Port Authentication, scroll down and select the 1/0/6 and 1/0/12 check boxes.

c. In the **Control Mode** list, select **Force Authorized**.

d. Click **Apply** to save settings.

4. Enable dot1x on the switch.

Make sure that 1/0/12 and 1/0/6 are configured as force authorized before you do this step; otherwise, you cannot access the switch through the web management interface.

a. Select **Security > Port Authentication > Basic > 802.1x Configuration**.

A screen similar to the following displays.

| System   | Switching | Routing | QoS | Security | Monitoring | Maintenance | Help | Index |
|--|-----------|---------|-----|----------|------------|-------------|------|-------|
| Management Security Access Port Authentication Traffic Control Control ACL   |           |         |     |          |            |             |      |       |
| Port Authentication  |           |         |     |          |            |             |      |       |
| <div> <div> <div>Basic</div> <div>802.1X Configuration</div> <div>Advanced</div> </div> <div> <div>Administrative Mode</div> <div>VLAN Assignment Mode</div> <div>EAPOL Flood Mode</div> <div>Dynamic VLAN Creation Mode</div> <div>Monitor Mode</div> <div>Users</div> <div>Login</div> <div>Authentication List</div> </div> <div> <div> <div>Disable</div> <div>Enable</div> </div> <div> <div>Disable</div> <div>Enable</div> </div> <div> <div>Disable</div> <div>Enable</div> </div> <div> <div>Disable</div> <div>Enable</div> </div> <div> <div>Disable</div> <div>Enable</div> </div> <div> <div>admin</div> </div> <div> <div>defaultList</div> </div> <div> <div>dot1xList</div> </div> </div> </div> |           |         |     |          |            |             |      |       |

b. For Administrative Mode, select the **Enable** radio button.

c. For VLAN Assignment Mode, select the **Enable** radio button.

d. Click **Apply** to save settings.

5. Configure the dot1x authentication list.

a. Select **Security > Management Security > Authentication List > Dot1x Authentication List**.

A screen similar to the following displays.

| System   | Switching | Routing | QoS | Security | Monitoring | Maintenance | Help | Index |
|--|-----------|---------|-----|----------|------------|-------------|------|-------|
| Management Security Access Port Authentication Traffic Control Control ACL   |           |         |     |          |            |             |      |       |
| Management Security Login Authentication List  |           |         |     |          |            |             |      |       |
| <div> <div> Local User Enable Password Line Password RADIUS TACACS Authentication List Login Authentication List </div> <div> <div> <input type="checkbox"/> List Name 1 2 3 4 5 6 </div> <div> defaultList Radius N/A N/A N/A N/A N/A </div> <div> <input checked="" type="checkbox"/> defaultList Local N/A N/A N/A N/A N/A </div> <div> <input type="checkbox"/> networkList Local N/A N/A N/A N/A N/A </div> </div> </div> |           |         |     |          |            |             |      |       |

- b. Select the **defaultList** check box.
  - c. In the **1** list, select **RADIUS**.
  - d. Click **Add**.
6. Configure the RADIUS authentication server.
  - a. Select **Security > Management Security > Radius > Server Configuration**.

A screen similar to the following displays.

| System   | Switching | Routing | QoS | Security | Monitoring | Maintenance | Help | Index |
|--|-----------|---------|-----|----------|------------|-------------|------|-------|
| Management Security Access Port Authentication Traffic Control Control ACL   |           |         |     |          |            |             |      |       |
| Management Security Server Configuration   |           |         |     |          |            |             |      |       |
| <div> <div> Local User Enable Password Line Password RADIUS TACACS </div> <div> <div> <input type="checkbox"/> Radius Server IP Address Radius Server Name Current Port Secret Configured Secret </div> <div> 192.168.0.1 <br/> <br/> <br/> Yes <br/> 12345 </div> </div> </div> |           |         |     |          |            |             |      |       |
| <div> <div> Radius Configuration Server Configuration Accounting Server Configuration TACACS </div> <div> Statistics </div> </div>   |           |         |     |          |            |             |      |       |
| <div> Radius Server Round Trip Time Access Requests Access Retransmissions Access Accepts Access Rejects Access Challenges Malformed Access Responses Bad Authenticators </div>  |           |         |     |          |            |             |      |       |

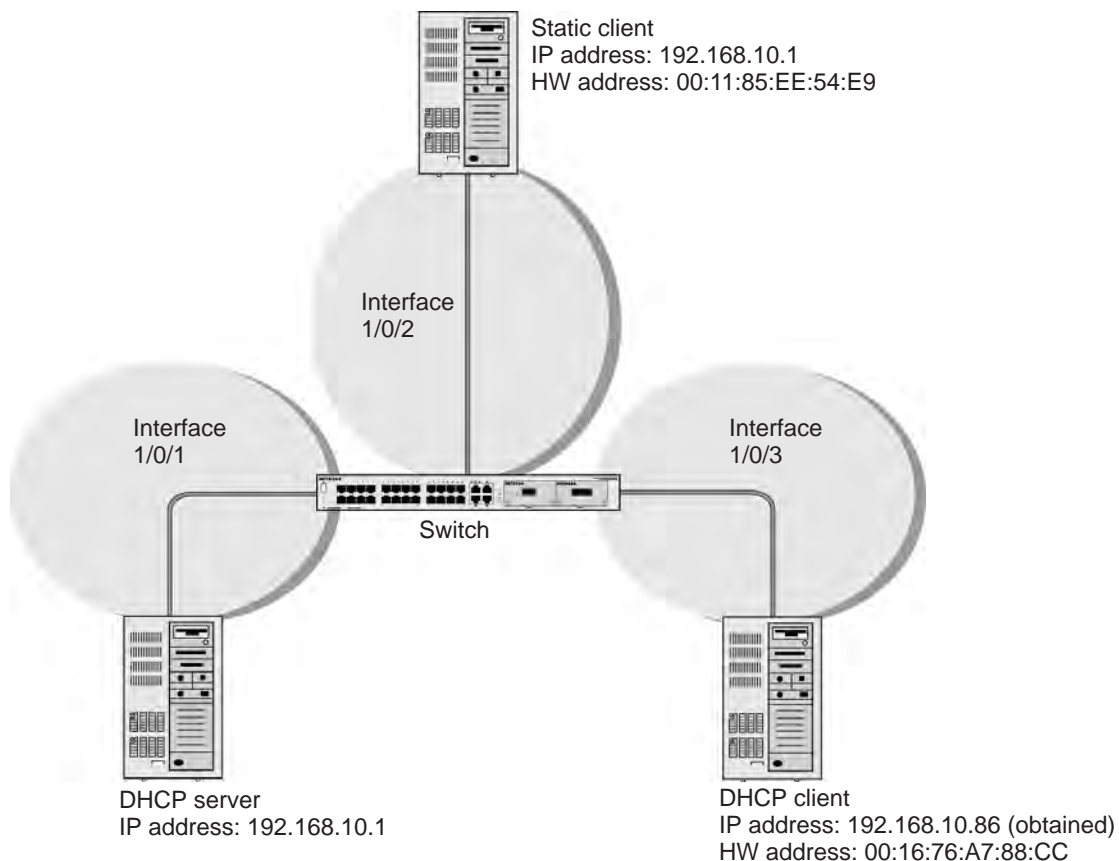
- b. In the **Radius Server IP Address** field, enter **192.168.0.1**.
  - c. In the **Secret Configured** field, select **Yes**.
  - d. In the **Secret** field, enter **12345**.
  - e. Click **Add**.

# Dynamic ARP Inspection

Dynamic ARP inspection (DAI) is a security feature that rejects invalid and malicious ARP packets. The feature prevents a class of man-in-the-middle attacks, where an unfriendly station intercepts traffic for other stations by poisoning the ARP caches of its unsuspecting neighbors. The miscreant sends ARP requests or responses mapping another station's IP address to its own MAC address.

DAI relies on DHCP snooping. DHCP snooping listens to DHCP message exchanges and builds a bindings database of valid tuples (MAC address, IP address, VLAN interface).

When DAI is enabled, the switch drops ARP packet if the sender MAC address and sender IP address do not match an entry in the DHCP snooping bindings database. However, it can be overcome through static mappings. Static mappings are useful when hosts configure static IP addresses, DHCP snooping cannot be run, or other switches in the network do not run dynamic ARP inspection. A static mapping associates an IP address to a MAC address on a VLAN.



**Figure 38. Dynamic ARP inspection**

## CLI: Configure Dynamic ARP Inspection

1. Enable DHCP snooping globally.

```
(Netgear Switch) (Config)# ip dhcp snooping
```

2. Enable DHCP snooping in a VLAN.

```
(Netgear Switch) (Config)# ip dhcp snooping vlan 1
```

3. Configure the port through which the DHCP server is reached as trusted.

```
(Netgear Switch) (Config)# interface 1/0/1
(Netgear Switch) (Interface 1/0/1)# ip dhcp snooping trust
```

4. View the DHCP Snooping Binding table.

```
(Netgear Switch) #show ip dhcp snooping binding
Total number of bindings: 1
```

| MAC Address       | IP Address    | VLAN | Interface | Type    | Lease (Secs) |
|-------------------|---------------|------|-----------|---------|--------------|
| 00:16:76:A7:88:CC | 192.168.10.86 | 1    | 1/0/2     | DYNAMIC | 86400        |

5. Enable ARP inspection in VLAN 1.

```
(Netgear Switch) (Config)# ip arp inspection vlan 1
```

Now all ARP packets received on ports that are members of the VLAN are copied to the CPU for ARP inspection. If there are trusted ports, you can configure them as trusted in the next step. ARP packets received on trusted ports are not copied to the CPU.

6. Configure port 1/0/1 as trusted.

```
(Netgear Switch) (Config)# interface 1/0/1
(Netgear Switch) (Interface 1/0/1)# ip arp inspection trust
```

Now, ARP packets from the DHCP client go through because a DHCP snooping entry exists. However, ARP packets from the static client are dropped. For information about how to prevent ARP packets from static clients to be dropped, see [Static Mapping on page 350](#).

## Local Browser Interface: Configure Dynamic ARP Inspection

1. Enable DHCP snooping globally.
  - a. Select **Security > Control > DHCP Snooping Global Configuration**.

A screen similar to the following displays.

| System  | Switching          | Routing             | QoS             | Security | Monitoring | Maintenance | Help | Index |         |                    |  |  |
|---|--------------------|---------------------|-----------------|----------|------------|-------------|------|-------|---------|--------------------|--|--|
| Management Security   | Access             | Port Authentication | Traffic Control | Control  | ACL        |             |      |       |         |                    |  |  |
| <div>Control</div> <div>DHCP Snooping Global Configuration</div> <div>           • DHCP Snooping           <div>             DHCP Snooping Mode             <input type="radio"/> Disable             <input checked="" type="radio"/> Enable           </div> </div> <div>           • Global Configuration           <div>             MAC Address Validation             <input type="radio"/> Disable             <input checked="" type="radio"/> Enable           </div> </div> <div>           • Interface Configuration           <div>             VLAN Configuration             <table border="1"> <thead> <tr> <th>VLAN ID</th> <th>DHCP Snooping Mode</th> </tr> </thead> <tbody> <tr> <td></td> <td></td> </tr> </tbody> </table> </div> </div> |                    |                     |                 |          |            |             |      |       | VLAN ID | DHCP Snooping Mode |  |  |
| VLAN ID   | DHCP Snooping Mode |                     |                 |          |            |             |      |       |         |                    |  |  |
|   |                    |                     |                 |          |            |             |      |       |         |                    |  |  |

- b. For DHCP Snooping Mode, select the **Enable** radio button.
  - c. Click **Apply**.
2. Enable DHCP snooping in a VLAN.
  - a. Select **Security > Control > DHCP Snooping Global Configuration**.

A screen similar to the following displays.

| System  | Switching          | Routing             | QoS             | Security | Monitoring | Maintenance | Help | Index |         |                    |  |  |
|---|--------------------|---------------------|-----------------|----------|------------|-------------|------|-------|---------|--------------------|--|--|
| Management Security   | Access             | Port Authentication | Traffic Control | Control  | ACL        |             |      |       |         |                    |  |  |
| <div>Control</div> <div>DHCP Snooping Global Configuration</div> <div>           • DHCP Snooping           <div>             DHCP Snooping Mode             <input type="radio"/> Disable             <input checked="" type="radio"/> Enable           </div> </div> <div>           • Global Configuration           <div>             MAC Address Validation             <input type="radio"/> Disable             <input checked="" type="radio"/> Enable           </div> </div> <div>           • Interface Configuration           <div>             VLAN Configuration             <table border="1"> <thead> <tr> <th>VLAN ID</th> <th>DHCP Snooping Mode</th> </tr> </thead> <tbody> <tr> <td></td> <td></td> </tr> </tbody> </table> </div> </div> |                    |                     |                 |          |            |             |      |       | VLAN ID | DHCP Snooping Mode |  |  |
| VLAN ID   | DHCP Snooping Mode |                     |                 |          |            |             |      |       |         |                    |  |  |
|   |                    |                     |                 |          |            |             |      |       |         |                    |  |  |

- b. In the **VLAN ID** field, enter **1**.
  - c. In the **DHCP Snooping Mode** field, select **Enable**.



A screen similar to the following displays.

| VLAN ID | DHCP Snooping Mode |
|---------|--------------------|
| 1       | Enable             |

3. Configure the port through which the DHCP server is reached as trusted.  
Here interface 1/0/1 is trusted.

- a. Select **Security > Control > DHCP Snooping Interface Configuration**.

A screen similar to the following displays.

| Interface | Trust Mode | Invalid Packets | Rate Limit(pps) | Burst Interval(secs) |
|-----------|------------|-----------------|-----------------|----------------------|
| 1/0/1     | Disable    | Disable         | None            | N/A                  |

- b. Select the check box for Interface **1/0/1**.
    - c. For Interface 1/0/1, set the Trust Mode as **Enable**.
    - d. Click **Apply**.

A screen similar to the following displays.

| Interface | Trust Mode | Invalid Packets | Rate Limit(pps) | Burst Interval(secs) |
|-----------|------------|-----------------|-----------------|----------------------|
| 1/0/1     | Enable     | Disable         | None            | N/A                  |

4. View the DHCP Snooping Binding table.
  - a. Select **Security > Control > DHCP Snooping Binding Configuration**.



A screen similar to the following displays.

| System   | Switching | Routing | QoS | Security | Monitoring | Maintenance | Help | Index |
|--|-----------|---------|-----|----------|------------|-------------|------|-------|
| Management Security Access Port Authentication Traffic Control Control ACL   |           |         |     |          |            |             |      |       |
| <div>Control</div> <div>Static Binding Configuration</div> <div> <input type="checkbox"/> Interface           <input type="text"/> MAC Address           <input type="text"/> VLAN ID           <input type="text"/> IP Address         </div> |           |         |     |          |            |             |      |       |

5. Enable ARP Inspection in VLAN 1.

- a. Select **Security > Control > Dynamic ARP Inspection > DAI VLAN Configuration**.

A screen similar to the following displays.

| System   | Switching  | Routing         | QoS          | Security    | Monitoring | Maintenance | Help | Index |         |            |                 |              |             |                            |         |        |  |         |                            |         |        |  |         |                               |         |        |  |         |
|--|------------|-----------------|--------------|-------------|------------|-------------|------|-------|---------|------------|-----------------|--------------|-------------|----------------------------|---------|--------|--|---------|----------------------------|---------|--------|--|---------|-------------------------------|---------|--------|--|---------|
| Management Security Access Port Authentication Traffic Control Control ACL   |            |                 |              |             |            |             |      |       |         |            |                 |              |             |                            |         |        |  |         |                            |         |        |  |         |                               |         |        |  |         |
| <div>Control</div> <div>VLAN Configuration</div> <table border="1"> <thead> <tr> <th>VLAN ID</th> <th>Admin Mode</th> <th>Invalid Packets</th> <th>ARP ACL Name</th> <th>Static Flag</th> </tr> </thead> <tbody> <tr> <td><input type="checkbox"/> 1</td> <td>Disable</td> <td>Enable</td> <td></td> <td>Disable</td> </tr> <tr> <td><input type="checkbox"/> 3</td> <td>Disable</td> <td>Enable</td> <td></td> <td>Disable</td> </tr> <tr> <td><input type="checkbox"/> 2000</td> <td>Disable</td> <td>Enable</td> <td></td> <td>Disable</td> </tr> </tbody> </table> |            |                 |              |             |            |             |      |       | VLAN ID | Admin Mode | Invalid Packets | ARP ACL Name | Static Flag | <input type="checkbox"/> 1 | Disable | Enable |  | Disable | <input type="checkbox"/> 3 | Disable | Enable |  | Disable | <input type="checkbox"/> 2000 | Disable | Enable |  | Disable |
| VLAN ID  | Admin Mode | Invalid Packets | ARP ACL Name | Static Flag |            |             |      |       |         |            |                 |              |             |                            |         |        |  |         |                            |         |        |  |         |                               |         |        |  |         |
| <input type="checkbox"/> 1   | Disable    | Enable          |              | Disable     |            |             |      |       |         |            |                 |              |             |                            |         |        |  |         |                            |         |        |  |         |                               |         |        |  |         |
| <input type="checkbox"/> 3   | Disable    | Enable          |              | Disable     |            |             |      |       |         |            |                 |              |             |                            |         |        |  |         |                            |         |        |  |         |                               |         |        |  |         |
| <input type="checkbox"/> 2000  | Disable    | Enable          |              | Disable     |            |             |      |       |         |            |                 |              |             |                            |         |        |  |         |                            |         |        |  |         |                               |         |        |  |         |

- b. In the **VLAN ID** field, enter 1.

- c. In the **Dynamic ARP Inspection** field, select **Enable**.

A screen similar to the following displays.

| System   | Switching  | Routing         | QoS          | Security    | Monitoring | Maintenance | Help | Index |         |            |                 |              |             |                                       |        |        |  |         |                            |         |        |  |         |                               |         |        |  |         |
|--|------------|-----------------|--------------|-------------|------------|-------------|------|-------|---------|------------|-----------------|--------------|-------------|---------------------------------------|--------|--------|--|---------|----------------------------|---------|--------|--|---------|-------------------------------|---------|--------|--|---------|
| Management Security Access Port Authentication Traffic Control Control ACL   |            |                 |              |             |            |             |      |       |         |            |                 |              |             |                                       |        |        |  |         |                            |         |        |  |         |                               |         |        |  |         |
| <div>Control</div> <div>VLAN Configuration</div> <table border="1"> <thead> <tr> <th>VLAN ID</th> <th>Admin Mode</th> <th>Invalid Packets</th> <th>ARP ACL Name</th> <th>Static Flag</th> </tr> </thead> <tbody> <tr> <td><input checked="" type="checkbox"/> 1</td> <td>Enable</td> <td>Enable</td> <td></td> <td>Disable</td> </tr> <tr> <td><input type="checkbox"/> 3</td> <td>Disable</td> <td>Enable</td> <td></td> <td>Disable</td> </tr> <tr> <td><input type="checkbox"/> 2000</td> <td>Disable</td> <td>Enable</td> <td></td> <td>Disable</td> </tr> </tbody> </table> |            |                 |              |             |            |             |      |       | VLAN ID | Admin Mode | Invalid Packets | ARP ACL Name | Static Flag | <input checked="" type="checkbox"/> 1 | Enable | Enable |  | Disable | <input type="checkbox"/> 3 | Disable | Enable |  | Disable | <input type="checkbox"/> 2000 | Disable | Enable |  | Disable |
| VLAN ID  | Admin Mode | Invalid Packets | ARP ACL Name | Static Flag |            |             |      |       |         |            |                 |              |             |                                       |        |        |  |         |                            |         |        |  |         |                               |         |        |  |         |
| <input checked="" type="checkbox"/> 1  | Enable     | Enable          |              | Disable     |            |             |      |       |         |            |                 |              |             |                                       |        |        |  |         |                            |         |        |  |         |                               |         |        |  |         |
| <input type="checkbox"/> 3   | Disable    | Enable          |              | Disable     |            |             |      |       |         |            |                 |              |             |                                       |        |        |  |         |                            |         |        |  |         |                               |         |        |  |         |
| <input type="checkbox"/> 2000  | Disable    | Enable          |              | Disable     |            |             |      |       |         |            |                 |              |             |                                       |        |        |  |         |                            |         |        |  |         |                               |         |        |  |         |

- d. Click **Apply**.

A screen similar to the following displays.

| System   | Switching  | Routing         | QoS          | Security    | Monitoring | Maintenance | Help | Index |         |            |                 |              |             |                                       |        |        |  |         |                            |         |        |  |         |                               |         |        |  |         |
|--|------------|-----------------|--------------|-------------|------------|-------------|------|-------|---------|------------|-----------------|--------------|-------------|---------------------------------------|--------|--------|--|---------|----------------------------|---------|--------|--|---------|-------------------------------|---------|--------|--|---------|
| Management Security Access Port Authentication Traffic Control Control ACL   |            |                 |              |             |            |             |      |       |         |            |                 |              |             |                                       |        |        |  |         |                            |         |        |  |         |                               |         |        |  |         |
| <div>Control</div> <div>VLAN Configuration</div> <table border="1"> <thead> <tr> <th>VLAN ID</th> <th>Admin Mode</th> <th>Invalid Packets</th> <th>ARP ACL Name</th> <th>Static Flag</th> </tr> </thead> <tbody> <tr> <td><input checked="" type="checkbox"/> 1</td> <td>Enable</td> <td>Enable</td> <td></td> <td>Disable</td> </tr> <tr> <td><input type="checkbox"/> 3</td> <td>Disable</td> <td>Enable</td> <td></td> <td>Disable</td> </tr> <tr> <td><input type="checkbox"/> 2000</td> <td>Disable</td> <td>Enable</td> <td></td> <td>Disable</td> </tr> </tbody> </table> |            |                 |              |             |            |             |      |       | VLAN ID | Admin Mode | Invalid Packets | ARP ACL Name | Static Flag | <input checked="" type="checkbox"/> 1 | Enable | Enable |  | Disable | <input type="checkbox"/> 3 | Disable | Enable |  | Disable | <input type="checkbox"/> 2000 | Disable | Enable |  | Disable |
| VLAN ID  | Admin Mode | Invalid Packets | ARP ACL Name | Static Flag |            |             |      |       |         |            |                 |              |             |                                       |        |        |  |         |                            |         |        |  |         |                               |         |        |  |         |
| <input checked="" type="checkbox"/> 1  | Enable     | Enable          |              | Disable     |            |             |      |       |         |            |                 |              |             |                                       |        |        |  |         |                            |         |        |  |         |                               |         |        |  |         |
| <input type="checkbox"/> 3   | Disable    | Enable          |              | Disable     |            |             |      |       |         |            |                 |              |             |                                       |        |        |  |         |                            |         |        |  |         |                               |         |        |  |         |
| <input type="checkbox"/> 2000  | Disable    | Enable          |              | Disable     |            |             |      |       |         |            |                 |              |             |                                       |        |        |  |         |                            |         |        |  |         |                               |         |        |  |         |

Now all the ARP packets received on the ports that are member of the VLAN are copied to the CPU for ARP inspection. If there are trusted ports, you can configure them as

trusted in the next step. ARP packets received on the trusted ports are not copied to the CPU.

---

**Note:** Make sure that the administrator computer has a DHCP snooping entry or can access the device through the trusted port for ARP. Otherwise, you might get disconnected from the device.

---

6. Configure port 1/0/1 as trusted.
  - a. Select **Security > Control > Dynamic ARP Inspection > DAI Interface Configuration**.
  - b. Select the Interface **1/0/1** check box.
  - c. For the **Trust Mode**, select **Enable**.
  - d. Click **Apply**.

A screen similar to the following displays.

| Interface                      | Trust Mode | Rate Limit(pps) | Burst Interval(secs) |
|--------------------------------|------------|-----------------|----------------------|
| <input type="checkbox"/> 1/0/1 | Disable    | 15              | 1                    |
| <input type="checkbox"/> 1/0/2 | Disable    | 15              | 1                    |
| <input type="checkbox"/> 1/0/3 | Disable    | 15              | 1                    |
| <input type="checkbox"/> 1/0/4 | Disable    | 15              | 1                    |
| <input type="checkbox"/> 1/0/5 | Disable    | 15              | 1                    |

Now ARP packets from the DHCP client will go through; however ARP packets from the static client are dropped, since it does not have a DHCP snooping entry. It can be overcome by static configuration as described in the following section, [Static Mapping on page 350](#).

## Static Mapping

The example is shown as CLI commands and as a local browser interface procedure.

### CLI: Configure Static Mapping

1. Create an ARP ACL.

```
(Netgear Switch) (Config)# arp access-list ArpFilter
```

## 2. Configure the rule to allow the static client.

```
(Netgear Switch) (Config-arp-access-list)# permit ip host 192.168.10.2
mac host 00:11:85:ee:54:e9
```

## 3. Configure ARP ACL used for VLAN 1.

```
(Netgear Switch) (Config)# ip arp inspection filter ArpFilter vlan 1
```

Now the ARP packets from the static client go through because the client has an entry in the ARP table. ACL ARP packets from the DHCP client go also through because the client has a DHCP snooping entry.

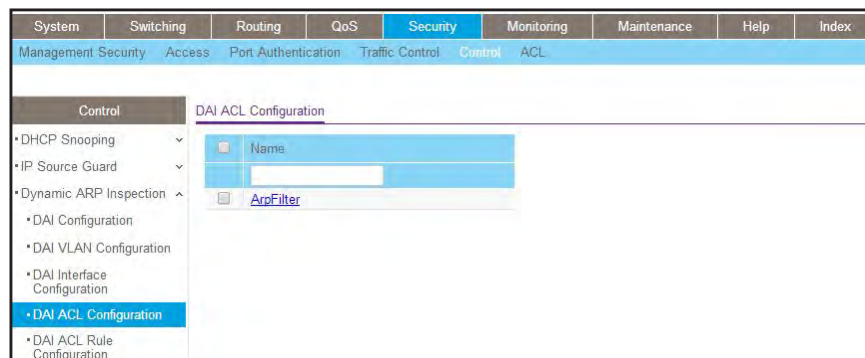
This command can include the optional **static** keyword. If the **static** keyword is given, packets that do not match a permit statement are dropped without consulting the DHCP snooping bindings. In this example, ARP packets from the DHCP client are dropped since it does not have a matching rule, though it has a DHCP snooping entry.

# Local Browser Interface: Configure Static Mapping

## 1. Create an ARP ACL.

- Select **Security > Control > Dynamic ARP Inspection > DAI ACL Configuration**.
- In the **Name** field, enter **ArpFilter**.
- Click **Add**.

A screen similar to the following displays.



## 2. Configure a rule to allow the static client.

- Select **Security > Control > Dynamic ARP Inspection > DAI ACL Rule Configuration**.
- In the **ACL Name** list, select **ArpFilter**.
- In the **Source IP Address** field, enter **192.168.10.2**.
- In the **Source MAC Address** field, enter **00:11:85:EE:54:E9**.
- Click **Add**.

A screen similar to the following displays.

The screenshot shows the switch configuration interface with the 'Security' tab selected. The left sidebar lists various configuration options under 'Control', including 'Dynamic ARP Inspection'. The main area shows the 'Rules' configuration for 'Dynamic ARP Inspection'. The 'ACL Name' is set to 'ArpFilter'. Below this, the 'DAI Rule Table' is displayed with columns for 'Source IP Address' and 'Source MAC Address'. A single rule is shown with the IP address '192.168.10.2' and the MAC address '00:11:85:EE:54:E9'.

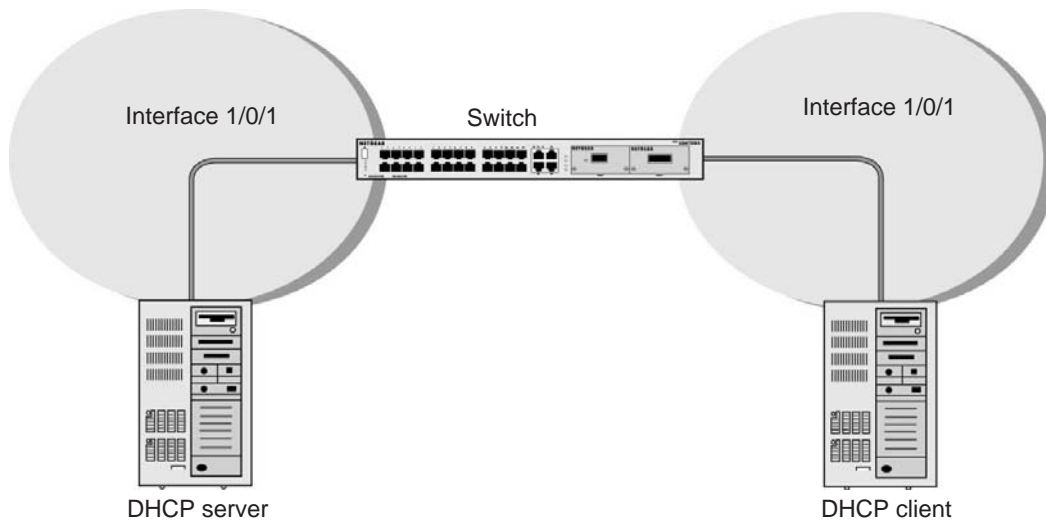
3. Configure the ARP ACL used for VLAN 1.
  - a. Select **Security > Control > Dynamic ARP Inspection > DAI VLAN Configuration**.
  - b. In the **ARP ACL Name** field, enter **ArpFilter**.
  - c. Click **Apply**.

A screen similar to the following displays.

The screenshot shows the switch configuration interface with the 'Security' tab selected. The left sidebar lists various configuration options under 'Control', including 'DAI VLAN Configuration'. The main area shows the 'VLAN Configuration' for 'Dynamic ARP Inspection'. The table has columns for 'VLAN ID', 'Admin Mode', 'Invalid Packets', 'ARP ACL Name', and 'Static Flag'. A single entry is shown for VLAN ID '1' with 'Admin Mode' set to 'Enable', 'Invalid Packets' set to 'Enable', 'ARP ACL Name' set to 'ArpFilter', and 'Static Flag' set to 'Disable'.

## DHCP Snooping

DHCP snooping is a security feature that monitors DHCP messages between a DHCP client and DHCP server to filter harmful DHCP message and to build a bindings database of (MAC address, IP address, VLAN ID, port) tuples that are considered authorized. The network administrator enables DHCP snooping globally and on specific VLANs and configures ports within the VLAN to be trusted or untrusted. DHCP servers must be reached through trusted ports.



**Figure 39. DHCP Snooping**

The example is shown as CLI commands and as a local browser interface procedure.

## CLI: Configure DHCP Snooping

1. Enable DHCP snooping globally.

```
(Netgear Switch) (Config)# ip dhcp snooping
```

2. Enable DHCP snooping in a VLAN.

```
(Netgear Switch) (Config)# ip dhcp snooping vlan 1
```

3. Configure the port through which the DHCP server is reached as trusted.

```
(Netgear Switch) (Config)# interface 1/0/1
(Netgear Switch) (Interface 1/0/1)# ip dhcp snooping trust
```

4. View the DHCP Snooping Binding table.

```
(Netgear Switch) #show ip dhcp snooping binding

Total number of bindings: 1

MAC Address      IP Address      VLAN  Interface  Type      Lease (Secs)
-----
00:16:76:A7:88:CC 192.168.10.89   1     1/0/2     DYNAMIC   86400
```

# Local Browser Interface: Configure DHCP Snooping

## 1. Enable DHCP snooping globally:

### a. Select **Security > Control > DHCP Snooping Global Configuration**.

A screen similar to the following displays.

| System  | Switching          | Routing             | QoS             | Security | Monitoring | Maintenance | Help | Index |         |                    |  |  |
|---|--------------------|---------------------|-----------------|----------|------------|-------------|------|-------|---------|--------------------|--|--|
| Management Security   | Access             | Port Authentication | Traffic Control | Control  | ACL        |             |      |       |         |                    |  |  |
| <div>Control</div> <div>DHCP Snooping Global Configuration</div> <div> <div>DHCP Snooping Mode</div> <div> <input checked="" type="radio"/> Disable           <input type="radio"/> Enable         </div> </div> <div> <div>MAC Address Validation</div> <div> <input type="radio"/> Disable           <input checked="" type="radio"/> Enable         </div> </div> <div>VLAN Configuration</div> <table border="1"> <thead> <tr> <th>VLAN ID</th> <th>DHCP Snooping Mode</th> </tr> </thead> <tbody> <tr> <td></td> <td></td> </tr> </tbody> </table> |                    |                     |                 |          |            |             |      |       | VLAN ID | DHCP Snooping Mode |  |  |
| VLAN ID   | DHCP Snooping Mode |                     |                 |          |            |             |      |       |         |                    |  |  |
|   |                    |                     |                 |          |            |             |      |       |         |                    |  |  |

### b. For DHCP Snooping Mode, select **Enable**.

### c. Click **Apply**.

A screen similar to the following displays.

| System  | Switching          | Routing             | QoS             | Security | Monitoring | Maintenance | Help | Index |         |                    |  |  |
|---|--------------------|---------------------|-----------------|----------|------------|-------------|------|-------|---------|--------------------|--|--|
| Management Security   | Access             | Port Authentication | Traffic Control | Control  | ACL        |             |      |       |         |                    |  |  |
| <div>Control</div> <div>DHCP Snooping Global Configuration</div> <div> <div>DHCP Snooping Mode</div> <div> <input checked="" type="radio"/> Disable           <input type="radio"/> Enable         </div> </div> <div> <div>MAC Address Validation</div> <div> <input type="radio"/> Disable           <input checked="" type="radio"/> Enable         </div> </div> <div>VLAN Configuration</div> <table border="1"> <thead> <tr> <th>VLAN ID</th> <th>DHCP Snooping Mode</th> </tr> </thead> <tbody> <tr> <td></td> <td></td> </tr> </tbody> </table> |                    |                     |                 |          |            |             |      |       | VLAN ID | DHCP Snooping Mode |  |  |
| VLAN ID   | DHCP Snooping Mode |                     |                 |          |            |             |      |       |         |                    |  |  |
|   |                    |                     |                 |          |            |             |      |       |         |                    |  |  |

## 2. Enable DHCP snooping in a VLAN.

### a. Select **Security > Control > DHCP Snooping Global Configuration**.

A screen similar to the following displays.

| System  | Switching          | Routing             | QoS             | Security | Monitoring | Maintenance | Help | Index |         |                    |  |  |
|---|--------------------|---------------------|-----------------|----------|------------|-------------|------|-------|---------|--------------------|--|--|
| Management Security   | Access             | Port Authentication | Traffic Control | Control  | ACL        |             |      |       |         |                    |  |  |
| <div>Control</div> <div>DHCP Snooping Global Configuration</div> <div> <div>DHCP Snooping Mode</div> <div> <input checked="" type="radio"/> Disable           <input type="radio"/> Enable         </div> </div> <div> <div>MAC Address Validation</div> <div> <input type="radio"/> Disable           <input checked="" type="radio"/> Enable         </div> </div> <div>VLAN Configuration</div> <table border="1"> <thead> <tr> <th>VLAN ID</th> <th>DHCP Snooping Mode</th> </tr> </thead> <tbody> <tr> <td></td> <td></td> </tr> </tbody> </table> |                    |                     |                 |          |            |             |      |       | VLAN ID | DHCP Snooping Mode |  |  |
| VLAN ID   | DHCP Snooping Mode |                     |                 |          |            |             |      |       |         |                    |  |  |
|   |                    |                     |                 |          |            |             |      |       |         |                    |  |  |

### b. In the **VLAN ID** list, select **1**.



- c. For DHCP Snooping Mode, select the **Enable** radio button.

A screen similar to the following displays.

| VLAN ID | DHCP Snooping Mode |
|---------|--------------------|
| 1       | Enable             |

- d. Click **Apply**.

3. Configure the port through which DHCP server is reached as trusted.

- a. Select **Security > Control > DHCP Snooping Interface Configuration**.

A screen similar to the following displays.

| Interface | Trust Mode | Invalid Packets | Rate Limit(pps) | Burst Interval(secs) |
|-----------|------------|-----------------|-----------------|----------------------|
| 1/0/1     | Enable     | Disable         | None            | N/A                  |

- b. Select the Interface **1/0/1** check box.

- c. For Interface 1/01/, in the Trust Mode field, select **Enable**.

- d. Click **Apply**.

A screen similar to the following displays.

| Interface | Trust Mode | Invalid Packets | Rate Limit(pps) | Burst Interval(secs) |
|-----------|------------|-----------------|-----------------|----------------------|
| 1/0/1     | Enable     | Disable         | None            | N/A                  |
| 1/0/2     | Disable    | Disable         | None            | N/A                  |

4. Select **Security > Control > DHCP Snooping Binding Configuration**.

A screen similar to the following displays.

| Interface | MAC Address       | VLAN ID | IP Address    |
|-----------|-------------------|---------|---------------|
| 1/0/2     | 00:18:8B:56:FD:35 | 1       | 192.168.10.94 |



# Find a Rogue DHCP Server

If you enable DHCP snooping, you can find a rogue DHCP server in the network.

## CLI: Find a Rogue DHCP server

1. Check the statistics on the untrusted ports.

```
(NETGEAR) #show ip dhcp snooping statistics
```

| Interface | MAC Verify<br>Failures | Client Ifc<br>Mismatch | DHCP Server<br>Msgs Rec'd |
|-----------|------------------------|------------------------|---------------------------|
| -----     | -----                  | -----                  | -----                     |
| 1/0/1     | 0                      | 0                      | 0                         |
| 1/0/2     | 0                      | 0                      | 0                         |
| 1/0/3     | 0                      | 0                      | 0                         |
| 1/0/4     | 0                      | 0                      | 0                         |
| 1/0/5     | 0                      | 0                      | 0                         |
| 1/0/6     | 0                      | 0                      | 0                         |
| 1/0/7     | 0                      | 0                      | 0                         |
| 1/0/8     | 0                      | 0                      | 0                         |
| 1/0/9     | 0                      | 0                      | 0                         |
| 1/0/10    | 0                      | 0                      | 0                         |
| 1/0/11    | 0                      | 0                      | 0                         |
| 1/0/12    | 0                      | 0                      | 0                         |
| 1/0/13    | 0                      | 0                      | 0                         |
| 1/0/14    | 0                      | 0                      | 0                         |
| 1/0/15    | 0                      | 0                      | 0                         |
| 1/0/16    | 0                      | 0                      | 0                         |
| 1/0/17    | 0                      | 0                      | 0                         |
| 1/0/18    | 0                      | 0                      | 0                         |
| 1/0/19    | 0                      | 0                      | 0                         |
| 1/0/20    | 0                      | 0                      | 0                         |
| 1/0/21    | 0                      | 0                      | 0                         |
| 1/0/22    | 0                      | 0                      | 0                         |
| 1/0/23    | 0                      | 0                      | 0                         |
| 1/0/24    | 0                      | 0                      | 0                         |
| 1/0/25    | 0                      | 0                      | 0                         |
| 1/0/26    | 0                      | 0                      | 0                         |
| 1/0/27    | 3704                   | 0                      | 4634                      |

In the previous command output, the messages in the DHCP Server Msgs Rec'd column for port 1/0/27 increased, indicating that the port is connected to a rogue DHCP server.

2. Control the logging DHCP messages filtration by the DHCP Snooping application for port 1/0/27.

```
(Netgear Switch) (Interface 1/0/27)#ip dhcp snooping log-invalid
```

3. Display the buffered logging output and search for “DHCP packet; op Reply” so you can determine the IP address and MAC address of the rogue DHCP server.

```
(Netgear Switch) #show logging buffered
<12> Jan  1 05:45:02 172.26.2.129-1 DHCP_SNP[108612668]: ds_util.c(1777) 1112 %%
DHCP packet: op Reply, htype 1, hlen 6, hops 0, xid 3478478447, secs 0, ciaddr
0.0.0.0, yiaddr 10.100.4.14, server 10.100.5.253, giaddr 0.0.0.0, chaddr
6C:B0:CE:19:AE:3D.
<12> Jan  1 05:45:02 172.26.2.129-1 DHCP_SNP[108612668]: ds_util.c(1735) 1111 %% IP
packet: ver/hlen 0x45, tos 0, len 299, id 0, flags/offset 00, ttl 64, proto 17,
src 10.100.5.253, dst 255.255.255.255.
<12> Jan  1 05:45:02 172.26.2.129-1 DHCP_SNP[108612668]: ds_util.c(1702) 1110 %%
Ethernet header: dest FF:FF:FF:FF:FF:FF, src 00:26:F2:F6:B3:6C, type/len 0x8100.
<12> Jan  1 05:45:02 172.26.2.129-1 DHCP_SNP[108612668]: ds_main.c(2596) 1109 %%
DHCP snooping dropping DHCP server message received on untrusted interface 1/0/27 on
vlan 1. This message appears when DHCP Snooping untrusted port drops the DHCP Server
message.
```

In the previous example, the IP address of the DHCP server is 10.100.5.253 and the MAC address is 00:26:F2:F6:B3:6C.

## Local Browser Interface: Find a Rogue DHCP server

1. Check the statistics on the untrusted ports:
  - a. Select **Security > Control > DHCP Snooping > Statistics**.

A screen similar to the following displays.

| System                     | Switching | Routing             | QoS             | Security | Monitoring | Maintenance | Help | Index |
|----------------------------|-----------|---------------------|-----------------|----------|------------|-------------|------|-------|
| Management Security        | Access    | Port Authentication | Traffic Control | Control  | ACL        |             |      |       |
|                            |           |                     |                 |          |            |             |      |       |
| Control                    |           | 1/0/15              | 0               | 0        | 0          |             |      |       |
| • DHCP Snooping ^          |           | 1/0/16              | 0               | 0        | 0          |             |      |       |
| • Global Configuration     |           | 1/0/17              | 0               | 0        | 0          |             |      |       |
| • Interface Configuration  |           | 1/0/18              | 0               | 0        | 0          |             |      |       |
| • Binding Configuration    |           | 1/0/19              | 0               | 0        | 0          |             |      |       |
| • Persistent Configuration |           | 1/0/20              | 0               | 0        | 0          |             |      |       |
| • Statistics               |           | 1/0/21              | 0               | 0        | 0          |             |      |       |
| • IP Source Guard          |           | 1/0/22              | 0               | 0        | 0          |             |      |       |
| • IPv6 Source Guard        |           | 1/0/23              | 0               | 0        | 0          |             |      |       |
| • Dynamic ARP Inspection   |           | 1/0/24              | 0               | 0        | 0          |             |      |       |
| • Captive Portal           |           | 1/0/25              | 0               | 0        | 0          |             |      |       |
|                            |           | 1/0/26              | 0               | 0        | 0          |             |      |       |
|                            |           | 1/0/27              | 3532            | 0        | 4418       |             |      |       |
|                            |           | 1/0/28              | 0               | 0        | 0          |             |      |       |

- b. Determine if messages in the DHCP Server Msgs Rec'd column increase for any port.

- c. The previous figure shows that the messages increased for port 1/0/27, indicating that the port is connected to a rogue DHCP server.
2. Enable the logging of invalid packets for port 1/0/27.
  - a. Select **Security > Control > DHCP Snooping > Interface Configuration**.

A screen similar to the following displays.

| System                     | Switching | Routing                                    | QoS             | Security        | Monitoring      | Maintenance         | Help | Index |
|----------------------------|-----------|--|-----------------|-----------------|-----------------|---------------------|------|-------|
| Management Security        | Access    | Port Authentication                        | Traffic Control | Control         | ACL             |                     |      |       |
| Control                    |           | DHCP Snooping Interface Configuration      |                 |                 |                 |                     |      |       |
| • DHCP Snooping            |           | 1 2 LAG All                                |                 | Go To Interface |                 |                     | Go   |       |
| • Global Configuration     |           |  |                 |                 |                 |                     |      |       |
| • Interface Configuration  |           |  |                 |                 |                 |                     |      |       |
| • Binding Configuration    |           |  |                 |                 |                 |                     |      |       |
| • Persistent Configuration |           |  |                 |                 |                 |                     |      |       |
| • Statistics               |           |  |                 |                 |                 |                     |      |       |
| • IP Source Guard          |           |  |                 |                 |                 |                     |      |       |
| • IPv6 Source Guard        |           |  |                 |                 |                 |                     |      |       |
| • Dynamic ARP Inspection   |           |  |                 |                 |                 |                     |      |       |
| • Captive Portal           |           |  |                 |                 |                 |                     |      |       |
|                            |           | <input type="checkbox"/> Interface         | Trust Mode      | Invalid Packets | Rate Limit(pps) | Burst Interval(sec) |      |       |
|                            |           | <input type="checkbox"/> 1/0/27            | Disable         | Enable          | None            | N/A                 |      |       |
|                            |           | <input type="checkbox"/> 1/0/1             | Disable         | Disable         | None            | N/A                 |      |       |
|                            |           | <input type="checkbox"/> 1/0/2             | Disable         | Disable         | None            | N/A                 |      |       |
|                            |           | <input type="checkbox"/> 1/0/3             | Disable         | Disable         | None            | N/A                 |      |       |
|                            |           | <input type="checkbox"/> 1/0/4             | Disable         | Disable         | None            | N/A                 |      |       |
|                            |           | <input type="checkbox"/> 1/0/5             | Disable         | Disable         | None            | N/A                 |      |       |
|                            |           | <input type="checkbox"/> 1/0/6             | Disable         | Disable         | None            | N/A                 |      |       |
|                            |           | <input type="checkbox"/> 1/0/7             | Disable         | Disable         | None            | N/A                 |      |       |
|                            |           | <input type="checkbox"/> 1/0/8             | Disable         | Disable         | None            | N/A                 |      |       |
|                            |           | <input type="checkbox"/> 1/0/9             | Disable         | Disable         | None            | N/A                 |      |       |
|                            |           | <input type="checkbox"/> 1/0/10            | Disable         | Disable         | None            | N/A                 |      |       |
|                            |           | <input type="checkbox"/> 1/0/11            | Disable         | Disable         | None            | N/A                 |      |       |
|                            |           | <input type="checkbox"/> 1/0/12            | Disable         | Disable         | None            | N/A                 |      |       |
|                            |           | <input type="checkbox"/> 1/0/13            | Disable         | Disable         | None            | N/A                 |      |       |
|                            |           | <input type="checkbox"/> 1/0/14            | Disable         | Disable         | None            | N/A                 |      |       |
|                            |           | <input type="checkbox"/> 1/0/15            | Disable         | Disable         | None            | N/A                 |      |       |
|                            |           | <input type="checkbox"/> 1/0/16            | Disable         | Disable         | None            | N/A                 |      |       |
|                            |           | <input type="checkbox"/> 1/0/17            | Disable         | Disable         | None            | N/A                 |      |       |
|                            |           | <input type="checkbox"/> 1/0/18            | Disable         | Disable         | None            | N/A                 |      |       |
|                            |           | <input type="checkbox"/> 1/0/19            | Disable         | Disable         | None            | N/A                 |      |       |
|                            |           | <input type="checkbox"/> 1/0/20            | Disable         | Disable         | None            | N/A                 |      |       |
|                            |           | <input type="checkbox"/> 1/0/21            | Disable         | Disable         | None            | N/A                 |      |       |
|                            |           | <input type="checkbox"/> 1/0/22            | Disable         | Disable         | None            | N/A                 |      |       |
|                            |           | <input type="checkbox"/> 1/0/23            | Disable         | Disable         | None            | N/A                 |      |       |
|                            |           | <input type="checkbox"/> 1/0/24            | Disable         | Disable         | None            | N/A                 |      |       |
|                            |           | <input type="checkbox"/> 1/0/25            | Disable         | Disable         | None            | N/A                 |      |       |
|                            |           | <input type="checkbox"/> 1/0/26            | Disable         | Disable         | None            | N/A                 |      |       |
|                            |           | <input checked="" type="checkbox"/> 1/0/27 | Disable         | Disable         | None            | N/A                 |      |       |

- b. Select the **1/0/27** check box.
  - c. In the **Invalid Packets** field, select **Enable**.
  - d. Click **Apply**.
3. Determine the IP address and MAC address for the rogue DHCP server:
  - a. Select **Monitoring > Logs > Logs > Buffered logs**.

A screen similar to the following displays.

The screenshot shows the MikroTik WinBox interface with the Log window open. The Log window displays a list of system events, including DHCP server status changes and network interface configurations. The Log window has tabs for System, Scheduling, Routing, QoS, Security, Monitoring, Maintenance, Help, and Info. The Log window also has buttons for Clear, Update, Export, and Refresh. The Log window shows a list of log entries with columns for Time, Message, and Source. The log entries include DHCP server status changes and network interface configurations.

- b.** Search for “DHCP packet; op Reply”.

In the previous figure, the IP address of the DHCP server is 10.100.5.253 and the MAC address is 00:26:F2:F6:B3:6C.

# Enter Static Binding into the Binding Database

You can also enter the static binding into the binding database.

## CLI: Enter Static Binding into the Binding Database

1. Enter the DHCP snooping static binding.

```
(Netgear Switch) (Config)# ip dhcp snooping binding 00:11:11:11:11:11
vlan 1 192.168.10 .1 interface 1/0/2
```

2. Check to make sure that the binding database has the static entry.

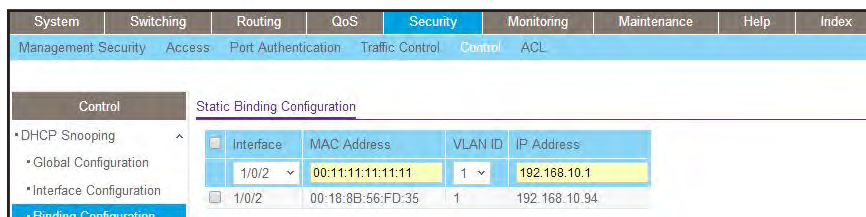
```
(Netgear Switch) #show ip dhcp snooping binding
Total number of bindings: 2
```

| MAC Address       | IP Address    | VLAN | Interface | Type    | Lease (Secs) |
|-------------------|---------------|------|-----------|---------|--------------|
| 00:11:11:11:11:11 | 192.168.10.1  | 1    | 1/0/2     | STATIC  |              |
| 00:16:76:A7:88:CC | 192.168.10.89 | 1    | 1/0/2     | DYNAMIC | 86348        |

## Local Browser Interface: Enter Static Binding into the Binding Database

1. Select **Security > Control > DHCP Snooping > Binding Configuration**.

A screen similar to the following displays.



2. Fill in the fields for the static binding and click **Apply**.

3. Check to make sure that the binding database shows the entry in the Static Binding Configuration table.

| System              | Switching | Routing             | QoS             | Security | Monitoring | Maintenance | Help | Index |
|---------------------|-----------|---------------------|-----------------|----------|------------|-------------|------|-------|
| Management Security | Access    | Port Authentication | Traffic Control | Control  | ACL        |             |      |       |
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|                     |           |                     |                 |          |            |             |      |       |
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|                     |           |                     |                 |          |            |             |      |       |
|                     |           |                     |                 |          |            |             |      |       |

## Local Browser Interface: Configure the Maximum Rate of DHCP Messages

1. Select **Security > Control > DHCP Snooping > Interface Configuration**.

A screen similar to the following displays.

| Interface | Trust Mode | Invalid Packets | Rate Limit(pps) | Burst Interval(secs) |
|-----------|------------|-----------------|-----------------|----------------------|
| 1/0/1     | Disable    | Disable         | None            | N/A                  |
| 1/0/2     | Disable    | Disable         | None            | N/A                  |
| 1/0/3     | Disable    | Disable         | None            | N/A                  |

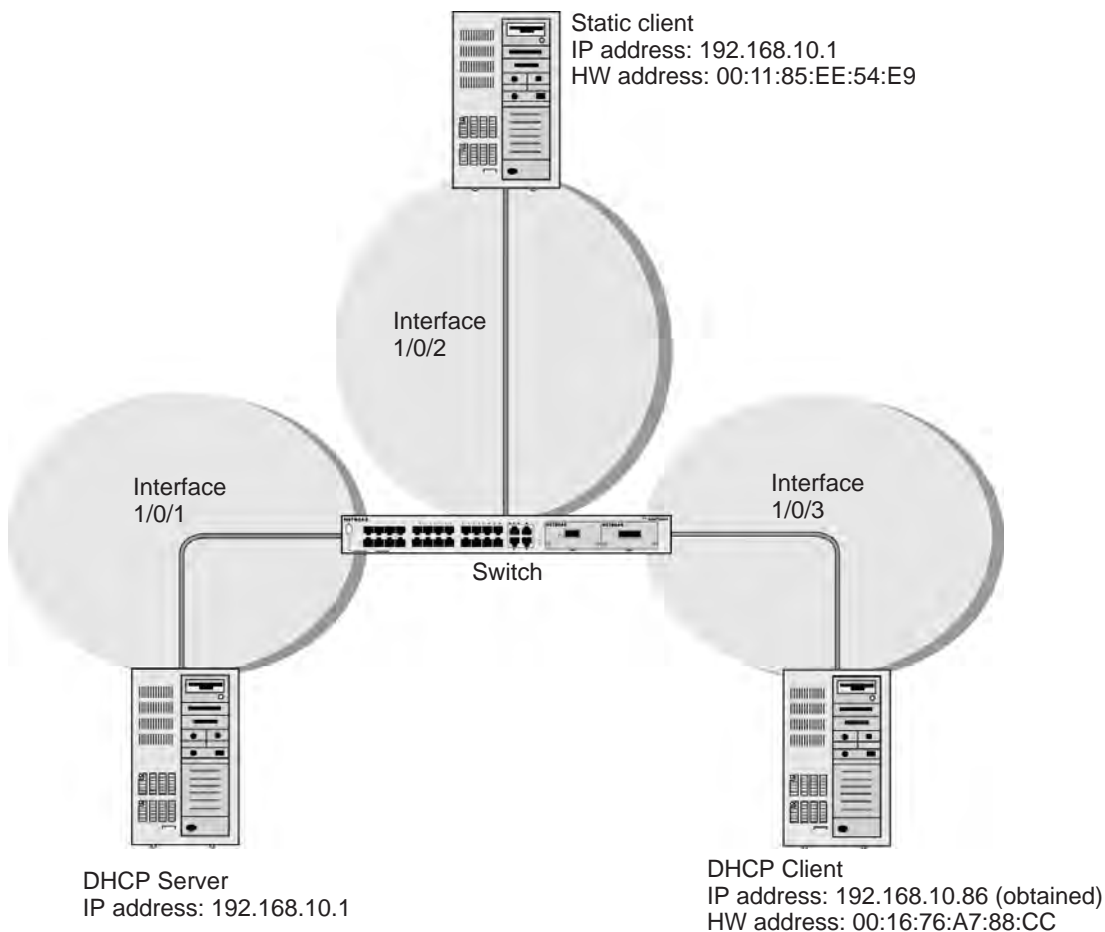
2. Select the interface, fill in the **Rate Limit (pps)** field, and then click **Apply**.

A screen similar to the following displays.

| Interface | Trust Mode | Invalid Packets | Rate Limit(pps) | Burst Interval(secs) |
|-----------|------------|-----------------|-----------------|----------------------|
| 1/0/1     | Disable    | Disable         | None            | N/A                  |
| 1/0/2     | Disable    | Disable         | None            | N/A                  |
| 1/0/3     | Disable    | Disable         | None            | N/A                  |

## IP Source Guard

IP Source Guard uses the DHCP snooping bindings database. When IP Source Guard is enabled, the switch drops incoming packets that do not match a binding in the bindings database. IP Source Guard can be configured to enforce just the source IP address or both the source IP address and source MAC address.



**Figure 40. IP Source Guard**

The example is shown as CLI commands and as a local browser interface procedure.

## CLI: Configure Dynamic ARP Inspection

1. Enable DHCP snooping globally.

```
(Netgear Switch) (Config)# ip dhcp snooping
```

2. Enable DHCP snooping in a VLAN.

```
(Netgear Switch) (Config)# ip dhcp snooping vlan 1
```



### 3. Configure the port through which the DHCP server is reached as trusted.

```
(Netgear Switch) (Config)# interface 1/0/1
(Netgear Switch) (Interface 1/0/1)# ip dhcp snooping trust
```

### 4. View the DHCP Snooping Binding table.

```
(Netgear Switch) #show ip dhcp snooping binding
```

Total number of bindings: 1

| MAC Address       | IP Address    | VLAN | Interface | Type    | Lease (Secs) |
|-------------------|---------------|------|-----------|---------|--------------|
| -----             | -----         | ---- | -----     | -----   | -----        |
| 00:16:76:A7:88:CC | 192.168.10.86 | 1    | 1/0/2     | DYNAMIC | 86400        |

If the entry does not exist in the DHCP Snooping Binding table, you can add the entry manually through the **ip verify binding** *mac-address* **vlan** *vlan-id* *ip-address* **interface** *interface-id* command in global configuration mode.

### 5. Enable IP Source Guard in interface 1/0/2.

```
(Netgear Switch) (Interface 1/0/2)#ip verify source [port-security]
```

With this configuration, the device verifies only the source IP address. If the port-security option is selected, the device verifies both the source IP address and the source MAC. But the port-security option needs you enable port-security in global mode and port mode like below:

```
(Netgear Switch) (Conf) # port-security
(Netgear Switch) (Interface 1/0/2) # port-security
```

# Local Browser Interface: Configure Dynamic ARP Inspection

1. Enable DHCP snooping globally.
  - a. Select **Security > Control > DHCP Snooping Global Configuration**.

A screen similar to the following displays.

| System  | Switching | Routing | QoS                 | Security        | Monitoring | Maintenance | Help | Index |
|---|-----------|---------|---------------------|-----------------|------------|-------------|------|-------|
| Management  | Security  | Access  | Port Authentication | Traffic Control | Control    | ACL         |      |       |
| <div>Control</div> <div>DHCP Snooping Global Configuration</div> <div>           • DHCP Snooping           <div>             DHCP Snooping Mode             <input checked="" type="radio"/> Disable             <input type="radio"/> Enable           </div> </div> <div>           • Global Configuration           <div>             MAC Address Validation             <input type="radio"/> Disable             <input checked="" type="radio"/> Enable           </div> </div> <div>           • Interface Configuration           <div>             VLAN Configuration           </div> </div> <div>           • Binding Configuration           <div>             VLAN ID             DHCP Snooping Mode           </div> </div> <div>           • Persistent Configuration           <div> <input type="text"/> <input type="text"/> </div> </div> <div>           • Statistics           <div> <input type="text"/> <input type="text"/> </div> </div> <div>           • IP Source Guard           <div> <input type="text"/> <input type="text"/> </div> </div> |           |         |                     |                 |            |             |      |       |

- b. For DHCP Snooping Mode, select the **Enable** radio button.

- c. Click **Apply**.

2. Enable DHCP snooping in a VLAN.

- a. Select **Security > Control > DHCP Snooping Global Configuration**.

A screen similar to the following displays.

| System  | Switching | Routing | QoS                 | Security        | Monitoring | Maintenance | Help | Index |
|---|-----------|---------|---------------------|-----------------|------------|-------------|------|-------|
| Management  | Security  | Access  | Port Authentication | Traffic Control | Control    | ACL         |      |       |
| <div>Control</div> <div>DHCP Snooping Global Configuration</div> <div>           • DHCP Snooping           <div>             DHCP Snooping Mode             <input type="radio"/> Disable             <input checked="" type="radio"/> Enable           </div> </div> <div>           • Global Configuration           <div>             MAC Address Validation             <input type="radio"/> Disable             <input checked="" type="radio"/> Enable           </div> </div> <div>           • Interface Configuration           <div>             VLAN Configuration           </div> </div> <div>           • Binding Configuration           <div>             VLAN ID             DHCP Snooping Mode           </div> </div> <div>           • Persistent Configuration           <div> <input type="text"/> <input type="text"/> </div> </div> <div>           • Statistics           <div> <input type="text"/> <input type="text"/> </div> </div> <div>           • IP Source Guard           <div> <input type="text"/> <input type="text"/> </div> </div> |           |         |                     |                 |            |             |      |       |

- b. In the VLAN Configuration table, in the **VLAN ID** list, select **1**.

- c. In the **DHCP Snooping Mode** field, select **Enable**.

A screen similar to the following displays.

| System   | Switching | Routing | QoS                 | Security        | Monitoring | Maintenance | Help | Index |
|--|-----------|---------|---------------------|-----------------|------------|-------------|------|-------|
| Management   | Security  | Access  | Port Authentication | Traffic Control | Control    | ACL         |      |       |
| <div>Control</div> <div>DHCP Snooping Global Configuration</div> <div>           • DHCP Snooping           <div>             DHCP Snooping Mode             <input type="radio"/> Disable             <input checked="" type="radio"/> Enable           </div> </div> <div>           • Global Configuration           <div>             MAC Address Validation             <input type="radio"/> Disable             <input checked="" type="radio"/> Enable           </div> </div> <div>           • Interface Configuration           <div>             VLAN Configuration           </div> </div> <div>           • Binding Configuration           <div>             VLAN ID             DHCP Snooping Mode           </div> </div> <div>           • Persistent Configuration           <div> <input checked="" type="checkbox"/> <input type="text"/> <input type="text"/> </div> </div> <div>           • Statistics           <div> <input type="text"/> <input type="text"/> </div> </div> <div>           • IP Source Guard           <div> <input type="text"/> <input type="text"/> </div> </div> <div>           • Dynamic ARP Inspection           <div> <input type="text"/> <input type="text"/> </div> </div> |           |         |                     |                 |            |             |      |       |

d. Click **Apply**.

A screen similar to the following displays.

| System   | Switching | Routing | QoS | Security | Monitoring | Maintenance | Help | Index |
|--|-----------|---------|-----|----------|------------|-------------|------|-------|
| Management Security Access Port Authentication Traffic Control <b>Control</b> ACL  |           |         |     |          |            |             |      |       |
| Control DHCP Snooping Global Configuration   |           |         |     |          |            |             |      |       |
| • DHCP Snooping ^ <div>             DHCP Snooping Mode <input type="radio"/> Disable <input checked="" type="radio"/> Enable             <br/>             MAC Address Validation <input type="radio"/> Disable <input checked="" type="radio"/> Enable           </div> |           |         |     |          |            |             |      |       |
| • Global Configuration<br>• Interface Configuration<br>• Binding Configuration<br>• Persistent Configuration<br>• Statistics<br>• IP Source Guard v  |           |         |     |          |            |             |      |       |
| VLAN Configuration   |           |         |     |          |            |             |      |       |
| <input checked="" type="checkbox"/> VLAN ID <div>             DHCP Snooping Mode             <br/>             1 Enable           </div>   |           |         |     |          |            |             |      |       |

3. Configure the port through which the DHCP server is reached as trusted.  
Here interface 1/0/1 is trusted.

a. Select **Security > Control > DHCP Snooping Interface Configuration**.

A screen similar to the following displays.

| System  | Switching  | Routing         | QoS             | Security             | Monitoring | Maintenance | Help | Index |           |            |                 |                 |                      |                                |        |         |      |     |   |         |         |      |     |                                |         |         |      |     |                                |         |         |      |     |
|---|------------|-----------------|-----------------|----------------------|------------|-------------|------|-------|-----------|------------|-----------------|-----------------|----------------------|--------------------------------|--------|---------|------|-----|---|---------|---------|------|-----|--------------------------------|---------|---------|------|-----|--------------------------------|---------|---------|------|-----|
| Management Security Access Port Authentication Traffic Control <b>Control</b> ACL   |            |                 |                 |                      |            |             |      |       |           |            |                 |                 |                      |                                |        |         |      |     |   |         |         |      |     |                                |         |         |      |     |                                |         |         |      |     |
| Control DHCP Snooping Interface Configuration   |            |                 |                 |                      |            |             |      |       |           |            |                 |                 |                      |                                |        |         |      |     |   |         |         |      |     |                                |         |         |      |     |                                |         |         |      |     |
| • DHCP Snooping ^ <div>             1 3 LAG All             <br/>             Go To Interface <input type="text"/> <b>Go</b> </div>   |            |                 |                 |                      |            |             |      |       |           |            |                 |                 |                      |                                |        |         |      |     |   |         |         |      |     |                                |         |         |      |     |                                |         |         |      |     |
| • Global Configuration<br>• <b>Interface Configuration</b><br>• Binding Configuration<br>• Persistent Configuration<br>• Statistics   |            |                 |                 |                      |            |             |      |       |           |            |                 |                 |                      |                                |        |         |      |     |   |         |         |      |     |                                |         |         |      |     |                                |         |         |      |     |
| <table border="1"> <thead> <tr> <th>Interface</th> <th>Trust Mode</th> <th>Invalid Packets</th> <th>Rate Limit(pps)</th> <th>Burst Interval(secs)</th> </tr> </thead> <tbody> <tr> <td><input type="checkbox"/> 1/0/1</td> <td>Enable</td> <td>Disable</td> <td>None</td> <td>N/A</td> </tr> <tr> <td><input checked="" type="checkbox"/> 1/0/1</td> <td>Disable</td> <td>Disable</td> <td>None</td> <td>N/A</td> </tr> <tr> <td><input type="checkbox"/> 1/0/2</td> <td>Disable</td> <td>Disable</td> <td>None</td> <td>N/A</td> </tr> <tr> <td><input type="checkbox"/> 1/0/3</td> <td>Disable</td> <td>Disable</td> <td>None</td> <td>N/A</td> </tr> </tbody> </table> |            |                 |                 |                      |            |             |      |       | Interface | Trust Mode | Invalid Packets | Rate Limit(pps) | Burst Interval(secs) | <input type="checkbox"/> 1/0/1 | Enable | Disable | None | N/A | <input checked="" type="checkbox"/> 1/0/1 | Disable | Disable | None | N/A | <input type="checkbox"/> 1/0/2 | Disable | Disable | None | N/A | <input type="checkbox"/> 1/0/3 | Disable | Disable | None | N/A |
| Interface   | Trust Mode | Invalid Packets | Rate Limit(pps) | Burst Interval(secs) |            |             |      |       |           |            |                 |                 |                      |                                |        |         |      |     |   |         |         |      |     |                                |         |         |      |     |                                |         |         |      |     |
| <input type="checkbox"/> 1/0/1  | Enable     | Disable         | None            | N/A                  |            |             |      |       |           |            |                 |                 |                      |                                |        |         |      |     |   |         |         |      |     |                                |         |         |      |     |                                |         |         |      |     |
| <input checked="" type="checkbox"/> 1/0/1   | Disable    | Disable         | None            | N/A                  |            |             |      |       |           |            |                 |                 |                      |                                |        |         |      |     |   |         |         |      |     |                                |         |         |      |     |                                |         |         |      |     |
| <input type="checkbox"/> 1/0/2  | Disable    | Disable         | None            | N/A                  |            |             |      |       |           |            |                 |                 |                      |                                |        |         |      |     |   |         |         |      |     |                                |         |         |      |     |                                |         |         |      |     |
| <input type="checkbox"/> 1/0/3  | Disable    | Disable         | None            | N/A                  |            |             |      |       |           |            |                 |                 |                      |                                |        |         |      |     |   |         |         |      |     |                                |         |         |      |     |                                |         |         |      |     |

- b. Select Interface **1/0/1** check box.  
 c. For interface 1/0/1, in the **Trust Mode** field, select **Enable**.  
 d. Click **Apply**.  
 a. Select **Security > Control > DHCP Snooping Interface Configuration**.

A screen similar to the following displays.

| System  | Switching  | Routing         | QoS             | Security             | Monitoring | Maintenance | Help | Index |           |            |                 |                 |                      |                                |        |         |      |     |   |         |         |      |     |                                |         |         |      |     |                                |         |         |      |     |
|---|------------|-----------------|-----------------|----------------------|------------|-------------|------|-------|-----------|------------|-----------------|-----------------|----------------------|--------------------------------|--------|---------|------|-----|---|---------|---------|------|-----|--------------------------------|---------|---------|------|-----|--------------------------------|---------|---------|------|-----|
| Management Security Access Port Authentication Traffic Control <b>Control</b> ACL   |            |                 |                 |                      |            |             |      |       |           |            |                 |                 |                      |                                |        |         |      |     |   |         |         |      |     |                                |         |         |      |     |                                |         |         |      |     |
| Control DHCP Snooping Interface Configuration   |            |                 |                 |                      |            |             |      |       |           |            |                 |                 |                      |                                |        |         |      |     |   |         |         |      |     |                                |         |         |      |     |                                |         |         |      |     |
| • DHCP Snooping ^ <div>             1 3 LAG All             <br/>             Go To Interface <input type="text"/> <b>Go</b> </div>   |            |                 |                 |                      |            |             |      |       |           |            |                 |                 |                      |                                |        |         |      |     |   |         |         |      |     |                                |         |         |      |     |                                |         |         |      |     |
| • Global Configuration<br>• <b>Interface Configuration</b><br>• Binding Configuration<br>• Persistent Configuration<br>• Statistics   |            |                 |                 |                      |            |             |      |       |           |            |                 |                 |                      |                                |        |         |      |     |   |         |         |      |     |                                |         |         |      |     |                                |         |         |      |     |
| <table border="1"> <thead> <tr> <th>Interface</th> <th>Trust Mode</th> <th>Invalid Packets</th> <th>Rate Limit(pps)</th> <th>Burst Interval(secs)</th> </tr> </thead> <tbody> <tr> <td><input type="checkbox"/> 1/0/1</td> <td>Enable</td> <td>Disable</td> <td>None</td> <td>N/A</td> </tr> <tr> <td><input checked="" type="checkbox"/> 1/0/1</td> <td>Disable</td> <td>Disable</td> <td>None</td> <td>N/A</td> </tr> <tr> <td><input type="checkbox"/> 1/0/2</td> <td>Disable</td> <td>Disable</td> <td>None</td> <td>N/A</td> </tr> <tr> <td><input type="checkbox"/> 1/0/3</td> <td>Disable</td> <td>Disable</td> <td>None</td> <td>N/A</td> </tr> </tbody> </table> |            |                 |                 |                      |            |             |      |       | Interface | Trust Mode | Invalid Packets | Rate Limit(pps) | Burst Interval(secs) | <input type="checkbox"/> 1/0/1 | Enable | Disable | None | N/A | <input checked="" type="checkbox"/> 1/0/1 | Disable | Disable | None | N/A | <input type="checkbox"/> 1/0/2 | Disable | Disable | None | N/A | <input type="checkbox"/> 1/0/3 | Disable | Disable | None | N/A |
| Interface   | Trust Mode | Invalid Packets | Rate Limit(pps) | Burst Interval(secs) |            |             |      |       |           |            |                 |                 |                      |                                |        |         |      |     |   |         |         |      |     |                                |         |         |      |     |                                |         |         |      |     |
| <input type="checkbox"/> 1/0/1  | Enable     | Disable         | None            | N/A                  |            |             |      |       |           |            |                 |                 |                      |                                |        |         |      |     |   |         |         |      |     |                                |         |         |      |     |                                |         |         |      |     |
| <input checked="" type="checkbox"/> 1/0/1   | Disable    | Disable         | None            | N/A                  |            |             |      |       |           |            |                 |                 |                      |                                |        |         |      |     |   |         |         |      |     |                                |         |         |      |     |                                |         |         |      |     |
| <input type="checkbox"/> 1/0/2  | Disable    | Disable         | None            | N/A                  |            |             |      |       |           |            |                 |                 |                      |                                |        |         |      |     |   |         |         |      |     |                                |         |         |      |     |                                |         |         |      |     |
| <input type="checkbox"/> 1/0/3  | Disable    | Disable         | None            | N/A                  |            |             |      |       |           |            |                 |                 |                      |                                |        |         |      |     |   |         |         |      |     |                                |         |         |      |     |                                |         |         |      |     |

4. View the DHCP Snooping Binding table.

Select **Security > Control > DHCP Snooping Binding Configuration**.

A screen similar to the following displays.

| Interface | MAC Address       | VLAN ID | IP Address    |
|-----------|-------------------|---------|---------------|
| 1/0/2     | 00:18:8B:56:FD:35 | 1       | 192.168.10.94 |

5. Enable IP source guard in the interface 1/0/2.
  - a. Select **Security > Control > IP Source Guard > Interface Configuration**.
  - b. Select the Interface **1/0/2** check box.
  - c. For the IPSG mode, select **Enable**.
  - d. Click **Apply**.

A screen similar to the following displays.

| Interface | IPSG Mode | IPSG Port Security |
|-----------|-----------|--------------------|
| 1/0/1     | Disable   | Disable            |
| 1/0/2     | Disable   | Disable            |

6. Set up IP source guard static binding.
  - a. Select **Security > Control > IP Source Guard > Binding Configuration**.
  - b. Select the Interface **1/0/2** check box.
  - c. In the **MAC Address** field, enter **00:05:05:05:05:05**.
  - d. In the **VLAN ID** field, enter **1**.
  - e. In the **IP Address** field, enter **192.168.10.80**.
  - f. Click **Add**.

A screen similar to the following displays.

| Interface | MAC Address       | VLAN ID | IP Address    | Filter Type |
|-----------|-------------------|---------|---------------|-------------|
| 1/0/2     | 00:05:05:05:05:05 | 1       | 192.168.10.80 |             |

# Command Authorization

Authorization determines if a user is authorized to perform certain activities such as entering specific EXEC commands.

TACACS+ servers support command authorization. The RADIUS protocol does not support command authorization but you can use a vendor-specific attribute (VSA) with attribute value (AV) pair 26 to download a list of commands that are permitted or denied for a user. This list of commands is downloaded from the RADIUS server. When a user executes a command, the command is validated against the downloaded command list for the user. Any change in a user command authorization access list takes effect after a user has logged on and logged in again.

The vendor-specific attribute `netgear-cmdAuth` is defined as follows:

```
VENDOR      netgear      4526
ATTRIBUTE   netgear-cmdAuth      1      string      netgear
```

Specify the command in the following format.

```
netgear-cmdAuth = "deny:spanning-tree;interface *",
```

---

**Note:** The maximum length of the command string in the vendor attribute cannot be longer than 64 bytes. RADIUS-based command authorization supports a maximum of 50 commands.

---



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**Note:** You can use both a TACACS+ server and a RADIUS server for command authorization. If the first method of command authorization returns an error, the second method is used for command authorization.

---

## CLI Example 1: Configure Command Authorization by a TACACS+ Server

The following example shows how to use the CLI to configure command authorization by a TACACS+ server for a Telnet user and allow the user to access specific commands only.

1. Change the authentication mode for Telnet users to TACACS.

```
(Netgear Switch)(Config)#aaa authentication login "networkList" tacacs
```

**2. Verify that TACACS authentication is set up for Telnet users.**

```
(Netgear Switch)#show authentication methods

Login Authentication Method Lists
-----
defaultList      :   local
networkList      :   tacacs

Enable Authentication Method Lists
-----
enableList       :   enable   none
enableNetList    :   enable   none

Line      Login Method List      Enable Method List
-----
Console   defaultList            enableList
Telnet     networkList            enableList
SSH        networkList            enableList

HTTPS      :local
HTTP       :local
DOT1X      :
```

**3. Create a command authorization list and configure TACACS as the authorization.**

```
(Netgear Switch)(Config)#aaa authorization commands "commandList" tacacs
```

**4. Configure command and privileged EXEC authorization for Telnet.**

```
(Netgear Switch)(Config)#line telnet
(Netgear Switch)(Config-telnet) #authorization commands commandList
(Netgear Switch)(Config-telnet) #exit
(Netgear Switch)(Config) #exit
```

**5. Configure a TACACS+ server.**

```
(Netgear Switch)(Config)#tacacs-server host 10.100.5.13
(Netgear Switch)(Config)#tacacs-server key 12345678
```

**6. Verify that command and privileged EXEC authorization are set up for Telnet.**

```
(Netgear Switch)#show authorization methods
Command Authorization Method Lists
-----
dfltCmdAuthList          :      none
commandlist              :      tacacs
Line      Command Method List
-----
Console    dfltCmdAuthList
Telnet     commandlist
SSH        dfltCmdAuthList
Exec Authorization Method Lists
-----
dfltExecAuthList         :      none
Line      Exec Method List
-----
Console    dfltExecAuthList
Telnet     dfltExecAuthList
SSH        dfltExecAuthList
```

**7. Using Linux on the TACACS server, configure an encryption key in the file tac\_plus.conf.**

```
key = "12345678"
accounting syslog;
accounting file = /var/log/tac_plus/tac_plus.acct
```



8. Using Linux on the TACACS server, allow a user named eric to access specific commands in the file `tac_plus.conf`.

```

user = eric {
    # member = network_user {
    default service = deny
    login = des qbVVseTcbtzS2

    service = exec {
    priv-lvl = 15
    }
    cmd = show {
        permit .*
    }
    cmd = exit {
        permit .*
    }
    cmd = configure {
        permit .*
    }
    cmd = interface {
        permit .*
    }
    cmd = switchport {
        permit "switchport access vlan.*"
        permit "switchport mode.*"
        permit "switchport trunk allowed vlan.*"
    }
}

```

## CLI Example 2: Configure Command Authorization by a RADIUS Server

The following example shows how to use the CLI to configure command authorization by a RADIUS server for a Telnet user and deny the user to access specific commands.

1. Configure a RADIUS server on the switch.

```

(Netgear Switch) #config
(Netgear Switch) (Config)#radius server host auth 172.26.2.41
(Netgear Switch) (Config)#radius server key auth 172.26.2.41
Enter secret (64 characters max):12345678
Re-enter secret:12345678

```

**2. Change the authentication mode for Telnet users to RADIUS.**

```
(Netgear Switch)(Config)#aaa authentication login networkList radius
```

**3. Verify that RADIUS authentication is set up for Telnet users.**

```
(Netgear Switch) #show authentication methods
Login Authentication Method Lists
-----
defaultList      : local
networkList      : radius

Enable Authentication Method Lists
-----
enableList       : enable  none
enableNetList    : enable  none

Line      Login Method List      Enable Method List
-----
Console   defaultList             enableList
Telnet    networkList             enableList
SSH       networkList             enableList

HTTPS      :local
HTTP       :local
DOT1X      :
```

**4. Create a command authorization list and configure RADIUS as the authorization.**

```
(Netgear Switch)(Config)# aaa authorization commands commandList radius
```

**5. Configure command authorization list for Telnet.**

```
Netgear Switch) (Config)#line telnet
(Netgear Switch) (Config-telnet)#authorization commands commandList
(Netgear Switch) (Config-telnet)#exit
```

**6. Verify that command authorization is set up for Telnet.**

```
(Netgear Switch) #show authorization methods
Command Authorization Method Lists
-----
dfltCmdAuthList      :      none
commandList          :      radius

Line      Command Method List
-----
Console   dfltCmdAuthList
Telnet    commandList
SSH       dfltCmdAuthList

Exec Authorization Method Lists
-----
dfltExecAuthList     :      none

Line      Exec Method List
-----
Console   dfltExecAuthList
Telnet    dfltExecAuthList
SSH       dfltExecAuthList
```

**7. Using Linux on the RADIUS server, configure NETGEAR as the vendor and 4526 as the vendor-specific value in the dictionary file for FreeRADIUS.**

```
VENDOR      netgear      4526
BEGIN-VENDOR netgear
ATTRIBUTE netgear-cmdAuth-deny 1      string
END-VENDOR netgear
```

**8. Using Linux on the RADIUS server, deny a user named eric access to specific commands in the user file for FreeRADIUS.**

```
eric Cleartext-Password := "testing"
    Service-Type = Login-User,
    netgear-cmdAuth-deny = "deny:poe *;spanningtree *;"
```

# Privileged Exec Command Mode Authorization

Authorization determines if a user is authorized to perform certain activities such as entering privileged EXEC commands.

When user command authentication succeeds, the user receives access to the user EXEC mode. You can also provide a user direct access to the privileged EXEC mode by using the EXEC authorization method.

If the EXEC authorization method uses a TACACS+ authorization server, a separate session is established with the TACACS+ server to return the authorization attributes.

If the EXEC authorization method uses a RADIUS authorization server, service-type attribute 6 or Cisco vendor-specific attribute (VSA) "shell:priv-lvl" is used. If the service-type attribute value is returned as administrator or the Cisco VSA "shell:priv-lvl" is at least FD\_USER\_MGR\_ADMIN\_ACCESS\_LEVEL(15), the user receives access to the privileged EXEC mode.

Because the RADIUS protocol does not support authorization, the privilege level attribute must be returned with the authentication response. If the service-type attribute is already present in RADIUS response packet as administrator, the Cisco VSA "shell:priv-lvl" is ignored.

## CLI Example 1: Configure EXEC Authorization by a TACACS+ Server

The following example shows how to use the CLI to configure command authorization by a TACACS+ server for a Telnet user and allow the user to access privileged EXEC mode directly.

1. Change the authentication mode for Telnet users to TACACS.

```
(Netgear Switch)(Config)#aaa authentication login "networkList" tacacs
```

**2. Verify that TACACS authentication is set up for Telnet users.**

```
(Netgear Switch) #show authentication methods

Login Authentication Method Lists
-----
defaultList      :   local
networkList      :   tacacs

Enable Authentication Method Lists
-----
enableList       :   enable   none
enableNetList    :   enable   none

Line      Login Method List      Enable Method List
-----
Console   defaultList            enableList
Telnet    networkList            enableList
SSH       networkList            enableList

HTTPS      :local
HTTP       :local
DOT1X      :
```

**3. Create an EXEC authorization list and configure TACACS as the authorization.**

```
(Netgear Switch)(Config)#aaa authorization exec "execList" tacacs
```

**4. Configure EXEC authorization for Telnet.**

```
(Netgear Switch)(Config)#line telnet
(Netgear Switch)(Config-telnet)#authorization exec execList
(Netgear Switch)(Config-telnet)#exit
```

## 5. Verify that EXEC authorization is set up for Telnet.

```
(Netgear Switch) #show authorization methods

Command Authorization Method Lists
-----
dfltCmdAuthList      :      none
commandlist          :      tacacs

Line      Command Method List
-----
Console   dfltCmdAuthList
Telnet    dfltCmdAuthList
SSH       dfltCmdAuthList

Exec Authorization Method Lists
-----
dfltExecAuthList     :      none
execList             :      tacacs

Line      Exec Method List
-----
Console   dfltExecAuthList
Telnet    execList
SSH       dfltExecAuthList
```

## 6. Using Linux on the TACACS server, configure an encryption key for the TACACS server in the file tac\_plus.conf.

```
key = "12345678"
accounting syslog;
accounting file = /var/log/tac_plus/tac_plus.acct
```

## 7. Using Linux on the TACACS server, allow a user named eric to access privileged EXEC mode directly as defined in the file tac\_plus.conf.

```
user = eric {
    # member = network_user {
    default service = permit
    login = des qbVVseTcbtzS2

    service = exec {
    priv-lvl = 15
    }
}
```

## CLI Example 2: Configure EXEC Authorization by a RADIUS Server

The following example shows how to use the CLI to configure command authorization by a RADIUS server for a Telnet user and allow the user to access privileged EXEC mode directly.

### 1. Configure a RADIUS server on the switch.

```
(Netgear Switch) #config
(Netgear Switch) (Config)#radius server host auth 172.26.2.41
(Netgear Switch) (Config)#radius server key auth 172.26.2.41
Enter secret (64 characters max):12345678
Re-enter secret:12345678
```

### 2. Change the authentication mode for Telnet users to RADIUS.

```
(Netgear Switch)(Config)#aaa authentication login networkList radius
```

### 3. Verify that the RADIUS authentication is set up for Telnet users.

```
(Netgear Switch) #show authentication methods
Login Authentication Method Lists
-----
defaultList      : local
networkList      : radius

Enable Authentication Method Lists
-----
enableList       : enable  none
enableNetList    : enable  none

Line    Login Method List    Enable Method List
-----  -
Console defaultList         enableList
Telnet   networkList          enableList
SSH      networkList             enableList

HTTPS    :local
HTTP     :local
DOT1X    :
```

### 4. Create an EXEC authorization list and configure RADIUS as the authorization.

```
(Netgear Switch)(Config)# aaa authorization exec execList radius
```



**5. Configure EXEC authorization for Telnet.**

```
(Netgear Switch) (Config)#line telnet
(Netgear Switch) (Config-telnet)# authorization exec execList
(Netgear Switch) (Config-telnet)#exit
```

**6. Verify that EXEC authorization is set up for Telnet.**

```
(Netgear Switch) #show authorization methods
Command Authorization Method Lists
-----
dfltCmdAuthList          :      none

Line      Command Method List
-----
Console   dfltCmdAuthList
Telnet    dfltCmdAuthList
SSH       dfltCmdAuthList

Exec Authorization Method Lists
-----
dfltExecAuthList         :      none
execList                 :      radius

Line      Exec Method List
-----
Console   dfltExecAuthList
Telnet    execList
SSH       dfltExecAuthList
```

**7. Using Linux on the RADIUS server, configure a user named eric as an administrator in the user file for FreeRADIUS.**

```
eric Cleartext-Password := "testing"
    Service-Type = Administrative-User,
```

**Note:** Instead, you can also configure a user named eric with Cisco-AVPair "shell:priv-lvl=15".

```
eric Cleartext-Password := "testing"
    Service-Type = Login-User,
    Cisco-AVPair = "shell:priv-lvl=15"
```

# Accounting

The accounting process records what a user does or has done on the switch. You can configure a TACACS+ accounting server or RADIUS accounting server to account for the following actions:

- Account for services that were used, such as in a billing environment. You can use this type of accounting as an auditing tool for security services.
- Account when a user logs in and logs out of a user EXEC session.

## CLI: Configure Telnet Command Accounting by a TACACS+ Server

---

**Note:** TACACS+ accounting supports both user EXEC command authorization and privileged EXEC command authorization.

---

```
(Netgear Switch)(Config)#tacacs-server host 10.100.5.13
(Netgear Switch)(Tacacs)#key 12345678

(Netgear Switch)(Tacacs)#exit
(Netgear Switch)(Config)#
(Netgear Switch)(Config)#aaa accounting commands default stop-only tacacs
(Netgear Switch)(Config)#line telnet
(Netgear Switch)(Config-telnet)#accounting commands default
(Netgear Switch)(Config-telnet)#exit

(Netgear Switch)#show accounting methods
```

| AcctType | MethodName   | MethodType | Method1 | Method2 |
|----------|--------------|------------|---------|---------|
| Exec     | dfltExecList | start-stop | radius  |         |
| Commands | dfltCmdList  | stop-only  | tacacs  |         |

| Line    | EXEC Method List | Command Method List |
|---------|------------------|---------------------|
| Console | none             | none                |
| Telnet  | dfltExecList     | dfltCmdList         |
| SSH     | none             | none                |
| HTTPS   | none             | none                |
| HTTP    | none             | none                |

## Configure Telnet EXEC Accounting by RADIUS Server

RADIUS accounting supports EXEC mode but does not support command mode.

```
(Netgear Switch)(Config)#radius server host acct 10.100.5.13
(Netgear Switch)(Config)#radius server key acct 10.100.5.13
Enter secret (64 characters max):12345678
Re-enter secret:12345678
(Netgear Switch)(Config)#radius accounting mode
(Netgear Switch)(Config)#aaa accounting exec default stop-only radius
(Netgear Switch)#show radius
Number of Configured Authentication Servers.... 0
Number of Configured Accounting Servers..... 1
Number of Named Authentication Server Groups... 0
Number of Named Accounting Server Groups..... 1
Number of Retransmits..... 4
Timeout Duration..... 5
RADIUS Accounting Mode..... Enable
RADIUS Attribute 4 Mode..... Disable
RADIUS Attribute 4 Value..... 0.0.0.0

(Netgear Switch) #show accounting methods
AcctType  MethodName          MethodType  Method1    Method2
-----  -
Exec      dfltExecList              stop-only   radius
Commands  dfltCmdList               stop-only   tacacs

Line      EXEC Method List          Command Method List
-----  -
Console   none                      none
Telnet    dfltExecList              dfltCmdList
SSH       none                      none
HTTPS     none                      none
HTTP      none                      none
```

# Use the Authentication Manager to Set Up an Authentication Method List

The authentication manager lets you configure an authentication method list, which you can apply on a per-port basis. If authentication is disabled, no authentication method is applied and the port provides open access. By default, authentication is disabled for all ports.

The authentication manager lets you configure the following authentication methods in an authentication method list:

- dot1x
- MAB
- captive portal (that is, web authentication)

The default authentication method list applies these authentication methods in the order dot1x, MAB, and captive portal as the default methods for all ports.

You cannot configure another authentication method after the captive portal method, that is, the captive portal method must be the last method in an authentication method list.

When a client connects to a port, the switch attempts to authenticate the client through the port-based authentication method list. If an authentication method times out (or an error occurs), the switch attempts to authenticate with the next authentication method in the list. If all authentication methods time out, the switch starts a timer for which the value is equal to the authentication restart timer. At the expiration of the timer, the authentication manager restarts the authentication process for the first method in the list. If the client connection goes down and comes up again, the authentication manager restarts the authentication sequence.

---

**Note:** The authentication manager controls only the order in which the switch executes the authentication methods. The authentication manager does not configure or change the authentication methods. You need to ensure that the switch is configured correctly so that the switch can execute the authentication methods as presented in the authentication method list.

---

The priority of an authentication method is determined by its position in authentication method list. If you do not configure authentication method priorities, the relative priorities (that is, the highest first) are in the same order as that of the port-based authentication list.

Authentication priority allows a higher-priority method to interrupt an authentication process that is in progress with a lower-priority method. Alternatively, if a client is already authenticated, an interrupt from a higher priority method can cause a client that is already authenticated through a lower-priority method to be reauthenticated through the higher-priority method.

## Configure a Dot1x-MAB Authentication Method List with Dot1x-MAB Priority

---

**Note:** This section describes how to configure the authentication order and priority. For information about configuring the dot1x authentication method, which is also referred to as 802.1x port security, see [802.1x Port Security](#) on page 327.

---

In this example, the authentication manager first selects dot1x as the authentication method. If dot1x authentication is successful, the client is authenticated. If the client is not enabled, dot1x and dot1x authentication time out, and the authentication manager selects MAB as the next authentication method. If MAB authentication is successful, the client is authenticated. If MAB authentication fails, the port is placed in the unauthorized state and the authentication manager starts a timer. When the timer expires, the authentication manager restarts the authentication process with dot1x authentication.

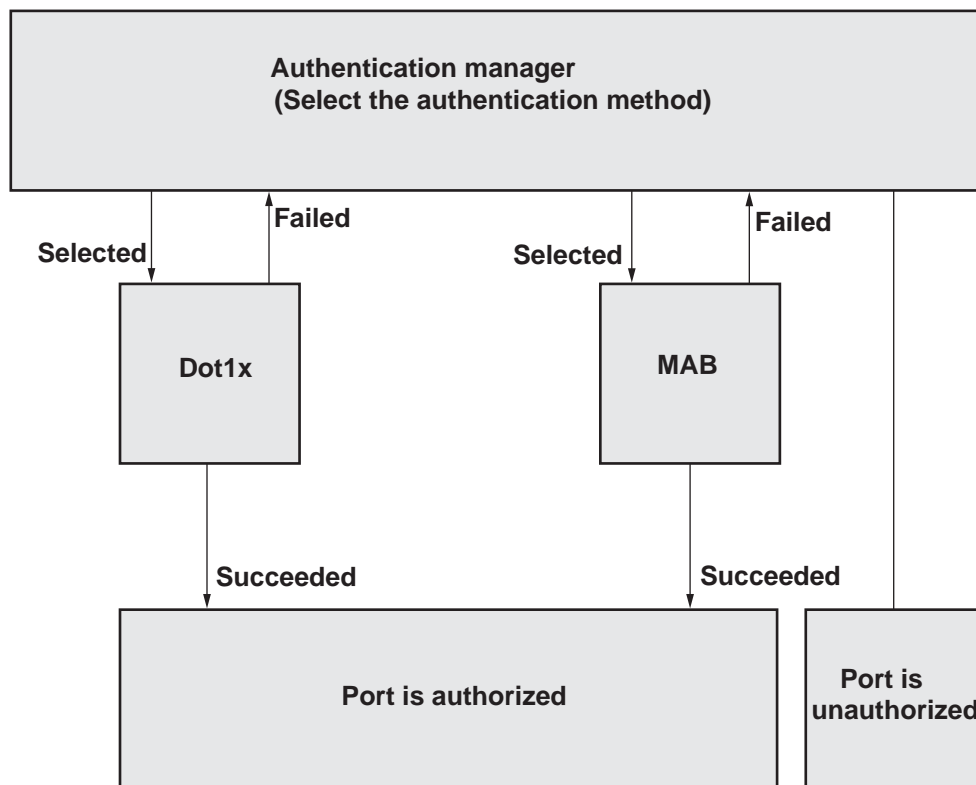


Figure 41. Dot1x, MAB, and captive portal authentication method list with default priority

The CLI command to enable authentication is as follows.

```
(Netgear Switch)#configure  
(Netgear Switch)(Config)#authentication enable
```

## Configure a Dot1x-MAB Authentication Method List with MAB-Dot1x Priority

---

**Note:** This section describes how to configure the authentication order and priority. For information about configuring the MAB authentication method, see [Configure MAC Authentication Bypass on a Switch on page 393](#).

---

If the switch authenticated a client by using MAB but the client is enabled for dot1x after it is authenticated, the EAPOL start frames that the client sends to the authentication manager causes the port to be placed in the unauthorized state and the switch then attempts to authenticate the client by using dot1x. This situation occurs because the default priority for dot1x authentication is higher than the default priority for MAB authentication.

To prevent the port from being placed in the unauthorized state, assign MAB authentication a higher priority than dot1x authentication. In that situation, if the client sends EAPOL start frames to the authentication manager, the authentication manager selects the first configured authentication method in the list, that is, dot1x, and compares the priority of the current authenticated method (that is, MAB) with the newly selected method (that is, dot1x). Because the priority for MAB authentication is higher than the priority for dot1x authentication, the authentication manager does not start dot1x authentication.

The CLI command to enable authentication is as follows.

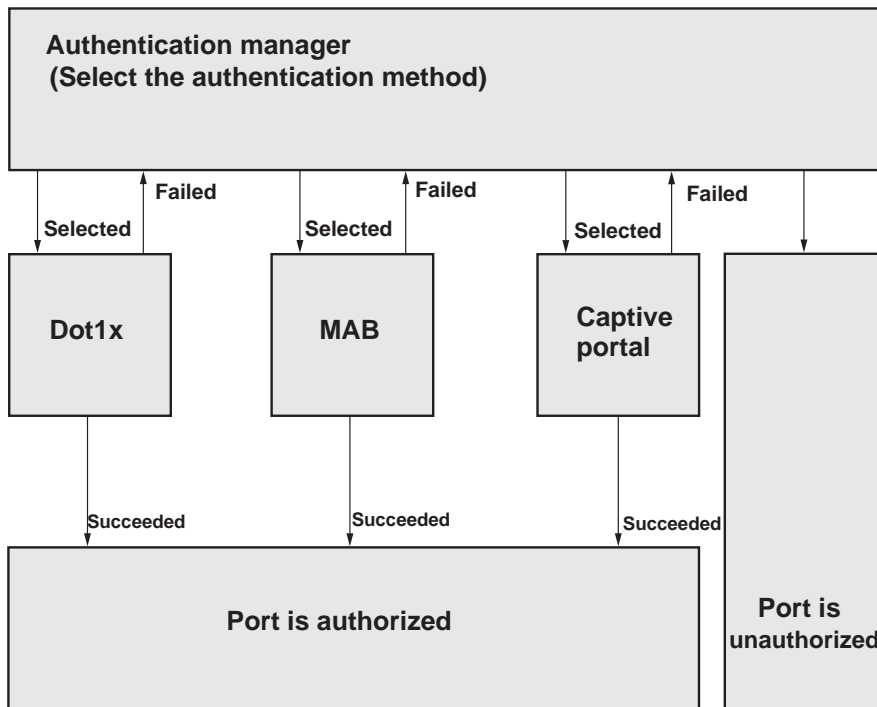
```
(Netgear Switch)#configure  
(Netgear Switch)(Config)#authentication enable
```

## Configure a Dot1x, MAB, and Captive Portal Authentication Method List with Default Priority

---

**Note:** This section describes how to configure the authentication order and priority. For information about configuring the captive portal authentication method, see [Chapter 36, Captive Portals](#).

---



**Figure 42. Dot1x, MAB, and captive portal authentication method list with default priority**

In this example, a visiting client attempts to connect to a corporate network in which the authentication manager is enabled. In such a situation, configure the authentication method list in the order dot1x, followed by MAB, and followed by captive portal.

If the client is enabled for dot1x but fails to authenticate using dot1x, the authentication manager places the port in the unauthorized state and stops the process. If the client is not enabled for dot1x, the dot1x authentication process times out, and the authentication manager selects the next configured authentication method in the list, which is MAB. Because the client's MAC address is unknown in the corporate network, the MAB authentication process also times out.

The authentication manager selects the third configured authentication method in the list, which is captive portal. If the client can provide valid credentials for web authentication, the client is admitted to the network. If the client cannot provide valid credentials, the authentication manager starts a timer for reauthentication because no other authentication method is available in the list. At the expiration of the timer, the authentication manager restarts the authentication process for the first method in the list.

The CLI command to enable authentication is as follows.

```
(Netgear Switch)#configure
(Netgear Switch)(Config)#authentication enable
```



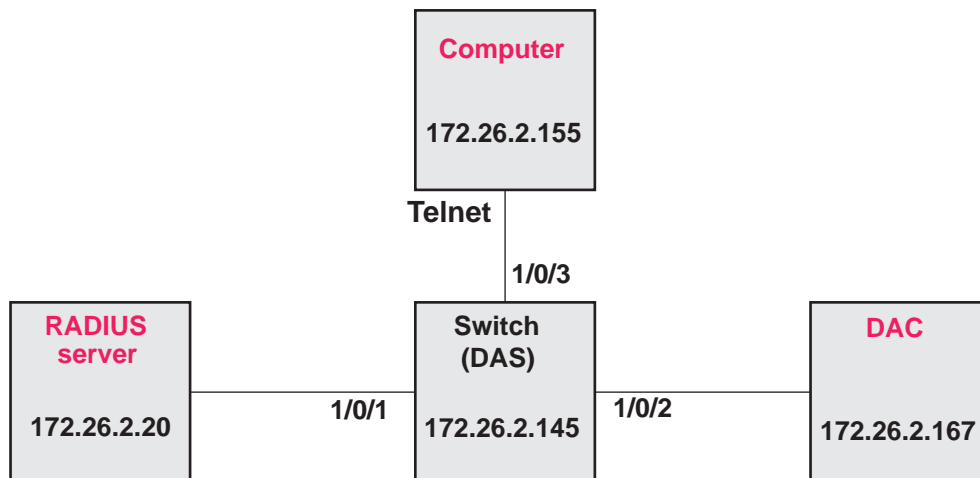
# RADIUS Change of Authorization

Dynamic authorization as defined in RFC 5176 describes the Dynamic Authorization Server (DAS) and Dynamic Authorization Client (DAC). The DAC can send two types of messages: a disconnect message (DM) and a change of authorization (CoA) message. The DAS acts on these messages and sends an acknowledgment (ACK) message or a negative acknowledgment (NAK) message. The DM from the DAC can cause the user session to be terminated. The CoA message from the DAC causes the authorization status of the user session to be changed.

The various users such as dot1x-aware users, dot1x-unaware users (for example, phones and printers), and captive portal clients, as well as console, Telnet, SSH, HTTP, and HTTPS users can connect to the switch by authenticating themselves using the configured authentication method such as local authentication, RADIUS, or TACACS+. When such a user is authenticated through a RADIUS server and dynamic authorization is enabled, you can manage the user session from the DAC by generating a DM or CoA message. A NETGEAR switch can detect these messages on UDP port number 3799.

When a NETGEAR switch receives a disconnect message or a CoA message, the following occurs:

- In DM and CoA messages, all attributes are treated as mandatory attributes and one or more unsupported attributes causes a DM-NAK message or CoA-NAK message to be generated with an Error-Cause attribute as Unsupported Service.
- If the DAS does not perform the expected action for a session, it sends a CoA-NAK message with an Error-Cause attribute as Unsupported Service.



**Figure 43. Configuration with a RADIUS server, DAS, and DAC**

To configure RADIUS authentication, authenticate a user, and manually disconnect a user:

1. Configure the switch's IP address (172.26.2.145 on VLAN 1).

The switch functions as the Dynamic Authorization Server (DAS).

```
(Netgear Switch) #config
(Netgear Switch) (Config)#interface vlan 1
(Netgear Switch) (Interface vlan 1)#ip address 172.26.2.145 /24
```

## 2. Configure the RADIUS server.

```
(Netgear Switch) #config
(Netgear Switch) (Config)#radius server host auth 172.26.2.20
(Netgear Switch) (Config)#radius server key auth 172.26.2.20
Enter secret (64 characters max):12345678
Re-enter secret:12345678
```

## 3. Configure change of authorization (CoA).

```
(Netgear Switch) (Config)#aaa server radius dynamic-author
(Netgear Switch) (config-radius-da)#client 172.26.2.167
(Netgear Switch) (config-radius-da)#auth-type all
```

## 4. Configure RADIUS as the authentication method for Telnet.

```
(Netgear Switch) (Config)#aaa authentication login test1 radius
(Netgear Switch) (Config)#line telnet
(Netgear Switch) (Config-telnet)#login authentication test1
(Netgear Switch) (Config-telnet)#exit
(Netgear Switch) (Config)#exit
```

## 5. On the Dynamic Authorization Client (DAC), install a RADIUS client.

The following example installs the FreeRADIUS client, which you can download from <http://freeradius.org/download.html> on a DAC that runs a Linux operating system.

```
[root@localhost root]# cd /usr/local/etc/raddb/
Create test.txt file using vi.
[root@localhost raddb]# vi test.txt
User-Name = "aaa"
Framed-IP-Address= "172.26.2.155"
```

## 6. Authenticate a Telnet user with RADIUS server credentials.

If the authentication is successful, the session displays in the output of the **show login sessions** command.

## 7. Disconnect the user from the DAC.

```
[root@localhost raddb]# cat /usr/local/etc/raddb/test.txt | radclient -x
172.26.2.145:3799 disconnect 12345678
```

# IPv6 Stateless RA Guard

Spoof attacks can occur on routed protocols. When you operate an IPv6 network in a shared Layer 2 network segment, the network can receive and process rogue router advertisement (RA) messages that are generated with malicious intent or are caused by an incorrect configuration of routers that are connected to the segment.

If the IPv6 network segments are part of one or more managed switches and all traffic between the IPv6 end devices traverses through the managed switches, the IPv6 RA Guard feature can provide protection against rogue RA messages.

The IPv6 RA Guard feature lets you block or reject rogue RA messages that are received on a port. The IPv6 RA Guard feature analyzes the RA messages and compares the configuration on the switch with the information in the RA message. If the frame is validated, the RA message is forwarded to the unicast or multicast destination. If the RA message is not validated, the RA message is dropped by the switch.

The IPv6 RA Guard feature can operate in the following two modes:

- **Stateless.** The switch does not maintain any state and simply validates the RA messages as they are received against the configured match criteria.
- **Stateful.** The switch dynamically learns about valid RA senders and stores this information to allow subsequent RA messages. The switch listens to the RA messages that are received over a short period that you can configure manually. The switch then allows RA messages that are received only on the ports on which valid RA messages were received during the listening period.

---

**Note:** On a managed switch, the IPv6 RA Guard feature supports only the stateless mode.

---

To configure the IPv6 RA Guard feature, display the configuration, and display the dropped messages:

## 1. Configure the IPv6 RA Guard feature on port 1.

```
(Netgear Switch) (Config)#interface 1/0/1
(Netgear Switch) (Interface 1/0/1)#ipv6 nd raguard attach-policy
(Netgear Switch) (Interface 1/0/1)#exit
(Netgear Switch) (Config)#exit
```

## 2. Display the configuration of the IPv6 RA Guard feature on port 1/0/1.

```
(Netgear Switch) #show ipv6 nd raguard policy
Ipv6 RA-Guard Configured Interfaces
Interface      Role
-----
1/0/1          Host
```

## 3. Display the router advertisement (RA) and redirect (REDIR) messages that were dropped by the IPv6 RA Guard feature.

```
(Netgear Switch) #Show ipv6 snooping counters
IPv6 Dropped Messages
RA(Router Advertisement - ICMP type 134)
REDIR(Router Redirect - ICMP type 137)To configure the IPv6 RA Guard feature,
display the configuration, and display the dropped messages:

1. Configure the IPv6 RA Guard feature on port 1.
2. Display the configuration of the IPv6 RA Guard feature on port 1/0/1.
```

| RA  | Redir |
|-----|-------|
| --- | ----- |
| 0   | 0     |

# Changing the SSH/Telnet Login Method to Radius

The following example shows how to change the SSH/Telnet login method to Radius.

By default, SSH/Telnet login is authenticated by local. If you want to use other method like Radius or Radius, or want to configure more methods for the SSH/Telnet login, follow the steps below:

## CLI: Change the SSH/Telnet Login Method to Radius

To change the SSH/Telnet login method to Radius through the CLI:

1. Change the authentication list 'networkList' to radius as the authentication method.

```
(Netgear Switch) (Config)#aaa authentication login networkList radius
```

## 2. Check if the networkList method changes from local to radius.

```
(Netgear Switch) #show authentication methods

Login Authentication Method Lists
-----
defaultList      :   local
networkList      :   radius

Enable Authentication Method Lists
-----
enableList       :   enable   none
enableNetList    :   enable   none

Line      Login Method List      Enable Method List
-----
Console   defaultList            enableList
Telnet     networkList            enableList
SSH        networkList            enableList

HTTPS      :local
HTTP       :local
DOT1X
```

## GUI: Change the SSH/Telnet Login Method to Radius

To change the SSH/Telnet login method to Radius through the GUI:

1. Check the authentication list for **SSH/Telnet**.
  - a. Select **Security > Access > SSH > SSH Configuration**.  
A screen similar to the following displays.

The screenshot shows the 'SSH Configuration' page under the 'Security' tab. The 'Access' menu is expanded, showing options like HTTP, HTTPS, SSH, and SSH Configuration. The 'SSH Configuration' section includes fields for SSH Admin Mode (Disable/Enable), SSH Version 1 (Disable/Enable), SSH Version 2 (Disable/Enable), SSH Session Timeout (5 minutes), Maximum Number of SSH Sessions (5), Current Number of SSH Sessions (10), Keys Present (No), Login Authentication List (networkList), Enable Authentication List (enableList), and SSH Port (22).

- b. Check if the Login Authentication List field is networkList.
- c. Check the same on **Security > Access > Telnet > Telnet Configuration**.
2. Change the networkList authentication method to Radius.
  - a. Select **Security > Management Security > Authentication list > Login Authentication List**.

A screen similar to the following displays.

The screenshot shows the 'Login Authentication List' page under the 'Management Security' tab. The 'Login Authentication List' section is expanded, showing a table with columns for List Name, 1, 2, 3, 4, 5, and 6. The 'networkList' entry is selected, and the 'Radius' option is chosen for the first column.

| List Name   | 1      | 2   | 3   | 4   | 5   | 6   |
|-------------|--------|-----|-----|-----|-----|-----|
| networkList | Radius | N/A | N/A | N/A | N/A | N/A |
| defaultList | Local  | N/A | N/A | N/A | N/A | N/A |
| networkList | Local  | N/A | N/A | N/A | N/A | N/A |

- b. In the Login Authentication List section of the screen, select the checkbox for networkList. The networkList appears in the List Name field at the top.
- c. Select the Radius in the dropbox for 1.
- d. Click **Apply**.

# 17

## 17 MAB

---

### MAC Authentication Bypass

This chapter includes the following sections:

- [MAC Authentication Bypass Concepts](#)
- [Configure MAC Authentication Bypass on a Switch](#)
- [Configure a Network Policy Server on a Microsoft Windows Server 2008 R2 or Later Server](#)
- [Configure an Active Directory on a Microsoft Windows Server 2008 R2 or Later Server](#)
- [Reduce the MAB Authentication Time](#)



# MAC Authentication Bypass Concepts

MAC Authentication Bypass (MAB) provides 802.1X-unaware clients controlled access to the network by using the MAC address of the client device as the identifier.

MAB has the following requirements:

- You must preconfigure the known and allowable MAC addresses and corresponding access rights in the authentication server.
- The port control mode of the port must be MAC-based.

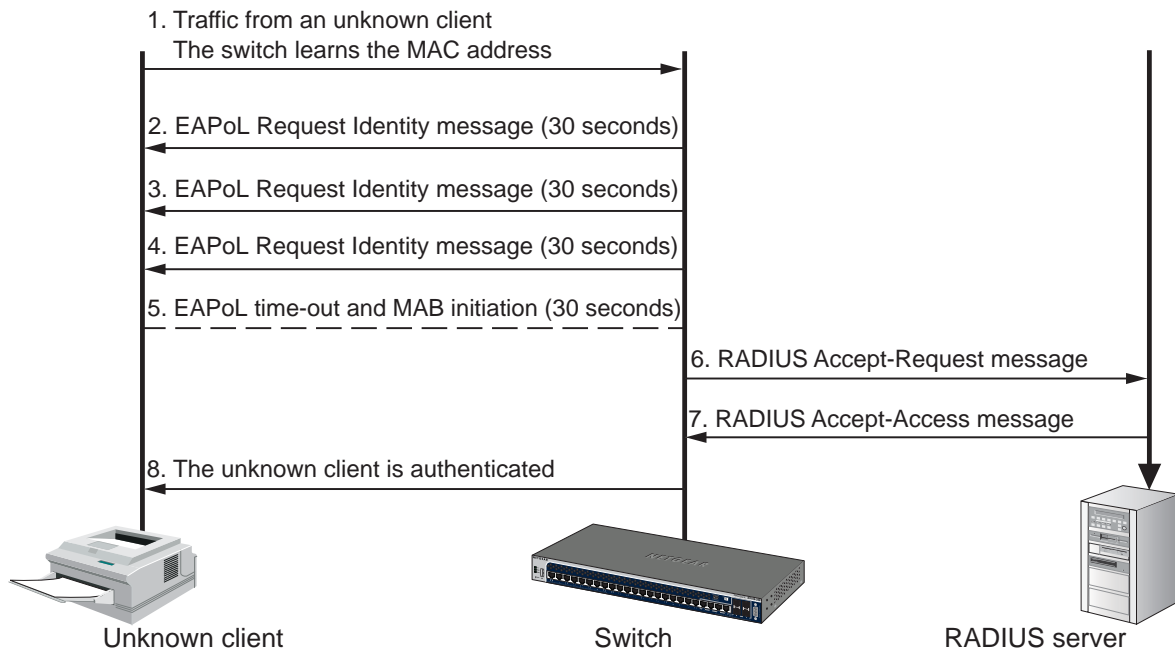
You can configure MAB on a per-port basis. If you configure MAB on a port and the port receives a packet from an unknown MAC address, the following sequence of events can occur:

1. The authenticator sends an EAPOL Request ID packet to the supplicant and the switch starts a timer that is based on the guest VLAN period for the supplicant.
2. If the client does not respond when the timer expires, the switch treats the client as an 802.1X-unaware client.
3. The authenticator sends a request to the authentication server with the MAC address of the client in hhhhhhhhhhhh (nondotted decimal MAC format) format as the user name and the MD5 hash of the MAC address as the password.
4. The authentication server checks its preconfigured database for the authorized MAC addresses and returns either an Access-Accept or Access-Reject message, depending on whether the server can find the MAC address in its database.

The switch can place the 802.1X-unaware client in a VLAN that is assigned by the RADIUS server or apply a specific filter ID to the client traffic.

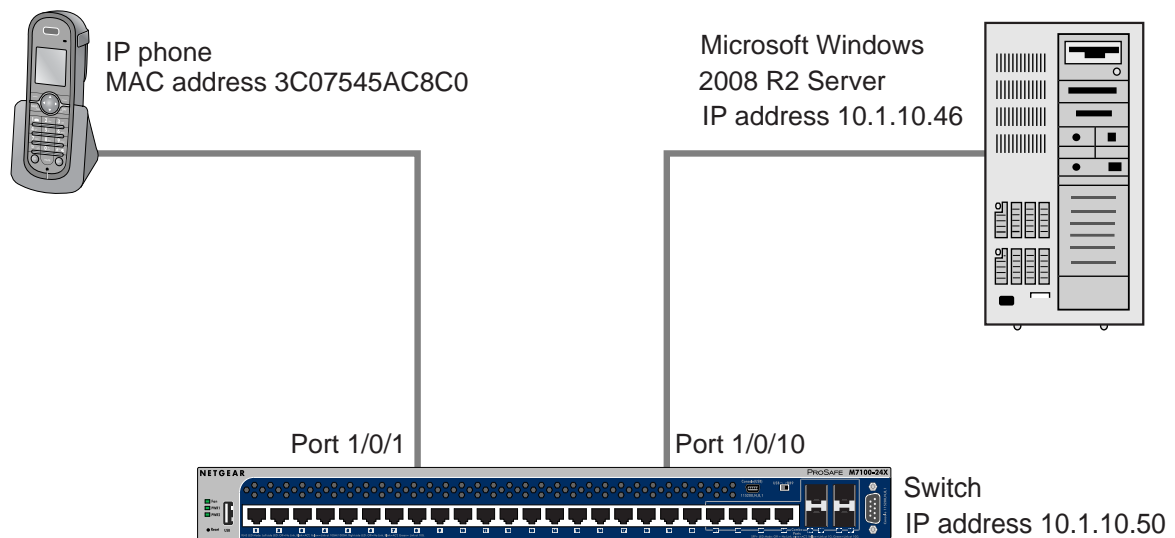
MAB initiates only after the 802.1X guest VLAN period times out. If the client responds to any of the EAPOL identity requests, MAB does not initiate for that client. MAB and guest VLANs are mutually exclusive. If you configure a guest VLAN instead of MAB on a port and the 802.1X guest VLAN period times out, the switch places the client in the guest VLAN. If you do not configure a guest VLAN or MAB on a port and the 802.1X guest VLAN period times out, the switch denies the client access.

The following figure illustrates MAB operation.



**Figure 44. MAB operation**

The following figure shows a switch that has MAB configured on port 1/0/1. The IP phone that is connected to this port can access the network after being authenticated successfully by the Microsoft network policy server.



**Figure 45. MAB topology with a switch, IP phone, and Microsoft server**

# Configure MAC Authentication Bypass on a Switch

This section provides an example of how to configure MAC Authentication Bypass (MAB) on a switch. The example is shown as CLI commands and as a local browser interface procedure.

## CLI: Configure the Switch to Perform MAB with a Microsoft Network Policy Server

1. Enable 802.1X authentication on the switch.

```
(Netgear Switch) #config
(Netgear Switch) (Config)#dot1x system-auth-control
```

2. Configure RADIUS to authenticate 802.1X users.

```
(Netgear Switch) (Config)#aaa authentication dot1x default radius
```

3. Configure the switch to communicate with the Microsoft network policy server.

In this example, the Microsoft network policy server IP address is 10.1.10.46. The shared key on the switch and the RADIUS server must match.

```
(Netgear Switch) (Config)#radius server host auth 10.1.10.46
(Netgear Switch) (Config)#radius server key auth 10.1.10.46
Enter secret (64 characters max):*****
Re-enter secret:*****
(Netgear Switch) (Config)#radius server primary 10.1.10.46
```

4. Configure force-authorization on the port that connects to the Microsoft network policy server (port 1/0/1 in this example).

```
(Netgear Switch) (Config)#interface 1/0/1
(Netgear Switch) (Interface 1/0/1)#dot1x port-control force-authorized
(Netgear Switch) (Interface 1/0/1)#exit
```

5. Configure MAB on the port that connects to the IP phone (port 1/0/10 in this example).

```
(Netgear Switch) #config
(Netgear Switch) (Config)#interface 1/0/10
(Netgear Switch) (Interface 1/0/10)#dot1x port-control mac-based
(Netgear Switch) (Interface 1/0/10)#dot1x mac-auth-bypass
(Netgear Switch) (Interface 1/0/10)#exit
(Netgear Switch) (config)#exit
```

6. To reduce the MAB authentication time, decrease the time of guest VLAN period.

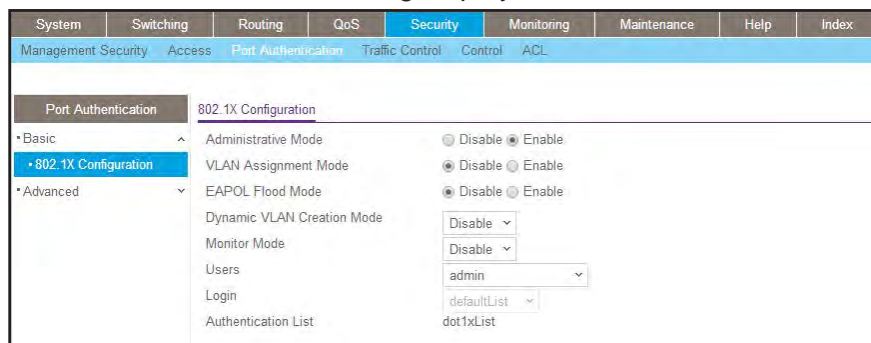
```
(Netgear Switch) #config
(Netgear Switch) (Config)#interface 1/0/10
(Netgear Switch) (Interface 1/0/10)#dot1x timeout guest-vlan-period 1
```

### Local Browser Interface: Configure the Switch to Perform MAB with a Microsoft Network Policy Server

1. Enable 802.1X authentication on the switch:

- a. Select **Security > Port Authentication > Basic > 802.1X Configuration**.

A screen similar to the following displays.



- b. Under 802.1X Configuration, next to Administrative Mode, select the **Enable** radio button.
    - c. Click **Apply**.
2. Configure RADIUS to authenticate 802.1X users:
  - a. Select **Security > Management Security > Authentication List > Dot1x Authentication List**.

A screen similar to the following displays.

| System              | Switching | Routing             | QoS             | Security | Monitoring | Maintenance | Help | Index |
|---------------------|-----------|---------------------|-----------------|----------|------------|-------------|------|-------|
| Management Security | Access    | Port Authentication | Traffic Control | Control  | ACL        |             |      |       |

**Management Security**
**Dot1x Authentication List**

- Local User
- Enable Password
- Line Password
- RADIUS
- TACACS
- Authentication List
  - Login Authentication List
  - Enable Authentication List
  - Dot1x Authentication List**

| List Name | Radius |
|-----------|--------|
| 1         | Radius |

☒ dot1xList

- b. Select the **dot1xList** check box.
  - c. From the 1 menu, select **Radius**.
  - d. Click **Apply**.
3. Configure the switch to communicate with the Microsoft network policy server.

In this example, the IP address of the Microsoft network policy server is 10.1.10.46. The shared key between the switch and the server must match.

- a. Select **Security > Management Security > RADIUS > Server Configuration**.

A screen similar to the following displays.

| System              | Switching | Routing             | QoS             | Security | Monitoring | Maintenance | Help | Index |
|---------------------|-----------|---------------------|-----------------|----------|------------|-------------|------|-------|
| Management Security | Access    | Port Authentication | Traffic Control | Control  | ACL        |             |      |       |

**Management Security**
**Server Configuration**

- Local User
- Enable Password
- Line Password
- RADIUS
  - Radius Configuration
  - Server Configuration**
  - Accounting Server Configuration
- TACACS
- Authentication List
- Login Sessions

| Radius Server IP Address | Radius Server Name | Current | Port | Secret Configured | Secret | Primary Server | Message Authenticator | Server Type |
|--------------------------|--------------------|---------|------|-------------------|--------|----------------|-----------------------|-------------|
| 10.1.10.46               | Microsoft-NPS      |         | 1812 | Yes               |        | Yes            | Enable                | Standard    |

**Statistics**

| Radius Server | Round Trip Time | Access Requests | Access Rejections | Access Accepts | Access Rejects | Access Challenges | Mismatched Access Responses | Bad Authenticators | Pending Requests | Timeouts | Unknown Types | Packets Dropped |
|---------------|-----------------|-----------------|-------------------|----------------|----------------|-------------------|-----------------------------|--------------------|------------------|----------|---------------|-----------------|
|               |                 |                 |                   |                |                |                   |                             |                    |                  |          |               |                 |

- b. Configure the following settings:
    - In the RADIUS Server IP Address field, enter **10.1.10.46**.
    - In the RADIUS Server Name field, enter **Microsoft-NPS**.
    - In the Port field, enter **1812**.
    - From the Secret Configured menu, select **Yes**.
    - In the Secret field, enter the secret key.
    - From the **Primary Server** menu, select **Yes**.
    - From the Message Authenticator menu, select **Enable**.
    - From the Server Type menu, select **Standard**.
  - c. Click **Add**.

4. Configure the port that connects to the Microsoft network policy server (in this example, port 1/0/1) to be force-authorized:

- a. Select **Security > Port Authentication > Advance > Port Authentication**.

A screen similar to the following displays.

| Port   | Control Mode     | MAB     | Guest Period | Transmit Period | Guest VLAN ID | Guest VLAN Period | Unauthorized VLAN ID | Supplicant Timeout | Server Timeout | Maximum Requests | PAC Capabilities |
|--------|------------------|---------|--------------|-----------------|---------------|-------------------|----------------------|--------------------|----------------|------------------|------------------|
| 1/0/1  | Force Authorized | Disable | 60           | 30              | 0             | 90                | 0                    | 30                 | 30             | 2                | Authenticate     |
| 1/0/2  | Auto             | Disable | 60           | 30              | 0             | 90                | 0                    | 30                 | 30             | 2                | Authenticate     |
| 1/0/3  | Auto             | Disable | 60           | 30              | 0             | 90                | 0                    | 30                 | 30             | 2                | Authenticate     |
| 1/0/4  | Auto             | Disable | 60           | 30              | 0             | 90                | 0                    | 30                 | 30             | 2                | Authenticate     |
| 1/0/5  | Auto             | Disable | 60           | 30              | 0             | 90                | 0                    | 30                 | 30             | 2                | Authenticate     |
| 1/0/6  | Auto             | Disable | 60           | 30              | 0             | 90                | 0                    | 30                 | 30             | 2                | Authenticate     |
| 1/0/7  | Auto             | Disable | 60           | 30              | 0             | 90                | 0                    | 30                 | 30             | 2                | Authenticate     |
| 1/0/8  | Auto             | Disable | 60           | 30              | 0             | 90                | 0                    | 30                 | 30             | 2                | Authenticate     |
| 1/0/9  | Auto             | Disable | 60           | 30              | 0             | 90                | 0                    | 30                 | 30             | 2                | Authenticate     |
| 1/0/10 | Auto             | Disable | 60           | 30              | 0             | 90                | 0                    | 30                 | 30             | 2                | Authenticate     |

- b. Select the check box that corresponds to port 0/1.

The table heading displays the information for port 0/1.

- c. Configure the following settings:

- From the Control Mode menu, select **Force Authorized**.
- From the MAB menu, select **Disable**.

Leave all other settings on the screen at their default value.

- d. Click **Apply**.

5. Configure the port that connects to the IP phone (in this example, port 1/0/10) for MAB:

- a. Select **Security > Port Authentication > Advance > Port Authentication**.

A screen similar to the following displays.

| Port   | Control Mode | MAB     | Guest Period | Transmit Period | Guest VLAN ID | Guest VLAN Period | Unauthorized VLAN ID | Supplicant Timeout | Server Timeout | Maximum Requests | PAC Capabilities |
|--------|--------------|---------|--------------|-----------------|---------------|-------------------|----------------------|--------------------|----------------|------------------|------------------|
| 1/0/10 | MAC Based    | Disable | 60           | 30              | 0             | 90                | 0                    | 30                 | 30             | 2                | Authenticate     |
| 1/0/1  | Auto         | Disable | 60           | 30              | 0             | 90                | 0                    | 30                 | 30             | 2                | Authenticate     |
| 1/0/2  | Auto         | Disable | 60           | 30              | 0             | 90                | 0                    | 30                 | 30             | 2                | Authenticate     |
| 1/0/3  | Auto         | Disable | 60           | 30              | 0             | 90                | 0                    | 30                 | 30             | 2                | Authenticate     |
| 1/0/4  | Auto         | Disable | 60           | 30              | 0             | 90                | 0                    | 30                 | 30             | 2                | Authenticate     |
| 1/0/5  | Auto         | Disable | 60           | 30              | 0             | 90                | 0                    | 30                 | 30             | 2                | Authenticate     |
| 1/0/6  | Auto         | Disable | 60           | 30              | 0             | 90                | 0                    | 30                 | 30             | 2                | Authenticate     |
| 1/0/7  | Auto         | Disable | 60           | 30              | 0             | 90                | 0                    | 30                 | 30             | 2                | Authenticate     |
| 1/0/8  | Auto         | Disable | 60           | 30              | 0             | 90                | 0                    | 30                 | 30             | 2                | Authenticate     |
| 1/0/9  | Auto         | Disable | 60           | 30              | 0             | 90                | 0                    | 30                 | 30             | 2                | Authenticate     |

- b. Select the check box that corresponds to port 0/10.

The table heading displays the information for port 0/10.

- c. Configure the following settings:

- From the Control Mode menu, select **MAC Based**.
- From the MAB menu, select **Enable**.

Leave all other settings on the screen at their default value.

d. Click **Apply**.

---

**Note:** For information about how to reduce the MAB authentication time, see [Reduce the MAB Authentication Time on page 407](#).

---

## Configure a Network Policy Server on a Microsoft Windows Server 2008 R2 or Later Server

1. Enable EAP-MD5 support.



### **WARNING:**

**Serious problems can occur if you modify the registry incorrectly by using the Registry Editor or by using another method. These problems might require that you reinstall your Microsoft operating system. Modify the registry at your own risk.**

To reenable EAP-MD5 support in Microsoft Windows Vista, add the following registry entries:

```
HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\RasMan\PPP\EAP\4
```

```
Value name: RolesSupported
Value type: REG_DWORD
Value data: 0000000a
```

```
Value name: FriendlyName
Value type: REG_SZ
Value data: MD5-Challenge
```

```
Value name: Path
Value type: REG_EXPAND_SZ
Value data: %SystemRoot%\System32\Raschap.dll
```

```
Value name: InvokeUsernameDialog
Value type: REG_DWORD
Value data: 00000001
```

```
Value name: InvokePasswordDialog
```



Value type: REG\_DWORD

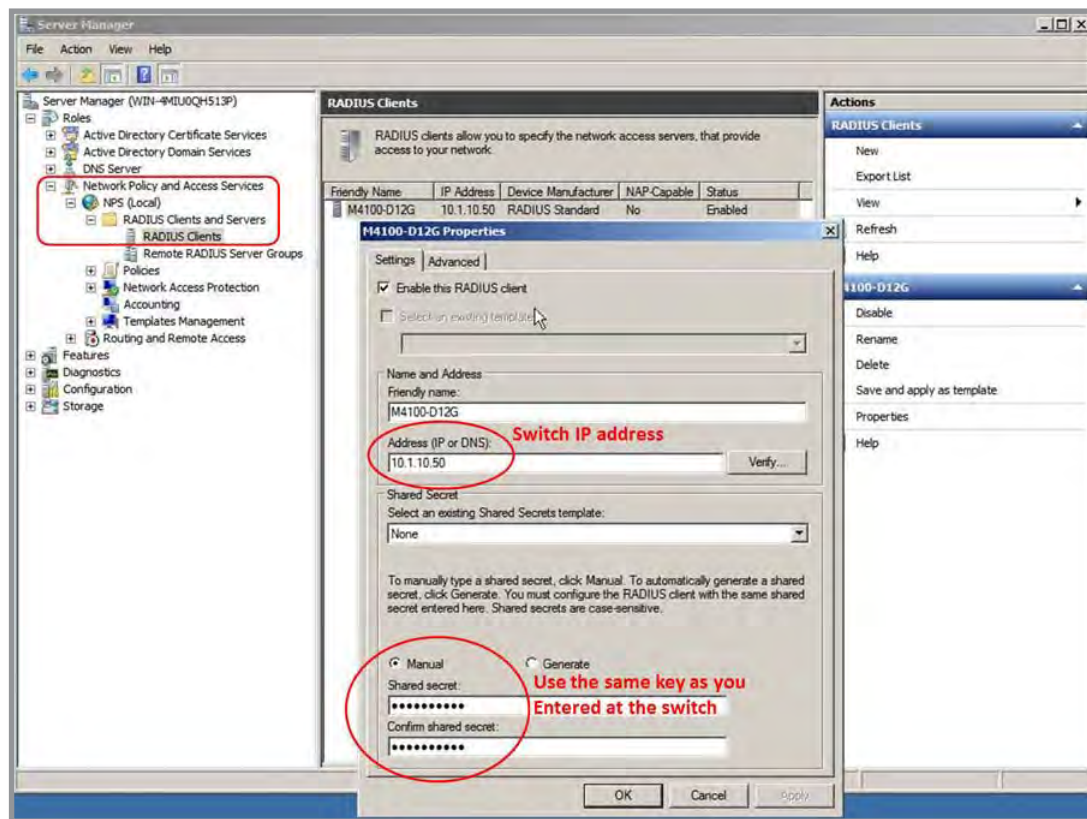
Value data: 00000001

2. If your Windows server 2008 R2 does not have service pack 1 installed, download and install Microsoft hot fix KB981190 from the following Microsoft website:

<http://support.microsoft.com/kb/981190>.

3. On the Windows server 2008 R2, configure the RADIUS client:
  - a. Click **Network Policy and Access Services > NPS > RADIUS Clients and Servers > RADIUS Clients**.

The server manager starts.



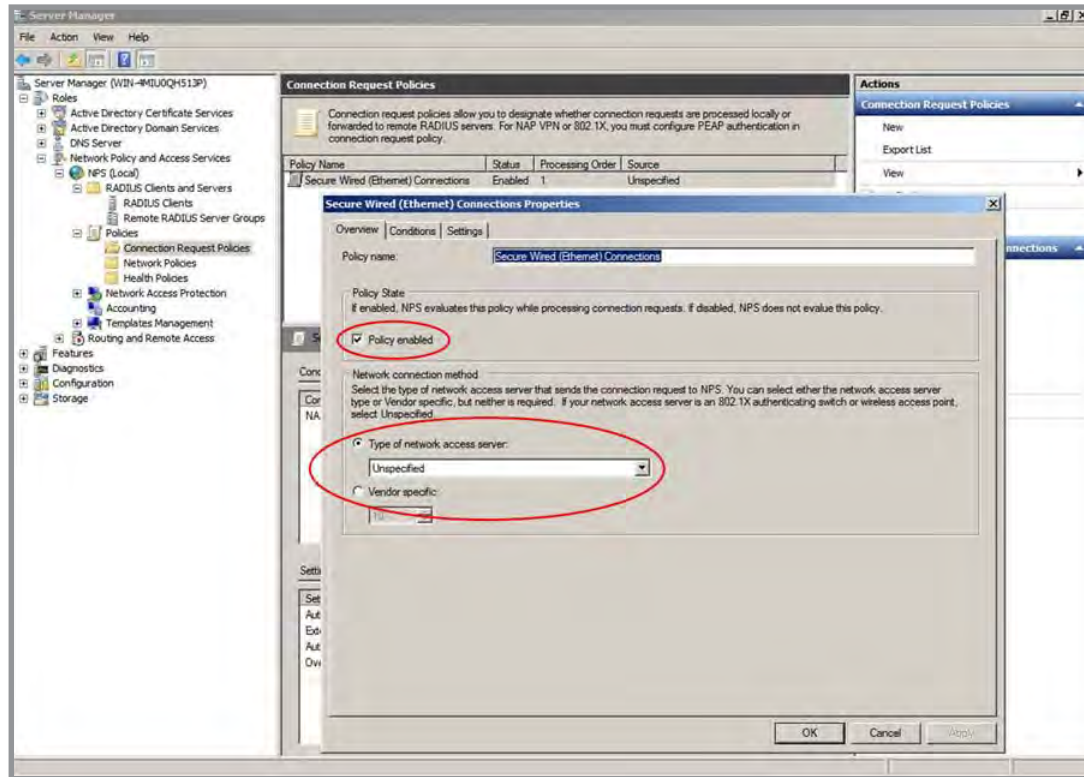
- b. Configure the following settings:
    - In the Friendly name field, enter the switch name (in this example, enter **M4100-D12G**).
    - In the Address (IP or DNS) field, enter the IP address of the switch that connects to the network policy server (in this example, enter **10.1.10.50**).
    - In the Shared secret field and Confirm shared secret field, enter the secret key.

The shared key between the switch and the server must match.

4. Configure the connection request policies for the network policy server:
  - a. Click **Network Policy and Access Services > NPS > Policies > Connection Request Policies**.

b. Double-click **Secured Wired (Ethernet) Connections**.

The Secure Wired (Ethernet) Connections Properties pop-up screen displays with the Overview tab selected:



c. Select the **Policy enabled** check box.

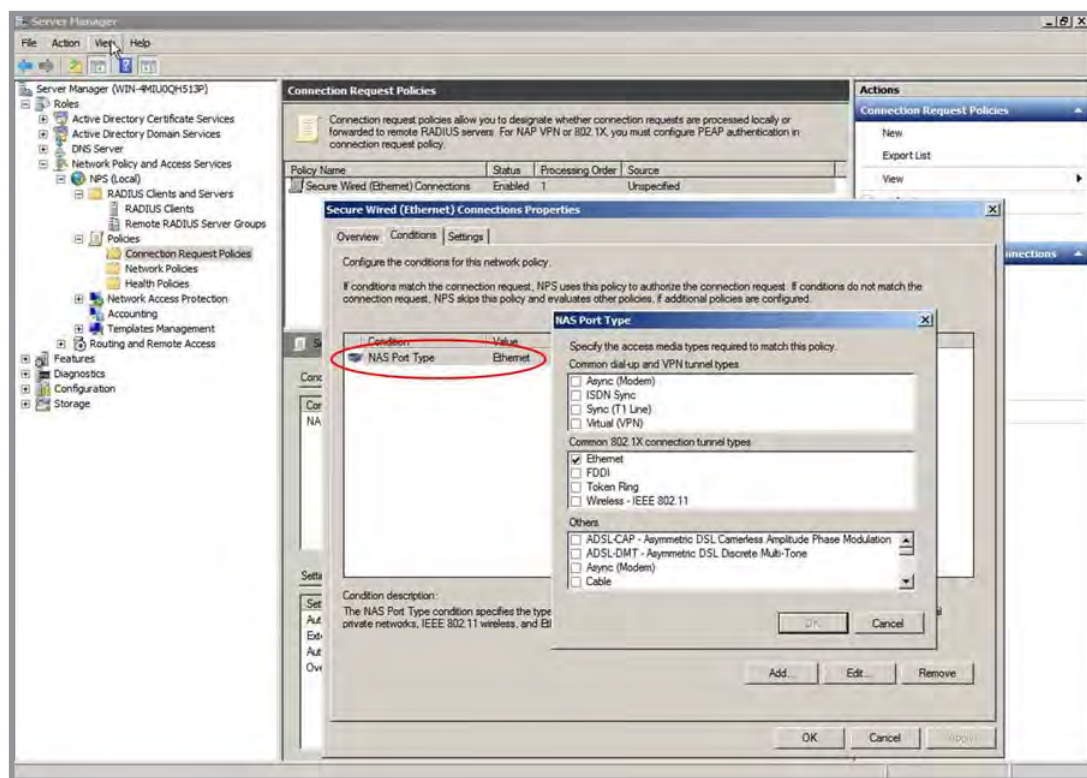
d. From the Type of network access server menu, select **Unspecified**.

Leave the Vendor specific radio button cleared.

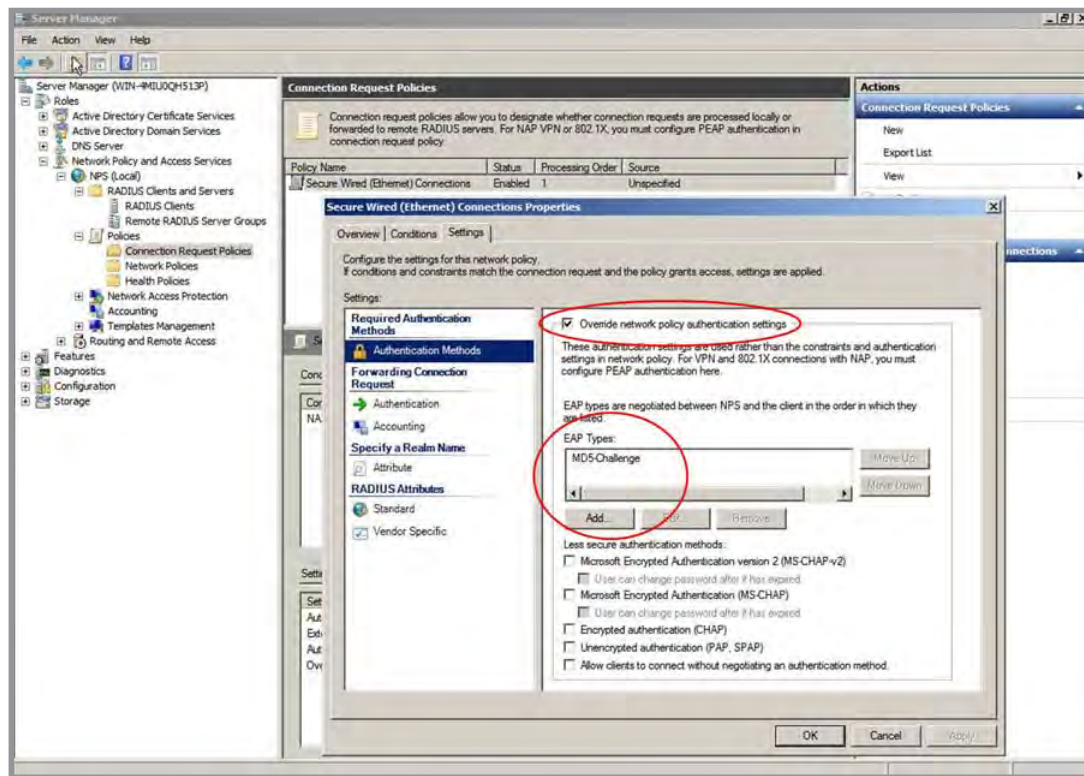
e. Click the **Apply** button.

f. Click the **Conditions** tab.

The screen adjusts.



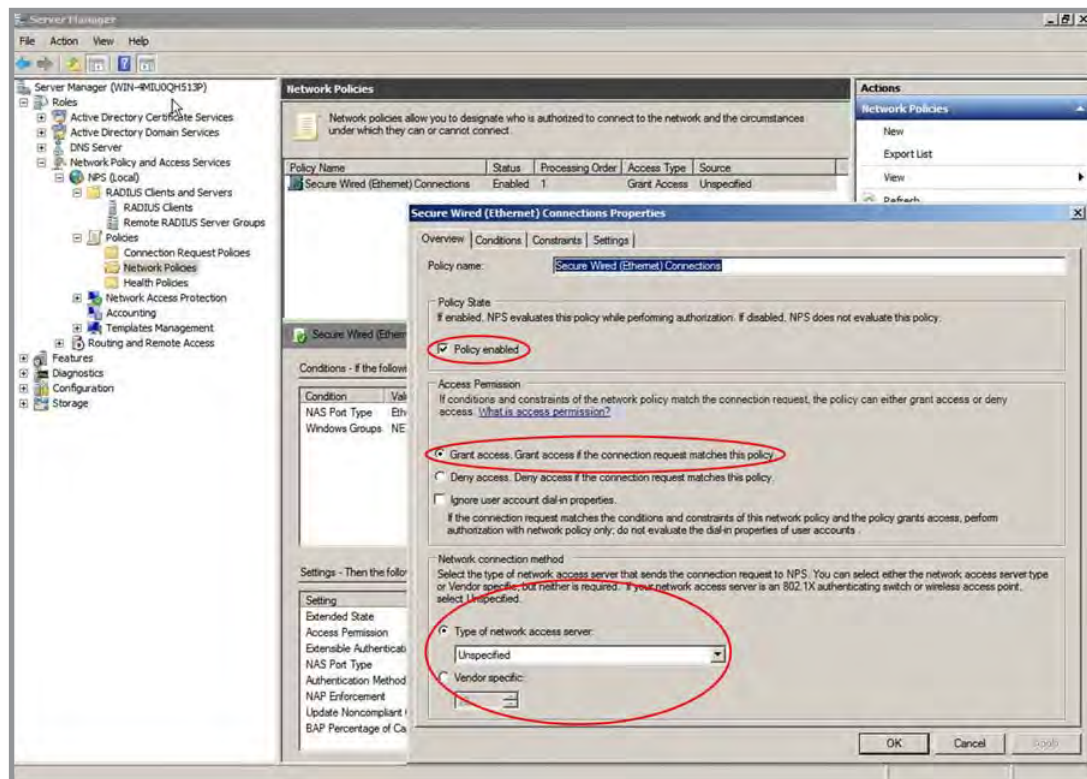
- g. Configure the NAS Port Type field as Ethernet.
  - h. Click the **Apply** button.
  - i. Click the **Settings** tab.
- The screen adjusts.



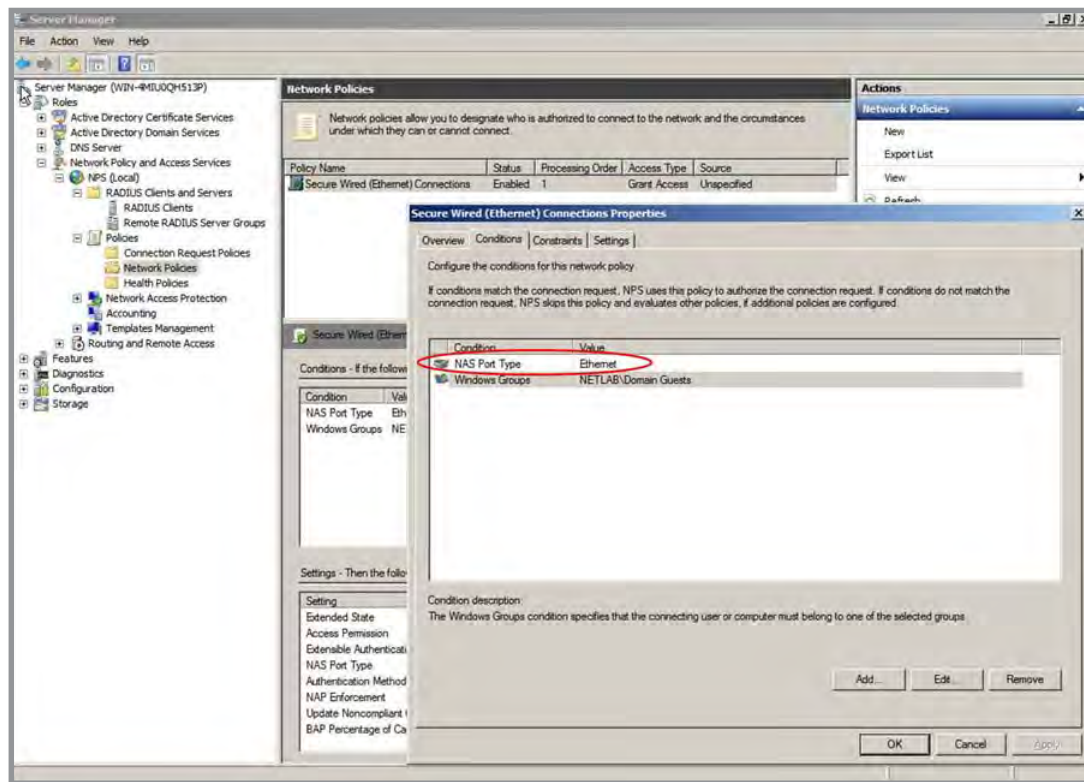
- j. Select the **Override Network policy authentication settings** check box.
- k. Under the EAP Types field, click the **Add** button.
- l. From the menu, select **MD5-Challenge**.
- m. Click the **OK** button.
- MD5-Challenge is added to the EAP Types field.
- n. From the EAP Types field, select **MD5-Challenge**.
- o. Click the **Apply** button.
5. Configure the network policies for the network policy server:
  - a. Click **Network Policy and Access Services > NPS > Policies > Network Policies**.
  - b. Double-click **Secured Wired (Ethernet) Connections**.

The Secure Wired (Ethernet) Connections Properties pop-up screen displays with the Overview tab selected:



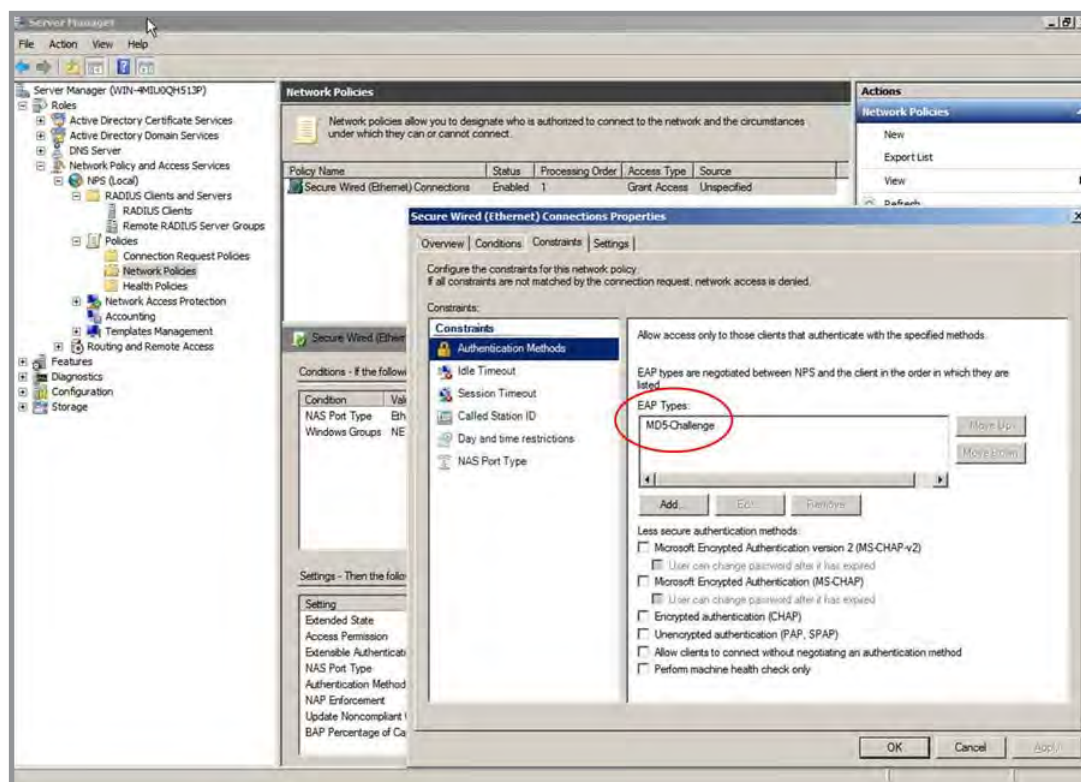


- c. Select the **Policy enabled** check box.
- d. Select the **Grant access** radio button.
- e. From the Type of network access server menu, select **Unspecified**.  
Leave the Vendor specific radio button cleared.
- f. Click the **Apply** button.
- g. Click the **Conditions** tab.  
The screen adjusts.



- h. Configure the NAS Port Type field as Ethernet.
- i. Click the **Apply** button.
- j. Click the **Constraints** tab.

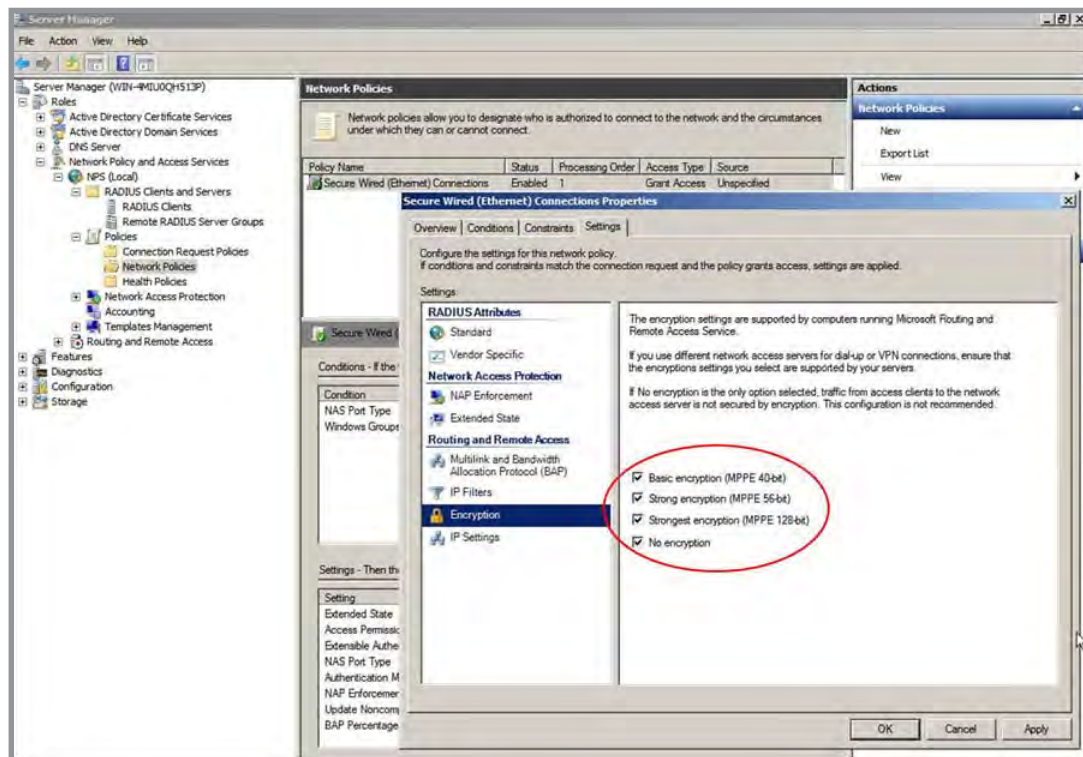
The screen adjusts.



- k. Under the EAP Types field, click the **Add** button.
  - l. From the menu, select **MD5-Challenge**.
  - m. Click the **OK** button.
- MD5-Challenge is added to the EAP Types field.
- n. From the EAP Types field, select **MD5-Challenge**.
  - o. Click the **Apply** button.
  - p. Click the **Settings** tab.

The screen adjusts.

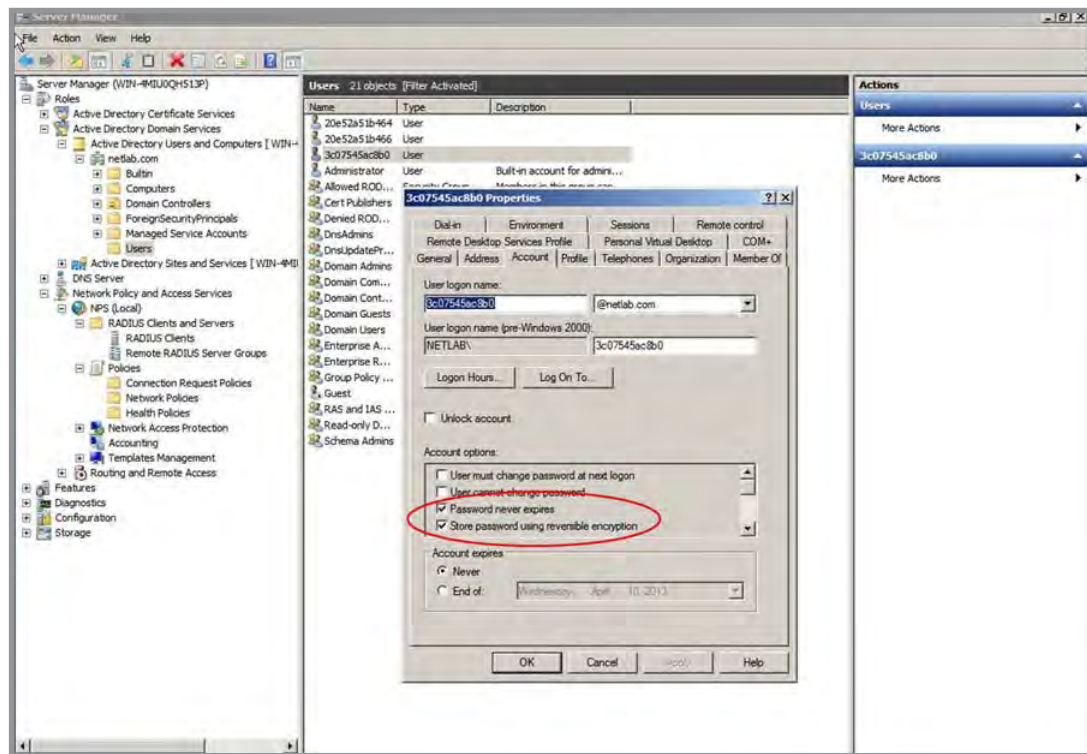




- q. Select all four encryption check boxes, including the **No encryption** check box.
- r. Click the **Apply** button.

## Configure an Active Directory on a Microsoft Windows Server 2008 R2 or Later Server

1. Create a user account with the following settings:
  - **Logon name.** The MAC address of the device for which you want to allow a connection.
  - **Password.** Any temporary password.
2. Right-click the new user account name and select **Properties**.



3. Select the **Password never expires** check box.
4. Select the **Store password using reversible encryption** check box.
5. Click the **Apply** button.
6. Create a Password Settings Object (PSO) as described at the following Microsoft website:

[http://technet.microsoft.com/en-us/library/cc754461\(v=ws.10\).aspx](http://technet.microsoft.com/en-us/library/cc754461(v=ws.10).aspx).

Use the default setting for all the attributes except for the following setting:  
msDS-PasswordComplexityEnabled = FALSE.

7. Apply PSO to the user account that you created in [Step 1](#), as described at the following Microsoft website:

[http://technet.microsoft.com/en-us/library/cc731589\(v=ws.10\).aspx#BKMK\\_1](http://technet.microsoft.com/en-us/library/cc731589(v=ws.10).aspx#BKMK_1).

8. Change the password for the user account that you created in [Step 1](#).

For the password, use the MAC address of the device for which you want to allow a connection, and use uppercase letters only.

# Reduce the MAB Authentication Time

MAB waits for the expiration of the guest VLAN period before MAB sends a request to the authentication server with the MAC address as the user name and the MD5 hash as the password. To reduce the MAB authentication time, decrease the guest VLAN period. The default period for the guest VLAN period is 90 seconds.

## CLI: Reduce the Authentication Time for MAB

Change the guest VLAN period timer to 10 seconds using the CLI:

```
(Netgear Switch) #config
(Netgear Switch) (Config)# interface 1/0/1
(Netgear Switch) (Interface 1/0/1)#dot1x timeout guest-vlan-period 10
```

## Local Browser Interface: Reduce the Authentication Time for MAB

Change the guest VLAN period timer to 10 seconds using the local browser interface:

1. Select **Security > Port Authentication > Advanced > Port Authentication**.

A screen similar to the following displays.

| Port   | Control Mode | MAB     | Quiet Period | Transmit Period | Guest VLAN ID | Guest VLAN Period | Unauthenticated VLAN ID | Supplicant Timeout | Server Timeout | Maximum Requests |
|--------|--------------|---------|--------------|-----------------|---------------|-------------------|-------------------------|--------------------|----------------|------------------|
| 1/0/1  | MAC Based    | Enable  | 60           | 30              | 0             | 10                | 0                       | 30                 | 30             | 2                |
| 1/0/2  | Auto         | Disable | 60           | 30              | 0             | 90                | 0                       | 30                 | 30             | 2                |
| 1/0/3  | Auto         | Disable | 60           | 30              | 0             | 90                | 0                       | 30                 | 30             | 2                |
| 1/0/4  | Auto         | Disable | 60           | 30              | 0             | 90                | 0                       | 30                 | 30             | 2                |
| 1/0/5  | Auto         | Disable | 60           | 30              | 0             | 90                | 0                       | 30                 | 30             | 2                |
| 1/0/6  | Auto         | Disable | 60           | 30              | 0             | 90                | 0                       | 30                 | 30             | 2                |
| 1/0/7  | Auto         | Disable | 60           | 30              | 0             | 90                | 0                       | 30                 | 30             | 2                |
| 1/0/8  | Auto         | Disable | 60           | 30              | 0             | 90                | 0                       | 30                 | 30             | 2                |
| 1/0/9  | Auto         | Disable | 60           | 30              | 0             | 90                | 0                       | 30                 | 30             | 2                |
| 1/0/10 | Auto         | Disable | 60           | 30              | 0             | 90                | 0                       | 30                 | 30             | 2                |

2. Select the check box that corresponds to port 0/1.

The table heading displays the information for port 0/1.

3. In the Guest VLAN Period field, enter **10**

Leave the other settings on the screen at the default value.

4. Click **Apply**.

# 18

## SNTP

---

### Simple Network Time Protocol

This chapter includes the following sections:

- [Simple Network Time Protocol Concepts](#)
- [Show SNTP \(CLI Only\)](#)
- [Configure SNTP](#)
- [Set the Time Zone \(CLI Only\)](#)
- [Set the Named SNTP Server](#)

# Simple Network Time Protocol Concepts

Simple Network Time Protocol (SNTP) offers the following benefits:

- It can be used to synchronize network resources and for adaptation of NTP.
- SNTP provides synchronized network timestamp.
- It can be used in broadcast or unicast mode.
- It supports SNTP client implemented over UDP, which listens on port 123.

## Show SNTP (CLI Only)

The following are examples of the commands used in the SNTP feature.

### show sntp

```
(Netgear Switch) #show sntp?  
  
<cr>      Press Enter to execute the command.  
client    Display SNTP Client Information.  
server    Display SNTP Server Information.
```

### show sntp client

```
(Netgear Switch) #show sntp client  
  
Client Supported Modes:    unicast broadcast  
SNTP Version:             4  
Port:                     123  
Client Mode:              unicast  
Unicast Poll Interval:    6  
Poll Timeout (seconds):   5  
Poll Retry:               1
```

## show sntp server

```
(Netgear Switch) #show sntp server

Server IP Address:      81.169.155.234
Server Type:            ipv4
Server Stratum:         3
Server Reference Id:    NTP Srv: 212.186.110.32
Server Mode:            Server
Server Maximum Entries: 3
Server Current Entries: 1

SNTP Servers
-----

IP Address:             81.169.155.234
Address Type:           IPV4
Priority:                1
Version:                4
Port:                   123
Last Update Time:       MAY 18 04:59:13 2005
Last Attempt Time:      MAY 18 11:59:33 2005
Last Update Status:     Other
Total Unicast Requests: 1111
Failed Unicast Requests: 361
```

## Configure SNTP

The example is shown as CLI commands and as a local browser interface procedure.

### CLI: Configure SNTP

NETGEAR switches do not have a built-in real-time clock. However, it is possible to use SNTP to get the time from a public SNTP/NTP server over the Internet. You may need permission from those public time servers. The following steps configure SNTP on the switch:

1. Configure the SNTP server IP address.

The IP address can be either from the public NTP server or your own. You can search the Internet to locate the public server. The servers available could be listed in domain-name format instead of address format. In that case, use the `ping` command on the PC to find

the server's IP address. The following example configures the SNTP server IP address to 208.14.208.19.

```
(Netgear Switch) (Config)#sntp server 208.14.208.19
```

**2. After configuring the IP address, enable SNTP client mode.**

The client mode can be either broadcast mode or unicast mode. If the NTP server is not your own, you must use unicast mode.

```
(Netgear Switch) (Config)#sntp client mode unicast
```

When the SNTP client mode is enabled, the client waits for the polling interval to send the query to the server. The default value is approximately 1 minute.

**3. After this period, issue the `show` command to confirm that the time was received.**

The time will be used in all logging messages.

```
(Netgear Switch) #show sntp server
Server IP Address:          208.14.208.19
Server Type:                ipv4
Server Stratum:             4
Server Reference Id:        NTP Srv: 208.14.208.3
Server Mode:                Server
Server Maximum Entries:     3
Server Current Entries:     1
SNTP Servers
-----

IP Address: 208.14.208.19
Address Type: IPV4
Priority: 1
Version: 4
Port: 123
Last Update Time: Mar 26 03:36:09 2006
Last Attempt Time: Mar 26 03:36:09 2006
Last Update Status: Success
Total Unicast Requests: 2
Failed Unicast Requests: 0
```



# Local Browser Interface: Configure SNTP

## 1. Configure the SNTP server.

### a. Select **System > Management > Time > SNTP Server Configuration**.

A screen similar to the following displays.

| Server Type | Address            | Port | Priority | Version |
|-------------|--------------------|------|----------|---------|
| IPv4        | 208.14.208.19      | 123  | 1        | 4       |
| DNS         | time-d.netgear.com | 123  | 1        | 4       |

| SNTP Server Status |                                |                                |                     |          |                 |
|--------------------|--------------------------------|--------------------------------|---------------------|----------|-----------------|
| Address            | Last Update Time               | Last Attempt Time              | Last Attempt Status | Requests | Failed Requests |
| time-d.netgear.com | Jan 1 00:00:00 1970 (UTC+0:00) | Jan 1 00:00:00 1970 (UTC+0:00) | Other               | 0        | 0               |

### b. Enter the following information:

- In the **Server Type** field, select **IPV4**.
- In the **Address** field, enter **208.14.208.19**.
- In the **Port** field, enter **123**.
- In the **Priority** field, enter **1**.
- In the **Version** field, enter **4**.

### c. Click **Add**.

## 2. Configure SNTP globally.

### a. Select **System > Management > Time > SNTP Global Configuration**.

A screen similar to the following displays.

Clock Source: ☐ Local ☒ SNTP

Client Mode: ☐ Disable ☒ Unicast ☐ Broadcast

Port:  (123 or 1025 to 65535) Default: 123

Unicast Poll Interval:  (6 to 10)

Broadcast Poll Interval:  (6 to 10)

Unicast Poll Timeout:  (1 to 30)

Unicast Poll Retry:  (0 to 10)

Time Zone Name:

Offset Hours:  (-12 to 13)

Offset Minutes:  (0 to 59)

- b. Enter the following information:
  - For Client Mode, Select the **Unicast** radio button.
  - In the **Time Zone Name** field, enter **PST**.
  - In the **Offset Hours** field, enter **-8**.
- c. Click **Apply**.

## Set the Time Zone (CLI Only)

The SNTP/NTP server is set to Coordinated Universal Time (UTC) by default. The following example shows how to set the time zone to Pacific Standard Time (PST), which is 8 hours behind GMT/UTC.

```
(Netgear switch)(config)#clock timezone PST -8
```

## Set the Named SNTP Server

The example is shown as CLI commands and as a local browser interface procedure.

### CLI: Set the Named SNTP Server

NETGEAR provides SNTP servers accessible by NETGEAR devices. Because NETGEAR might change IP addresses assigned to its time servers, it is best to access an SNTP server by DNS name instead of using a hard-coded IP address. The public time servers available are time-a, time-b, and time-c.

Enable a DNS name server and access a time server with the following commands:

```
(Netgear switch) (config)#ip domain-lookup
(Netgear switch) (config)#ip name-server 192.168.1.1
(Netgear switch) (config)#sntp server time-a.netgear.com
```

where *192.168.1.1* is the public network gateway IP address for your device.

This method of setting DNS name look-up can be used for any other applications that require a public IP address, for example, a RADIUS server.

## Local Browser Interface: Set the Named SNTP Server

### 1. Configure the SNTP server.

#### a. Select **System > Management > Time > SNTP Server Configuration**.

A screen similar to the following displays.

| System     | Switching   | Routing  | QoS     | Security | Monitoring | Maintenance | Help | Index          |
|------------|-------------|----------|---------|----------|------------|-------------|------|----------------|
| Management | Device View | Services | Chassis | PoE      | SNMP       | LLDP        | ISDP | Timer Schedule |

| Management                         |  | SNTP Server Configuration               |                                 |                                 |                     |          |                 |
|------------------------------------|--|---|---------------------------------|---------------------------------|---------------------|----------|-----------------|
| • System Information               |  | <input type="checkbox"/> Server Type    | Address                         | Port                            | Priority            | Version  |                 |
| • System CPU Status                |  | <input checked="" type="checkbox"/> DNS | time-f.netgear.com              | 123                             | 1                   | 4        |                 |
| • Switch Statistics                |  | <input type="checkbox"/> IPv4           | 208.14.208.19                   | 123                             | 1                   | 4        |                 |
| • USB Device Information           |  | <input type="checkbox"/> DNS            | time-d.netgear.com              | 123                             | 1                   | 4        |                 |
| • Loopback Interface               |  |   |                                 |                                 |                     |          |                 |
| • Network Interface                |  |   |                                 |                                 |                     |          |                 |
| • Time                             |  | SNTP Server Status                      |                                 |                                 |                     |          |                 |
| • Time Configuration               |  | Address                                 | Last Update Time                | Last Attempt Time               | Last Attempt Status | Requests | Failed Requests |
| • <b>SNTP Server Configuration</b> |  | 208.14.208.19                           | Jan 1 00:00:00 1970 (UTC+0:00)  | Jan 1 00:00:00 1970 (UTC+0:00)  | Other               | 0        | 0               |
| • Summer Time Configuration        |  | time-d.netgear.com                      | Jul 14 19:49:28 2014 (UTC+0:00) | Jul 14 19:50:40 2014 (UTC+0:00) | Success             | 4        | 0               |
| • DNS                              |  |   |                                 |                                 |                     |          |                 |
| • SDM Template Preference          |  |   |                                 |                                 |                     |          |                 |
| • Green Ethernet                   |  |   |                                 |                                 |                     |          |                 |

#### b. Enter the following information:

- In the **Server Type** list, select **DNS**.
- In the **Address** field, enter **time-f.netgear.com**
- In the **Port** field, enter **123**.
- In the **Priority** field, enter **1**.
- In the **Version** field, enter **4**.

#### c. Click **Add**.

### 2. Configure the DNS server.

#### a. Select **System > Management > DNS > DNS Configuration**.

A screen similar to the following displays.

| System     | Switching   | Routing  | QoS     | Security | Monitoring | Maintenance | Help | Index          |
|------------|-------------|----------|---------|----------|------------|-------------|------|----------------|
| Management | Device View | Services | Chassis | PoE      | SNMP       | LLDP        | ISDP | Timer Schedule |

| Management                 |  | DNS Configuration          |   |
|----------------------------|--|----------------------------|---|
| • System Information       |  | DNS Status                 | <input type="radio"/> Disable <input checked="" type="radio"/> Enable |
| • System CPU Status        |  | DNS Default Name           | <input type="text"/> (1 to 255 alphanumeric characters)               |
| • Switch Statistics        |  | Retry Number               | <input type="text"/> (0 to 100)                                       |
| • USB Device Information   |  | Response Timeout (secs)    | <input type="text"/> (0 to 3600 secs)                                 |
| • Loopback Interface       |  |                            |   |
| • Network Interface        |  |                            |   |
| • Time                     |  | DNS Server Configuration   |   |
| • DNS                      |  | Serial No                  | DNS Server  |
| • <b>DNS Configuration</b> |  |                            | 192.168.1.1   |
| • Host Configuration       |  | <input type="checkbox"/> 1 | 219.141.140.10  |
| • SDM Template Preference  |  | <input type="checkbox"/> 2 | 12.7.210.170  |
| • Green Ethernet           |  |                            |   |

- b.** Enter the following information:
  - For DNS Status, select the **Enable** radio button
  - In the **DNS Server** field, enter **192.168.1.1**.
- c.** Click **Add**.

# 19

## 19 Tools

---

Tools to manage, monitor, and personalize the switch and network

This chapter includes the following sections:

- [Traceroute](#)
- [Configuration Scripting](#)
- [Pre-Login Banner](#)
- [Port Mirroring](#)
- [Remote SPAN](#)
- [Dual Image](#)
- [Outbound Telnet](#)
- [Error Disablement and Automatic Error Recovery](#)
- [Loop Protection](#)
- [Nondisruptive Configuration Management](#)
- [Full Memory Dump](#)

# Traceroute

This section describes the traceroute feature. Use traceroute to discover routes that packets take when traveling on a hop-by-hop basis to their destination through the network.

- Traceroute maps network routes by sending packets with small time-to-live (TTL) values and watches the ICMP time-out announcements.
- The traceroute command displays all L3 devices.
- It can be used to detect issues on the network.
- Traceroute tracks up to 20 hops.
- The default UDP port is used 33343 unless you specify otherwise in the `traceroute` command.

The following shows an example of using the `traceroute` command to determine how many hops there are to the destination. The command output shows each IP address that the packet passes through and how long it takes for the packet to reach its destination. In this example, the packet takes 16 hops to reach its destination.

## CLI: Traceroute

```
(Netgear Switch) #traceroute?
<ipaddr>      Enter IP address.

(Netgear Switch) #traceroute 216.109.118.74 ?
<cr>          Press Enter to execute the command.
<port>        Enter port no.

(Netgear Switch) #traceroute 216.109.118.74
tracing route over a maximum of 20 hops
 1  10.254.24.1          40 ms      9 ms      10 ms
 2  10.254.253.1         30 ms      49 ms     21 ms
 3  63.237.23.33         29 ms      10 ms     10 ms
 4  63.144.4.1           39 ms      63 ms     67 ms
 5  63.144.1.141         70 ms      50 ms     50 ms
 6  205.171.21.89        39 ms      70 ms     50 ms
 7  205.171.8.154        70 ms      50 ms     70 ms
 8  205.171.8.222        70 ms      50 ms     80 ms
 9  205.171.251.34       60 ms      90 ms     50 ms
10  209.244.219.181      60 ms      70 ms     70 ms
11  209.244.11.9         60 ms      60 ms     50 ms
12  4.68.121.146         50 ms      70 ms     60 ms
13  4.79.228.2           60 ms      60 ms     60 ms
14  216.115.96.185       110 ms     59 ms     70 ms
15  216.109.120.203      70 ms      66 ms     95 ms
16  216.109.118.74       78 ms     121 ms     69 ms
```

## Local Browser Interface: Traceroute

1. Select **Maintenance > Troubleshooting > Traceroute**.

A screen similar to the following displays.

| System  | Switching | Routing | QoS | Security | Monitoring | Maintenance | Help | Index |
|---|-----------|---------|-----|----------|------------|-------------|------|-------|
| <a href="#">Save Config</a> <a href="#">Reset</a> <a href="#">Upload</a> <a href="#">Download</a> <a href="#">File Management</a> <a href="#">Troubleshooting</a>   |           |         |     |          |            |             |      |       |
| <div>Troubleshooting</div> <div>TraceRoute IPv4</div>   |           |         |     |          |            |             |      |       |
| <div> <div>• Ping IPv4</div> <div>• Ping IPv6</div> <div>• <b>Traceroute IPv4</b></div> <div>• Traceroute IPv6</div> </div> <div> <div>IP Address/Hostname</div> <div>Probes Per Hop</div> <div>Max TTL</div> <div>Init TTL</div> <div>MaxFail</div> <div>Interval(secs)</div> <div>Port</div> <div>Size</div> <div>Source</div> </div> <div> <div>216.109.118.74</div> <div>3</div> <div>30</div> <div>1</div> <div>5</div> <div>3</div> <div>33434</div> <div>0</div> <div>None</div> </div> <div> <div>(Max 255 characters/x.x.x.x)</div> <div>(1 to 10)</div> <div>(1 to 255)</div> <div>(1 to 255)</div> <div>(1 to 255)</div> <div>(1 to 60)</div> <div>(1 to 65535)</div> <div>(0 to 39936)</div> </div> |           |         |     |          |            |             |      |       |

Use this screen to specify that the switch must discover the routes that packets actually take when traveling to their destination through the network on a hop-by-hop basis. Once you click the Apply button, the switch sends three traceroute packets to each hop and the results are displayed in the result table.

2. In the **IP Address/Hostname** field, enter **216.109.118.74**.
3. Click the **Apply** button.

Your settings are saved.

## Configuration Scripting

This section provides the following examples:

- [script Command](#)
- [script list Command and script delete Command](#)
- [script apply running-config.scr Command](#)
- [Create a Configuration Script](#)
- [Upload a Configuration Script](#)

Configuration scripting:

- Allows you to generate text-formatted files.
- Provides scripts that can be uploaded and downloaded to the system.
- Provides flexibility to create command configuration scripts.
- Can be applied to several switches.
- Can save up to 10 scripts or 500 K of memory.
- Provides script format of one CLI command per line.



Consider the following:

- The total number of scripts stored is limited by the NVRAM/FLASH size.
- Application of scripts is partial if a script fails. For example, if the script executes 5 of 10 commands and the script fails, the script stops at 5.
- Scripts cannot be modified or deleted while being applied.
- Validation of scripts checks for syntax errors only. It does not validate that the script will run successfully.

## script Command

```
(Netgear Switch) #script ?

apply      Applies configuration script to the switch.
delete     Deletes a configuration script file from the switch.
list       Lists all configuration script files present on the switch.
show       Displays the contents of configuration script.
validate   Validate the commands of configuration script.
```

## script list Command and script delete Command

```
(Netgear Switch) #script list

Configuration Script Name      Size(Bytes)
-----
basic.scr                     93
running-config.scr            3201

2 configuration script(s) found.
1020706 bytes free.

(Netgear Switch) #script delete basic.scr

Are you sure you want to delete the configuration script(s)? (y/n) y

1 configuration script(s) deleted.
```

## script apply running-config.scr Command

```
(Netgear Switch) #script apply running-config.scr

Are you sure you want to apply the configuration script? (y/n) y

The system has unsaved changes.
Would you like to save them now? (y/n) y

Configuration Saved!
```

## Create a Configuration Script

```
(Netgear Switch) #show running-config running-config.scr

Config script created successfully.

(Netgear Switch)                                #script list

Configuration Script Name      Size(Bytes)
-----
running-config.scr           3201

1 configuration script(s) found.
1020799 bytes free.
```

## Upload a Configuration Script

```
(Netgear Switch) #copy nvram: script running-config.scr
tftp://192.168.77.52/running-config.scr

Mode..... TFTP
Set TFTP Server IP..... 192.168.77.52
TFTP Path..... ./
TFTP Filename..... running-config.scr
Data Type..... Config Script
Source Filename..... running-config.scr

Are you sure you want to start? (y/n) y

File transfer operation completed successfully.
```

# Pre-Login Banner

Pre-login banner:

- Allows you to create message screens that display when a user logs in to the CLI.
- By default, no banner file exists.
- You can upload or download.
- File size cannot be larger than 2 K.

The Pre-Login Banner feature is only for the CLI interface.

## Create a Pre-Login Banner

This command is provided for the CLI only.

1. On your computer, use Notepad to create a banner.txt file that contains the banner to be displayed.

```
Login Banner - Unauthorized access is punishable by law.
```

2. Transfer the file from the PC to the switch using TFTP.

```
(Netgear Switch) #copy tftp://192.168.77.52/banner.txt nvram:clibanner

Mode..... TFTP
Set TFTP Server IP..... 192.168.77.52
TFTP Path..... ./
TFTP Filename..... banner.txt
Data Type..... Cli Banner

Are you sure you want to start? (y/n) y

CLI Banner file transfer operation completed successfully!

(Netgear Switch) #exit

(Netgear Switch) >logout

Login Banner - Unauthorized access is punishable by law.
User:
```

---

**Note:** The `no clibanner` command removes the banner from the switch.

---

# Port Mirroring

The port mirroring feature:

- Allows you to monitor network traffic with an external network analyzer.
- Forwards a copy of each incoming and outgoing packet to a specific port.
- Is used as a diagnostic tool, debugging feature, or means of fending off attacks.
- Assigns a specific port to copy all packets to.
- Allows inbound or outbound packets to switch to their destination and to be copied to the mirrored port.

The example is shown as CLI commands and as a local browser interface procedure.

## CLI: Specify the Source (Mirrored) Ports and Destination (Probe)

```
(Netgear Switch)#config
(Netgear Switch)(Config)#monitor session 1 mode
Enable mirror
(Netgear Switch)(Config)#monitor session 1 source interface 1/0/2
Specify the source interface.
(Netgear Switch)(Config)#monitor session 1 destination interface 1/0/3
Specify the destination interface.
(Netgear Switch)(Config)#exit
(Netgear Switch)#show monitor session 1
```

| Session ID | Admin Mode | Probe Port | Mirrored Port |
|------------|------------|------------|---------------|
| 1          | Enable     | 1/0/3      | 1/0/2         |

## Local Browser Interface: Specify the Source (Mirrored) Ports and Destination (Probe)

1. Select **Monitoring > Mirroring > Port Mirroring**.

A screen similar to the following displays.

The screenshot shows the 'Monitoring' tab in the web interface. Under 'Mirroring', 'Multiple Port Mirroring' is selected. The 'Global Configuration' section includes fields for Session ID (1), Admin Mode (True), Destination Port (1/0/3), Filter Type (None), and Filter Name. The 'Source Interface Configuration' section has a table with columns: Interface, Direction, and Status. The table lists interfaces 1/0/1, 1/0/2, and 1/0/3. Interface 1/0/2 is selected with a checkmark and has 'Tx and Rx' in the Direction field. A 'Go' button is present next to the 'Go To Interface' field.

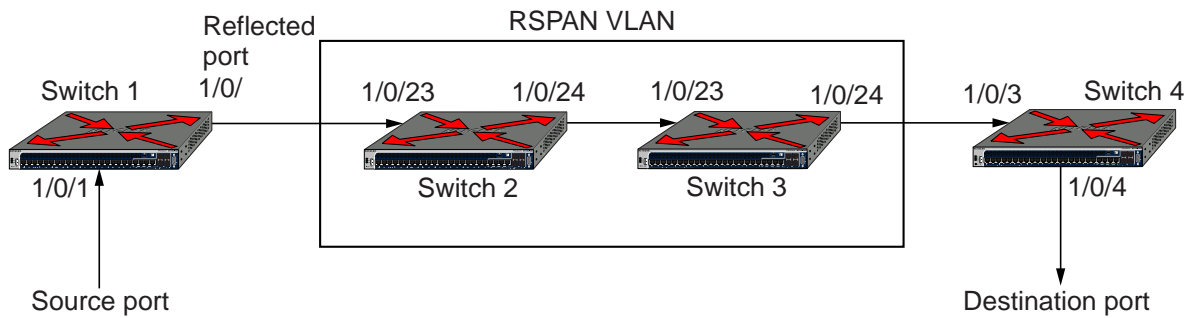
| Interface                                 | Direction | Status |
|---|-----------|--------|
| <input type="checkbox"/> 1/0/1            | None      |        |
| <input checked="" type="checkbox"/> 1/0/2 | Tx and Rx |        |
| <input type="checkbox"/> 1/0/3            | None      |        |

2. Next to **Admin Mode** field, select the **True** radio button.
3. From the **Destination Port** menu, select **1/0/3**.
4. Scroll down and select the check box to the left of interface **1/0/2**.
5. Click the **Apply** button.

Your settings are saved.

## Remote SPAN

Mirroring lets you monitor traffic to and from a port by copying the traffic to a probe port for analysis. Mirroring is usually limited to on one switch. With a remote switched port analyzer (RSPAN), you can extend mirroring to all participating switches.



**Figure 46. Example of an RSPAN topology**

In the previous figure, Switch 1 is the source switch, Switch 2 and Switch 3 are intermediate switches, and Switch 4 is the destination switch.

You must configure the ports that are connected to the destination switch with tagging, with the VLAN ID as the RSPAN VLAN. You must also configure the ports on the intermediate switches that are connected to the source switch and destination switch with the RSPAN VLAN. Only one RSPAN VLAN is supported.

On the source switch, the traffic that is received on and transmitted from source port (1/0/1) is tagged with the RSPAN VLAN and transmitted on the configured reflector port. The reflector port (1/0/2) is the physical interface that carries the mirrored traffic to the destination switch.

The intermediate switches forward the incoming tagged traffic to the destination switch. Enable RSPAN VLAN egress tagging on the ports of the intermediate switches that are connected to the destination switch.

The destination switch accepts all the packets that are tagged with the RSPAN VLAN and mirrors the packets on the destination port to which you must connect a traffic analyzer.

The original tag is retained at the destination switch. Mirrored traffic has double tagging: The inner tag is the original VLAN ID and the outer tag is the RSPAN VLAN ID.

## CLI: Enable RSPAN on a Switch

1. On the source switch (Switch 1), configure the following settings:
  - Source ports (the ports for which the traffic must be mirrored)
  - RSPAN VLAN (the destination for the mirrored traffic)
  - Reflector port (the port that is connected, through the intermediate switches, to the destination switch)
  - Tx/Rx (both egress and ingress traffic must be mirrored)

```

(Netgear Switch) #vlan database
(Netgear Switch) (Vlan)#vlan 5
(Netgear Switch) (Vlan)#exit
(Netgear Switch) #config
(Netgear Switch) (Config)#vlan 5
(Netgear Switch) (Config)(Vlan 5)#remote-span
(Netgear Switch) (Config)(Vlan 5)#exit
(Netgear Switch) (Config)#monitor session 1 mode
(Netgear Switch) (Config)#monitor session 1 source interface 1/0/1
(Netgear Switch) (Config)#monitor session 1 destination remote vlan 5 reflector-port
1/0/2
(Netgear Switch) (Config)#exit
(Netgear Switch) #show monitor session 1

```

| Session ID | Admin Mode | Probe Port | Src VLAN | Mirrored Port | Ref. Port | Src RVLAN | Dst RVLAN | Type  | IP ACL | MAC ACL |
|------------|------------|------------|----------|---------------|-----------|-----------|-----------|-------|--------|---------|
| 1          | Enable     |            |          | 1/0/1         | 1/0/2     |           | 5         | Rx,Tx |        |         |

- On the intermediate switches (Switch 2 and Switch 3), configure the ports that are connected to the source and destination switches as tagged members of the VLAN.

**Note:** You do not need to configure RSPAN on the intermediate switches.

```

(Netgear Switch) #vlan database
(Netgear Switch) (Vlan)#vlan 5
(Netgear Switch) (Vlan)#exit
(Netgear Switch) #config
(Netgear Switch) (Config)#interface 1/0/23
(Netgear Switch) (Interface 1/0/23)#vlan participation include 5
(Netgear Switch) (Interface 1/0/23)#vlan tagging 5
(Netgear Switch) (Interface 1/0/23)#exit
(Netgear Switch) (Config)#interface 1/0/24
(Netgear Switch) (Interface 1/0/24)#vlan participation include 5
(Netgear Switch) (Interface 1/0/24)#vlan tagging 5
(Netgear Switch) (Interface 1/0/24)#exit

```

- On the destination switch (Switch 4), configure the following settings:
  - RSPAN VLAN (the source of the mirrored traffic)
  - The probe port (the port that is connected, through the intermediate switches, to the source switch)



```

(Netgear Switch) #vlan database
(Netgear Switch) (Vlan)#vlan 5
(Netgear Switch) (Vlan)#exit
(Netgear Switch) #config
(Netgear Switch) (Config)#vlan 5
(Netgear Switch) (Config)(Vlan 5)#remote-span
(Netgear Switch) (Config)(Vlan 5)#exit
(Netgear Switch) (Config)#interface 1/0/3
(Netgear Switch) (Interface 1/0/3)#vlan participation include 5
(Netgear Switch) (Interface 1/0/3)#vlan tagging 5
(Netgear Switch) (Interface 1/0/3)#exit
(Netgear Switch) (Config)#monitor session 1 mode
(Netgear Switch) (Config)#monitor session 1 source remote vlan 5
(Netgear Switch) (Config)#monitor session 1 destination interface 1/0/4
(Netgear Switch) #show monitor session 1

```

| Session ID | Admin Mode | Probe Port | Src VLAN | Mirrored Port | Ref. Port | Src RVLAN | Dst RVLAN | Type | IP ACL | MAC ACL |
|------------|------------|------------|----------|---------------|-----------|-----------|-----------|------|--------|---------|
| 1          | Enable     | 1/0/4      |          |               |           | 5         |           |      |        |         |

## Dual Image

Traditionally switches contain a single image in the permanent storage. This image is loaded into memory every time there is a reboot. The dual image feature allows switches to have two images in permanent storage. You can denote one of these images as an active image that will be loaded in subsequent reboots and the other image as a backup image. This feature provides for reduced down time for the switches, when the firmware is being upgraded or downgraded.

The images are stored in the file system with the file names *image1* and *image2*. These names are used in the CLI, Web, and SNMP interfaces. Each of the images can be associated with a textual description. The switch provides commands to associate and retrieve the text description for an image. A switch also provides commands to activate the backup image such that it is loaded in subsequent reboots. This activation command makes the current active image as the backup image for subsequent reboots.

On three successive errors executing the **active-image**, the switch attempts to execute the **backup-image**. If there are errors executing the **backup-image** as well, the bootloader will invoke the boot menu.

The Dual Image feature works seamlessly with the stacking feature. All members in the stack must be uniform in their support for the dual Image feature. The Dual Image feature works in the following way in a stack.

- When an image is activated, the management node notifies all the participating nodes. All nodes activate the specified image.
- When any node is unable to execute the **active-image** successfully, it attempts to execute the **backup-image**. Such cases will require user intervention to correct the problem, by using appropriate stacking commands.

## CLI: Download a Backup Image and Make It Active

```
(Netgear Switch) #copy tftp://192.168.0.1/switch.stk image2
Mode..... TFTP
Set Server IP..... 192.168.0.1
Path..... ./
Filename..... switchs.stk
Data Type..... Code
Destination Filename..... image2
Management access will be blocked for the duration of the transfer Are you sure you
want to start? (y/n) y

TFTP code transfer starting
101888 bytes transferred...277504 bytes transferred...410112 bytes
transferred...628224 bytes transferred...803328 bytes transferred...978944 bytes
transferred...1154560 bytes transferred...1330176 bytes transferred...1505280 bytes
transferred...1680896 bytes transferred...1861632 bytes transferred...2040320 bytes
transferred...2215936 bytes transferred...2391040 bytes transferred...2566656 bytes
transferred...2741760 bytes transferred...2916864 bytes transferred...3092992 bytes
transferred...3268096 bytes transferred...3443712 bytes transferred...3619328 bytes
transferred...3794432 bytes transferred...3970048 bytes transferred...4145152 bytes
transferred...4320768 bytes transferred...4496384 bytes transferred...4669952 bytes
transferred...4849152 bytes transferred...5027840 bytes transferred...5202944 bytes
transferred...5378560 bytes transferred...5554176 bytes transferred...5729280 by
tes transferred...5904896 bytes transferred...6078976 bytes transferred...6255616
bytes transferred...6423040 bytes transferred...6606336 bytes transferred...6781952
bytes transferred...6957056 bytes transferred...7111168 bytes transferred...7307776
bytes transferred...7483392 bytes transferred...7658496 bytes transferred...

Verifying CRC of file in Flash File System
Distributing the code to the members of the stack!
File transfer operation completed successfully.
(Netgear Switch) #
(Netgear Switch) #show bootvar
Image Descriptions
  image1 : default image
  image2 :
```

| Images currently available on Flash   |           |         |                |             |
|---------------------------------------|-----------|---------|----------------|-------------|
| unit                                  | image1    | image2  | current-active | next-active |
| 1                                     | 5.11.2.51 | 8.0.0.2 | image1         | image1      |
| (Netgear Switch) #boot system image2  |           |         |                |             |
| Activating image image2 ..            |           |         |                |             |
| (Netgear Switch) #show bootvar        |           |         |                |             |
| Image Descriptions                    |           |         |                |             |
| image1 : default image                |           |         |                |             |
| image2 :                              |           |         |                |             |
| Images currently available on Flash   |           |         |                |             |
| unit                                  | image1    | image2  | current-active | next-active |
| 1                                     | 5.11.2.51 | 8.0.0.2 | image1         | image2      |
| Image2 will be executed after reboot. |           |         |                |             |

## Local Browser Interface: Download a Backup Image and Make It Active

1. Download a backup image using tftp.
  - a. Select **Maintenance > Download > File Download**.

A screen similar to the following displays.

- b. From the **File Type** menu, select **Archive**.
  - c. From the **Image Name** menu, select **image2**.
  - d. From the **Transfer Mode** menu, select **TFTP**.
  - e. From the **Server Address Type** menu, select **IPv4**.
  - f. In the **Server Address** field, enter **10.100.5.17**.
  - g. In the **Remote File Name**, enter **M4300.stk**.
  - h. Click the **Apply** button.

Your settings are saved.

2. Activate image2.

a. Select **Maintenance > File Management > Dual Image Configuration**.

A screen similar to the following displays.

| System   | Switching  | Routing      | QoS               | Security          | Monitoring      | Maintenance | Help | Index |
|--|------------|--------------|-------------------|-------------------|-----------------|-------------|------|-------|
| Save Config  | Reset      | Upload       | Download          | File Management   | Troubleshooting |             |      |       |
| File Management  |            |              |                   |                   |                 |             |      |       |
| Dual Image Configuration   |            |              |                   |                   |                 |             |      |       |
| <div> <div>• Copy</div> <div>• Dual Image Configuration</div> </div> |            |              |                   |                   |                 |             |      |       |
| Unit   | Image Name | Active Image | Next Active Image | Image Description | Version         |             |      |       |
| 1  | image2     | False        | True              |                   | 6.11.15.11      |             |      |       |
| <input type="checkbox"/> 1   | image1     | True         | True              |                   | 10.2.0.5        |             |      |       |
| <input checked="" type="checkbox"/> 1                                | image2     | False        | False             |                   | 6.11.15.11      |             |      |       |

b. Under Dual Image Configuration, select the check box next image 2.

The Image name field in the table heading displays image 2.

c. From the **Next Active Image** menu, select **True**.

d. Click the **Apply** button.

Your settings are saved.

## Outbound Telnet

In this section, the following examples are provided:

- [CLI: show network](#)
- [CLI: transport output telnet](#)
- [Local Browser Interface: Configure Telnet](#)
- [CLI: Configure the Session Limit and Session Time-out](#)
- [Local Browser Interface: Configure the Session Time-out](#)

Outbound Telnet:

- Establishes an outbound Telnet connection between a device and a remote host.
- A Telnet connection is initiated, each side of the connection is assumed to originate and terminate at a network virtual terminal (NVT).
- Server and user hosts do not maintain information about the characteristics of each other's terminals and terminal handling conventions.
- Must use a valid IP address.

## CLI: show network

```
(Netgear Switch) >telnet 192.168.77.151
Trying 192.168.77.151...
(Netgear Switch)
User:admin
Password:
(Netgear Switch)      >en
Password:

(Netgear Switch)      #show network

IP Address..... 192.168.77.151
Subnet Mask..... 255.255.255.0
Default Gateway..... 192.168.77.127
Burned In MAC Address..... 00:10:18.82.04:E9
Locally Administered MAC Address..... 00:00:00:00:00:00
MAC Address Type..... Burned In
Network Configuration Protocol Current... DHCP
Management VLAN ID..... 1
Web Mode..... Enable
Java Mode ..... Disable
```

## CLI: show telnet

```
(Netgear Switch)#show telnet

Outbound Telnet Login Timeout (minutes)..... 5
Maximum Number of Outbound Telnet Sessions..... 5
Allow New Outbound Telnet Sessions..... Yes
```

## CLI: transport output telnet

```
(Netgear Switch) (Config)#lineconfig ?  
  
<cr>                                Press Enter to execute the command.  
  
(Netgear Switch) (Config)#lineconfig  
  
(Netgear Switch) (Line)#transport ?  
  
input                               Displays the protocols to use to connect to a  
                                   specific line of the router.  
output                             Displays the protocols to use for outgoing  
                                   connections from a line.  
  
(Netgear Switch) (Line)#transport output ?  
  
telnet                             Allow or disallow new telnet sessions.  
  
(Netgear Switch) (Line)#transport output telnet ?  
  
<cr>                                Press Enter to execute the command.  
  
(Netgear Switch) (Line)#transport output telnet  
  
(Netgear Switch) (Line)#
```

## Local Browser Interface: Configure Telnet

### 1. Select **Security > Access > Telnet**.

A screen similar to the following displays.

| System   | Switching | Routing             | QoS             | Security | Monitoring | Maintenance | Help | Index |
|--|-----------|---------------------|-----------------|----------|------------|-------------|------|-------|
| Management Security  | Access    | Port Authentication | Traffic Control | Control  | ACL        |             |      |       |
| <div> <div>Access</div> <div> <div>Enable Authentication List</div> <div>enableList</div> </div> </div> <div> <div> <div>• HTTP</div> <div>• HTTPS</div> <div>• SSH</div> <div>• Telnet</div> <div>• Console Port</div> <div>• Denial of Service Configuration</div> <div>• Access Control</div> </div> <div> <div>Inbound Telnet</div> <div> <div>Telnet Server Admin Mode</div> <div> <input type="radio"/> Disable           <input checked="" type="radio"/> Enable         </div> <div>Allow new telnet sessions</div> <div> <input type="radio"/> Disable           <input checked="" type="radio"/> Enable         </div> <div>Session Timeout (Minutes)</div> <div> <input type="text" value="5"/> (1 to 160)         </div> <div>Maximum Number of Sessions</div> <div> <input type="text" value="5"/> (0 to 5)         </div> <div>Current Number of Sessions</div> <div> <input type="text" value="0"/> </div> </div> </div> <div> <div>Outbound Telnet</div> <div> <div>Allow new telnet sessions</div> <div> <input type="radio"/> Disable           <input checked="" type="radio"/> Enable         </div> <div>Session Timeout (Minutes)</div> <div> <input type="text" value="5"/> (1 to 160)         </div> <div>Maximum Number of Sessions</div> <div> <input type="text" value="5"/> (0 to 5)         </div> <div>Current Number of Sessions</div> <div> <input type="text" value="0"/> </div> </div> </div> </div> |           |                     |                 |          |            |             |      |       |

### 2. Under Outbound Telnet, for Admin Mode, select the **Enable** radio button.

### 3. Click the **Apply** button.

Your settings are saved.

## CLI: Configure the Session Limit and Session Time-out

```
(Netgear Switch) (Line)#session-limit ?
<0-5>          Configure the maximum number of outbound telnet sessions
allowed.

(Netgear Switch) (Line)#session-limit 5

(Netgear Switch) (Line)#session-timeout ?

<1-160>        Enter time in minutes.

(Netgear Switch) (Line)#session-timeout 15
```



## Local Browser Interface: Configure the Session Time-out

### 1. Select **Security > Access > Telnet**.

A screen similar to the following displays.

| System  | Switching | Routing | QoS | Security | Monitoring | Maintenance | Help | Index |
|---|-----------|---------|-----|----------|------------|-------------|------|-------|
| Management Security Access Port Authentication Traffic Control Control ACL  |           |         |     |          |            |             |      |       |
| <div>Access</div> <div>Enable Authentication List <span>enableList</span></div> <div> <div> <div>• HTTP</div> <div>• HTTPS</div> <div>• SSH</div> <div>• Telnet</div> <div>• Console Port</div> <div>• Denial of Service Configuration</div> <div>• Access Control</div> </div> <div> <div>Telnet Server Admin Mode</div> <div>Allow new telnet sessions</div> <div>Session Timeout (Minutes)</div> <div>Maximum Number of Sessions</div> <div>Current Number of Sessions</div> </div> <div> <div>Disable</div> <div>Enable</div> <div>Disable</div> <div>Enable</div> <div>5</div> <div>5</div> <div>0</div> </div> </div> |           |         |     |          |            |             |      |       |

Outbound Telnet

Allow new telnet sessions

Session Timeout (Minutes)

Maximum Number of Sessions

Current Number of Sessions

Disable

Enable

15

5

0

### 2. Enter the following information:

- In the **Session Timeout (Minutes)** field, enter **15**.
- In the **Maximum Number of Sessions** field, enter **5**.

### 3. Click the **Apply** button.

Your settings are saved.

## Error Disablement and Automatic Error Recovery

The switch supports interface error disablement, also referred to as Diagnostic Disable (D-Disable), and error autorecovery of the disabled interface. If the switch detects an error condition for an interface, it places the interface in a diagnostic-disabled (error-disabled) state by shutting down the interface. The error-disabled interface does not allow any traffic until the interface is reenabled.

Either you can manually reenable the error-disabled interface or you can enable the error autorecovery feature, which automatically reenables the interface after the expiration of the time-out interval. The default time-out for autorecovery is 300 seconds. If an interface is reenabled but the reason that the interface was placed in the D-Disable state is not resolved, the interface is placed back in the D-Disable state.

The following features are supported by autorecovery:

- **Keepalive.** If loop protection is enabled, loop protection detects a loop, and the loop protection action is to disable the interface, the interface is placed in the D-Disable state. If autorecovery is enabled, the interface comes back up after the time-out interval expires.
- **BPDU storm.** If the number of BPDUs exceeds 15 for three consecutive seconds, the interface is placed in the D-Disable state. If autorecovery is enabled, the interface comes back up after the time-out interval expires.
- **BPDU guard.** The STP BPDU guard feature lets you enforce the STP domain borders and keep the active topology consistent and predictable. (Switches behind edge ports for which STP BPDU guard is enabled cannot influence the overall STP topology.) If the BPDU guard feature is enabled and a port receives BPDUs, the port is placed in the D-Disable state. If autorecovery is enabled, the port comes back up after the time-out interval expires.
- **Broadcast storm.** If broadcast storm control is enabled, the threshold value is exceeded, and the broadcast storm action is to disable the interface, the interface is placed in the D-Disable state. If autorecovery is enabled, the interface comes back up after the time-out interval expires.
- **Multicast storm.** If multicast storm control is enabled, the threshold value is exceeded, and the multicast storm action is to disable the interface, the interface is placed in the D-Disable state. If autorecovery is enabled, the interface comes back up after the time-out interval expires.
- **Unicast storm.** If unicast storm control is enabled, the threshold value is exceeded, and the unicast storm action is to disable the interface, the interface is placed in the D-Disable state. If autorecovery is enabled, the interface comes back up after the time-out interval expires.
- **Auto-DoS.** If auto-DoS is enabled and the switch detects a DoS attack, the interface is placed in the D-Disable state. If autorecovery is enabled, the interface comes back up after the time-out interval expires.
- **Port MAC address locking.** If dynamic MAC address locking is configured, the number of MAC addresses exceeds the threshold, and the port security violation action is to shut down the port, the port is placed in the D-Disable state. If autorecovery is enabled, the port comes back up after the time-out interval expires.
- **Dynamic ARP inspection.** If dynamic ARP inspection (DAI) is enabled and the threshold value is reached, the interface is placed in the D-Disable state. If autorecovery is enabled, the interface comes back up after the time-out interval expires.
- **DHCP rate limiting.** If DHCP snooping is enabled and the incoming DHCP packet rate exceeds the threshold, the interface is placed in the D-Disable state. If autorecovery is enabled, the interface comes back up after the time-out interval expires.
- **UDLD.** If Unidirectional Link Detection (UDLD) is enabled and the unidirectional connection is detected, the interface is placed in the D-Disable state. If autorecovery is enabled, the interface comes back up after the time-out interval expires.

The following example shows how you can configure autorecovery for UDLD, change the time-out interval for autorecovery, and show the status of autorecovery for all features:

**1. Enable autorecovery for UDLD.**

```
(Netgear Switch) #config
(Netgear Switch) (Config)#errdisable recovery cause udld
```

**2. Change the time-out interval for autorecovery.**

```
(Netgear Switch) #config
(Netgear Switch) (Config) #errdisable recovery interval 30
```

**3. Display the status of autorecovery for all features.**

```
(Netgear Switch) #show errdisable recovery
```

| Errdisable Reason | Auto-recovery Status |
|-------------------|----------------------|
| -----             | -----                |
| dhcp-rate-limit   | Enabled              |
| arp-inspection    | Enabled              |
| udld              | Enabled              |
| bcast-storm       | Enabled              |
| mcast-storm       | Enabled              |
| ucast-storm       | Enabled              |
| bpduguard         | Enabled              |
| bpdustorm         | Enabled              |
| keepalive         | Enabled              |
| Port MAC Locking  | Enabled              |
| Denial Of Service | Enabled              |

```
Timeout for Auto-recovery from D-Disable state 30
```

## Loop Protection

Loops inside a network are costly because they consume resources and reduce the performance of the network. Detecting loops manually can be cumbersome.

The switch can automatically identify loops in the network. You can enable loop protection per port or globally.

If loop protection is enabled, the switch sends predefined PDU packets to a Layer 2 multicast destination address (09:00:09:09:13:A6) on all ports for which the feature is enabled. You can selectively disable PDU packet transmission for loop protection on specific ports even

while port loop protection is enabled. If the switch receives a packet with the previously mentioned multicast destination address, the source MAC address in the packet is compared with the MAC address of the switch. If the MAC address does not match, the packet is forwarded to all ports that are members of the same VLAN, just like any other multicast packet. The packet is not forwarded to the port from which it was received.

If the source MAC address matches the MAC address of the switch, the switch can perform one of the following actions, depending on how you configure the action:

- The port is shut down.
- A log message is generated. (If a syslog server is configured, the log message can be sent to the syslog server.)
- The port is shut down and a log message is generated.

If loop protection is disabled, the multicast packet is silently dropped.

You can configure the interval between two successive loop protection PDU packets with the **transmit-interval** command. The default interval parameter is 5 seconds. If the switch receives a loop protocol packet on a port for which the action is set to shut down the port, the port can no longer receive and send frames.

Loop protection operates at the port level, regardless of VLAN assignment and membership, detecting loops across VLANs. The protection uses the OUI-Extended Ethernet Type frame format (0x88b7), which is an IEEE-sanctioned format for vendor-specific packets.

Loop protection does not impact end nodes and is not intended for ports that serve as uplinks between spanning tree-aware switches. Loop protection can coexist with Spanning Tree Protocol (STP). You can enable both loop protection and STP on a port because these features function independently of each other. STP does not bring a port down when a loop is detected but keeps the port in blocking state. Because PDUs are allowed in a blocking state, loop protection packets are received and loop protection brings down the port that is involved in the loop (if the configured action is to shut down the port).

The following example shows how you can enable loop protection on ports 1/0/1 and 1/0/2:

**1. Enable loop protection globally.**

```
(Netgear Switch) (Config) #keepalive
```

Enable loop protection on ports 1/0/1 and 1/0/2 and set the violation action to shutting down the port and logging a message.

```
(Netgear Switch) (Config)#interface 1/0/1,1/0/2
(Netgear Switch) (Interface 1/0/1-1/0/2)#keepalive
(Netgear Switch) (Interface 1/0/1-1/0/2)#keepalive action both
```

# Nondisruptive Configuration Management

If you are managing a large network with thousands of switches, the best way to change the switch configuration is to provide a new startup configuration file to the switch and let the switch gracefully resolve any differences between the running configuration and the new configuration by using the Nondisruptive Configuration Management feature.

For example, if VLANs 10, 20, and 30 are configured on the switch while the new configuration includes VLANs 10, 20, and 40, the switch must delete VLAN 30, create VLAN 40, and leave traffic that is being forwarded on VLANs 10 and 20 undisturbed.

To apply a new switch configuration without using the Nondisruptive Configuration Management feature, you must either restart the switch or send a delta configuration to the switch. Restarting the switch is disruptive, and managing delta configurations on a large scale can be difficult.

The following example shows how you can install a new configuration on a switch by using the Nondisruptive Configuration Management feature:

1. Download the file with the new configuration to switch.

```
(Netgear Switch) # Copy tftp://172.26.2.21/new_config.scr nvram:script new_config.scr
```

2. Merge the new configuration with the current configuration.

```
(Netgear Switch) # Reload configuration new_config.scr
```

3. Save the changes.

```
(Netgear Switch) #save
```

# Full Memory Dump

The full memory dump feature provides the ability to retrieve the state of a crashed system and load it into a debugger to recreate the crashed state. This capability is useful when the switch encounters a crash.

The following example shows how to enable this feature and dump the information from a switch.

1. Select the way to transfer the exception dump.

You can select NFS, TFTP, or USB. If you select NFS, you need an NFS share mount point on the network. Similarly, for TFTP mode, you need a TFTP server on the network. For USB mode, you need a USB sticker plugged into the USB slot on the front panel.

```
(Netgear Switch) (Config) #exception protocol tftp
```

2. Configure the IP address for the NFS or TFTP server.

```
(Netgear Switch) (Config) #exception dump tftp-server 172.26.2.100
```

3. Change the name of the dump file.

The file name is formed as follows:

- If hostname is selected: file-name-prefix\_hostname\_Time\_Stamp.bin
- If hostname is not selected:  
file-name-prefix\_MAC\_Address\_Time\_Stamp.bin

By default, the file name is `core`, but you can change it with the following command:

```
(Netgear Switch) (Config) #exception core-file mydump
```

4. (Optional) Enable the switch-chip-register.

This dumps the register value in the chipset.

```
(Netgear Switch) (Config) #exception switch-chip-register enable
```

# 20

## 20 Syslog

---

### System logging

This chapter includes the following sections:

- [Syslog Concepts](#)
- [Show Logging](#)
- [Show Logging Buffered](#)
- [Show Logging Traplogs](#)
- [Show Logging Hosts](#)
- [Configure Logging for a Port](#)
- [Email Alerting](#)

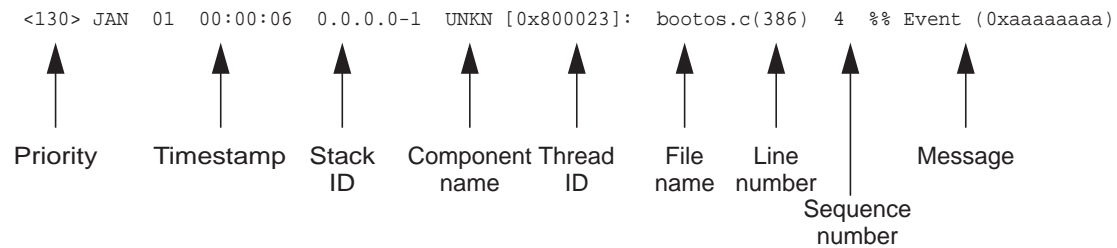


# Syslog Concepts

The syslog feature:

- Allows you to store system messages and errors.
- Can store to local files on the switch or a remote server running a syslog daemon.
- Provides a method of collecting message logs from many systems.

The following illustration explains how to interpret log files.



**Figure 47. Log Files**

## Show Logging

The example is shown as CLI commands and as a local browser interface procedure.

### CLI: Show Logging

```
(Netgear Switch) #show logging

Logging Client Local Port      : 514
CLI Command Logging           : disabled
Console Logging               : disabled
Console Logging Severity Filter : alert
Buffered Logging              : enabled

Syslog Logging                : enabled

Log Messages Received         : 66
Log Messages Dropped          : 0
Log Messages Relayed          : 0
Log Messages Ignored          : 0
```

## Local Browser Interface: Show Logging

### 1. Configure the syslog.

- a. From the main menu, select **Monitoring > Logs > Sys Log Configuration**.

A screen similar to the following displays.

| System  | Switching    | Routing | QoS  | Security        | Monitoring | Maintenance | Help | Index |                 |              |        |      |                 |  |  |  |  |  |
|---|--------------|---------|------|-----------------|------------|-------------|------|-------|-----------------|--------------|--------|------|-----------------|--|--|--|--|--|
| Ports Logs Mirroring sFlow  |              |         |      |                 |            |             |      |       |                 |              |        |      |                 |  |  |  |  |  |
| <div> <div> <div>Logs</div> <ul style="list-style-type: none"> <li>• Buffered Logs</li> <li>• Command Log Configuration</li> <li>• Console Log Configuration</li> <li>• <b>Syslog Configuration</b></li> <li>• Trap Logs</li> <li>• Event Logs</li> <li>• Persistent Logs</li> </ul> </div> <div> <div>Syslog Configuration</div> <div> <div>Admin Status</div> <div> <input type="radio"/> Disable           <input checked="" type="radio"/> Enable         </div> </div> <div> <div>Local UDP Port</div> <div>514 (1 to 65535)</div> </div> <div> <div>Messages Received</div> <div>919</div> </div> <div> <div>Messages Relayed</div> <div>0</div> </div> <div> <div>Messages Ignored</div> <div>0</div> </div> </div> </div> |              |         |      |                 |            |             |      |       |                 |              |        |      |                 |  |  |  |  |  |
| <div> <div>Host Configuration</div> <table border="1"> <thead> <tr> <th>IP Address Type</th> <th>Host Address</th> <th>Status</th> <th>Port</th> <th>Severity Filter</th> </tr> </thead> <tbody> <tr> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> </tbody> </table> </div>  |              |         |      |                 |            |             |      |       | IP Address Type | Host Address | Status | Port | Severity Filter |  |  |  |  |  |
| IP Address Type   | Host Address | Status  | Port | Severity Filter |            |             |      |       |                 |              |        |      |                 |  |  |  |  |  |
|   |              |         |      |                 |            |             |      |       |                 |              |        |      |                 |  |  |  |  |  |

- b. In the Syslog Configuration, next to the Admin Status, select the **Enable** radio button.

- c. Click **Apply**.

### 2. Configure the command log.

- a. Select **Monitoring > Logs > Command Log**.

A screen similar to the following displays.

| System   | Switching | Routing | QoS | Security | Monitoring | Maintenance | Help | Index |
|--|-----------|---------|-----|----------|------------|-------------|------|-------|
| Ports Logs Mirroring sFlow   |           |         |     |          |            |             |      |       |
| <div> <div> <div>Logs</div> <ul style="list-style-type: none"> <li>• Buffered Logs</li> <li>• <b>Command Log Configuration</b></li> <li>• Console Log Configuration</li> </ul> </div> <div> <div>Command Log Configuration</div> <div> <div>Admin Status</div> <div> <input checked="" type="radio"/> Disable           <input type="radio"/> Enable         </div> </div> </div> </div> |           |         |     |          |            |             |      |       |

- b. Under Command Log, for Admin Status, select the **Disable** radio button.

- c. Click **Apply**.

### 3. Configure the console log.

- a. Select **Monitoring > Logs > Console Log**.

A screen similar to the following displays.

| System  | Switching | Routing | QoS | Security | Monitoring | Maintenance | Help | Index |
|---|-----------|---------|-----|----------|------------|-------------|------|-------|
| Ports Logs Mirroring sFlow  |           |         |     |          |            |             |      |       |
| <div> <div> <div>Logs</div> <ul style="list-style-type: none"> <li>• Buffered Logs</li> <li>• Command Log Configuration</li> <li>• <b>Console Log Configuration</b></li> <li>• Syslog Configuration</li> <li>• Trap Logs</li> <li>• Event Logs</li> <li>• Persistent Logs</li> </ul> </div> <div> <div>Console Log Configuration</div> <div> <div>Admin Status</div> <div> <input type="radio"/> Disable           <input checked="" type="radio"/> Enable         </div> </div> <div> <div>Severity Filter</div> <div>Alert</div> </div> </div> </div> |           |         |     |          |            |             |      |       |

- b. Under Console Log Configuration, for Admin Status, select the **Disable** radio button.
  - c. Click **Apply**.
4. Configure the buffer logs.
- a. Select **Monitoring > Logs > Buffer Logs**.

A screen similar to the following displays.

| System   | Switching | Routing   | QoS   | Security | Monitoring | Maintenance | Help | Index |
|--|-----------|-----------|-------|----------|------------|-------------|------|-------|
| Ports  | Logs      | Mirroring | sFlow |          |            |             |      |       |
| <div> <div> <div>Logs</div> <div> <div>Buffered Logs</div> <div> <div>• Command Log Configuration</div> <div>• Console Log Configuration</div> <div>• Syslog Configuration</div> <div>• Trap Logs</div> <div>• Event Logs</div> <div>• Persistent Logs</div> </div> </div> <div> <div>Buffered Logs</div> <div> <div>Admin Status: <input type="radio"/> Disable <input checked="" type="radio"/> Enable</div> <div>Behavior: <span>Wrap</span></div> </div> </div> </div> <div> <div>Message Log</div> <div> <div>Total number of Messages: 102</div> <div> <div>Description</div> <div> &lt;14&gt; Jan 1 02:09:23 192.168.10.138-1 UNITMGR[127337108]: unitmgr.c(6895) 921 %% Copy of running configuration to backup unit complete<br/> &lt;14&gt; Jan 1 02:06:55 192.168.10.138-1 CLI_WEB[127641740]: emweb_common_custom.c(119) 919 %% HTTP Session 11 ended for user adm<br/> &lt;14&gt; Jan 1 01:53:03 192.168.10.138-1 General[127641740]: main_login.c(214) 918 %% HTTP Session 13 initiated for user admin connected fr<br/> &lt;14&gt; Jan 1 01:53:03 192.168.10.138-1 CLI_WEB[127641740]: emweb_common_custom.c(162) 917 %% HTTP Session 13 started for user ad<br/> &lt;14&gt; Jan 1 01:51:57 192.168.10.138-1 UNITMGR[127337108]: unitmgr.c(6895) 916 %% Copy of running configuration to backup unit complete<br/> &lt;14&gt; Jan 1 01:49:57 192.168.10.138-1 UNITMGR[127337108]: unitmgr.c(6895) 914 %% Copy of running configuration to backup unit complete<br/> &lt;14&gt; Jan 1 01:46:44 192.168.10.138-1 UNITMGR[127337108]: unitmgr.c(6895) 912 %% Copy of running configuration to backup unit complete<br/> &lt;14&gt; Jan 1 01:42:36 192.168.10.138-1 UNITMGR[127337108]: unitmgr.c(6895) 910 %% Copy of running configuration to backup unit complete </div> </div> </div> </div> </div> |           |           |       |          |            |             |      |       |

- b. Under Buffer Logs, for Admin Status, select the **Enable** radio button.
- c. Click **Apply**.

# Show Logging Buffered

The example is shown as CLI commands and as a local browser interface procedure.

## CLI: Show Logging Buffered

```
(Netgear Switch) #show logging buffered ?

<cr>    Press Enter to execute the command.

(Netgear Switch) #show logging buffered

Buffered (In-Memory) Logging      : enabled
Buffered Logging Wrapping Behavior : On
Buffered Log Count                : 3949

<14> Jan 13 00:42:58 172.26.2.129-1 CLI_WEB[101123540]: emweb_common_custom.c(119)
6497 %% HTTP Session 11 ended for user admin connected from 10.120.5.28
<14> Jan 13 00:36:21 172.26.2.129-1 UNITMGR[102633148]: unitmgr.c(6898) 6496 %% Copy
of running configuration to backup unit complete
<14> Jan 13 00:34:21 172.26.2.129-1 UNITMGR[102633148]: unitmgr.c(6898) 6494 %% Copy
of running configuration to backup unit complete
<13> Jan 13 00:33:45 172.26.2.129-1 TRAPMGR[102518604]: traputil.c(701) 6492 %% Link
Up: tunnel0
<13> Jan 13 00:33:44 172.26.2.129-1 TRAPMGR[102518604]: traputil.c(701) 6491 %% Link
Down: tunnel0
<13> Jan 13 00:33:44 172.26.2.129-1 TRAPMGR[102518604]: traputil.c(701) 6490 %% Link
Up: tunnel0
```

The priority (that is, the number that is stated in angle brackets before each logging message, for example, <14> in the previous example) is calculated by multiplying the facility number by 8 and adding the numerical value of the severity. If you know the priority, you can determine the facility and severity in the following ways:

- Facility = Priority divided by 8. The whole number is the facility. For example, if the priority is 14, divide 14 by 8. The result is 1.75. The whole number is 1, which is the facility.
- Severity = Priority minus 8. For example, if the priority is 14, subtract 8 from 14. The result is 6, which is the severity.

## Local Browser Interface: Show Logging Buffered

Select **Monitoring > Logs > Buffer Logs**. A screen similar to the following displays.

## Show Logging Traplogs

The example is shown as CLI commands and as a local browser interface procedure.

### CLI: Show Logging Traplogs

```
(Netgear Switch) #show logging traplogs ?
<cr> Press Enter to execute the command.
(Netgear Switch) #show logging traplogs
Number of Traps Since Last Reset..... 6
Trap Log Capacity.....256
Number of Traps Since Log Last Viewed..... 6

Log System Up Time      Trap
---
0  0 days 00:00:46      Link Up: Unit: 3 Slot: 0 Port: 2
1  0 days 00:01:01      Cold Start: Unit: 0
2  0 days 00:21:33      Failed User Login: Unit: 1 User ID: admin
3  0 days 18:33:31      Failed User Login: Unit: 1 User ID: \
4  0 days 19:27:05      Multiple Users: Unit: 0      Slot: 3 Port: 1
5  0 days 19:29:57      Multiple Users: Unit: 0      Slot: 3 Port: 1
```

## Local Browser Interface: Show Logging Trap Logs

Select **Monitoring > Logs > Trap Logs**. A screen similar to the following displays.

| System                      | Switching | Routing                               | QoS                 | Security   | Monitoring | Maintenance | Help | Index |
|-----------------------------|-----------|---------------------------------------|---------------------|--|------------|-------------|------|-------|
| Ports                       | Logs      | Mirroring                             | sFlow               |  |            |             |      |       |
|                             |           |                                       |                     |  |            |             |      |       |
| Logs                        |           | Trap Logs                             |                     |  |            |             |      |       |
| • Buffered Logs             |           | Number of Traps Since Last Reset      |                     | 34   |            |             |      |       |
| • Command Log Configuration |           | Trap Log Capacity                     |                     | 256  |            |             |      |       |
| • Console Log Configuration |           | Number of Traps Since Log Last Viewed |                     | 34   |            |             |      |       |
| • Syslog Configuration      |           |                                       |                     |  |            |             |      |       |
| • Trap Logs                 |           | Trap Logs                             |                     |  |            |             |      |       |
| • Event Logs                |           |                                       |                     |  |            |             |      |       |
| • Persistent Logs           |           |                                       |                     |  |            |             |      |       |
|                             |           | Log                                   | System Up Time      | Trap   |            |             |      |       |
|                             |           | 0                                     | Jan 1 00:02:15 1970 | Cold Start: Unit: 0  |            |             |      |       |
|                             |           | 1                                     | Jan 1 00:01:47 1970 | Link Up: vlan 1  |            |             |      |       |
|                             |           | 2                                     | Jan 1 00:01:39 1970 | Spanning Tree Topology Change Initiated: 0, Interface: 2/0/3 |            |             |      |       |
|                             |           | 3                                     | Jan 1 00:01:39 1970 | Spanning Tree Topology Change: 0, Unit: 1                    |            |             |      |       |
|                             |           | 4                                     | Jan 1 00:01:39 1970 | Link Up: 2/0/3   |            |             |      |       |
|                             |           | 5                                     | Jan 1 00:01:36 1970 | Power On Start has completed on unit 1.                      |            |             |      |       |
|                             |           | 6                                     | Jan 1 00:01:26 1970 | SFP inserted in 2/0/41                                       |            |             |      |       |
|                             |           | 7                                     | Jan 1 00:01:23 1970 | Entity Database: Configuration Changed                       |            |             |      |       |
|                             |           | 8                                     | Jan 1 00:01:18 1970 | SFP inserted in 3/0/1  |            |             |      |       |

## Show Logging Hosts

The example is shown as CLI commands and as a local browser interface procedure.

### CLI: Show Logging Hosts

```
(Netgear Switch) #show logging hosts ?

<cr>                                     Press Enter to execute the command.

(Netgear Switch) #show logging hosts

Index  IP Address          Severity    Port  Status
-----
1      192.168.21.253      critical    514   Active
```

## Local Browser Interface: Show Logging Hosts

Select **Monitoring > Logs > Sys Log Configuration**. A screen similar to the following displays.

| IP Address Type | Host Address   | Status | Port | Severity Filter |
|-----------------|----------------|--------|------|-----------------|
| IP4             | 192.168.21.253 | Active | 514  | Critical        |

## Configure Logging for a Port

The example is shown as CLI commands and as a local browser interface procedure.

### CLI: Configure Logging for the Port

```
(Netgear Switch)      #config

(Netgear Switch) (Config)#logging ?

buffered              Buffered (In-Memory) Logging Configuration.
cli-command           CLI Command Logging Configuration.
console               Console Logging Configuration.
host                  Enter IP Address for Logging Host
syslog                Syslog Configuration.

(Netgear Switch) (Config)#logging host ?
<hostaddress>        Enter Logging Host IP Address
reconfigure           Logging Host Reconfiguration
remove                Logging Host Removal
(Netgear Switch) (Config)#logging host 192.168.21.253 ?

<cr>                  Press Enter to execute the command.
<port>                Enter Port Id
```



```

(Netgear Switch) (Config)#logging host 192.168.21.253 4 ?

<cr>          Press Enter to execute the command.
<severitylevel> Enter Logging Severity Level (emergency|0, alert|1, critical|2,
error|3, warning|4, notice|5, info|6, debug|7).

(Netgear Switch) (Config)#logging host 192.168.21.253 4 1 ?

<cr>          Press Enter to execute the command.

(Netgear Switch) (Config)#logging host 192.168.21.253 4 1

(Netgear Switch) #show logging hosts

Index  IP Address          Severity  Port  Status
-----
1      192.168.21.253      alert    4     Active

```

## Local Browser Interface: Configure Logging for the Port

### 1. Select **Monitoring > Logs > Sys Log Configuration**.

A screen similar to the following displays.

| System | Switching | Routing   | QoS   | Security | Monitoring | Maintenance | Help | Index |
|--------|-----------|-----------|-------|----------|------------|-------------|------|-------|
| Ports  | Logs      | Mirroring | sFlow |          |            |             |      |       |

**Logs**

- Buffered Logs
- Command Log Configuration
- Console Log Configuration
- Syslog Configuration**
- Trap Logs
- Event Logs
- Persistent Logs

### Syslog Configuration

Admin Status: ☐ Disable ☒ Enable

Local UDP Port:  (1 to 65535)

Messages Received: 925

Messages Relayed: 0

Messages Ignored: 0

### Host Configuration

| IP Address Type | Host Address   | Status | Port | Severity Filter |
|-----------------|----------------|--------|------|-----------------|
| IPv4            | 192.168.21.253 | Active | 4    | Alert           |

### 2. Enter the following information:

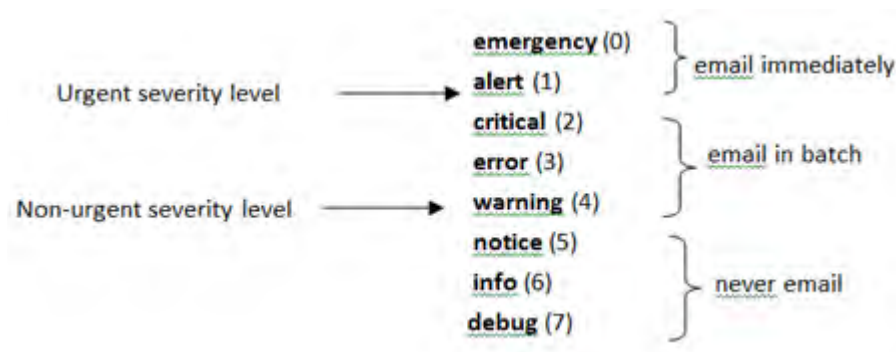
- In the **Host Address** field, enter your host address **192.168.21.253**.
- In the **Port** field, enter **4**.
- In the **Severity Filter** list, select **Alert**.

### 3. Click **Add**.

# Email Alerting

Email alerting is an extension of the logging system. The logging system allows you to configure a set of destinations for log messages. This feature adds the email configuration, through which the log messages are sent to a configured SMTP server such that an administrator can receive the log in an email account of their choice.

This feature is enabled globally. When email alerting is enabled, selected log messages are sent to an SMTP server. Log messages are divided into three groups by severity level: urgent, nonurgent, and never.



**Figure 48. Log message severity levels**

The network administrator can adjust the urgent and non-urgent severity levels. These levels are global and apply to all destination email addresses. Log messages in the urgent group are sent immediately to the SMTP server with each log message in a separate mail. After a delay period that you can configure, log messages in the nonurgent group are placed in a batch in a single email message.

Email alerting also provides a configuration option that allows the network administrator to specify the severity level at which SNMP traps are logged. Using this option, the administrator can put traps in the urgent group, the non-urgent group, or the never group for emailing. Traps are not emailed by default. For traps to be emailed, the network administrator has to either increase the severity at which traps are logged, or lower the severity level of log messages that are emailed.

The network administrator can configure multiple destination email addresses, and for each email address, specify whether to deliver urgent log messages, nonurgent log messages, or both.

When the log buffer is full, an exception occurs to how messages are sent to the SMTP server. When the log buffer is full before the periodic timer expires, the periodic timer is ignored and all log messages that were not sent previously are immediately forwarded to the SMTP server.

## CLI: Send Log Messages to admin@switch.com Using Account aaaa@netgear.com

1. Configure an SMTP server, for example, smtp.netgear.com. Before you configure the SMTP server, you need to have an account on SMTP server.

```
(Netgear Switch) (Config)#mail-server "smtp.netgear.com" port 465
(Netgear Switch) (Mail-Server)#security tlsv1
(Netgear Switch) (Mail-Server)# username aaaa
(Netgear Switch) (Mail-Server)# password xxxxxx
(Netgear Switch) (Mail-Server)#exit
```

2. Configure logging mail. The from-addr is the source address of the email and the to-addr is the destination address of the email.

```
(Netgear Switch) (Config)#logging email
(Netgear Switch) (Config)#logging email from-addr aaaa@netgear.com
(Netgear Switch) (Config)#logging email message-type urgent to-addr
admin@switch.com
(Netgear Switch) (Config)#logging email message-type non-urgent to-addr
admin@switch.com
```

3. Increase the severity of traps to 3 (error). By default, it is 6 (informational).

```
(Netgear Switch) (Config)#logging traps 3
```

# 21

## 21 Switch Stacks

---

### Manage switch stacks

This chapter describes the concepts and recommended operating procedures to manage NETGEAR stackable managed switches that are running release 12.0 or a newer release.

This chapter includes the following sections:

- [Switch Stack Management and Connectivity](#)
- [Stack Master and Stack Members](#)
- [Install and Power-up a Stack](#)
- [Switch Firmware and Firmware Mismatch](#)
- [Stack Switches Using a 10G Copper Port](#)
- [Add, Remove, or Replace a Stack Member](#)
- [Switch Stack Configuration Files](#)
- [Preconfigure a Switch](#)
- [Renumber Stack Members](#)
- [Move the Stack Master to a Different Unit](#)

---

**Note:** On model M4300-96X in which an APM402XL port card is installed, the APM402XL port card supports stacking over 40G ports only (that is, over port 1 and port 5 only). When you expands the ports, you cannot use the 10G ports for stacking.

---

# Switch Stack Management and Connectivity

You manage the switch stack through the stack master. You cannot manage stack members on an individual basis. To access the stack master, use either a serial connection to the switch master's console port or a Telnet connection to the IP address of the stack.

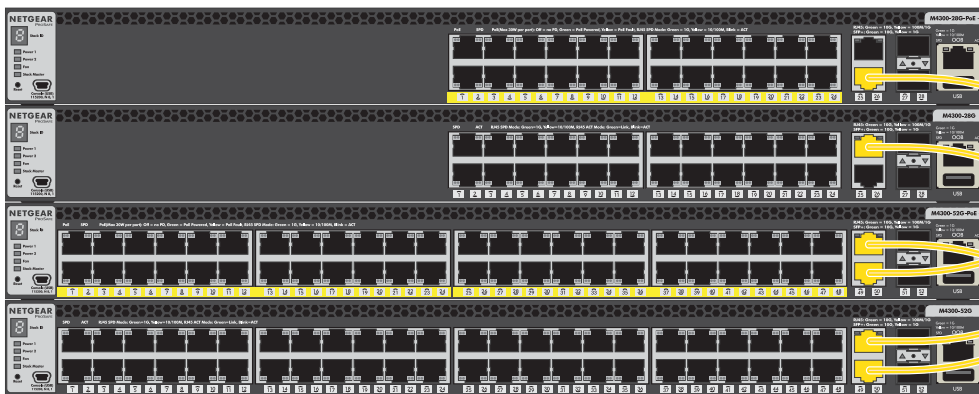
You can use these methods to manage switch stacks:

- Web management interface.
- CLI (over a serial connection).
- A network management application through SNMP.

## Stack Master and Stack Members

A switch stack is a set of up to eight switches that are connected through their stack ports. The switch that controls the operation of the stack is the stack master. The stack master and the other switches in the stack are stack members. Stack members use stacking technology to behave and work together as a unified system. Layer 2 and Layer 3 protocols present the entire switch stack as a single entity to the network.

The following figure shows an example of switches that are interconnected to form a stack.



**Figure 49. Stacked switches**

## Stack Master

The stack master is the single point of stack-wide management. From the stack master, you can configure:

- System-level (global) features that apply to all stack members
- Interface-level features for all interfaces on any stack member

A switch stack is identified in the network by its network IP address. The network IP address is assigned according to the MAC address of the stack master. Every stack member is uniquely identified by its own stack member number.

The stack master contains the saved and running configuration files for the switch stack. The configuration files include the system-level settings for the switch stack and the interface-level settings for all stack members. Each stack member retains a copy of the saved file for backup purposes. If the master is removed from the stack, another member is elected master, and then runs from that saved configuration.

All stack members are eligible stack masters. If the stack master becomes unavailable, the remaining stack members participate in electing a new stack master. A set of factors determine which switch is elected the stack master. The stack master is elected or re-elected based on one of these factors and in the order listed:

1. The switch that is currently the stack master
2. The switch with the highest stack member priority value

---

**Note:** NETGEAR recommends assigning the highest priority value to the switch that you prefer to be the stack master. This ensures that the switch is re-elected as stack master if a re-election occurs.

---

3. The switch with the higher MAC address

A stack master retains its role unless one of these events occurs:

- The stack master is removed from the switch stack.
- The stack master is reset or powered off.
- The stack master fails.
- The switch stack membership is increased by adding powered-on standalone switches or switch stacks.

In the case of a master re-election, the new stack master becomes available after a few seconds. In the meantime, the switch stack uses the forwarding tables in memory to minimize network disruption. The physical interfaces on the other available stack members are not affected while a new stack master is elected. If a new stack master is elected and the previous stack master becomes available, the previous stack master does not resume its role as stack master.

## Stack Members

A switch stack can include up to eight stack members connected through their stack ports. A switch stack always includes one stack master.

A standalone switch is a switch stack with one stack member that also operates as the stack master. You can connect one standalone switch to another to create a switch stack containing two stack members, with one of them being the stack master. You can connect standalone switches to an existing switch stack to increase the stack membership.

The operation of the switch stack continues uninterrupted during membership changes unless you remove the stack master or you add powered-on standalone switches or switch stacks.

## Stack Member Numbers

A stack member number (1 to 8) identifies each member in the switch stack. The member number also determines the interface-level configuration that a stack member uses. You can display the stack member number by issuing the **show switch user EXEC** command.

A new, out-of-the-box switch (one that did not join a switch stack or was not manually assigned a stack member number) ships with a default stack member number of 1. When the switch joins a switch stack, the default stack member number of the switch changes to the lowest available member number in the stack.

Stack members in the same switch stack cannot be assigned the same stack member number. Every stack member, including a standalone switch, retains its member number until you manually change the number or unless the number is already being used by another member in the stack. For more information, see [Renumber Stack Members on page 466](#).

## Stack Member Priority Values

You can change a stack member priority. This is useful if you want to change the master of the stack. To change the stack member priority, issue the **switch unit priority value** command in the global config mode.

## Install and Power-up a Stack

Many switch models include a *Hardware Installation Guide* with information about rack mounting and stack cabling.



## Compatible Switch Models

NETGEAR stackable managed switches include the following M4300 switch models:

- Full 10G models:
  - M4300-16X
  - M4300-8X8F
  - M4300-12X12F
  - M4300-24X24F
- 1G models with 10G uplinks:
  - M4300-28G
  - M4300-28G-POE+
  - M4300-52G
  - M4300-52G-POE+
- 10G models with RJ45/SFP+ combo ports:
  - M4300-24X
  - M4300-24XF
  - M4300-48X
  - M4300-48XF
- 10G modular chassis model:
  - M4300-96X

## Install a Switch Stack

### To install a switch stack:

1. Install the switches in a rack.
2. Install all stacking cables, including the redundant stack link.  
NETGEAR highly recommends that you install a redundant link between the switches.
3. Identify the switch to be the master and power it up.
4. Monitor the console port.  
Allow the master switch to come up to the login prompt. If the switch has the default configuration, it should come up as unit #1, and automatically become a master switch. If not, renumber the units.
5. If you want to configure switches offline, preconfigure the other switches to be added to the stack.  
For more information, see [Preconfigure a Switch on page 465](#).
6. Power on a second switch, making sure it is adjacent (that is, the next physical switch in the stack) to the switch already powered up.

This ensures that the second switch comes up as a member of the stack, and not a master of a separate stack.

7. Monitor the master switch to make sure that the second switch joins the stack.

You can issue the **show switch** command to determine when the switch joins the stack. It will be assigned a unit number (unit #2, if it has the default configuration).

8. As an option, renumber this stack member.

For more information, see [Renumber Stack Members on page 466](#).

9. To add more members to the stack, repeat steps [Step 6](#) through [Step 8](#).

Always power on a switch adjacent to the switches already in the stack.

## Switch Firmware and Firmware Mismatch

All stack members must run the same firmware version to ensure full compatibility in the stack protocol version among the stack members.

If a stack member is running a different firmware version than the stack master, that stack member is not allowed to join the stack. To list the stack members and firmware versions, issue the **show switch** command.

If a switch is added to a stack and it does not run the same firmware version as the master, the following occurs:

- The new unit boots up and becomes a member of the stack.
- Ports on the added unit remain in the detached state.
- A message displays on the CLI indicating a code (firmware) mismatch with the newly added unit.

To enable the newly added unit to merge normally with the stack, issue the **copy xmodem | ymodem | zmodem | tftp://ip/filepath/filename** command. This command copies the firmware image from a stack member to the one with incompatible firmware. That switch automatically reloads and joins the stack as a fully functioning member.

## Upgrade the Firmware

All stack members must run the same firmware version. Ports on stack members that do not match the master switch firmware version do not come up. In that situation, the output of the **show switch** command shows a code (firmware) mismatch error.

---

**Note:** NETGEAR recommends that you schedule the firmware upgrade when there is no excessive network traffic (such as a broadcast event).

---

**To download new firmware to the master switch and other switches in the stack:**

1. Using TFTP or xmodem, issue the `copy` command on the master switch.

After the firmware is successfully loaded onto the master switch, the firmware automatically propagates to the other units in the stack.

**CAUTION:**

To avoid errors during firmware propagation, do not move stack cables or reconfigure units.

2. If an error occurs during firmware propagation, do the following:
  - a. Check to make sure the master switch is running the correct firmware.
  - b. Attempt again to copy the firmware to the units that did not get updated by issuing the `copy` command in stack configuration mode.
3. After the firmware is loaded to all members of the stack, reset all the switches  
The new firmware takes effect.

## Migrate Configuration with a Firmware Upgrade

In some cases, a configuration might not be carried forward in a firmware update.

**If a configuration is not carried forward in a firmware update, to download new firmware to the master switch and other switches in the stack:**

1. Save the current configuration by uploading it from the stack, using the `copy` command from the CLI.
2. Load new firmware onto the stack manager.
3. Reboot the stack.
4. Upon reboot, enter the boot menu and erase the configuration (that is, restore is to factory default settings).
5. Continue with the boot of the operational firmware.
6. After the stack is up, download the saved configuration to the master.

This saved configuration is automatically propagated to all members of the stack.

## Local Browser Interface: Copy Master Firmware to a Stack Member

1. Select **Maintenance > File Management > Copy**.

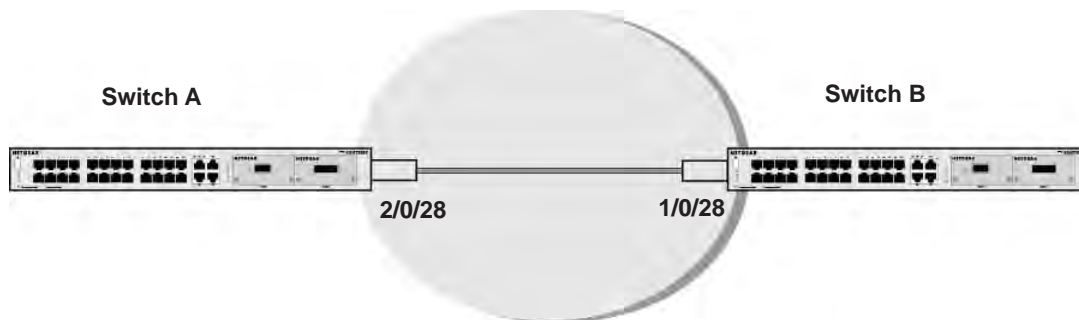
A screen similar to the following displays.



2. In the **Stack Member** menu, select **2**.
3. Click **Apply**.

## Stack Switches Using a 10G Copper Port

This example shows how to stack two switches at close range.



**Figure 50. Connect switches through their 10G copper ports**

### To set up a stack between two switches:

1. Using a Cat6e Ethernet cable, connect a 10G copper port on one switch with a 10G copper port on the other switch.
2. Configure the Switch A and Switch B as described in one of the following sections:
  - [CLI: Configure the 10G Copper Ports as Stack Ports on page 458](#)
  - [Local Browser Interface: Copy Master Firmware to a Stack Member on page 457](#)

## CLI: Configure the 10G Copper Ports as Stack Ports

1. On Switch A, configure the stack port and reboot the switch.

```
(Netgear Switch) #show stack-port
```

| Unit | Interface | Configured | Running    | Link Status | Link Speed (Gb/s) |
|------|-----------|------------|------------|-------------|-------------------|
|      |           | Stack Mode | Stack Mode |             |                   |
| 2    | 0/25      | Ethernet   | Ethernet   | Link Down   | 10                |
| 2    | 0/26      | Ethernet   | Ethernet   | Link Down   | 10                |
| 2    | 0/27      | Ethernet   | Ethernet   | Link Down   | 10                |
| 2    | 0/28      | Ethernet   | Ethernet   | Link Down   | 10                |

```

(Netgear Switch) #
(Netgear Switch) #config
(Netgear Switch) (Config)#stack
(Netgear Switch) (Config-stack)#stack-port 2/0/28 stack
(Netgear Switch) (Config-stack)#exit
(Netgear Switch) (Config)#exit
(Netgear Switch)#exit
(Netgear Switch) #reload
Management switch has unsaved changes.
Would you like to save them now? (y/n) y
Config file 'startup-config' created successfully.
Configuration Saved!
Are you sure you want to reload the stack? (y/n)y

```

2. After Switch A reboots, check the stack port configuration.

```
(M4300-28G-PoE+) #show stack-port
```

| Unit | Interface | Configured | Running    | Link Status | Link Speed (Gb/s) |
|------|-----------|------------|------------|-------------|-------------------|
|      |           | Stack Mode | Stack Mode |             |                   |
| 2    | 0/25      | Ethernet   | Ethernet   | Link Down   | 10                |
| 2    | 0/26      | Ethernet   | Ethernet   | Link Down   | 10                |
| 2    | 0/27      | Ethernet   | Ethernet   | Link Down   | 10                |
| 2    | 0/28      | Stack      | Stack      | Link Down   | 10                |

**3. On Switch B, configure the stack port and reboot the switch.**

```
(Netgear Switch) #show stack-port
```

| Unit | Interface | Configured    | Running       | Link<br>Status | Link<br>Speed (Gb/s) |
|------|-----------|---------------|---------------|----------------|----------------------|
|      |           | Stack<br>Mode | Stack<br>Mode |                |                      |
| 1    | 0/25      | Ethernet      | Ethernet      | Link Down      | 10                   |
| 1    | 0/26      | Ethernet      | Ethernet      | Link Down      | 10                   |
| 1    | 0/27      | Ethernet      | Ethernet      | Link Down      | 10                   |
| 1    | 0/28      | Ethernet      | Ethernet      | Link Down      | 10                   |

```

(Netgear Switch) #
(Netgear Switch) #config
(Netgear Switch) (Config)#stack
(Netgear Switch) (Config-stack)#stack-port 1/0/28 stack
(Netgear Switch) (Config-stack)#exit
(Netgear Switch) (Config)#exit
(Netgear Switch)#exit
(Netgear Switch) #reload
Management switch has unsaved changes.
Would you like to save them now? (y/n) y
Config file 'startup-config' created successfully.
Configuration Saved!
Are you sure you want to reload the stack? (y/n)y

```

**4. After Switch B reboots, check the stack port configuration.**

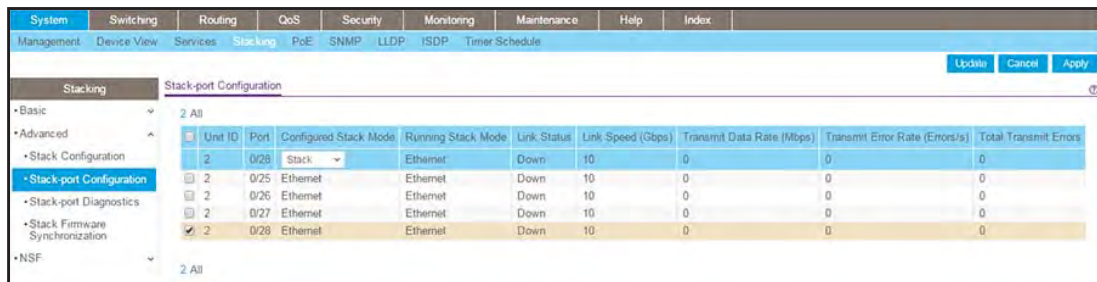
```
(M4300-28G-PoE+) #show stack-port
```

| Unit | Interface | Configured    | Running       | Link<br>Status | Link<br>Speed (Gb/s) |
|------|-----------|---------------|---------------|----------------|----------------------|
|      |           | Stack<br>Mode | Stack<br>Mode |                |                      |
| 1    | 0/25      | Ethernet      | Ethernet      | Link Down      | 10                   |
| 1    | 0/26      | Ethernet      | Ethernet      | Link Down      | 10                   |
| 1    | 0/27      | Ethernet      | Ethernet      | Link Down      | 10                   |
| 1    | 0/28      | Stack         | Stack         | Link Down      | 10                   |

## Local Browser Interface: Configure the 10G Copper Ports as Stack Ports

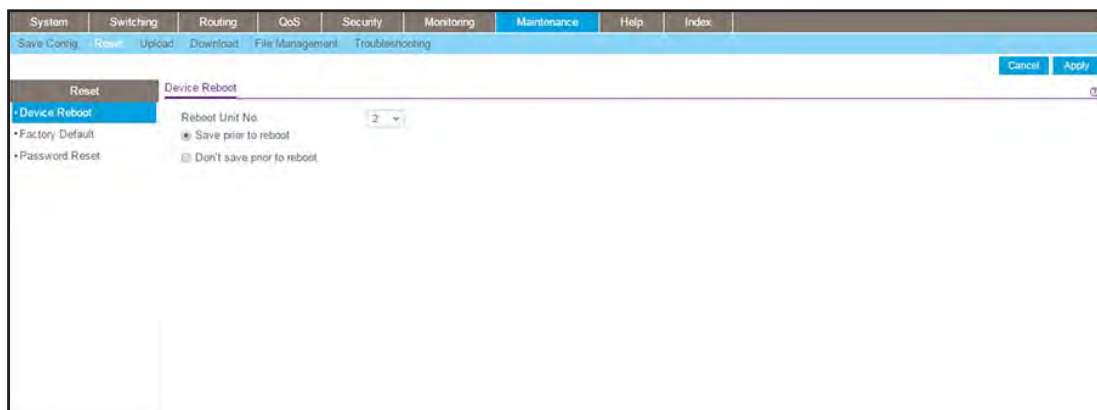
1. On Switch A, configure a stack port as an Ethernet port.
  - a. Select **System > Stacking > Advanced > Stack Port Configuration**.

A screen similar to the following displays.



- b. Scroll down and select the **2/0/28** check box.
  - c. In the **Configured Stack Mode** menu, select **Stack**.
  - d. Click **Apply** to save the settings.
2. Reboot the switch.
  - a. Select **Maintenance > Reset > Device Reboot**.

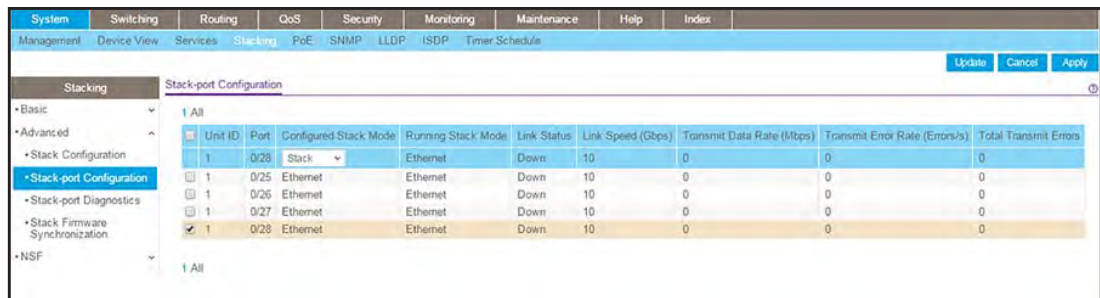
A screen similar to the following displays.



- b. In the **Reboot Unit No.** menu, select **2**.
  - c. Click **Apply**.
3. On Switch B, configure a stack port as an Ethernet port.
  - a. Select **System > Stacking > Advanced > Stack Port Configuration**.

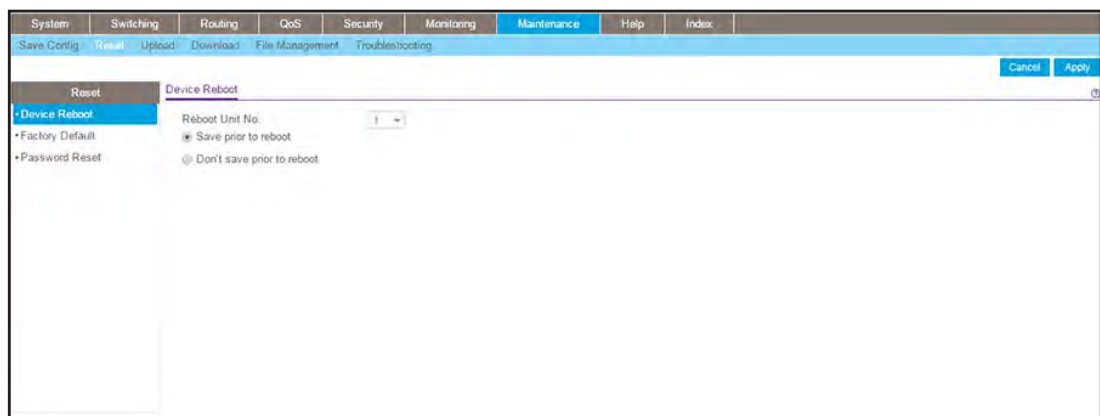
A screen similar to the following displays.





- b. Scroll down and select the **1/0/28** check box.
  - c. In the **Configured Stack Mode** menu, select **Stack**.
  - d. Click **Apply** to save the settings.
4. Reboot the switch.
    - a. Select **Maintenance > Reset > Device Reboot**.

A screen similar to the following displays.



- b. In the **Reboot Unit No.** menu, select **1**.
- c. Click **Apply**.

The switch reboots.

## Add, Remove, or Replace a Stack Member

You can manage an operating stack.

### Add Switches to an Operating Stack

**To add new switches to an operating stack:**

1. Make sure that the redundant stack connection is functional.

All stack members must be connected in a logical ring.

2. Preconfigure any new switches.
3. Power off all new switches that must join the stack.



**CAUTION:**

If you cable one or more powered-on switches to the stack, the existing stack and the new switches assume that two stacks are merging. They elect a single, new stack master, and you cannot specify which switch becomes the new master. All stack members assume the configuration that is based on the new stack master. Stack members change their stack member numbers to the lowest available numbers.

4. Install the new switches in the rack.

This procedure assumes installation below the bottom-most switch, or above the top-most switch.

5. Disconnect the redundant stack cable that connects the last switch in the stack to the first switch in the stack at the position in the ring where you intend to insert the new switch.

---

**Note:** If you want to merge an operational stack into the this stack, add the switches as a group by unplugging one stacking cable in the operational stack and physically connecting all unpowered units at that point.

---

6. Connect this cable to the new switch, following the established order of stack-up to stack-down connections.
7. Power up the new switches one by one.
8. Verify, by monitoring the master switch console port, that the new switch joins the stack by issuing the `show switch` command. The new switch joins as a member (never as master; the existing master of the stack must not change).
9. If the firmware version of the newly added member is not the same as the existing stack, update the firmware (see [Upgrade the Firmware on page 455.](#)).

## Remove a Switch from a Stack

**To remove a switch from a stack:**

1. Make sure that the redundant stack connection is functional.  
All stack members must be connected in a logical ring.
2. Power down the switch that you want to remove.

**CAUTION:**

If the switch stack is not cabled correctly, removing powered-on stack members might cause the switch stack to divide (that is, partition) into two or more switch stacks, each with the same configuration. Make sure that the switch stack is cabled correctly.

3. Disconnect the stack cables.
4. If you do not intend to replace the switch, reconnect the stack cable from the stack member above to the stack member below the switch that you intend to remove.
5. Remove the switch from the rack.
6. To remove the switch not only from the stack but also from the stack configuration, issue the `no member unit-id` command.

**Note:** If the switch stack divides, and you want the switch stacks to remain separate, change the IP address or addresses of the newly created switch stacks.

7. If the switch stack divides but you do not intend to partition the switch stack, do the following:
  - a. Power off the newly created switch stacks.
  - b. Reconnect them to the original switch stack through their stack ports.
  - c. Power on the switches.

## Replace a Stack Member

### To replace a stack member:

1. Make sure that the redundant stack connection is functional.  
All stack members must be connected in a logical ring.
2. Power down the switch that you intend to remove and disconnect its stack cables.
3. Remove the switch from the rack.
4. If you intend to install a different model switch, remove the unit from the configuration by issue the `no member unit-id` command.
5. Install the new switch in the rack:
  - If you are installing the same model switch, place the switch in the same position in the stack as the switch that you just removed.
  - If you are installing a different model switch, either place the switch in the same position as the previous switch, or at the bottom of the stack.
6. Cable the new switch, following the established order of stacking cables.
7. Power up the new switch.

Verify, by monitoring the master switch console port, that the new switch successfully joins the stack by issuing the **show switch** command. The new switch must join as a member (not as master; the existing master of the stack must not change).

8. If the firmware version of the newly added member is not the same as the existing stack, update the firmware (see [Upgrade the Firmware on page 455](#)).

## Switch Stack Configuration Files

The configuration files include all global and interface-specific settings that define the operation of the stack and its individual members. If you issue the **save config** command, all stack members store a copy of the configuration settings. If a stack master becomes unavailable, the stack member that assumes the role of stack master operates from the saved configuration files.

When a new, out-of-box switch joins a switch stack, the switch uses the system-level settings of that switch stack. However, if you want the store to store this system level configuration, you must issue the **save config** command.

You can back up and restore the stack configuration by using the **copy** command in the same way as you back up and restore a standalone switch configuration.

The following table provides switch stack configuration scenarios. Most of the scenarios assume that at least two switches are connected through their stack ports.

**Table 3. Switch stack master scenarios**

| Scenario   | Action   | Result  |
|--|--|---|
| Stack master election specifically determined by existing stack masters.<br><br><b>Note:</b> NETGEAR does not recommend this scenario. | Connect two powered-on switch stacks through the stack ports.  | Only one of the stack masters becomes the new stack master. No other stack members become the stack master. |
| Stack master election specifically determined by the stack member priority value.  | <ul style="list-style-type: none"> <li>Connect two switches through their stack ports.</li> <li>To set a stack member to a higher member priority value, issue the <b>switch stack-member-number priority new-priority-number</b> global configuration command.</li> <li>Restart both stack members at the same time.</li> </ul> | The stack member with the higher-priority value is elected stack master.                                    |
| Stack master election specifically determined by the MAC address.  | Assuming that both stack members have the same priority value and firmware image, restart both stack members at the same time.   | The stack member with the higher MAC address is elected stack master.                                       |

**Table 3. Switch stack master scenarios (continued)**

| Scenario              | Action  | Result  |
|-----------------------|---|---|
| Add a stack member.   | <ul style="list-style-type: none"> <li>Power off the new switch</li> <li>Through their stack ports, connect the new switch to a powered-on switch stack.</li> <li>Power on the new switch.</li> </ul> | <p>The stack master is retained.</p> <p>The new switch is added to the switch stack.</p>  |
| Stack master failure. | Remove (or power off) the stack master.   | One of the remaining stack members becomes the new stack master. All other members in the stack remain stack members and do not reboot. |

## Preconfigure a Switch

You can preconfigure (that is, supply a configuration to) a new switch before it joins the switch stack. You can specify the stack member number, the switch type, and the interfaces that are associated with a switch that is not currently part of the stack.

---

**Note:** If you are replacing a switch with the same model in the same position in the stack, you do not need to preconfigure it. The new switch assumes the same configuration as the previous switch.

---

### To preconfigure a switch:

1. Issue the **member** *unit-id switchindex* command.
2. To view the supported unit types, use the **show supported switchtype** command.
3. Configure the unit that you defined in [Step 1](#), just as if the unit were physically present.

Ports for the preconfigured unit come up in a detached state.

4. To see the ports, use the **show port all** command.

Now you can configure the detached ports for VLAN membership and any other port-specific configuration.

After you preconfigure a unit type for a specific unit number, attaching a unit with a different unit type for this unit number causes the switch to report an error. In this situation, the output of the **show switch** command indicates a configuration mismatch for the new unit and the ports on that unit do not come up. To resolve this situation, you can change the unit number of the mismatched unit or delete the preconfigured unit type by issuing the **no member unit-id** command.

When you add a preconfigured switch to the switch stack, the stack applies either the preconfigured configuration or the default configuration. The following table lists the events that can occur when the switch stack compares the preconfigured configuration with the new switch.

**Table 4. Preconfigured switches compared to stack configuration**

| Switch Type Is the Same | Stack Member Number                      | Result  |
|-------------------------|--|---|
| Yes                     | Is the same                              | The switch stack applies the configuration to the preconfigured new switch and adds it to the stack.  |
| Yes                     | Does not match                           | <ul style="list-style-type: none"> <li>The switch stack applies its default stack member number to the preconfigured switch and adds it to the stack.</li> <li>The stack member number configuration in the preconfigured switch changes to reflect the new information.</li> </ul> |
|                         | Is not found in the stack configuration  | <ul style="list-style-type: none"> <li>The switch stack applies the default configuration to the new switch and adds it to the stack.</li> <li>The preconfigured information is changed to reflect the new information.</li> </ul>  |
|                         | Is not found in the preconfigured switch | The switch stack applies the default configuration to the preconfigured switch and adds it to the stack.  |

## Renumber Stack Members

This example is provided as CLI commands and a local browser interface procedure.

### CLI: Renumber Stack Members

---

**Note:** When you issue a command such as `move management` or `renumber`, NETGEAR recommends that you wait until the command fully executes before issuing the next command. For example, after you issue a `reset` command for a stack member, issue the `show port` command to verify that the switch remerged with the stack and that all ports joined before you issue a next command.

---

- If specific numbering is required, NETGEAR recommends that you assign stack members their numbers when they are first installed and configured in the stack.
- If the stack unit number for a switch is unused, you can renumber the unit by issuing the `switch <oldunit-id> renumber <newunit-id>` global config mode command.
- If you preconfigured the new unit ID, you might need to remove the new unit ID from the configuration before renumbering the unit.

- If you need to reassign multiple existing stack unit numbers, the configuration could become mismatched. To avoid this situation, NETGEAR recommends that you power down all switches except the master, and then add them back one at a time (see [Add Switches to an Operating Stack on page 461](#)).

To renumber stack members, issue the following CLI command:

```
(Netgear Switch) (Config)#switch 3 renumber 2
```

All the switches in the stack will be reset to perform Manager unit renumbering and the configuration of Manager switch interfaces will be cleared.

Are you sure you want to renumber? (y/n) y

## Local Browser Interface: Renumber Stack Members

- Renumber the stacking member's ID from 3 to 2.
  - Select **System > Management > Basic > Stack Configuration**.

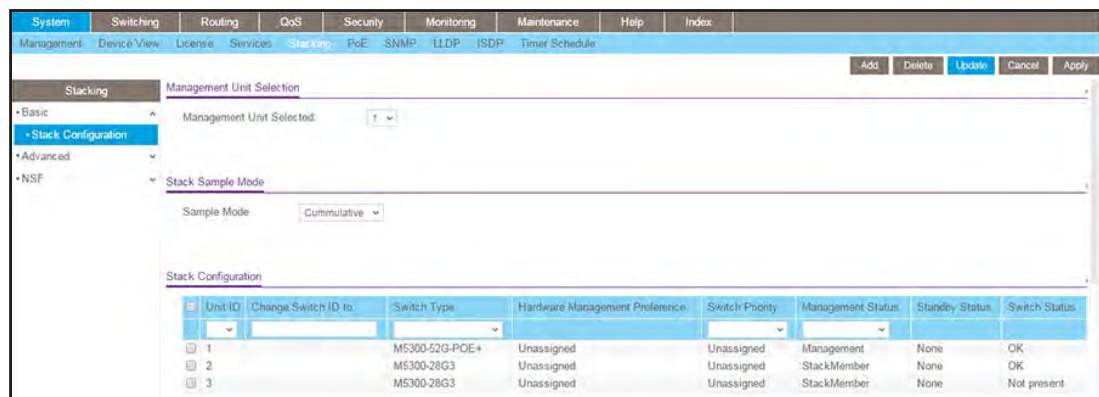
A screen similar to the following displays.

| Unit ID | Change Switch ID to | Switch Type    | Hardware Management Preference | Switch Priority | Management Status | Standby Status | Switch Status |
|---------|---------------------|----------------|--------------------------------|-----------------|-------------------|----------------|---------------|
| 2       | 2                   | M5300-28G3     | Unassigned                     | Unassigned      | StackMember       | Opr Standby    | OK            |
| 1       |                     | M5300-52G-POE+ | Unassigned                     | Unassigned      | Management        | None           | OK            |
| 3       |                     | M5300-28G3     | Unassigned                     | Unassigned      | StackMember       | Opr Standby    | OK            |

- Scroll down and select the **3** check box.
- In the **Change Switch ID to** field, enter **2**.
- Click **Apply** to save the settings.

Now, the unit ID of the stacking member is 2.





## Move the Stack Master to a Different Unit

This example is provided as CLI commands and a local browser interface procedure.

### CLI: Move the Stack Master to a Different Unit

1. To move the stack master to a different unit number, issue the **movemanagement** *<fromunit-id>* *<to unit-id>* command.

The operation takes between 30 seconds and 3 minutes, depending on the stack size and configuration.

2. Make sure that you can log in on the console that is attached to the new master.
3. To verify that all units rejoined the stack, issue the **show switch** command.
4. Reset the stack by issuing the **reload** command.

To move the stack master to a different unit number, issue the following CLI command:

```
(Netgear Switch) (Config)#stack
(Netgear Switch) (Config-stack)#movemanagement 1 2
```

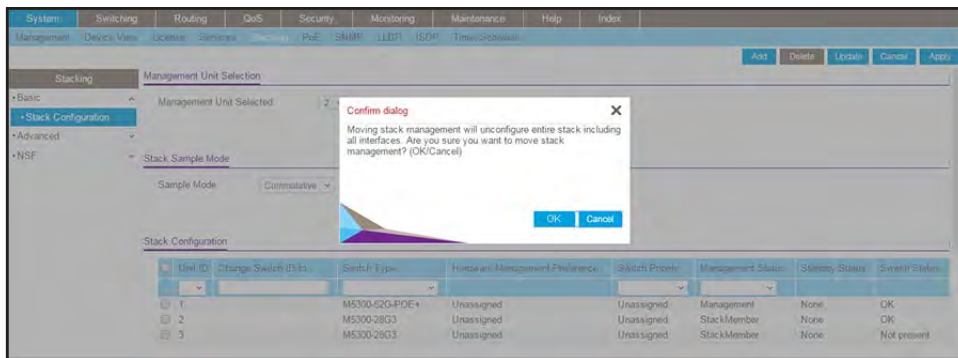
### Local Browser Interface: Move the Stack Master to a Different Unit

1. Select **System > Management > Basic > Stack Configuration**.

A screen similar to the following displays.

2. In the **Management Unit Selected** menu, select **2**.

A warning window displays.



3. Click the **OK** button.
4. Click **Apply** to save the settings.

---

**Note:** If the master receives its IP address from a DHCP server and you move the master to a different unit, its IP address might change and you could lose the connection to the switch.

---

# 22

## 22 SNMP

---

### Simple Network Management Protocol

This chapter includes the following sections:

- [Add a New Community](#)
- [Enable SNMP Trap](#)
- [SNMP Version 3](#)
- [sFlow](#)
- [Time-Based Sampling of Counters with sFlow](#)

# Add a New Community

The example is shown as CLI commands and as a local browser interface procedure.

## CLI: Add a New Community

```
(Netgear switch) #config
(Netgear switch) (Config)#snmp-server community rw public@4
```

## Local Browser Interface: Add a New Community

1. Select **System > SNMP > SNMP V1/V2 > Community Configuration**.

A screen similar to the following displays.

| Community Name | Client Address | Client IP Mask | Access Mode | Status |
|----------------|----------------|----------------|-------------|--------|
| public@4       | 0.0.0.0        | 0.0.0.0        | Read-Write  | Enable |
| public         | 0.0.0.0        | 0.0.0.0        | Read-Only   | Enable |
| private        | 0.0.0.0        | 0.0.0.0        | Read-Write  | Enable |

2. In the **Community Name** field, enter **public@4**.
3. In the **Client Address** field, enter **0.0.0.0**.
4. In the **Client IP Mask** field, enter **0.0.0.0**.
5. In the **Access Mode** field, select **Read/Write**.
6. In the **Status** field, select **Enable**.
7. Click **Add**.

# Enable SNMP Trap

The example is shown as CLI commands and as a local browser interface procedure.

## CLI: Enable SNMP Trap

This example shows how to send SNMP trap to the SNMP server.

```
(Netgear switch) #config
(Netgear switch) (Config)# snmptrap public 10.100.5.17
                                Enable send trap to SNMP server 10.100.5.17
(Netgear switch) (Config)#snmp-server traps linkmode
                                Enable send link status to the SNMP server
when link status changes.
```

## Local Browser Interface: Enable SNMP Trap

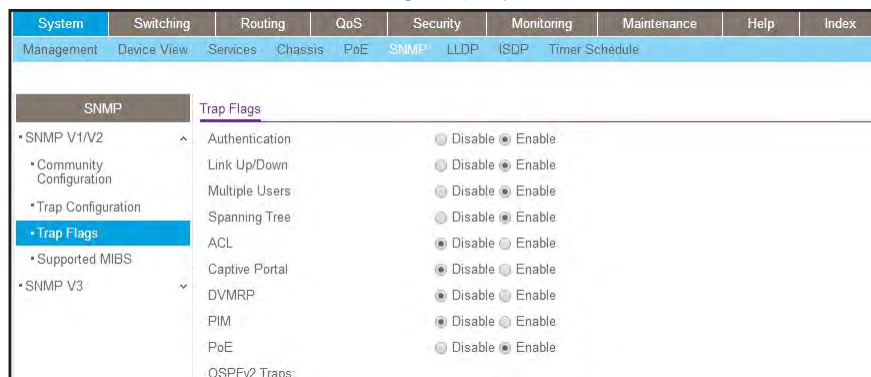
1. Enable SNMP trap for the server 10.100.5.17.
  - a. Select **System > SNMP > SNMP V1/V2 > Trap Configuration**.

A screen similar to the following displays.

| System  | Switching   | Routing  | QoS         | Security | Monitoring | Maintenance | Help | Index          |                |         |          |         |        |        |         |      |             |        |
|---|-------------|----------|-------------|----------|------------|-------------|------|----------------|----------------|---------|----------|---------|--------|--------|---------|------|-------------|--------|
| Management  | Device View | Services | Chassis     | PoE      | SNMP       | LLDP        | ISDP | Timer Schedule |                |         |          |         |        |        |         |      |             |        |
| SNMP  |             |          |             |          |            |             |      |                |                |         |          |         |        |        |         |      |             |        |
| Trap Configuration  |             |          |             |          |            |             |      |                |                |         |          |         |        |        |         |      |             |        |
| <table border="1"> <thead> <tr> <th>Community Name</th> <th>Version</th> <th>Protocol</th> <th>Address</th> <th>Status</th> </tr> </thead> <tbody> <tr> <td>public</td> <td>SNMP V1</td> <td>IPv4</td> <td>10.100.5.17</td> <td>Enable</td> </tr> </tbody> </table> |             |          |             |          |            |             |      |                | Community Name | Version | Protocol | Address | Status | public | SNMP V1 | IPv4 | 10.100.5.17 | Enable |
| Community Name  | Version     | Protocol | Address     | Status   |            |             |      |                |                |         |          |         |        |        |         |      |             |        |
| public  | SNMP V1     | IPv4     | 10.100.5.17 | Enable   |            |             |      |                |                |         |          |         |        |        |         |      |             |        |

- b. In the **Community Name** field, enter **public**.
  - c. In the **Version** list, select **SNMPv1**.
  - d. In the **Address** field, enter **10.100.5.17**.
  - e. In the **Status** field, select **Enable**.
  - f. Click the **Add** button.
2. Set the Link Up/Down flag.
  - a. Select **System > SNMP > SNMP V1/V2 > Trap Flags**.

A screen similar to the following displays.



- b. For Link Up/Down, select the **Enable** radio button.
- c. Click **Apply**.

## SNMP Version 3

The example is shown as CLI commands and as a local browser interface procedure.

### CLI: Configure SNMPv3

```
(Netgear Switch) #config
(Netgear Switch) (Config)#users passwd admin
Enter old password:
Enter new password:12345678
Confirm new password:12345678
Password Changed!
change the password to "12345678"
(Netgear Switch) (Config)#users snmpv3 authentication admin md5
Set the authentication mode to md5
(Netgear Switch) (Config)#users snmpv3 encryption admin des 12345678
Set the encryption mode to des and the key is "12345678"
```

## Local Browser Interface: Configure SNMPv3

### 1. Change the user password.

If you set the authentication mode to MD5, you must make the length of password longer than 8 characters.

#### a. Select **Security > Management Security > User Configuration > User Management**.

A screen similar to the following displays.

| User Name | Edit Password | Password | Confirm Password | Access Mode | Lockout Status | Password Expiration Date |
|-----------|---------------|----------|------------------|-------------|----------------|--------------------------|
| admin     | Disable       | *****    | *****            | READ_WRITE  | FALSE          |                          |
| guest     | Disable       | *****    | *****            | READ_ONLY   | FALSE          |                          |

#### b. Under User Management, scroll down and select the User Name **admin** check box. Now admin appears in the User Name field at the top.

#### c. In the **Password** field, enter **12345678**.

#### d. In the **Confirm Password** field, enter **12345678**.

#### e. Click **Apply** to save the settings.

### 2. Configure the SNMP V3 user.

#### a. Select **System > Management > User Configuration**.

A screen similar to the following displays.

User Name: admin

SNMP V3 Access Mode: Read/Write

Authentication Protocol: MD5

Encryption Protocol: DES

Encryption Key: 8 to 64 hexadecimal characters

#### b. In the **User Name** field, select the **admin**.

#### c. For Authentication Protocol, select the **MD5** radio button.

#### d. For Encryption Protocol, select the **DES** radio button.

#### e. In the **Encryption Key** field, enter **12345678**.

#### f. Click **Apply** to save the settings.

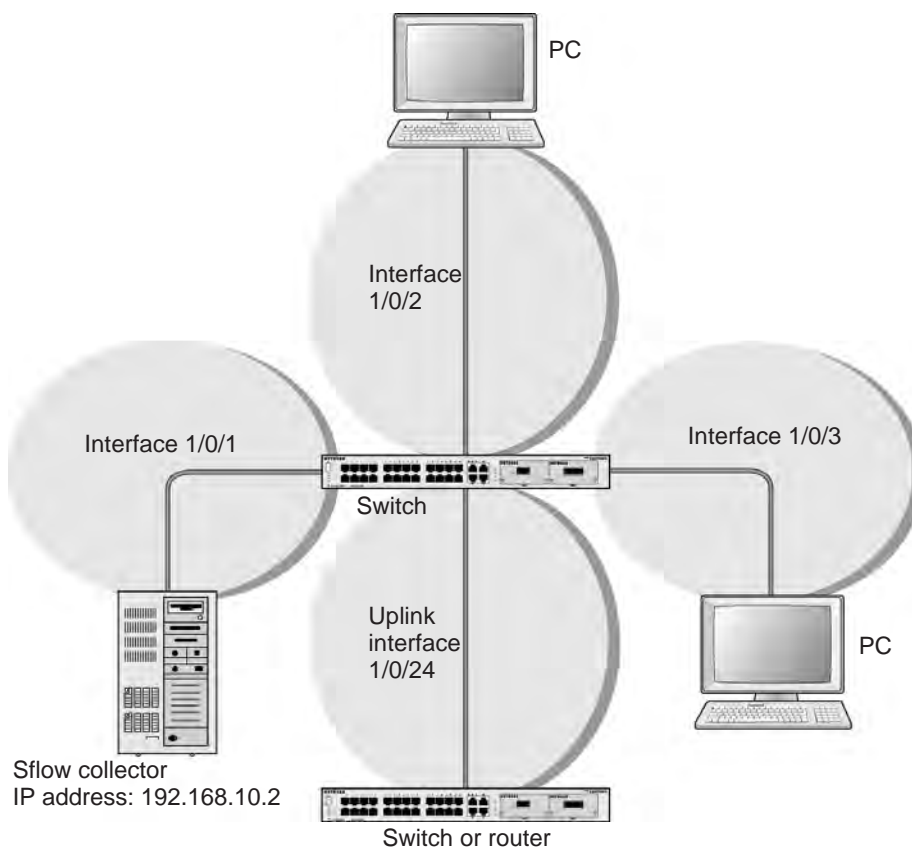


# sFlow

sFlow is the standard for monitoring high-speed switched and routed networks. sFlow technology is built into network equipment and gives complete visibility into network activity, enabling effective management and control of network resources.

The sFlow monitoring system consists of an sFlow agent (embedded in a switch or router or in a standalone probe) and a central sFlow collector. The sFlow agent uses sampling technology to capture traffic statistics from the device it is monitoring. The sFlow datagrams are used to immediately forward the sampled traffic statistics to an sFlow collector for analysis.

The sFlow agent uses two forms of sampling: statistical packet-based sampling of switched or routed packet flows, and time-based sampling of counters.



**Figure 51. sFlow**

## CLI: Configure Statistical Packet-Based Sampling of Packet Flows with sFlow

1. Configure the sFlow receiver (sFlow collector) IP address. In this example, sFlow samples will be sent to the destination address 192.168.10.2.

```
(Netgear Switch) (Config)# sflow receiver 1 ip 192.168.10.2
```

2. Configure the sFlow receiver timeout. Here sFlow samples will be sent to this receiver for the duration of 31536000 seconds. That is approximately 1 year.

```
(Netgear Switch) (Config)# sflow receiver 1 owner NetMonitor timeout 31536000
```

3. Here, the default maximum datagram size is 1400. It can be modified to a value between 200 and 9116 using the command `sflow receiver 1 maxdatagram <size>`.

```
(Netgear Switch) #show sflow receivers
```

| Receiver Index | Owner String | Time out | Max Datagram Size | Port | IP Address   |
|----------------|--------------|----------|-------------------|------|--------------|
| 1              | NetMonit     | 31535988 | 1400              | 6343 | 192.168.10.2 |
| 2              |              | 0        | 1400              | 6343 | 0.0.0.0      |
| 3              |              | 0        | 1400              | 6343 | 0.0.0.0      |
| 4              |              | 0        | 1400              | 6343 | 0.0.0.0      |
| 5              |              | 0        | 1400              | 6343 | 0.0.0.0      |
| 6              |              | 0        | 1400              | 6343 | 0.0.0.0      |
| 7              |              | 0        | 1400              | 6343 | 0.0.0.0      |
| 8              |              | 0        | 1400              | 6343 | 0.0.0.0      |

4. Configure the sampling port sFlow receiver index, sampling rate, and sampling maximum header size. You need to repeat these for all the ports to be sampled.

```
(Netgear Switch) (Config)# interface 1/0/1
(Netgear Switch) (Interface 1/0/1)# sflow sampler 1
(Netgear Switch) (Interface 1/0/1)# sflow sampler rate 1024
(Netgear Switch) (Interface 1/0/1)# sflow sampler maxheadersize 64
```

**5. View the sampling port configurations.**

| (Netgear Switch)) #show sflow samplers |          |               |            |
|--|----------|---------------|------------|
| Sampler                                | Receiver | Packet        | Max Header |
| Data Source                            | Index    | Sampling Rate | Size       |
| -----                                  | -----    | -----         | -----      |
| 1/0/1                                  | 1        | 1024          | 64         |

## Local Browser Interface: Configure Statistical Packet-based Sampling with sFlow

1. Configure the sFlow receiver IP address.
  - a. Select **Monitoring > sFlow > Advanced > sFlow Receiver Configuration**.
  - b. Select the **1** check box.
  - c. In the **Receiver Owner** field, enter **NetMonitor**.
  - d. In the **Receiver Timeout** field, enter **31536000**.
  - e. In the **Receiver Address** field, enter **192.168.10.2**.

A screen similar to the following displays.

| System  | Switching      | Routing          | QoS        | Security              | Monitoring     | Maintenance   | Help             | Index |                |                |                  |            |                       |                |               |                  |   |            |          |       |      |              |      |   |   |   |   |       |      |         |      |   |   |   |   |       |      |         |      |   |   |   |   |       |      |         |      |   |
|---|----------------|------------------|------------|-----------------------|----------------|---------------|------------------|-------|----------------|----------------|------------------|------------|-----------------------|----------------|---------------|------------------|---|------------|----------|-------|------|--------------|------|---|---|---|---|-------|------|---------|------|---|---|---|---|-------|------|---------|------|---|---|---|---|-------|------|---------|------|---|
| Ports   | Logs           | Monitoring       |            |                       |                |               |                  |       |                |                |                  |            |                       |                |               |                  |   |            |          |       |      |              |      |   |   |   |   |       |      |         |      |   |   |   |   |       |      |         |      |   |   |   |   |       |      |         |      |   |
| sFlow   |                |                  |            |                       |                |               |                  |       |                |                |                  |            |                       |                |               |                  |   |            |          |       |      |              |      |   |   |   |   |       |      |         |      |   |   |   |   |       |      |         |      |   |   |   |   |       |      |         |      |   |
| sFlow Receiver Configuration  |                |                  |            |                       |                |               |                  |       |                |                |                  |            |                       |                |               |                  |   |            |          |       |      |              |      |   |   |   |   |       |      |         |      |   |   |   |   |       |      |         |      |   |   |   |   |       |      |         |      |   |
| Basic   |                |                  |            |                       |                |               |                  |       |                |                |                  |            |                       |                |               |                  |   |            |          |       |      |              |      |   |   |   |   |       |      |         |      |   |   |   |   |       |      |         |      |   |   |   |   |       |      |         |      |   |
| Advanced  |                |                  |            |                       |                |               |                  |       |                |                |                  |            |                       |                |               |                  |   |            |          |       |      |              |      |   |   |   |   |       |      |         |      |   |   |   |   |       |      |         |      |   |   |   |   |       |      |         |      |   |
| sFlow Agent Information   |                |                  |            |                       |                |               |                  |       |                |                |                  |            |                       |                |               |                  |   |            |          |       |      |              |      |   |   |   |   |       |      |         |      |   |   |   |   |       |      |         |      |   |   |   |   |       |      |         |      |   |
| <table><thead><tr><th>Receiver Index</th><th>Receiver Owner</th><th>Receiver Timeout</th><th>No Timeout</th><th>Maximum Datagram Size</th><th>Router Address</th><th>Receiver Port</th><th>Datagram Version</th></tr></thead><tbody><tr><td>1</td><td>natMonitor</td><td>31536000</td><td>False</td><td>1400</td><td>192.168.10.2</td><td>6343</td><td>5</td></tr><tr><td>2</td><td>0</td><td>0</td><td>False</td><td>1400</td><td>0.0.0.0</td><td>6343</td><td>5</td></tr><tr><td>3</td><td>0</td><td>0</td><td>False</td><td>1400</td><td>0.0.0.0</td><td>6343</td><td>5</td></tr><tr><td>4</td><td>0</td><td>0</td><td>False</td><td>1400</td><td>0.0.0.0</td><td>6343</td><td>5</td></tr></tbody></table> |                |                  |            |                       |                |               |                  |       | Receiver Index | Receiver Owner | Receiver Timeout | No Timeout | Maximum Datagram Size | Router Address | Receiver Port | Datagram Version | 1 | natMonitor | 31536000 | False | 1400 | 192.168.10.2 | 6343 | 5 | 2 | 0 | 0 | False | 1400 | 0.0.0.0 | 6343 | 5 | 3 | 0 | 0 | False | 1400 | 0.0.0.0 | 6343 | 5 | 4 | 0 | 0 | False | 1400 | 0.0.0.0 | 6343 | 5 |
| Receiver Index  | Receiver Owner | Receiver Timeout | No Timeout | Maximum Datagram Size | Router Address | Receiver Port | Datagram Version |       |                |                |                  |            |                       |                |               |                  |   |            |          |       |      |              |      |   |   |   |   |       |      |         |      |   |   |   |   |       |      |         |      |   |   |   |   |       |      |         |      |   |
| 1   | natMonitor     | 31536000         | False      | 1400                  | 192.168.10.2   | 6343          | 5                |       |                |                |                  |            |                       |                |               |                  |   |            |          |       |      |              |      |   |   |   |   |       |      |         |      |   |   |   |   |       |      |         |      |   |   |   |   |       |      |         |      |   |
| 2   | 0              | 0                | False      | 1400                  | 0.0.0.0        | 6343          | 5                |       |                |                |                  |            |                       |                |               |                  |   |            |          |       |      |              |      |   |   |   |   |       |      |         |      |   |   |   |   |       |      |         |      |   |   |   |   |       |      |         |      |   |
| 3   | 0              | 0                | False      | 1400                  | 0.0.0.0        | 6343          | 5                |       |                |                |                  |            |                       |                |               |                  |   |            |          |       |      |              |      |   |   |   |   |       |      |         |      |   |   |   |   |       |      |         |      |   |   |   |   |       |      |         |      |   |
| 4   | 0              | 0                | False      | 1400                  | 0.0.0.0        | 6343          | 5                |       |                |                |                  |            |                       |                |               |                  |   |            |          |       |      |              |      |   |   |   |   |       |      |         |      |   |   |   |   |       |      |         |      |   |   |   |   |       |      |         |      |   |
| sFlow Receiver Configuration  |                |                  |            |                       |                |               |                  |       |                |                |                  |            |                       |                |               |                  |   |            |          |       |      |              |      |   |   |   |   |       |      |         |      |   |   |   |   |       |      |         |      |   |   |   |   |       |      |         |      |   |
| sFlow Interface Configuration   |                |                  |            |                       |                |               |                  |       |                |                |                  |            |                       |                |               |                  |   |            |          |       |      |              |      |   |   |   |   |       |      |         |      |   |   |   |   |       |      |         |      |   |   |   |   |       |      |         |      |   |

- f. Click **Apply**.**

A screen similar to the following displays.

| System   | Switching      | Routing        | QoS              | Security   | Monitoring            | Maintenance    | Help          | Index            |
|--|----------------|----------------|------------------|------------|-----------------------|----------------|---------------|------------------|
| Parts  | Logs           | Monitoring     |                  |            |                       |                |               |                  |
| <div> <div>sFlow</div> <div>sFlow Receiver Configuration</div> </div>  |                |                |                  |            |                       |                |               |                  |
| <div> <div>Basic</div> <div>Advanced</div> </div>  |                |                |                  |            |                       |                |               |                  |
| <div> <div>sFlow Agent Information</div> <div>sFlow Receiver Configuration</div> <div>sFlow Interface Configuration</div> </div> |                |                |                  |            |                       |                |               |                  |
|  | Receiver Index | Receiver Owner | Receiver Timeout | No Timeout | Maximum Datagram Size | Router Address | Receiver Port | Datagram Version |
|  | 1              | netmon         | 31536000         | False      | 1400                  | 192.168.10.2   | 6343          | 5                |
|  | 2              | 0              | 0                | False      | 1400                  | 0.0.0.0        | 6343          | 5                |
|  | 3              | 0              | 0                | False      | 1400                  | 0.0.0.0        | 6343          | 5                |
|  | 4              | 0              | 0                | False      | 1400                  | 0.0.0.0        | 6343          | 5                |

2. Configure the sampling ports sFlow receiver index, sampling rate, and sampling maximum header size.
  - a. Select **Monitoring > sFlow > Advanced > sFlow Interface Configuration**.

A screen similar to the following displays.

| System                                    |                | Switching  |                | Routing       |                     | QoS   |  | Security |  | Monitoring |  | Maintenance |  | Help |  | Index |  |
|---|----------------|--|----------------|---------------|---------------------|-------|--|----------|--|------------|--|-------------|--|------|--|-------|--|
| Ports                                     |                | Logs   |                | Mirroring     |                     | sFlow |  |          |  |            |  |             |  |      |  |       |  |
| sFlow                                     |                | sFlow Interface Configuration  |                |               |                     |       |  |          |  |            |  |             |  |      |  |       |  |
| Basic                                     |                | 1 2 3 All  |                |               |                     |       |  |          |  |            |  |             |  |      |  |       |  |
| Advanced                                  |                | Go To Interface <input type="text"/> <input type="button" value="Go"/> |                |               |                     |       |  |          |  |            |  |             |  |      |  |       |  |
| sFlow Agent Information                   |                |  |                |               |                     |       |  |          |  |            |  |             |  |      |  |       |  |
| sFlow Receiver Configuration              |                |  |                |               |                     |       |  |          |  |            |  |             |  |      |  |       |  |
| sFlow Interface Configuration             |                |  |                |               |                     |       |  |          |  |            |  |             |  |      |  |       |  |
| Interface                                 | Receiver Index | Poller Interval  | Receiver Index | Sampling Rate | Maximum Header Size |       |  |          |  |            |  |             |  |      |  |       |  |
| <input checked="" type="checkbox"/> 1/0/1 | 0              | 0  | 1              | 1024          | 64                  |       |  |          |  |            |  |             |  |      |  |       |  |
| <input type="checkbox"/> 1/0/2            | 0              | 0  | 0              | 0             | 128                 |       |  |          |  |            |  |             |  |      |  |       |  |

- b. Select the Interface **1/0/1** check box.
- c. In the **Sampling Rate** field, enter **1024**.
- d. In the **Maximum Header Size** field, enter **64**.
- e. Click **Apply**.

A screen similar to the following displays.

| System                                    |                | Switching  |                | Routing       |                     | QoS   |  | Security |  | Monitoring |  | Maintenance |  | Help |  | Index |  |
|---|----------------|--|----------------|---------------|---------------------|-------|--|----------|--|------------|--|-------------|--|------|--|-------|--|
| Ports                                     |                | Logs   |                | Mirroring     |                     | sFlow |  |          |  |            |  |             |  |      |  |       |  |
| sFlow                                     |                | sFlow Interface Configuration  |                |               |                     |       |  |          |  |            |  |             |  |      |  |       |  |
| Basic                                     |                | 1 2 3 All  |                |               |                     |       |  |          |  |            |  |             |  |      |  |       |  |
| Advanced                                  |                | Go To Interface <input type="text"/> <input type="button" value="Go"/> |                |               |                     |       |  |          |  |            |  |             |  |      |  |       |  |
| sFlow Agent Information                   |                |  |                |               |                     |       |  |          |  |            |  |             |  |      |  |       |  |
| sFlow Receiver Configuration              |                |  |                |               |                     |       |  |          |  |            |  |             |  |      |  |       |  |
| sFlow Interface Configuration             |                |  |                |               |                     |       |  |          |  |            |  |             |  |      |  |       |  |
| Interface                                 | Receiver Index | Poller Interval  | Receiver Index | Sampling Rate | Maximum Header Size |       |  |          |  |            |  |             |  |      |  |       |  |
| <input checked="" type="checkbox"/> 1/0/1 | 0              | 0  | 1              | 1024          | 64                  |       |  |          |  |            |  |             |  |      |  |       |  |
| <input type="checkbox"/> 1/0/2            | 0              | 0  | 0              | 0             | 128                 |       |  |          |  |            |  |             |  |      |  |       |  |

## Time-Based Sampling of Counters with sFlow

### CLI: Configure Time-Based Sampling of Counters with sFlow

1. Configure the sampling port sFlow receiver index, and polling interval. You need to repeat this for all the ports to be polled.

```
(Netgear Switch) (Config)# interface 1/0/1
(Netgear Switch) (Interface 1/0/1)# sflow poller 1
(Netgear Switch) (Interface 1/0/1)# sflow poller interval 300
```

## 2. View the polling port configurations.

```
(Netgear Switch) #show sflow pollers
```

| Poller      | Receiver | Poller   |
|-------------|----------|----------|
| Data Source | Index    | Interval |
| -----       | -----    | -----    |
| 1/0/1       | 1        | 300      |

## Local Browser Interface: Configure Time-Based Sampling of Counters with sFlow

Configure the sampling ports sFlow receiver index, and polling interval:

1. Select **Monitoring > sFlow > Advanced > sFlow Interface Configuration**.
2. Select the Interface **1/0/1** check box.
3. In the **Poller Interval** field, enter **300**.

A screen similar to the following displays.

| System   Switching   Routing   QoS   Security   <b>Monitoring</b>   Maintenance   Help   Index |           |                |                 |                |               |                     |
|--|-----------|----------------|-----------------|----------------|---------------|---------------------|
| Ports   Logs   Mirroring   <b>sFlow</b>  |           |                |                 |                |               |                     |
| sFlow  |           |                |                 |                |               |                     |
| sFlow Interface Configuration  |           |                |                 |                |               |                     |
| 1 2 3 All Go To Interface <input type="text"/> Go  |           |                |                 |                |               |                     |
|  | Interface | Receiver Index | Poller Interval | Receiver Index | Sampling Rate | Maximum Header Size |
| <input checked="" type="checkbox"/>  | 1/0/1     | 1              | 300             | 1              | 1024          | 64                  |
| <input type="checkbox"/>   | 1/0/2     | 0              | 0               | 0              | 0             | 128                 |

4. Click **Apply**.

# 23

## 23 DNS

---

### Domain Name System

This chapter includes the following sections:

- [Domain Name System Concepts](#)
- [Specify Two DNS Servers](#)
- [Manually Add a Host Name and an IP Address](#)

# Domain Name System Concepts

The Domain Name System (DNS) protocol maps a host name to an IP address, allowing you to replace the IP address with the host name for IP commands such as a ping and a traceroute, and for features such as RADIUS, DHCP relay, SNTP, SNMP, TFTP, SYSLOG, and UDP relay.

You can obtain the DNS server IP address from your ISP or public DNS server list. DNS is used to resolve the host's IP address. It enables a static host name entry to be used to resolve the IP address. The following are examples of how the DNS feature is used.

## Specify Two DNS Servers

The following example shows how to specify two DNS servers (that is, two IP addresses for DNS servers) and to resolve an IP address using the DNS server. The example is shown as CLI commands and as a local browser interface procedure.

### CLI: Specify Two DNS Servers

```
(Netgear Switch)#config
(Netgear Switch) (Config)#ip name-server 12.7.210.170 219.141.140.10
(Netgear Switch) (Config)#ip domain-lookup
(Netgear Switch) (Config)#exit
(Netgear Switch)#ping www.netgear.com

Send count=3, Receive count=3 from 206.82.202.46
```



## Local Browser Interface: Specify Two DNS Servers

1. Select **System > Management > DNS > DNS Configuration**.

A screen similar to the following displays.

| Serial No. | DNS Server     | Preference |
|------------|----------------|------------|
| 1          | 219.141.140.10 | 1          |
| 2          | 12.7.210.170   | 0          |

2. Under DNS Server Configuration, in the **DNS Server** field, enter **12.7.210.170**.
3. Click **Add**.
4. In the **DNS Server** field, enter **219.141.140.10**.
5. Click **Add**.

Both DNS servers now show in the DNS Server Configuration table.

## Manually Add a Host Name and an IP Address

The following example shows commands to add a static host name entry to the switch so that you can use this entry to resolve the IP address. The example is shown as CLI commands and as a local browser interface procedure.

### CLI: Manually Add a Host Name and an IP Address

```
(Netgear Switch)#config
(Netgear Switch) (Config)#ip host www.netgear.com 206.82.202.46
(Netgear Switch) (Config)#ip domain-lookup
(Netgear Switch) (Config)#ping www.netgear.com

Send count=3, Receive count=3 from 206.82.202.46
```

## Local Browser Interface: Manually Add a Host Name and an IP Address

1. Select **System > Management > DNS > Host Configuration**.

A screen similar to the following displays.

| Management             |                        |
|------------------------|------------------------|
| System Information     | DNS Host Configuration |
| System CPU Status      |                        |
| Switch Statistics      |                        |
| USB Device Information |                        |
| Loopback Interface     |                        |
| Network Interface      |                        |
| Time                   |                        |
| DNS                    |                        |
| DNS Configuration      |                        |
| Host Configuration     |                        |

| Host Name (1 to 255 characters) | IP Address    |
|---------------------------------|---------------|
| www.netgear.com                 | 206.92.202.46 |

| Dynamic Host Mapping |       |         |      |           |
|----------------------|-------|---------|------|-----------|
| Host                 | Total | Elapsed | Type | Addresses |
|                      |       |         |      |           |

2. Under DNS Host Configuration, enter the following information:

- In the **Host Name** field, enter **www.netgear.com**.
- In the **IP Address** field, enter **206.82.202.46**.

3. Click **Add**.

The host name and IP address now show in the DNS Host Configuration table.

# 24

## 24 DHCP Server

---

### Dynamic Host Configuration Protocol Server

This chapter includes the following sections:

- [Dynamic Host Configuration Protocol Concepts](#)
- [Configure a DHCP Server in Dynamic Mode](#)
- [Configure a DHCP Server that Assigns a Fixed IP Address](#)

# Dynamic Host Configuration Protocol Concepts

When a client sends a request to a Dynamic Host Configuration Protocol (DHCP) server, the DHCP server assigns the IP address from address pools that are specified on the switch. The network in the DHCP pool must belong to the same subnet.

A DHCP server allows the switch to dynamically assign an IP address to a DHCP client that is attached to the switch. It also enables the IP address to be assigned based on the client's MAC address. The following are examples of how the DHCP Server feature is used.

## Configure a DHCP Server in Dynamic Mode

The following example shows how to create a DHCP server with a dynamic pool. The example is shown as CLI commands and as a local browser interface procedure.

### CLI: Configure a DHCP Server in Dynamic Mode

```
(Netgear Switch) #vlan database
(Netgear Switch) (Vlan)#vlan 200
(Netgear Switch) (Vlan)#vlan routing 200
(Netgear Switch) (Vlan)#exit
(Netgear Switch) (Config)#interface 1/0/1
(Netgear Switch) (Interface 1/0/1)#vlan participation include 200
(Netgear Switch) (Interface 1/0/1)#vlan pvid 200
(Netgear Switch) (Interface 1/0/1)#exit
(Netgear Switch) (Config)#interface vlan 200
(Netgear Switch) (Interface-vlan 200)#routing
(Netgear Switch) (Interface-vlan 200)#ip address 192.168.100.1 255.255.255.0
(Netgear Switch) #config
(Netgear Switch) (Config)#service dhcp
(Netgear Switch) (Config)#ip dhcp pool pool_dynamic
(Netgear Switch) (Config)#network 192.168.100.0 255.255.255.0
```

---

**Note:** If there is no DHCP L3 relay between client PC and DHCP server, there must be an active route whose subnet is the same as the DHCP dynamic pool's subnet.

---

# Local Browser Interface: Configure a DHCP Server in Dynamic Mode

## 1. Create VLAN 200.

### a. Select **Switching > VLAN > Basic > VLAN Configuration**.

A screen similar to the following displays.

### b. Under VLAN Configuration, in the **VLAN ID** field, enter **200**.

### c. Click **Add**.

## 2. Add port 1/0/1 to VLAN 200.

### a. Select **Switching > VLAN > Advanced > VLAN Membership**.

A screen similar to the following displays.

### b. In the **VLAN ID** field, select **200**.

### c. Click **Unit 1**. The ports display.

### d. Click the gray boxes under ports **1** and **24** until **U** displays.

The U specifies that the egress packet is untagged for the port.

### e. Click **Apply**.

## 3. Assign PVID to the VLAN 200.

- a. Select **Switching > VLAN > Advanced > Port PVID Configuration**.

A screen similar to the following displays.

| Interface | PVID | VLAN Member | VLAN Tag | Acceptable Frame Types | Configured Ingress Filtering | Current Ingress Filtering | Port Priority (0 to 7) |
|-----------|------|-------------|----------|------------------------|------------------------------|---------------------------|------------------------|
| 1/0/1     | 200  | 1           | None     | Admit All              | Disable                      | Disable                   | 0                      |
| 1/0/2     | 1    | 1           | None     | Admit All              | Disable                      | Disable                   | 0                      |
| 1/0/3     | 1    | 1           | None     | Admit All              | Disable                      | Disable                   | 0                      |
| 1/0/4     | 1    | 1           | None     | Admit All              | Disable                      | Disable                   | 0                      |

- b. Under Port PVID Configuration, scroll down and select the **1/0/1** check box.  
 c. In the **PVID (1 to 4093)** field, enter **200**.  
 d. Click **Apply** to save the settings.

4. Create a new DHCP pool.

- a. Select **System > Services > DHCP Server > DHCP Server Configuration**.

A screen similar to the following displays.

- b. For Admin Mode, select the **Enable** radio button.  
 c. Click **Apply** to enable the DHCP service.  
 d. Select **System > Services > DHCP Server > DHCP Pool Configuration**.

A screen similar to the following displays.

- e. Under DHCP Pool Configuration, enter the following information:
  - In the **Pool Name** list, select **Create**.
  - In the **Pool Name** field, enter **pool\_dynamic**.
  - In the **Type of Binding** list, select **Dynamic**.
  - In the **Network Number** field, enter **192.168.100.0**.
  - In the **Network Mask** field, enter **255.255.255.0**. As an alternate, you can enter **24** in the **Network Prefix Length** field. Do not fill in both the Network Mask field and Network Prefix Length fields.
  - In the **Days** field, enter **1**.
- f. Click **Add**.

The pool\_dynamic name is now added to the Pool Name drop-down list.

## Configure a DHCP Server that Assigns a Fixed IP Address

The following example shows how to set up a DHCP server with an IP address pool and let the DHCP server assign a fixed IP address based on a MAC address. The example is shown as CLI commands and as a local browser interface procedure.

### CLI: Configure a DHCP Server that Assigns a Fixed IP Address

```
(Netgear Switch)#config
(Netgear Switch) (Config)#service dhcp
(Netgear Switch) (Config)#ip dhcp pool pool_manual
(Netgear Switch) (Config-dhcp-pool)#client-name dhcpclient
(Netgear Switch) (Config-dhcp-pool)#hardware-address 00:01:02:03:04:05
(Netgear Switch) (Config-dhcp-pool)#host 192.168.200.1 255.255.255.0
(Netgear Switch) (Config-dhcp-pool)#client-identifier 01:00:01:02:03:04:05
```

---

**Note:** The unique identifier is a concatenation of the media type and MAC addresses. For example, the Microsoft client identifier for Ethernet address c8:19:24:88:f1:77 is 01:c8:19:24:88:f1:77, where 01 represents the Ethernet media type. For more information, see the “Address Resolution Protocol Parameters” section of RFC 1700.

---



## Local Browser Interface: Configure a DHCP Server that Assigns a Fixed IP Address

1. Select **System > Services > DHCP Server > DHCP Server Configuration**.

A screen similar to the following displays.

2. For Admin Mode, select the **Enable** radio button.
3. Click **Apply** to enable the DHCP service.
4. Select **System > Services > DHCP Server > DHCP Pool Configuration**.

A screen similar to the following displays.

5. Under DHCP Pool Configuration, enter the following information:
  - In the **Pool Name** list, select **Create**.
  - In the **Pool Name** field, enter **pool\_manual**.
  - In the **Type of Binding** list, select **Manual**.
  - In the **Client Name** field, enter **dhcpclient**.
  - In the **Hardware Address** field, enter **00:01:02:03:04:05**.



- In the **Hardware Type** list, select **ethernet**.
  - In the **Host Number** field, enter **192.168.200.1**.
  - In the **Network Mask** field, enter **255.255.255.0**. As an alternate, you can enter **24** in the **Network Prefix Length** field.
  - In the **Days** field, enter **1**.
6. Click **Add**. The pool\_manual name is now added to the Pool Name drop-down list.

# 25

## 25 DHCPv6 Server

---

### Dynamic Host Configuration Protocol version 6 Server

This chapter includes the following sections:

- [Dynamic Host Configuration Protocol Version 6 Concepts](#)
- [CLI: Configure DHCPv6 Prefix Delegation](#)
- [Local Browser Interface: Configure DHCPv6 Prefix Delegation](#)
- [Configure a Stateless DHCPv6 Server](#)
- [Configure a Stateful DHCPv6 Server](#)
- [CLI: Set Up a Configuration With a DHCPv6 Server and DHCPv6 Relay](#)

# Dynamic Host Configuration Protocol Version 6 Concepts

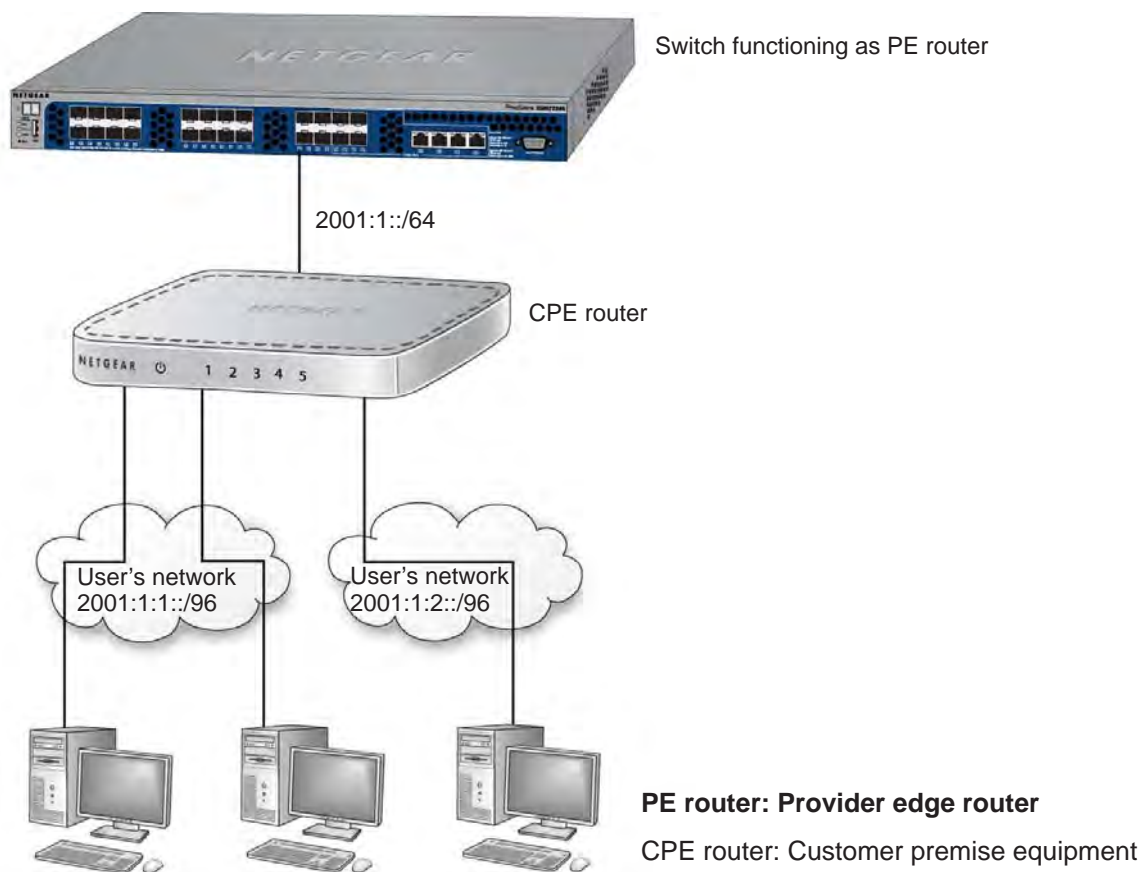
Dynamic Host Configuration Protocol version 6 (DHCPv6) for IPv6 is used to assign IPv6 addresses statefully and distribute other configuration information such as domain name or DNS server.

DHCPv6 supports stateful address allocation, prefix delegation, and stateless services. This chapter describes how to configure the prefix delegation mode using a DHCPv6 pool. When you create a DHCPv6 pool, you need to assign a prefix to the client DHCP unique identifier (DUID).

DUID is used to identify the client's unique DUID value. The format is xx:xx:xx:xx:xx:xx. RFC3315 defines three types:

- Link-layer address plus time:
  - 00:01:hardware type:time:link-layer address
  - Hardware type - 16 bit hardware type reserved by IANA. 1 means an Ethernet device.
  - Time: 32-bit unsigned integer. The time in seconds when this DUID was generated since 00:00:00 1/1/2000.
  - Link-layer address - The link layer address of a device generating the DUID.
- Vendor-assigned unique ID based on Enterprise Number:
  - 00:02:enterprise-number:identifier
  - Enterprise-number - 32-bit integer reserved by IANA.
  - Identifier - Variable length data for each vendor
- Link-layer address:
  - 00:03:hardware type:link-layer address
  - Hardware type - 16 bit hardware type reserved by IANA. 1 means an Ethernet device.
  - Link-layer address - The link layer address of a device generating the DUID.

In the following case, the CPE router requests prefix from the PE router. The PE router chooses prefix (2001:1::/64) for delegation, and responds with the prefix to the requesting CPE router. The CPE router subnets the prefix and assigns the longer prefixes to links in the user's network. The CPE router is then responsible to assign the 2001:1:1::/96 to one user's network and 2001:1:2::/96 to another user's network.



**Figure 52. DHCPv6 stateful IPv6 address assignment**

## CLI: Configure DHCPv6 Prefix Delegation

### 1. Enable IPv6 routing.

```
(Netgear Switch) #configure
(NETGEAR SWITCH) (Config)#ip routing
(NETGEAR SWITCH) (Config)#ipv6 unicast routing
```

### 2. Create a DHCPv6 pool and enable DHCP service.

```
(NETGEAR SWITCH) (Config)#service dhcpv6
(NETGEAR SWITCH) (Config)#ipv6 dhcp pool pool1
(NETGEAR SWITCH) (Config dhcp6 pool)#domain name netgear.com
(NETGEAR SWITCH) (Config dhcp6s pool)#prefix delegation 2001:1::/64
00:01:00:01:15:40:14:4f:00:00:00:4d:aa:d0
(NETGEAR SWITCH) (Config dhcp6s pool)#exit
```

### 3. Enable DHCPv6 service on port 1/0/9.

```
(NETGEAR SWITCH) (Config)#interface 1/0/9
(NETGEAR SWITCH) (Interface 1/0/9)#routing
(NETGEAR SWITCH) (Interface 1/0/9)#ipv6 address 2001:1::1/64
(NETGEAR SWITCH) (Interface 1/0/9)#ipv6 enable
(NETGEAR SWITCH) (Interface 1/0/9)#ipv6 dhcp server pool1 preference 20
(NETGEAR SWITCH) (Interface 1/0/9)#exit
```

### 4. Show DHCPv6 binding.

```
(NETGEAR SWITCH) #show ipv6 dhcp binding
Client Address..... FE80::200:FF:FE4D:AAD0
Client Interface..... 1/0/9
Client DUID.....
00:01:00:01:15:40:14:4f:00:00:00:4d:aa:d0
Identity Association ID..... 5090000
Binding Prefix Address/Length..... 2001:1::/64
Binding Prefix Type ..... IA_PD
Binding Expiration (secs)..... 4294967284
Binding Prefix Valid Lifetime (secs)..... infinite
Binding Prefix Preferred Lifetime (secs)..... infinite
```

## Local Browser Interface: Configure DHCPv6 Prefix Delegation

### 1. Enable IP routing globally.

#### a. Select **Routing > IP > Basic > IP Configuration**.

A screen similar to the following displays.

| System  | Switching | Routing  | QoS | Security | Monitoring | Maintenance | Help | Index |
|---|-----------|--|-----|----------|------------|-------------|------|-------|
| <div>Routing Table</div> <div>IP IPv6 VLAN ARP RIP OSPF OSPFv3 Router Discovery VRRP Multicast IPv6 Multicast</div> |           |  |     |          |            |             |      |       |
| <div>IP</div> <div>IP Configuration</div>   |           |  |     |          |            |             |      |       |
| <div>Basic</div> <div>IP Configuration</div> <div>Statistics</div> <div>Advanced</div>                              |           | <div>Default Time to Live 64</div> <div>Routing Mode <input checked="" type="radio"/> Enable <input type="radio"/> Disable</div> <div>ICMP Echo Replies <input checked="" type="radio"/> Enable <input type="radio"/> Disable</div> <div>ICMP Redirects <input type="radio"/> Enable <input checked="" type="radio"/> Disable</div> <div>ICMP Rate Limit Interval 1000 (0 to 2147483647 ms)</div> <div>ICMP Rate Limit Burst Size 100 (1 to 200)</div> <div>Maximum Next Hops 4</div> <div>Maximum Routes 8150</div> |     |          |            |             |      |       |

#### b. For Routing Mode, select the **Enable** radio button.

#### c. Click **Apply** to save the settings.

2. Enable IPv6 unicast globally.

a. Select **Routing > IPv6 > Basic > Global Configuration**.

A screen similar to the following displays.

| System  | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table   | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |
| IPv6 Global Configuration   |           |         |      |          |            |             |        |                  |      |           |                |
| <div>IPv6 Unicast Routing <input type="radio"/> Disable <input checked="" type="radio"/> Enable</div> <div>Hop Limit <input type="text" value="64"/> (1 to 255)</div> <div>ICMPv6 Rate Limit Error Interval <input type="text" value="1000"/> (0 to 2147483647 msecs)</div> <div>ICMPv6 Rate Limit Burst Size <input type="text" value="100"/> (1 to 200)</div> |           |         |      |          |            |             |        |                  |      |           |                |












b. For IPv6 Unicast Routing, select the **Enable** radio button.

c. Click **Apply** to save the settings.

3. Enable IPv6 address on interface 1/0/9.

a. Select **Routing > IPv6 > Advanced > Interface Configuration**.

A screen similar to the following displays.

| System                       | Switching | Routing   | QoS       | Security  | Monitoring         | Maintenance                       | Help         | Index            |                  |           |                             |                   |                    |
|------------------------------|-----------|---|-----------|-----------|--------------------|-----------------------------------|--------------|------------------|------------------|-----------|-----------------------------|-------------------|--------------------|
| Routing Table                | IP        | IPv6  | VLAN      | ARP       | RIP                | OSPF                              | OSPFv3       | Router Discovery | VRRP             | Multicast | IPv6 Multicast              |                   |                    |
|                              |           |   |           |           |                    |                                   |              |                  |                  |           |                             |                   |                    |
| IPv6                         |           | IPv6 Interface Configuration  |           |           |                    |                                   |              |                  |                  |           |                             |                   |                    |
| • Basic                      | ▼         | 1 2 3 VLANs All   |           |           |                    |                                   |              |                  |                  |           |                             |                   |                    |
| • Advanced                   | ^         |   |           |           |                    |                                   |              |                  |                  |           |                             |                   |                    |
| • Global Configuration       |           |  | Interface | IPv6 Mode | DHCPv6 Client Mode | Stateless Address AutoConfig Mode | Routing Mode | Admin Mode       | Operational Mode | MTU       | Duplicate Address Detection | Address Transmits | Life Time Interval |
| • Interface Configuration    |           |  | 1/0/9     | Disable   | Disable            | Disable                           | Disable      | Enable           | Disable          | 1500      | 1                           |                   | 1800               |
| • Prefix Configuration       |           |  | 1/0/1     | Disable   | Disable            | Disable                           | Disable      | Enable           | Disable          | 1500      | 1                           |                   | 1800               |
| • Statistics                 |           |  | 1/0/2     | Disable   | Disable            | Disable                           | Disable      | Enable           | Disable          | 1500      | 1                           |                   | 1800               |
| • Neighbour Table            |           |  | 1/0/3     | Disable   | Disable            | Disable                           | Disable      | Enable           | Disable          | 1500      | 1                           |                   | 1800               |
| • Static Route Configuration |           |  | 1/0/4     | Disable   | Disable            | Disable                           | Disable      | Enable           | Disable          | 1500      | 1                           |                   | 1800               |
| • Route Table                |           |  | 1/0/5     | Disable   | Disable            | Disable                           | Disable      | Enable           | Disable          | 1500      | 1                           |                   | 1800               |
| • Route Preference           |           |  | 1/0/6     | Disable   | Disable            | Disable                           | Disable      | Enable           | Disable          | 1500      | 1                           |                   | 1800               |
| • Tunnel Configuration       |           |  | 1/0/7     | Disable   | Disable            | Disable                           | Disable      | Enable           | Disable          | 1500      | 1                           |                   | 1800               |
|                              |           |  | 1/0/8     | Disable   | Disable            | Disable                           | Disable      | Enable           | Disable          | 1500      | 1                           |                   | 1800               |
|                              |           |  | 1/0/9     | Disable   | Disable            | Disable                           | Disable      | Enable           | Disable          | 1500      | 1                           |                   | 1800               |

b. Scroll down and select the interface **1/0/9** check box to the left of the Interface column.

1/0/9 displays in the Interface field of the table heading.

c. Enter the following information:

- In the **IPv6 Mode** field, select **Enable**.
- In the **Routing Mode** field, select **Enable**.

d. Click **Apply** to apply the settings.

4. Configure the prefix on interface 1/0/9.

a. Select **Routing > IPv6 > Advanced > Prefix Configuration**.

A screen similar to the following displays.

| System   | Switching     | Routing | QoS             | Security            | Monitoring  | Maintenance | Help   | Index            |      |           |                |             |               |       |                 |                     |             |             |    |  |  |  |  |
|--|---------------|---------|-----------------|---------------------|-------------|-------------|--------|------------------|------|-----------|----------------|-------------|---------------|-------|-----------------|---------------------|-------------|-------------|----|--|--|--|--|
| Routing Table  | IP            | IPv6    | VLAN            | ARP                 | RIP         | OSPF        | OSPFV3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |             |               |       |                 |                     |             |             |    |  |  |  |  |
| <div>IPv6</div> <div>IPv6 Interface Selection</div> <div>Interface: 1/0/9</div> <div>IPv6 Interface Configuration</div> <table border="1"> <thead> <tr> <th>IPv6 Prefix</th> <th>Prefix Length</th> <th>EUI64</th> <th>Valid Life Time</th> <th>Preferred Life Time</th> <th>Onlink Flag</th> </tr> </thead> <tbody> <tr> <td>2001:1:1::1</td> <td>64</td> <td></td> <td></td> <td></td> <td></td> </tr> </tbody> </table> |               |         |                 |                     |             |             |        |                  |      |           |                | IPv6 Prefix | Prefix Length | EUI64 | Valid Life Time | Preferred Life Time | Onlink Flag | 2001:1:1::1 | 64 |  |  |  |  |
| IPv6 Prefix  | Prefix Length | EUI64   | Valid Life Time | Preferred Life Time | Onlink Flag |             |        |                  |      |           |                |             |               |       |                 |                     |             |             |    |  |  |  |  |
| 2001:1:1::1  | 64            |         |                 |                     |             |             |        |                  |      |           |                |             |               |       |                 |                     |             |             |    |  |  |  |  |

- b. In the **Interface** list, select interface **1/0/9**.
- c. In the **IPv6 Prefix** field, enter **2001:1:1::1**.
- d. In the **Prefix Length** field, select **64**.
- e. Click **Add**.

The IPv6 prefix for interface 1/0/9 is created.

5. Enable the DHCPv6 server configuration.
  - a. Select **System > Services > DHCPv6 Server > DHCPv6 Server Configuration**.

A screen similar to the following displays.

| System  | Switching   | Routing  | QoS     | Security | Monitoring | Maintenance | Help | Index          |
|---|-------------|----------|---------|----------|------------|-------------|------|----------------|
| Management  | Device View | Services | Chassis | PoE      | SNMP       | LLDP        | ISDP | Timer Schedule |
| <div>Services</div> <div>DHCPv6 Server Configuration</div> <div>Admin Mode: <input type="radio"/> Disable <input checked="" type="radio"/> Enable</div> <div>DHCPv6 Server DUID</div> <div>DHCPv6 Server Configuration</div> <div>DHCPv6 Pool Configuration</div> <div>DHCPv6 Prefix Delegation Configuration</div> |             |          |         |          |            |             |      |                |

- b. For Admin Mode, select the **Enable** radio button.
- c. Click **Apply** to save the settings.
6. Create a DHCPv6 pool named pool1.
  - a. Select **System > Services > DHCP Server > DHCPv6 Pool Configuration**.

A screen similar to the following displays.

The screenshot shows the 'DHCPv6 Pool Configuration' page. On the left, a sidebar lists various services, with 'DHCPv6 Pool Configuration' highlighted. The main content area contains the following fields:

- Pool Name:** A dropdown menu currently showing 'Create'.
- Pool Name:** A text input field containing 'pool1'.
- Default Router Addresses:** A dropdown menu.
- Domain Name:** A dropdown menu.

- b. In the **Pool Name** list, select **Create**.
  - c. In the **Pool Name** field, enter **pool1**.
  - d. Click **Apply** to save the settings.
7. Configure the prefix in the pool1.
  - a. Select **System > Services > DHCPv6 Server > DHCPv6 Pool Configuration**.

A screen similar to the following displays.

The screenshot shows the 'DHCPv6 Prefix Delegation Configuration' page. On the left, a sidebar lists various services, with 'DHCPv6 Prefix Delegation Configuration' highlighted. The main content area features a table with the following data:

| Pool Name | Prefix   | Prefix Length | DUID                   | Client Name | Valid Lifetime | Prefix Lifetime |
|-----------|----------|---------------|------------------------|-------------|----------------|-----------------|
| pool1     | 2001:1:: | 64            | 00:01:00:01:15:40:14:4 |             |                |                 |

- b. In the **Pool Name** field, select **pool1**.
  - c. In the **Prefix** field, enter **2001:1::**.
  - d. In the **Prefix Length** field, enter **64**.
  - e. Click **Apply** to save the settings.
8. Configure DHCPv6 on interface 1/0/9.
  - a. Select **System > Services > DHCPv6 Server > DHCPv6 Interface Configuration**.



A screen similar to the following displays.

| Interface | Admin mode | Pool Name | Rapid Commit | Preference |
|-----------|------------|-----------|--------------|------------|
| 1/0/9     | Enable     |           |              |            |
| 1/0/1     | Disable    |           |              |            |
| 1/0/2     | Disable    |           |              |            |
| 1/0/3     | Disable    |           |              |            |
| 1/0/4     | Disable    |           |              |            |
| 1/0/5     | Disable    |           |              |            |
| 1/0/6     | Disable    |           |              |            |
| 1/0/7     | Disable    |           |              |            |
| 1/0/8     | Disable    |           |              |            |
| 1/0/9     | Disable    |           |              |            |

- b. Scroll down and select the interface **1/0/9** check box to the left of the Interface column.

1/0/9 displays in the Interface field of the table heading.

- c. In the **Admin mode** field, select **Enable**.  
 d. In the **Pool Name** field, select **pool1**.  
 e. Click **Apply** to save the settings.

## Configure a Stateless DHCPv6 Server

This example show how you can use a DHCPv6 server to pass on information about a DNS server to clients that receive an IPv6 address in autoconfiguration mode or manual mode. The configured DHCP pool does not contain a prefix pool but contains information about the DNS server. The `ipv6 nd other-config-flag` command must be enabled on the IPv6 interface.

The following sections show how to configure a DNS server for clients with a stateless IPv6 address using a DHCPv6 server.

### CLI: Configure a Stateless DHCPv6 Server

1. Enable IPv6 routing.

```
(Netgear Switch) (Config)#ipv6 unicast-routing
```

## 2. Create an IPv6 pool with a DNS server and enable the DHCPv6 service.

```
(Netgear Switch) (Config)#ipv6 dhcp pool ipv6_server
(Netgear Switch) (Config-dhcp6s-pool)#dns-server 2011:9:18::1
(Netgear Switch) (Config-dhcp6s-pool)#exit
(Netgear Switch) (Config)#service dhcpv6
```

## 3. Enable the IPv6 DHCP server on interface 2/0/21.

**Note:** In this case, you must configure the `ipv6 nd other-config-flag` command on the interface, otherwise the host cannot update the DNS server.

```
(Netgear Switch) (Config)#interface 2/0/21
(Netgear Switch) (Interface 2/0/21)#routing
(Netgear Switch) (Interface 2/0/21)#ipv6 address 2003:1000::1/64
(Netgear Switch) (Interface 2/0/21)#ipv6 enable
(Netgear Switch) (Interface 2/0/21)#ipv6 nd other-config-flag
(Netgear Switch) (Interface 2/0/21)#ipv6 dhcp server ipv6_server
(Netgear Switch) (Interface 2/0/21)#exit
```

# Local Browser Interface: Configure a Stateless DHCPv6 Server

## 1. Enable ipv6 routing.

### a. Select **Routing > IPv6 > Basic > Global Configuration**.

A screen similar to the following displays.

| System  | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table   | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |
| <div> <div>IPv6</div> <div>IPv6 Global Configuration</div> </div> <div> <div> <div>Basic</div> <div>Global Configuration</div> <div>Route Table</div> <div>Advanced</div> </div> <div> <div>IPv6 Unicast Routing</div> <div> <div>Disable</div> <div>Enable</div> </div> <div> <div>Hop Limit</div> <div>64</div> <div>(1 to 255)</div> </div> <div> <div>ICMPv6 Rate Limit Error Interval</div> <div>1000</div> <div>(0 to 2147483647 msec)</div> </div> <div> <div>ICMPv6 Rate Limit Burst Size</div> <div>100</div> <div>(1 to 200)</div> </div> </div> </div> |           |         |      |          |            |             |        |                  |      |           |                |

### b. For IPv6 Unicast Routing, select the **Enable** radio button.

### c. Click **Apply** to save the settings.

## 2. Enable IPv6 routing on interface 2/0/21.

### a. Select **Routing > IPv6 > Advanced > Interface Configuration**.

A screen similar to the following displays.

| Interface                                  | IPv6 Mode | DHCPv6 Client Mode | Stateless Address AutoConfig Mode | Routing Mode | Admin Mode | Operational Mode | MTU  | Duplicate Address Detection Transmits |
|--|-----------|--------------------|-----------------------------------|--------------|------------|------------------|------|---------------------------------------|
| <input checked="" type="checkbox"/> 2/0/21 | Enable    | Disable            | Disable                           | Enable       | Enable     | Disable          | 1500 | 1                                     |
| <input type="checkbox"/> 2/0/1             | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500 | 1                                     |
| <input type="checkbox"/> 2/0/2             | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500 | 1                                     |
| <input type="checkbox"/> 2/0/3             | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500 | 1                                     |
| <input type="checkbox"/> 2/0/4             | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500 | 1                                     |
| <input type="checkbox"/> 2/0/5             | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500 | 1                                     |
| <input type="checkbox"/> 2/0/6             | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500 | 1                                     |
| <input type="checkbox"/> 2/0/7             | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500 | 1                                     |
| <input type="checkbox"/> 2/0/8             | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500 | 1                                     |
| <input type="checkbox"/> 2/0/9             | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500 | 1                                     |
| <input type="checkbox"/> 2/0/10            | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500 | 1                                     |

b. Scroll down and select the **2/0/21** check box to the left of the Interface column.  
2/0/21 displays in the Interface field of the table heading.

c. In the **IPv6 Mode** field, select **Enable**.

d. In the **Routing Mode** field, select **Enable**.

e. Click **Apply** to save the settings.

3. Configure IPv6 address on interface 2/0/21.

a. Select **Routing > IPv6 > Advanced > Prefix Configuration**.

A screen similar to the following displays.

| IPv6 Prefix               | Prefix Length | EUI64   | Valid Life Time | Preferred Life Time | Onion Flag | Autonomous Flag | Current State |
|---------------------------|---------------|---------|-----------------|---------------------|------------|-----------------|---------------|
| 2003:1000::1              | 64            | Disable |                 |                     |            |                 | (TENT)        |
| fe80::6ab0:caff:fe19::a40 | 64            | Disable |                 |                     |            |                 |               |

b. In the **Interface** list, select **1/0/21**.

c. In the **IPv6 Prefix** field, enter **2003:1000::1**.

d. In the **Prefix Length** field, enter **64**.

e. In the **EUI64** field, select **Disable**.

f. Click **Add**.

4. Enable DHCPv6 service.

a. Select **System > Services > DHCPv6 Server > DHCPv6 Server Configuration**.

A screen similar to the following displays.

The screenshot shows the 'DHCPv6 Server Configuration' page. The left sidebar has a tree view under 'Services' with 'DHCPv6 Server Configuration' selected. The main content area shows 'Admin Mode' with 'Disable' and 'Enable' radio buttons, where 'Enable' is selected. Below it is the 'DHCPv6 Server DUID' field.

- b. For Admin Mode, select the **Enable** radio button.
  - c. Click **Apply** to save the settings.
5. Create a DHCPv6 pool.
  - a. Select **System > Services > DHCP Server > DHCPv6 Pool Configuration**.

A screen similar to the following displays.

The screenshot shows the 'DHCPv6 Pool Configuration' page. The left sidebar has a tree view under 'Services' with 'DHCPv6 Pool Configuration' selected. The main content area has several fields: 'Pool Name' with a 'Create' dropdown and a text field containing 'ipv6\_server'; 'DNS Server Addresses' with a list of input fields, the first containing '2011:9:8::1'; and a 'Domain Name' dropdown.

- b. From the **Pool Name** list, select **Create**.
  - c. In the **Pool Name** field, enter **ipv6\_server**.
  - d. In the **DNS Server Addresses** fields, enter **2011:9:18::1** (which is the IPv6 address of the DNS server).
  - e. Click **Apply** to save the settings.
6. Enable DHCPv6 pool on interface 2/0/21.
  - a. Select **System > Services > DHCPv6 Server > DHCPv6 Interface Configuration**.

A screen similar to the following displays.

| Interface | Admin mode | Pool Name | Rapid Commit | Preference |
|-----------|------------|-----------|--------------|------------|
| 2/0/21    | Enable     | ipv6_s1   | Disable      | 20         |
| 2/0/1     | Disable    |           |              |            |
| 2/0/2     | Disable    |           |              |            |
| 2/0/3     | Disable    |           |              |            |
| 2/0/4     | Disable    |           |              |            |
| 2/0/5     | Disable    |           |              |            |
| 2/0/6     | Disable    |           |              |            |
| 2/0/7     | Disable    |           |              |            |
| 2/0/8     | Disable    |           |              |            |
| 2/0/9     | Disable    |           |              |            |
| 2/0/10    | Disable    |           |              |            |

- b.** Select the **2/0/21** check box to the left of the Interface column.  
2/0/21 displays in the Interface field of the table heading.
- c.** In the **Admin mode** field, select **Enable**.
- d.** In the **Pool Name** field, select **ipv6\_server**.
- e.** Click **Apply** to save the settings.

## Configure a Stateful DHCPv6 Server

This example shows how you can use a DHCPv6 server to assign an IPv6 address directly to a client in the same way that an IPv4 DHCPv4 server assigns an IPv4 address to an IPv4 client. A stateful DHCPv6 server assigns the IPv6 address to a client based on the configured IPv6 prefix in the DHCPv6 pool.

The following sections show how to configure a DHCPv6 server that functions in stateful mode.

### CLI: Configure a Stateful DHCPv6 Server

- 1.** Enable IPv6 routing.

```
(Netgear Switch) (Config)#ipv6 unicast-routing
```

## 2. Create an IPv6 pool with a DNS server and enable the DHCPv6 service.

```
(Netgear Switch) (Config)#ipv6 dhcp pool ipv6_server
(Netgear Switch) (Config-dhcp6s-pool)#address prefix 2001:1:2::/64
(Netgear Switch) (Config-dhcp6s-pool)#exit
(Netgear Switch) (Config)#service dhcpv6
```

## 3. Enable the IPv6 DHCP server on interface 1/0/1.

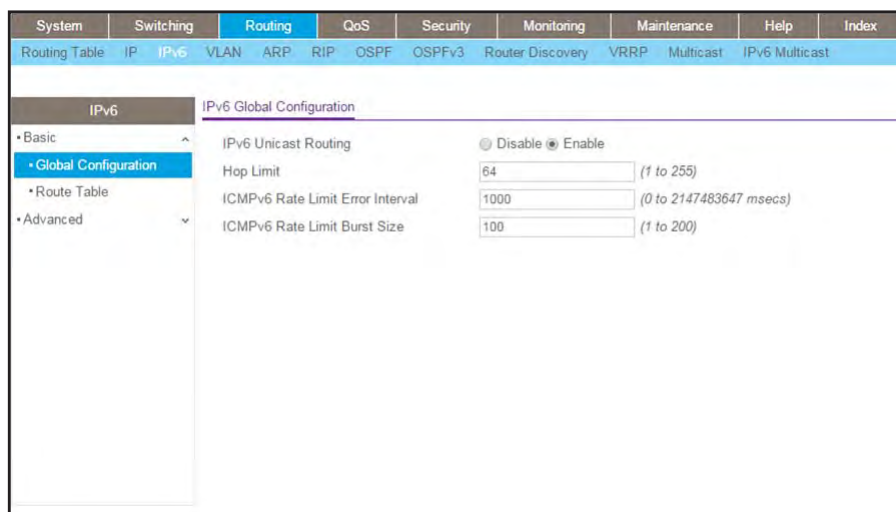
```
(Netgear Switch) (Config)#interface 1/0/1
(Netgear Switch) (Interface 1/0/1)#routing
(Netgear Switch) (Interface 1/0/1)#ipv6 address 2001:1:2::1/64
(Netgear Switch) (Interface 1/0/1)#ipv6 enable
(Netgear Switch) (Interface 1/0/1)#ipv6 dhcp server ipv6_server
(Netgear Switch) (Interface 1/0/1)#exit
```

# Local Browser Interface: Configure a Stateful DHCPv6 Server

## 1. Enable ipv6 routing.

### a. Select **Routing > IPv6 > Basic > Global Configuration**.

A screen similar to the following displays.



### b. For IPv6 Unicast Routing, select the **Enable** radio button.

### c. Click **Apply** to save the settings.

## 2. Enable IPv6 routing on interface 1/0/1.

### a. Select **Routing > IPv6 > Advanced > Interface Configuration**.



A screen similar to the following displays.

| Interface | IPv6 Mode | DHCPv6 Client Mode | Stateless Address AutoConfig Mode | Routing Mode | Admin Mode | Operational Mode | MTU  | Duplicate Address Detection Transmits | Life Time Interval | Adv NS Interval | Adv Reachable Interval |
|-----------|-----------|--------------------|-----------------------------------|--------------|------------|------------------|------|---------------------------------------|--------------------|-----------------|------------------------|
| 1/0/1     | Enable    | Disable            | Disable                           | Enable       | Enable     | Enable           | 1500 | 1                                     | 1800               | 0               | 0                      |
| 1/0/2     | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500 | 1                                     | 1800               | 0               | 0                      |
| 1/0/3     | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500 | 1                                     | 1800               | 0               | 0                      |
| 1/0/4     | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500 | 1                                     | 1800               | 0               | 0                      |
| 1/0/5     | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500 | 1                                     | 1800               | 0               | 0                      |
| 1/0/6     | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500 | 1                                     | 1800               | 0               | 0                      |
| 1/0/7     | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500 | 1                                     | 1800               | 0               | 0                      |
| 1/0/8     | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500 | 1                                     | 1800               | 0               | 0                      |
| 1/0/9     | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500 | 1                                     | 1800               | 0               | 0                      |
| 1/0/10    | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500 | 1                                     | 1800               | 0               | 0                      |

- b. Select the **1/0/1** check box to the left of the Interface column.

1/0/1 displays in the Interface field of the table heading.

- c. In the **IPv6 Mode** field, select **Enable**.
- d. In the **Routing Mode** field, select **Enable**.
- e. Click **Apply** to save the settings.

3. Configure the IPv6 address on interface 1/0/1.

- a. Select **Routing > IPv6 > Advanced > Prefix Configuration**.

A screen similar to the following displays.

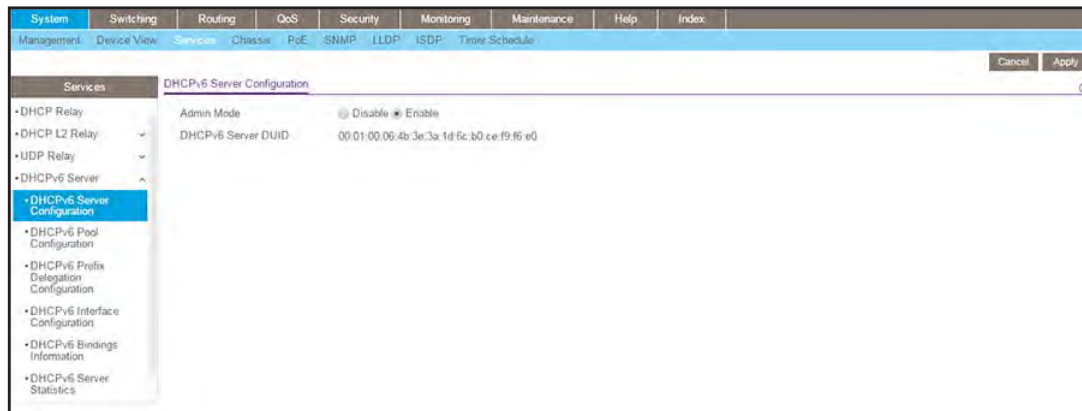
| IPv6 Prefix               | Prefix Length | EUI64   | Valid Life Time | Preferred Life Time | Onlink Flag | Autonomous Flag | Current State |
|---------------------------|---------------|---------|-----------------|---------------------|-------------|-----------------|---------------|
| 2001:1:2::1               | 64            | Disable | 1800            | 1800                | 0           | 0               | [ACTIVE]      |
| fe80::6eb0:cfff:fef3:f6e3 | 64            | Disable |                 |                     |             |                 |               |

- b. In the **Interface** list, select **1/0/1**.
- c. In the **IPv6 Prefix** field, enter **2001:1:2::1**.
- d. In the **Length** field, enter **64**.
- e. In the **EUI64** field, select **Disable**.
- f. Click **Add**.

4. Enable the DHCPv6 service.

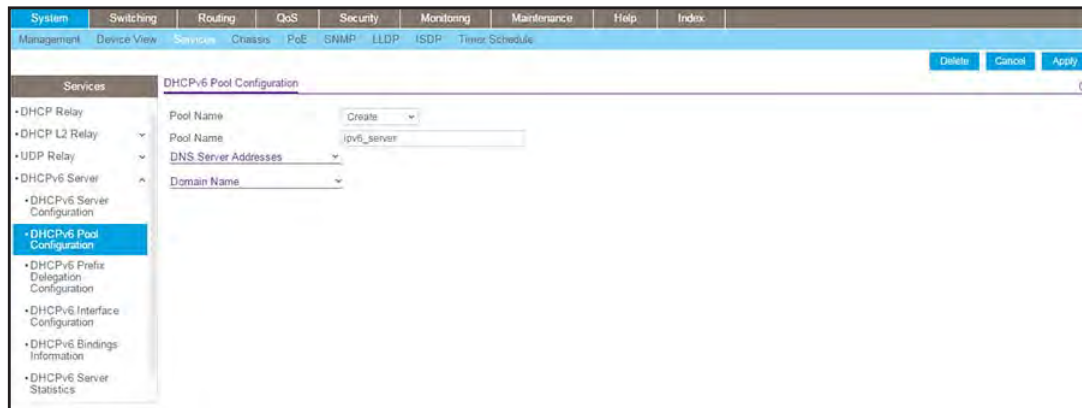
- a. Select **System > Services > DHCPv6 Server > DHCPv6 Server Configuration**.

A screen similar to the following displays.



- b. For Admin Mode, select the **Enable** radio button.
  - c. Click **Apply** to save the settings.
5. Create the DHCPv6 pool.
- a. Select **System > Services > DHCP Server > DHCPv6 Pool Configuration**.

A screen similar to the following displays.



- b. In the **Pool Name** list, select **Create**.
  - c. In the **Pool Name** field, enter **ipv6\_server**.
  - d. Click **Apply** to save the settings.
6. Configure the prefix for the DHCPv6 pool.
- a. Select **System > Services > DHCPv6 Prefix Delegation Configuration > DHCPv6 Prefix Delegation Configuration**.



A screen similar to the following displays.

| Pool Name | Prefix     | Prefix Length | DUID    | Client Name | Valid Lifetime | Prefer Lifetime |
|-----------|------------|---------------|---------|-------------|----------------|-----------------|
| ipv6_sr   | 2001:1:2:: | 64            | ab cdef |             | 4294967295     | 4294967295      |

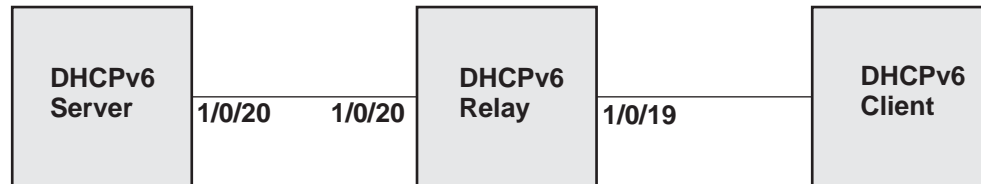
- b. In **Pool Name** list, select **ipv6\_server**.
  - c. In the **Prefix** field, enter **2001:1:2::**.
  - d. In the **Prefix Length** field, enter **64**.
  - e. Click **Add**.
7. Enable the DHCPv6 pool on interface 1/0/1.
    - a. **Select System > Services > DHCPv6 Server > DHCPv6 Interface Configuration.**

A screen similar to the following displays.

| Interface | Admin mode | Pool Name | Rapid Commit | Preference |
|-----------|------------|-----------|--------------|------------|
| 1/0/1     | Enable     | ipv6_sr   |              |            |
| 1/0/2     | Disable    |           |              |            |
| 1/0/3     | Disable    |           |              |            |
| 1/0/4     | Disable    |           |              |            |
| 1/0/5     | Disable    |           |              |            |
| 1/0/6     | Disable    |           |              |            |
| 1/0/7     | Disable    |           |              |            |
| 1/0/8     | Disable    |           |              |            |
| 1/0/9     | Disable    |           |              |            |
| 1/0/10    | Disable    |           |              |            |
| 1/0/11    | Disable    |           |              |            |
| 1/0/12    | Disable    |           |              |            |
| 1/0/13    | Disable    |           |              |            |
| 1/0/14    | Disable    |           |              |            |

- b. Select the interface **1/0/1** check box to the left of the Interface column.  
1/0/1 displays in the Interface field of the table heading.
- c. In the **Admin mode** field, select **Enable**.
- d. In the **Pool Name** field, enter **ipv6\_server**.
- e. Click **Apply** to save the settings.

# CLI: Set Up a Configuration With a DHCPv6 Server and DHCPv6 Relay



**Figure 53. Configuration with a DHCPv6 server and DHCPv6 relay**

This is a two-step process:

- [Configure the DHCPv6 Server](#)
- [Configure the DHCPv6 Relay](#)

## Configure the DHCPv6 Server

### 1. Enable IPv6 routing.

```
(Netgear Switch) (Config)#ipv6 dhcp pool ipv6_server  
(Netgear Switch) (Config)#ip routing
```

### 2. Create a DHCPv6 pool and enable DHCP service.

```
(Netgear Switch) (Config)#service dhcpv6  
(Netgear Switch) (Config)#ipv6 dhcp pool pool1  
(Netgear Switch) (Config-dhcp6s-pool)#domain-name netgear.com  
(Netgear Switch) (Config-dhcp6s-pool)#address prefix 2001:2::/64  
(Netgear Switch) (Config-dhcp6s-pool)#exit
```

### 3. Enable DHCPv6 service on VLAN 1.

```
(Netgear Switch) (Config)#interface vlan 1
(Netgear Switch) (Interface vlan 1)#ipv6 address 2001:1::1/64
(Netgear Switch) (Interface vlan 1)#ipv6 enable
(Netgear Switch) (Interface vlan 1)#ipv6 dhcp server pool1 preference 20
(Netgear Switch) (Interface vlan 1)#exit

(Netgear Switch) (Config)#interface 1/0/20
(Netgear Switch) (Interface 1/0/20)#vlan pvid 1
(Netgear Switch) (Interface 1/0/20)#vlan participation include 1
(Netgear Switch) (Interface 1/0/20)#exit
```

### 4. Configure a static route for 2001:2::/64.

```
(Netgear Switch) (Config)#ipv6 route 2001:2::/64 2001:1::2
(Netgear Switch) (Config)#exit
```

## Configure the DHCPv6 Relay

### 1. Enable IPv6 routing.

```
(Netgear Switch) (Config)#ip routing
(Netgear Switch) (Config)#ipv6 unicast-routing
```

### 2. On the DHCPv6 relay, configure the interface that is connected to the DHCPv6 server.

```
(Netgear Switch) (Config)#interface vlan 1
(Netgear Switch) (Interface vlan 1)#ipv6 address 2001:1::2/64
(Netgear Switch) (Interface vlan 1)#ipv6 enable
(Netgear Switch) (Interface vlan 1)#exit

(Netgear Switch) (Config)#interface 1/0/20
(Netgear Switch) (Interface 1/0/20)#vlan pvid 1
(Netgear Switch) (Interface 1/0/20)#vlan participation include 1
(Netgear Switch) (Interface 1/0/20)#exit
```

**3. On the DHCPv6 relay, configure the interface that is connected to the DHCPv6 client.**

```
(Netgear Switch) #vlan data
(Netgear Switch) (Vlan)#vlan 2
(Netgear Switch) (Vlan)#vlan routing 2
(Netgear Switch) (Vlan)#exit

(Netgear Switch) (Config)#interface vlan 2
(Netgear Switch) (Interface vlan 2)#ipv6 address 2001:2::1/64
(Netgear Switch) (Interface vlan 2)#ipv6 dhcp relay destination 2001:1::2
(Netgear Switch) (Interface vlan 2)#ipv6 enable
(Netgear Switch) (Interface vlan 2)#exit

(Netgear Switch) (Config)#interface 1/0/19
(Netgear Switch) (Interface 1/0/19)#vlan pvid 2
(Netgear Switch) (Interface 1/0/19)#vlan participation include 2
(Netgear Switch) (Interface 1/0/19)#ipv6 enable
(Netgear Switch) (Interface 1/0/19)#exit
```

**4. Enable DHCPv6.**

```
(Netgear Switch) (Config)#service dhcpv6
```

**5. Display the DHCPv6 binding information.**

```
(Netgear Switch) #show ipv6 dhcp binding

Total number of bindings : 1

Client Address..... fe80::6458:f6b:e2b:a0c3
Client Interface..... vlan 2
Client DUID.....
00:01:00:01:1d:c5:22:15:00:21:cc:70:0b:bf
Identity Association ID..... 83894732
Binding Prefix Address..... 2001:2::1
Binding Prefix Type ..... IA_NA
Binding Expiration (secs)..... 4294967255
Binding Prefix Valid Lifetime (secs)..... infinite
Binding Prefix Preferred Lifetime (secs)..... infinite
```

# 26

## 26 DVLANS and Private VLANs

---

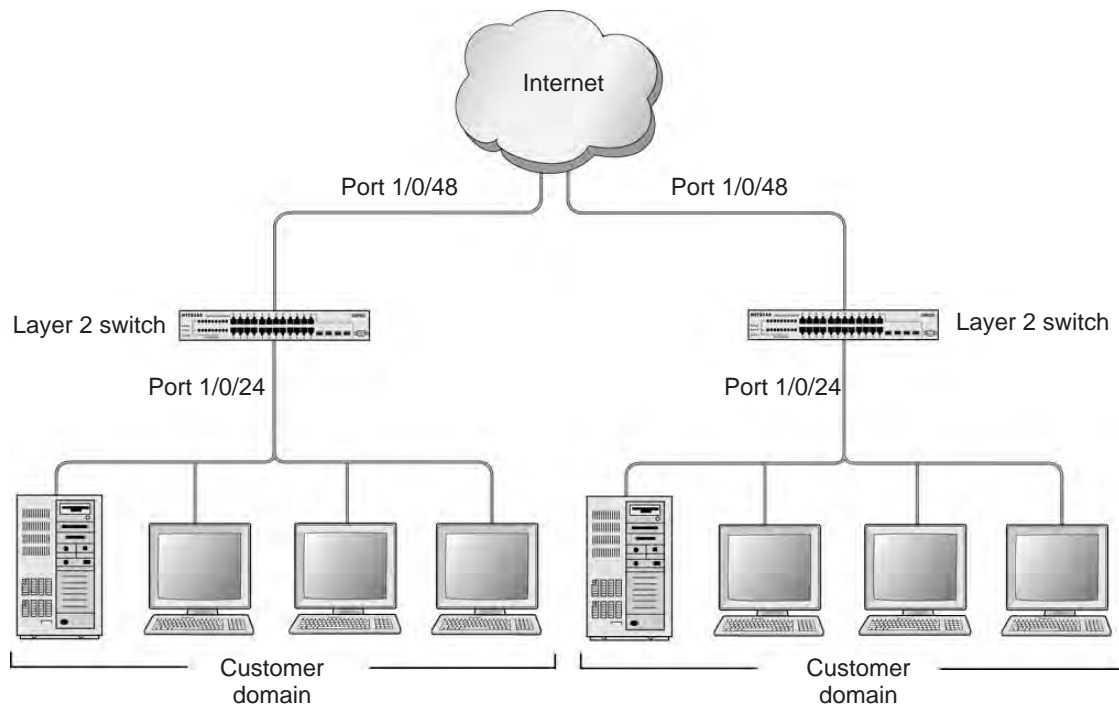
### Double VLANS and private VLAN groups

This chapter includes the following sections:

- [Double VLANs](#)
- [Private VLAN Groups](#)

# Double VLANs

This section describes how to enable the double DVLAN feature. Double VLANs pass traffic from one customer domain to another through the metro core. Custom VLAN IDs are preserved and a provider service VLAN ID is added to the traffic so the traffic can pass the metro core in a simple and cost-effective manner. You can use VLANs to specify customer ports and a service provider port. In this example, the switches have the same configuration.



**Figure 54. Double VLANs**

The following example shows how to configure the NETGEAR switch shown in the preceding figure to add a double VLAN tag for traffic going from the subnet domain connected to port 1/0/24. This example assumes that a Layer 2 switch connects all these devices in your domain. The Layer 2 switch tags the packet going to the NETGEAR switch port 1/0/24. The example is shown as CLI commands and as a local browser interface procedure.

## CLI: Enable a Double VLAN

```

Create a VLAN 200.
(Netgear Switch)#vlan database
(Netgear Switch) (Vlan)#vlan 200
(Netgear Switch) (Vlan)#exit

Add interface 1/0/24 to VLAN 200, add pvid 200 to port.
(Netgear Switch) #config
(Netgear Switch) (Config)#interface 1/0/24
(Netgear Switch) (Interface 1/0/24)#vlan pvid 200
(Netgear Switch) (Interface 1/0/24)#vlan participation include 200
(Netgear Switch) (Interface 1/0/24)#exit

Add interface 1/0/48 to the VLAN 200 in a tagging mode.
(Netgear Switch) (Config)#interface 1/0/48
(Netgear Switch) (Interface 1/0/48)#vlan participation include 200
(Netgear Switch) (Interface 1/0/48)#vlan tagging 200
(Netgear Switch) (Interface 1/0/48)#exit

Select interface 1/0/48 as the provider port.
(Netgear Switch) (Config)#
(Netgear Switch) (Config)#interface 1/0/48
(Netgear Switch) (Interface 1/0/48)#mode dvlan-tunnel
(Netgear Switch) (Interface 1/0/48)#exit

```

## Local Browser Interface: Enable a Double VLAN

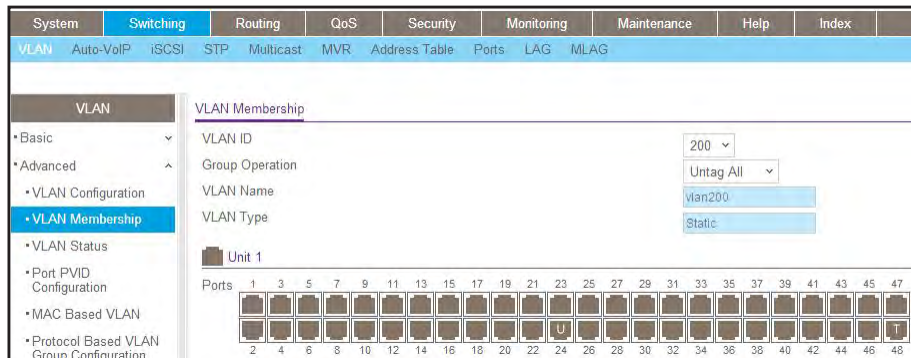
1. Create static VLAN 200:
  - a. Select **Switching > VLAN > Basic > VLAN Configuration**.

A screen similar to the following displays.

| VLAN ID | VLAN Name | VLAN Type | Make-Static |
|---------|-----------|-----------|-------------|
| 200     | vlan200   | Default   | Enable      |

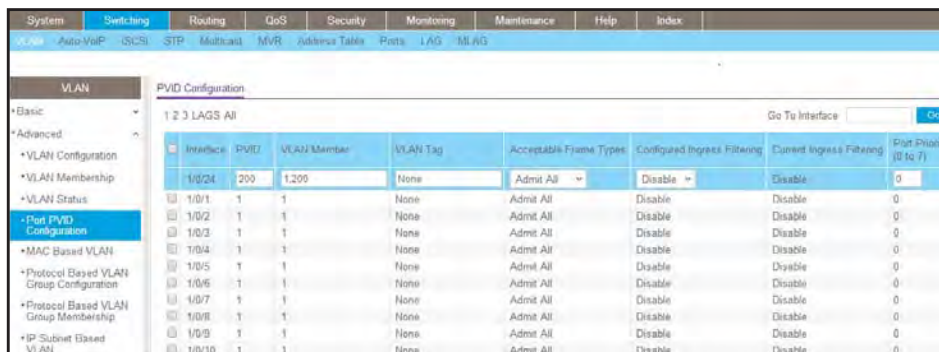
- b. Under VLAN Configuration, enter the following information:
  - In the **VLAN ID** field, enter **200**.
  - In the **VLAN Name** field, enter **vlan200**.
  - In the **VLAN Type** field, select **Static**.
- c. Click **Add**.
2. Add ports 24 and 48 to VLAN 200.
  - a. Select **Switching > VLAN > Advanced > VLAN Membership**.

A screen similar to the following displays.



- b. Under VLAN Membership, in the **VLAN ID** field, select **200**.
- c. Click **Unit 1**. The ports display:
  - Click the gray box under port **24** twice until **U** displays. The U specifies that the egress packet is untagged for the port.
  - Click the gray box under port **48** once until **T** displays. The T specifies that the egress packet is tagged for the port.
- d. Click **Apply** to save the settings.
3. Change the port VLAN ID (PVID) of port 24 to 200:
  - a. Select **Switching > VLAN > Advanced > Port PVID Configuration**.

A screen similar to the following displays.



- b. Scroll down and select the Interface **1/0/24** check box. Now 1/0/24 appears in the Interface field at the top.
- c. In the **PVID (1 to 4093)** field, enter **200**.



- d. Click **Apply** to save the settings.
4. Configure port 48 as the provider service port:
  - a. Select **Switching > VLAN > Advanced > Port DVLAN Configuration**.

A screen similar to the following displays.

| Global Configuration |            |
|----------------------|------------|
| Global EtherType     | 802.1Q Tag |

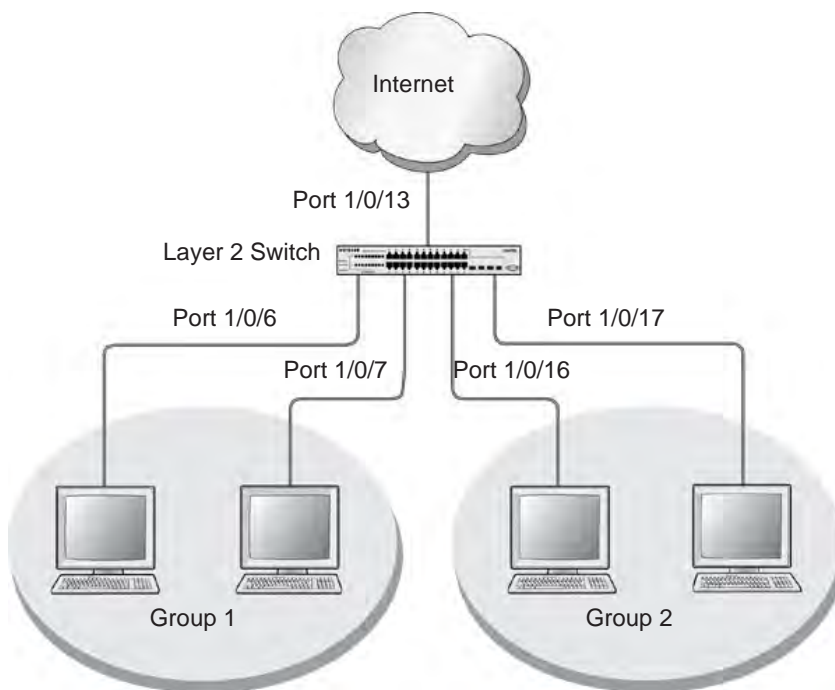
| DVLAN Configuration   |            |
|---|------------|
| 1 2 3 LAGS All Go To Interface <input type="text"/> <input type="button" value="Go"/> |            |
| Interface   | Admin Mode |
| <input checked="" type="checkbox"/> 1/0/48  | Enable     |
| <input type="checkbox"/> 1/0/1  | Disable    |
| <input type="checkbox"/> 1/0/2  | Disable    |
| <input type="checkbox"/> 1/0/3  | Disable    |
| <input type="checkbox"/> 1/0/4  | Disable    |
| <input type="checkbox"/> 1/0/5  | Disable    |
| <input type="checkbox"/> 1/0/6  | Disable    |
| <input type="checkbox"/> 1/0/7  | Disable    |
| <input type="checkbox"/> 1/0/8  | Disable    |

- b. Scroll down and select the Interface **1/0/48** check box. Now 1/0/48 appears in the Interface field at the top.
- c. In the **Admin Mode** field, select **Enable**.
- d. Click **Apply** to save the settings.

# Private VLAN Groups

The private VLAN group allows you to create groups of users within a VLAN that cannot communicate with members in different groups but only within the same group. There are two modes for the private group. The mode can be either isolated or community. When in isolated mode, the member port in the group cannot forward its egress traffic to any other members in the same group. the default mode is community, in which each member port can forward traffic to other members in the same group, but not to members in other groups. The following examples show how to create a private group.

The following example creates two groups. Group 1 is in community mode, and Group 2 is in isolated mode.



**Figure 55. Private VLAN groups in community mode and isolated mode**

## CLI: Create a Private VLAN Group

### 1. Enter the following commands.

```
(Netgear Switch) #
(Netgear Switch) #vlan data
(Netgear Switch) (Vlan)#vlan 200
(Netgear Switch) (Vlan)#exit

(Netgear Switch) #config
(Netgear Switch) (Config)#interface 1/0/6
(Netgear Switch) (Interface 1/0/6)#vlan participation include 200
(Netgear Switch) (Interface 1/0/6)#vlan pvid 200
(Netgear Switch) (Interface 1/0/6)#exit

(Netgear Switch) (Config)#interface 1/0/7
(Netgear Switch) (Interface 1/0/7)#vlan participation include 200
(Netgear Switch) (Interface 1/0/7)#vlan pvid 200
(Netgear Switch) (Interface 1/0/7)#exit
(Netgear Switch) (Config)#interface 1/0/16
(Netgear Switch) (Interface 1/0/16)#vlan participation include 200
(Netgear Switch) (Interface 1/0/16)#vlan participation pvid 200
(Netgear Switch) (Interface 1/0/16)#exit

(Netgear Switch) (Config)#interface 1/0/17
(Netgear Switch) (Interface 1/0/17)#vlan participation include 200
(Netgear Switch) (Interface 1/0/17)#vlan pvid 200
(Netgear Switch) (Interface 1/0/17)#exit
```

### 2. Create a VLAN 200 and include 1/0/6,1/0/7, 1/0/16, and 1/0/17.

```
(Netgear Switch) (Config)#
(Netgear Switch) (Config)#private-group name group1 1 mode community
```

### 3. Create a private group in community mode.

```
(Netgear Switch) (Config)#private-group name group2 2 mode isolated
```

### 4. Create a private group in isolated mode.

```
(Netgear Switch) (Config)#interface range 1/0/6-1/0/7
(Netgear Switch) (conf-if-range-1/0/6-1/0/7)#switchport private-group 1
(Netgear Switch) (conf-if-range-1/0/6-1/0/7)#exit
```

5. Add 1/0/16 and 1/0/7 to the private group 1.

```
(Netgear Switch) (Config)#interface range 1/0/16-1/0/17
(Netgear Switch) (conf-if-range-1/0/16-1/0/17)#switchport private-group 2
```

6. Add 1/0/16 and 1/0/7 to the private group 2.

```
(Netgear Switch) (conf-if-range-1/0/16-1/0/17)#exit
```

## Local Browser Interface: Create a Private VLAN Group

1. Create VLAN 200.

a. Select **Switching > VLAN > Basic > VLAN Configuration**.

A screen similar to the following displays.

| VLAN ID | VLAN Name | VLAN Type | Make Static |
|---------|-----------|-----------|-------------|
| 200     | vlan200   | Static    | Enable      |
| 1       | default   | Default   | Disable     |

b. Enter the following information:

- In the **VLAN ID** field, enter **200**.
- In the **VLAN Name** field, enter **VLAN200**.
- In the **VLAN Type** field, select **Static**.

c. Click **Add**.

2. Add ports 1/0/6, 1/0/7, 1/0/16, and 1/0/17 to VLAN 200.

a. Select **Switching > VLAN > Advanced > VLAN Membership**.

A screen similar to the following displays.

The screenshot shows the 'VLAN Membership' configuration page. On the left, a sidebar lists configuration options: Basic, Advanced, VLAN Configuration, **VLAN Membership**, VLAN Status, Port PVID Configuration, MAC Based VLAN, and Protocol Based VLAN Group Configuration. The main area is titled 'VLAN Membership' and contains fields for 'VLAN ID' (set to 200), 'Group Operation' (set to Untag All), 'VLAN Name' (set to Vlan200), and 'VLAN Type' (set to Static). Below these fields is a 'Unit 1' section with a grid of 48 ports. Ports 6, 7, 16, and 17 are marked with a 'U' in a gray box, indicating they are untagged.

- b. Under VLAN Membership, in the **VLAN ID** list, select **200**.
- c. Click **Unit 1**. The ports display.
- d. Click the gray boxes under ports **6, 7, 16** and **17** until **U** displays. The U specifies that the egress packet is untagged for the port.
- e. Click **Apply**.
3. Specify the PVID on ports 1/0/6, 1/0/7, 1/0/16, and 1/0/17.
  - a. Select **Switching > VLAN > Advanced > Port PVID Configuration**.

A screen similar to the following displays.

The screenshot shows the 'Port PVID Configuration' page. The left sidebar is the same as the previous screenshot. The main area is titled 'PVID Configuration' and shows a table with columns: Interface, PVID, VLAN Member, VLAN Tag, Acceptable Frame Types, Configured Ingress Filtering, Current Ingress Filtering, and Port Priority (0 to 7). The table lists configurations for interfaces 1/0/1 through 1/0/8. Interfaces 1/0/6, 1/0/7, 1/0/16, and 1/0/17 are highlighted in yellow, indicating they are selected. The 'PVID' field for these interfaces is set to 200.

- b. Under PVID Configuration, scroll down and select the Interface **1/0/6, 1/0/7, 1/0/16,** and **1/0/17** check boxes.
- c. In the **PVID (1 to 4093)** field, enter **200**.
- d. In the **Acceptable Frame Type** list, select **Admit All**.
- e. Click **Apply** to save the settings.
4. Create a private group, group1.
  - a. Select **Security > Traffic Control > Private Group VLAN > Private Group VLAN > Private Group Configuration**.

A screen similar to the following displays.

| System   | Switching | Routing             | QoS             | Security | Monitoring | Maintenance | Help | Index |            |          |            |        |   |           |
|--|-----------|---------------------|-----------------|----------|------------|-------------|------|-------|------------|----------|------------|--------|---|-----------|
| Management Security  | Access    | Port Authentication | Traffic Control | Control  | ACL        |             |      |       |            |          |            |        |   |           |
| <div>Traffic Control</div> <div>Private Group Configuration</div> <div> <div> <div>MAC Filter</div> <div>Port Security</div> <div>Private Group</div> <div>Private Group Configuration</div> <div>Private Group Membership</div> <div>Protected Port</div> </div> <div> <div>Private Group Configuration</div> </div> </div> <table border="1"> <thead> <tr> <th>Group Name</th> <th>Group ID</th> <th>Group Mode</th> </tr> </thead> <tbody> <tr> <td>group1</td> <td>1</td> <td>community</td> </tr> </tbody> </table> |           |                     |                 |          |            |             |      |       | Group Name | Group ID | Group Mode | group1 | 1 | community |
| Group Name   | Group ID  | Group Mode          |                 |          |            |             |      |       |            |          |            |        |   |           |
| group1   | 1         | community           |                 |          |            |             |      |       |            |          |            |        |   |           |

- b. In the **Group Name** field, enter **group1**.
  - c. In the **Group ID** field, enter **1**.
  - d. In the **Group Mode** list, select **community**.
  - e. Click **Add**.
5. Add port 6 and 7 to group1.
  - a. Select **Security > Traffic Control > Private Group VLAN > Private Group Membership**.

A screen similar to the following displays.

| System   | Switching  | Routing             | QoS             | Security | Monitoring | Maintenance | Help | Index |          |            |            |    |        |           |       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| Management Security  | Access     | Port Authentication | Traffic Control | Control  | ACL        |             |      |       |          |            |            |    |        |           |       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| <div>Traffic Control</div> <div>Private Group Membership</div> <div> <div> <div>MAC Filter</div> <div>Port Security</div> <div>Private Group</div> <div>Private Group Configuration</div> <div>Private Group Membership</div> <div>Protected Port</div> <div>Private Vlan</div> <div>Storm Control</div> </div> <div> <div>Private Group Membership</div> </div> </div> <table border="1"> <thead> <tr> <th>Group ID</th> <th>Group Name</th> <th>Group Name</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>group1</td> <td>community</td> </tr> </tbody> </table> <div>Unit 1</div> <table border="1"> <thead> <tr> <th>Ports</th> <th>1</th> <th>3</th> <th>5</th> <th>7</th> <th>9</th> <th>11</th> <th>13</th> <th>15</th> <th>17</th> <th>19</th> <th>21</th> <th>23</th> <th>25</th> <th>27</th> <th>29</th> <th>31</th> <th>33</th> <th>35</th> <th>37</th> <th>39</th> <th>41</th> <th>43</th> <th>45</th> <th>47</th> </tr> </thead> <tbody> <tr> <td>1</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> 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|  |  |  |  |  |  |  |  |  |  | 45 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 46 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 47 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Group ID   | Group Name | Group Name          |                 |          |            |             |      |       |          |            |            |    |        |           |       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1  | group1     | community           |                 |          |            |             |      |       |          |            |            |    |        |           |       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Ports  | 1          | 3                   | 5               | 7        | 9          | 11          | 13   | 15    | 17       | 19         | 21         | 23 | 25     | 27        | 29    | 31 | 33 | 35 | 37 | 39 | 41 | 43 | 45 | 47 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1  |            |                     |                 |          |            |             |      |       |          |            |            |    |        |           |       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2  |            |                     |                 |          |            |             |      |       |          |            |            |    |        |           |       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3  |            |                     |                 |          |            |             |      |       |          |            |            |    |        |           |       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4  |            |                     |                 |          |            |             |      |       |          |            |            |    |        |           |       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 5  |            |                     |                 |          |            |             |      |       |          |            |            |    |        |           |       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 6  |            |                     |                 |          |            |             |      |       |          |            |            |    |        |           |       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 7  |            |                     |                 |          |            |             |      |       |          |            |            |    |        |           |       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 8  |            |                     |                 |          |            |             |      |       |          |            |            |    |        |           |       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 9  |            |                     |                 |          |            |             |      |       |          |            |            |    |        |           |       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 10   |            |                     |                 |          |            |             |      |       |          |            |            |    |        |           |       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 11   |            |                     |                 |          |            |             |      |       |          |            |            |    |        |           |       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 12   |            |                     |                 |          |            |             |      |       |          |            |            |    |        |           |       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 13   |            |                     |                 |          |            |             |      |       |          |            |            |    |        |           |       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 14   |            |                     |                 |          |            |             |      |       |          |            |            |    |        |           |       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 15   |            |                     |                 |          |            |             |      |       |          |            |            |    |        |           |       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 16   |            |                     |                 |          |            |             |      |       |          |            |            |    |        |           |       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 17   |            |                     |                 |          |            |             |      |       |          |            |            |    |        |           |       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 18   |            |                     |                 |          |            |             |      |       |          |            |            |    |        |           |       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 19   |            |                     |                 |          |            |             |      |       |          |            |            |    |        |           |       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 20   |            |                     |                 |          |            |             |      |       |          |            |            |    |        |           |       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 21   |            |                     |                 |          |            |             |      |       |          |            |            |    |        |           |       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 22   |            |                     |                 |          |            |             |      |       |          |            |            |    |        |           |       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 23   |            |                     |                 |          |            |             |      |       |          |            |            |    |        |           |       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 24   |            |                     |                 |          |            |             |      |       |          |            |            |    |        |           |       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 25   |            |                     |                 |          |            |             |      |       |          |            |            |    |        |           |       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 26   |            |                     |                 |          |            |             |      |       |          |            |            |    |        |           |       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 27   |            |                     |                 |          |            |             |      |       |          |            |            |    |        |           |       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 28   |            |                     |                 |          |            |             |      |       |          |            |            |    |        |           |       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 29   |            |                     |                 |          |            |             |      |       |          |            |            |    |        |           |       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 30   |            |                     |                 |          |            |             |      |       |          |            |            |    |        |           |       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 31   |            |                     |                 |          |            |             |      |       |          |            |            |    |        |           |       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 32   |            |                     |                 |          |            |             |      |       |          |            |            |    |        |           |       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 33   |            |                     |                 |          |            |             |      |       |          |            |            |    |        |           |       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 34   |            |                     |                 |          |            |             |      |       |          |            |            |    |        |           |       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 35   |            |                     |                 |          |            |             |      |       |          |            |            |    |        |           |       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 36   |            |                     |                 |          |            |             |      |       |          |            |            |    |        |           |       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 37   |            |                     |                 |          |            |             |      |       |          |            |            |    |        |           |       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 38   |            |                     |                 |          |            |             |      |       |          |            |            |    |        |           |       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 39   |            |                     |                 |          |            |             |      |       |          |            |            |    |        |           |       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 40   |            |                     |                 |          |            |             |      |       |          |            |            |    |        |           |       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 41   |            |                     |                 |          |            |             |      |       |          |            |            |    |        |           |       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 42   |            |                     |                 |          |            |             |      |       |          |            |            |    |        |           |       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 43   |            |                     |                 |          |            |             |      |       |          |            |            |    |        |           |       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 44   |            |                     |                 |          |            |             |      |       |          |            |            |    |        |           |       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 45   |            |                     |                 |          |            |             |      |       |          |            |            |    |        |           |       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 46   |            |                     |                 |          |            |             |      |       |          |            |            |    |        |           |       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 47   |            |                     |                 |          |            |             |      |       |          |            |            |    |        |           |       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

- b. In the **Group ID** list, select **1**.
  - c. Click **Unit 1**. The ports display.
  - d. Click the gray boxes under ports **6** and **7**. A check mark displays in each box.
  - e. Click **Apply**.
6. Create a private group, group2.
  - a. Select **Security > Traffic Control > Private Group VLAN > Private Group Configuration**.

A screen similar to the following displays.

The screenshot shows the 'Security' tab with 'Traffic Control' selected. Under 'Traffic Control', 'Private Group Configuration' is chosen. The 'Private Group Configuration' section contains a table with columns: Group Name, Group ID, and Group Mode. The table has two rows: one for 'group2' with ID '2' and mode 'isolated', and another for 'group1' with ID '1' and mode 'community'. The 'group2' row is highlighted in blue.

| Group Name | Group ID | Group Mode |
|------------|----------|------------|
| group2     | 2        | isolated   |
| group1     | 1        | community  |

- b. In the **Group Name** field, enter **group2**.
  - c. In the **Group ID** field, enter **2**.
  - d. In the **Group Mode** field, select **isolated**.
  - e. Click **Add**.
7. Add ports 16 and 17 to group2.
- a. Select **Security > Traffic Control > Private Group VLAN > Private Group VLAN > Private Group Membership**.

A screen similar to the following displays.

The screenshot shows the 'Security' tab with 'Traffic Control' selected. Under 'Traffic Control', 'Private Group Membership' is chosen. The 'Private Group Membership' section contains a 'Group ID' dropdown menu set to '2'. Below this, there are two 'Group Name' fields, one with 'group2' and another with 'isolated'. At the bottom, there is a 'Unit 1' section with a grid of ports. Ports 16 and 17 are highlighted with checkmarks, indicating they are assigned to the group.

| Unit 1 | Ports   |
|--------|---|
| 1      | 1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47  |
| 2      | 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 |

- b. In the **Group ID** list, select **2**.
- c. Click **Unit 2**. The ports display.
- d. Click the gray boxes under ports **16** and **17**, and a check mark displays in each box.
- e. Click **Apply**.

# 27

## STP

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### Spanning Tree Protocol

This chapter includes the following sections:

- [Spanning Tree Protocol Concepts](#)
- [Configure Classic STP \(802.1d\)](#)
- [Configure Rapid STP \(802.1w\)](#)
- [Configure Multiple STP \(802.1s\)](#)
- [Configure PVSTP and PVRSTP](#)



# Spanning Tree Protocol Concepts

The purpose of the Spanning Tree Protocol (STP) is to eliminate loops in the switch system. There are three STPs: Classic STP (802.1d), Rapid STP (RSTP, 802.1w), and Multiple STP (MSTP, 802.1s).

While STP can take 30 to 50 seconds to respond to a topology change, RSTP is typically able to respond to changes within a few seconds. RSTP can revert back to 802.1d in order to interoperate with legacy bridges on a per-port basis. This drops the benefits it introduces.

In Multiple Spanning Tree Protocol (MSTP), each Spanning Tree instance can contain several VLANs. Each Spanning Tree instance is independent of other instances. This approach provides multiple forwarding paths for data traffic, enabling load balancing, and reducing the number of Spanning Tree instances required to support a large number of VLANs.

## Configure Classic STP (802.1d)

The example is shown as CLI commands and as a local browser interface procedure.

### CLI: Configure Classic STP (802.1d)

```
(Netgear Switch) (Config)# spanning-tree
(Netgear Switch) (Config)# spanning-tree mode stp
(Netgear switch) (Interface 1/0/3)# spanning-tree port mode
```

### Local Browser Interface: Configure Classic STP (802.1d)

1. Enable 802.1d on the switch.
  - a. Select **Switching > STP > STP Configuration**.

A screen similar to the following displays.

| System  | Switching | Routing | QoS | Security  | Monitoring | Maintenance   | Help  | Index |      |
|---|-----------|---------|-----|-----------|------------|---------------|-------|-------|------|
| VLAN  | Auto-VoIP | iSCSI   | STP | Multicast | MVR        | Address Table | Ports | LAG   | MLAG |
| <div>STP</div> <div>STP Configuration</div> <div> <div>* Basic</div> <div>* STP Configuration</div> <div>* Advanced</div> </div> <div> <div>Spanning Tree Admin Mode</div> <div>Force Protocol Version</div> <div>Configuration Name</div> <div>Configuration Revision Level</div> <div>Forward BPDU while STP Disabled</div> <div>BPDU Guard</div> <div>BPDU Filter</div> <div>Configuration Digest Key</div> <div>Configuration Format Selector</div> </div> <div> <div> <input type="radio"/> Disable <input checked="" type="radio"/> Enable         </div> <div> <input checked="" type="radio"/> IEEE 802.1d <input type="radio"/> IEEE 802.1w <input type="radio"/> IEEE 802.1s         </div> <div> <input type="text" value="20-0C-C8-4D-95-72"/> </div> <div> <input type="text" value="0"/> (0 to 65535)         </div> <div> <input checked="" type="radio"/> Disable <input type="radio"/> Enable         </div> <div> <input checked="" type="radio"/> Disable <input type="radio"/> Enable         </div> <div> <input checked="" type="radio"/> Disable <input type="radio"/> Enable         </div> <div> <input type="text" value="0xac36177f50283cd4b83821d8ab26de62"/> </div> <div> <input type="text" value="0"/> </div> </div> |           |         |     |           |            |               |       |       |      |

- b. Enter the following information:
      - For Spanning Tree Admin Mode, select the **Enable** radio button.
      - For Force Protocol Version, select the **IEEE 802.1d** radio button.
    - c. Click **Apply**.
  2. Configure the CST port.
    - a. Select **Switching > STP > CST Port Configuration**.

A screen similar to the following displays.

| System  | Switching     | Routing          | QoS            | Security                       | Monitoring | Maintenance             | Help                                    | Index       |                 |           |               |                  |                |                                |            |                         |   |             |                 |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |
|---|---------------|------------------|----------------|--------------------------------|------------|-------------------------|---|-------------|-----------------|-----------|---------------|------------------|----------------|--------------------------------|------------|-------------------------|---|-------------|-----------------|-------|-----|---------|---|---------|---|---|---------|---------|---------|-------|-----|---------|---|---------|---|---|---------|---------|---------|-------|-----|---------|---|---------|---|---|---------|---------|---------|-------|-----|---------|---|---------|---|---|---------|---------|---------|-------|-----|---------|---|---------|---|---|---------|---------|---------|-------|-----|---------|---|---------|---|---|---------|---------|---------|-------|-----|---------|---|---------|---|---|---------|---------|---------|
| VLAN  | Auto-VoIP     | IGMP             | STP            | Multicast                      | MVR        | Address Table           | Ports                                   | LAG         | MLAG            |           |               |                  |                |                                |            |                         |   |             |                 |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |
| STP   |               |                  |                |                                |            |                         |   |             |                 |           |               |                  |                |                                |            |                         |   |             |                 |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |
| CST Port Configuration  |               |                  |                |                                |            |                         |   |             |                 |           |               |                  |                |                                |            |                         |   |             |                 |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |
| 1 2 3 LAGS All  |               |                  |                |                                |            |                         |   |             |                 |           |               |                  |                |                                |            |                         |   |             |                 |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |
| Go To   |               |                  |                |                                |            |                         |   |             |                 |           |               |                  |                |                                |            |                         |   |             |                 |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |
| <table><tr><th>Interface</th><th>Port Priority</th><th>Admin. Edge Port</th><th>Port Path Cost</th><th>Auto Calculated Port Path Cost</th><th>Hello Time</th><th>External Port Path Cost</th><th>Auto Calculated External Port Path Cost</th><th>BPDU Filter</th><th>BPDU Forwarding</th></tr><tr><td>1/0/1</td><td>128</td><td>Disable</td><td>0</td><td>Enabled</td><td>2</td><td>0</td><td>Enabled</td><td>Disable</td><td>Disable</td></tr><tr><td>1/0/2</td><td>128</td><td>Disable</td><td>0</td><td>Enabled</td><td>2</td><td>0</td><td>Enabled</td><td>Disable</td><td>Disable</td></tr><tr><td>1/0/3</td><td>128</td><td>Disable</td><td>0</td><td>Enabled</td><td>2</td><td>0</td><td>Enabled</td><td>Disable</td><td>Disable</td></tr><tr><td>1/0/4</td><td>128</td><td>Disable</td><td>0</td><td>Enabled</td><td>2</td><td>0</td><td>Enabled</td><td>Disable</td><td>Disable</td></tr><tr><td>1/0/5</td><td>128</td><td>Disable</td><td>0</td><td>Enabled</td><td>2</td><td>0</td><td>Enabled</td><td>Disable</td><td>Disable</td></tr><tr><td>1/0/6</td><td>128</td><td>Disable</td><td>0</td><td>Enabled</td><td>2</td><td>0</td><td>Enabled</td><td>Disable</td><td>Disable</td></tr><tr><td>1/0/7</td><td>128</td><td>Disable</td><td>0</td><td>Enabled</td><td>2</td><td>0</td><td>Enabled</td><td>Disable</td><td>Disable</td></tr></table> |               |                  |                |                                |            |                         |   |             |                 | Interface | Port Priority | Admin. Edge Port | Port Path Cost | Auto Calculated Port Path Cost | Hello Time | External Port Path Cost | Auto Calculated External Port Path Cost | BPDU Filter | BPDU Forwarding | 1/0/1 | 128 | Disable | 0 | Enabled | 2 | 0 | Enabled | Disable | Disable | 1/0/2 | 128 | Disable | 0 | Enabled | 2 | 0 | Enabled | Disable | Disable | 1/0/3 | 128 | Disable | 0 | Enabled | 2 | 0 | Enabled | Disable | Disable | 1/0/4 | 128 | Disable | 0 | Enabled | 2 | 0 | Enabled | Disable | Disable | 1/0/5 | 128 | Disable | 0 | Enabled | 2 | 0 | Enabled | Disable | Disable | 1/0/6 | 128 | Disable | 0 | Enabled | 2 | 0 | Enabled | Disable | Disable | 1/0/7 | 128 | Disable | 0 | Enabled | 2 | 0 | Enabled | Disable | Disable |
| Interface   | Port Priority | Admin. Edge Port | Port Path Cost | Auto Calculated Port Path Cost | Hello Time | External Port Path Cost | Auto Calculated External Port Path Cost | BPDU Filter | BPDU Forwarding |           |               |                  |                |                                |            |                         |   |             |                 |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |
| 1/0/1   | 128           | Disable          | 0              | Enabled                        | 2          | 0                       | Enabled                                 | Disable     | Disable         |           |               |                  |                |                                |            |                         |   |             |                 |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |
| 1/0/2   | 128           | Disable          | 0              | Enabled                        | 2          | 0                       | Enabled                                 | Disable     | Disable         |           |               |                  |                |                                |            |                         |   |             |                 |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |
| 1/0/3   | 128           | Disable          | 0              | Enabled                        | 2          | 0                       | Enabled                                 | Disable     | Disable         |           |               |                  |                |                                |            |                         |   |             |                 |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |
| 1/0/4   | 128           | Disable          | 0              | Enabled                        | 2          | 0                       | Enabled                                 | Disable     | Disable         |           |               |                  |                |                                |            |                         |   |             |                 |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |
| 1/0/5   | 128           | Disable          | 0              | Enabled                        | 2          | 0                       | Enabled                                 | Disable     | Disable         |           |               |                  |                |                                |            |                         |   |             |                 |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |
| 1/0/6   | 128           | Disable          | 0              | Enabled                        | 2          | 0                       | Enabled                                 | Disable     | Disable         |           |               |                  |                |                                |            |                         |   |             |                 |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |
| 1/0/7   | 128           | Disable          | 0              | Enabled                        | 2          | 0                       | Enabled                                 | Disable     | Disable         |           |               |                  |                |                                |            |                         |   |             |                 |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |       |     |         |   |         |   |   |         |         |         |

- b. Under CST Port Configuration, scroll down and select the Interface **1/0/3** check box. Now 1/0/3 appears in the Interface field at the top.
      - c. In the **Port Mode** field, select **Enable**.
      - d. Click **Apply**.

## Configure Rapid STP (802.1w)

The example is shown as CLI commands and as a local browser interface procedure.

### CLI: Configure Rapid STP (802.1w)

```
(Netgear switch) (Config)# spanning-tree
(Netgear switch) (Config)# spanning-tree mode rstp
(Netgear switch) (Interface 1/0/3)# spanning-tree port mode
```

## Local Browser Interface: Configure Rapid STP (802.1w)

1. Enable 802.1w on the switch:
  - a. Select **Switching > STP > STP Configuration**.

A screen similar to the following displays.

| System | Switching | Routing | QoS | Security  | Monitoring | Maintenance   | Help  | Index |
|--------|-----------|---------|-----|-----------|------------|---------------|-------|-------|
| VLAN   | Auto-VoIP | iSCSI   | STP | Multicast | MVR        | Address Table | Ports | LAG   |

STP

Basic

STP Configuration

Advanced

Spanning Tree Admin Mode

Force Protocol Version

Configuration Name

Configuration Revision Level

Forward BPDUs while STP Disabled

BPDU Guard

BPDU Filter

Configuration Digest Key

Configuration Format Selector

Disable

Enable

IEEE 802.1d

IEEE 802.1w

IEEE 802.1s

20-0C-C8-4D-95-72

0

(0 to 65535)

Disable

Enable

Disable

Enable

Disable

Enable

0xac36177f50283cd4b83821d8ab26de62

0

- b. Enter the following information:
      - For Spanning Tree Admin Mode, select the **Enable** radio button.
      - For Force Protocol Version, select the **IEEE 802.1w** radio button.
    - c. Click **Apply**.
  2. Configure the CST port.
    - a. Select **Switching > STP > CST Port Configuration**.

A screen similar to the following displays.

| System | Switching | Routing | QoS | Security  | Monitoring | Maintenance   | Help  | Index |
|--------|-----------|---------|-----|-----------|------------|---------------|-------|-------|
| VLAN   | Auto-VoIP | iSCSI   | STP | Multicast | MVR        | Address Table | Ports | LAG   |

STP

Basic

STP Configuration

Advanced

CST Port Configuration

1 2 3 LAGS All

Go To

| Interface | Port Priority | Admin Edge Port | Port Path Cost | Auto-Calculated Port Path Cost | Hello Timer | External Port Path Cost | Auto-Calculated External Port Path Cost | BPDU Filter | BPDU Forwarding |
|-----------|---------------|-----------------|----------------|--------------------------------|-------------|-------------------------|---|-------------|-----------------|
| 1/0/1     | 128           | Disable         | 0              | Enabled                        | 2           | 0                       | Enabled                                 | Disable     | Disable         |
| 1/0/2     | 128           | Disable         | 0              | Enabled                        | 2           | 0                       | Enabled                                 | Disable     | Disable         |
| 1/0/3     | 128           | Disable         | 0              | Enabled                        | 2           | 0                       | Enabled                                 | Disable     | Disable         |
| 1/0/4     | 128           | Disable         | 0              | Enabled                        | 2           | 0                       | Enabled                                 | Disable     | Disable         |
| 1/0/5     | 128           | Disable         | 0              | Enabled                        | 2           | 0                       | Enabled                                 | Disable     | Disable         |
| 1/0/6     | 128           | Disable         | 0              | Enabled                        | 2           | 0                       | Enabled                                 | Disable     | Disable         |

- b. Under CST Port Configuration, scroll down and select the Interface **1/0/3** check box.  
Now 1/0/3 appears in the Interface field at the top.
      - c. In the **Port Mode** field, select **Enable**.
      - d. Click **Apply**.

# Configure Multiple STP (802.1s)

The example is shown as CLI commands and as a local browser interface procedure.

## CLI: Configure Multiple STP (802.1s)

```
(Netgear switch) (Config)# spanning-tree
(Netgear switch) (Config)# spanning-tree mode mst
(Netgear Switch) (Config)#spanning-tree configuration name mstp_1
(Netgear Switch) (Config)#spanning-tree configuration revision 0
```

Configure an MSTP region name and revision for the switches in the same MSTP region. The switches in the same MSTP region must be configured with the same region name and revision.

Create a mst instance 1:

```
(Netgear switch) (Config)# spanning-tree mst instance 1
```

Associate the mst instance 1 with the VLAN 2 and 3:

```
(Netgear switch) (Config)# spanning-tree mst priority 1 4096
(Netgear switch) (Config)# spanning-tree mst vlan 1 2
(Netgear switch) (Config)# spanning-tree mst vlan 1 3
```

Create a mst instance 2:

```
(Netgear switch) (Config)# spanning-tree mst instance 2
```

Associate the mst instance 2 with the VLAN 11 and 12:

```
(Netgear switch) (Config)# spanning-tree mst priority 2 4096
(Netgear switch) (Config)# spanning-tree mst vlan 2 11
(Netgear switch) (Config)# spanning-tree mst vlan 2 12
```

Configure the priority and cost on port 1/0/3:

```
(Netgear switch) (Interface 1/0/3)# spanning-tree mst 1 port-priority 128
(Netgear switch) (Interface 1/0/3)# spanning-tree mst 1 cost 0
```

# Local Browser Interface: Configure Multiple STP (802.1s)

1. Enable 802.1s on the switch.
  - a. Select **Switching > STP > STP Configuration**.

A screen similar to the following displays.

| System | Switching | Routing | QoS | Security  | Monitoring | Maintenance   | Help  | Index |
|--------|-----------|---------|-----|-----------|------------|---------------|-------|-------|
| VLAN   | Auto-VoIP | iSCSI   | STP | Multicast | MVR        | Address Table | Ports | LAG   |

STP

STP Configuration

Basic

STP Configuration

Advanced

Spanning Tree Admin Mode

Force Protocol Version

Configuration Name

Configuration Revision Level

Forward BPDUs while STP is Disabled

BPDUs Guard

BPDUs Filter

Configuration Digest Key

Configuration Format Selector

Disable

Enable

IEEE 802.1d

IEEE 802.1w

IEEE 802.1s

20-0C-C8-4D-95-72

0

(0 to 65535)

Disable

Enable

Disable

Enable

0xac36177f50283cd4b83821d8ab26de62

0

- b. Enter the following information:
  - For Spanning Tree Admin Mode, select the **Enable** radio button.
  - For Force Protocol Version, select the **IEEE 802.1s** radio button.
  - In the **Configuration Name** field, enter **mstp\_1**.
  - In the **Configuration Revision Level** field, enter **0**.

- c. Click **Apply**.

2. Configure MST.

- a. Select **Switching > STP > MST Configuration**.

A screen similar to the following displays.

| System | Switching | Routing | QoS | Security  | Monitoring | Maintenance   | Help  | Index |
|--------|-----------|---------|-----|-----------|------------|---------------|-------|-------|
| VLAN   | Auto-VoIP | iSCSI   | STP | Multicast | MVR        | Address Table | Ports | LAG   |

STP

MST Configuration

Basic

Advanced

STP Configuration

CST Configuration

CST Port Configuration

CST Port Status

MST Configuration

MST Port Status

STP Statistics

| MST ID | Priority | Bridge ID               | VLAN ID       | Time Since Topology Change | Topology Change Count | Topology Change | Designated Root         |
|--------|----------|-------------------------|---------------|----------------------------|-----------------------|-----------------|-------------------------|
| 0      | 32768    | 80:00:20:0C:C8:4D:95:72 | 1,100,200,500 | 0 day 0 hr 5 min 18 sec    | 4                     | False           | 80:00:00:8E:F2:FF:2F:2E |
| 1      | 4096     | 10:01:20:0C:C8:4D:95:72 | 2,3           | 0 day 0 hr 2 min 23 sec    | 1                     | False           | 10:01:20:0C:C8:4D:95:72 |
| 2      | 4096     | 10:02:20:0C:C8:4D:95:72 | 11,12         | 0 day 0 hr 1 min 45 sec    | 1                     | False           | 10:02:20:0C:C8:4D:95:72 |

- b. Configure MST ID 1.
  - In the **MST ID** field, enter **1**.
  - In the **Priority** field, enter **4096**.
  - In the **VLAN ID** field, enter **2**.
  - Click **Add**.
  - In the **VLAN ID** field, enter **3**.

- Click **Apply**.
- c. Configure MST ID 2.
  - In the **MST ID** field, enter **2**.
  - In the **Priority** field, enter **4096**.
  - In the **VLAN Id** field, enter **11**.
  - Click **Add**.
  - In the **VLAN Id** field, enter **12**.
  - Click **Apply**.
- 3. Configure the MST port.
  - a. Select **Switching > STP > MST Port Status**.

A screen similar to the following displays.

| Interface | Port Priority | Port Path Cost | Auto Calculated Port Path Cost | Port ID | Port Uptime Since Last Clear Counters | Port Mode | Port Forwarding State | Port Role | Designated Root         |
|-----------|---------------|----------------|--------------------------------|---------|---------------------------------------|-----------|-----------------------|-----------|-------------------------|
| 1/0/1     | 128           | 0              | Enabled                        | 80.03   | 0 day 0 hr 13 min 9 sec               | Enable    | Disabled              | Disabled  | 80.01.20.0C:C8.4D.95.72 |
| 1/0/2     | 128           | 0              | Enabled                        | 80.01   | 0 day 0 hr 13 min 9 sec               | Enable    | Disabled              | Disabled  | 80.01.20.0C:C8.4D.95.72 |
| 1/0/3     | 128           | 0              | Enabled                        | 80.02   | 0 day 0 hr 13 min 9 sec               | Enable    | Disabled              | Disabled  | 80.01.20.0C:C8.4D.95.72 |

4. Under MST Port Configuration, scroll down and select the Interface **1/0/3** check box. Now 1/0/3 appears in the Interface field at the top.
5. Enter the following information:
  - In the **Port Priority** field, enter **128**.
  - In the **Port Path Cost** field, enter **0**.
6. Click **Apply**.

## Configure PVSTP and PVRSTP

Per VLAN Rapid Spanning Tree Protocol (PVRSTP) is similar to Rapid Spanning Tree Protocol (RSTP) as defined by IEEE 802.1w but with one main difference: PVRSTP runs one instance per VLAN. That is, each configured VLAN runs an independent instance of PVRSTP and each instance elects a root bridge independent of another instance. A region can include as many root bridges as there are VLANs that are configured for PVRSTP. PVRSTP is equivalent to Cisco's RPVST+ and can interoperate with it.



Per VLAN Spanning Tree Protocol (PVSTP) is similar to the Spanning Tree Protocol (STP) as defined by IEEE 802.1d, but with one main difference: PVSTP runs one instance per VLAN. The protocol is equivalent to Cisco's PVST+ and can interoperate with it.

If you enable PVSTP or PVRSTP on a switch, all other spanning tree modes on the switch become disabled. The difference between Multiple Spanning Tree Protocol (MSTP) and PVSTP or PVRSTP lies primarily in the way that the protocol maps spanning tree instances to VLANs: PVSTP or PVRSTP creates a spanning tree instance for each VLAN, whereas MSTP maps one or more VLANs to each Multiple Spanning Tree (MST) instance.

If a switch that runs PVRSTP receives PVSTP Bridge Protocol Data Units (BPDUs), the switch falls back from PVRSTP to PVSTP after its migration-delay timer expires.

A switch that runs PVSTP or PVRSTP transmits IEEE spanning tree BPDUs along with Shared Spanning Tree Protocol (SSTP) BPDUs. The SSTP BPDU are transmitted as untagged packets on an access or native VLAN and transmitted as tagged packets on other VLANs. If a switch that runs PVSTP or PVRSTP receives IEEE spanning tree BPDUs, the switch include them in an access VLAN instance or native VLAN instance.

The Per VLAN Spanning Tree (PVST) behavior is as follows:

- An access port sends IEEE spanning tree BPDUs.
- A trunk port sends IEEE spanning tree BPDUs and SSTP BPDUs on the native VLAN. For other VLANs, the trunk port transmits SSTP BPDUs as tagged packets with the respective VLAN. If the trunk port receives IEEE spanning tree BPDUs, the received BPDUs are processed by the instance that is mapped to the native VLAN. The SSTP BPDUs are processed by instances to which the respective VLANs are mapped.

If a switch that is running an IEEE standard spanning tree protocol (such as STP, RSTP, or MSTP) receives SSTP BPDUs, the switch does not treat them as standard BPDUs. Instead, the incoming SSTP BPDUs are flooded to all the ports of the corresponding VLAN. As a comparison, incoming STP BPDUs are multicasted over the region.

A switch that runs an IEEE standard spanning tree protocol uses its Common and Internal Spanning Tree (CIST) to communicate with a switch that runs PVSTP or PVRSTP. On the other hand, a switch that runs PVSTP or PVRSTP uses an access VLAN instance or native VLAN instance to communicate with a switch that runs an IEEE standard spanning tree protocol.

PVRSTP embeds support for the FastUplink feature to speed up the selection of a new root and the FastBackbone feature to speed up the selection of indirect ports. You do not need to configure these features for RVRSTP. However, for PVSTP, you need to configure these features:

- **FastUplink.** This feature allows for a quick selection of a port with the lowest cost after the root port fails. That is, FastUplink reduces the converge time after a link fails. This feature is similar to Cisco's UplinkFast feature. If the primary link fails, FastUplink creates an alternate path immediately, speeding up the transition from the failed primary link to the backup link.
- **FastBackbone.** This feature allows for faster convergence time when an indirect link to the root fails. If a root port or blocked port receives an inferior BPDU from the designated

switch, the switch acts as if an indirect link to the root failed. To speed up the convergence time, the switch expires the maximum age timer immediately and forces the port through the Listening and Learning states.

The following diagram shows a simple PVSTP configuration.

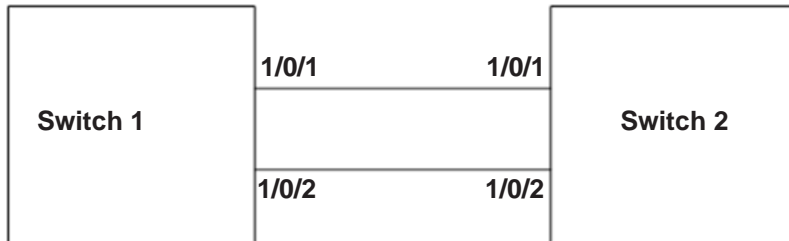


Figure 56. PVSTP configuration

## CLI: Configure PVSTP

You must configure PVSTP on Switch 1 and Switch 2. This example assumes that all switches can support PVSTP.

### CLI: Configure PVSTP on Switch 1

1. Ensure that ports 1/0/1 and 1/0/2 are in VLAN 1002 in tagged mode because BPDU packets for PVSTP are transmitted in tagged packets.
2. Enable PVSTP.

```
(Netgear Switch) #config
(Netgear Switch) (Config)#spanning-tree mode pvst
```

**Note:** After you enable PVSTP (or PVRSTP) globally, PVSTP (or PVRSTP) is applied to VLANs automatically.



**3. Verify the PVSTP status.**

```
(Netgear Switch) #show spanning-tree vlan 1002
VLAN 1002
Spanning-tree enabled protocol pvst
RootID      Priority      33770
            Address      6C:B0:CE:19:AE:3D
            Cost          20000
            Port          1(1/0/1 )
            Hello Time 2 Sec Max Age 20 sec Forward Delay 15 sec
BridgeID     Priority      33770 (priority 32768 sys-id-ext 1002)
            Address      6C:B0:CE:F9:F6:E0
            Hello Time 2 Sec Max Age 20 sec Forward Delay 15 sec
            Aging Time 300 sec
```

| Interface | Role      | Sts        | Cost  | Prio.Nbr |
|-----------|-----------|------------|-------|----------|
| -----     | -----     | -----      | ----- | -----    |
| 1/0/1     | Root      | Forwarding | 20000 | 128.1    |
| 1/0/2     | Alternate | Discarding | 20000 | 128.2    |

**4. Enable the FastUplink and FastBackbone features to speed up the selection of a new root and indirect ports, respectively.**

```
(Netgear Switch) (Config)#spanning-tree uplinkfast
(Netgear Switch) (Config)#spanning-tree backbonefast
```

**5. To enable the switch to be elected as the root in VLAN 1000, set the PVSTP priority to 0.**

```
(Netgear Switch) (Config)#spanning-tree vlan 1000 priority 0
```

**CLI: Configure PVSTP on Switch 2**

1. Ensure that ports 1/0/1 and 1/0/2 are in VLAN 1002 in tagged mode because BPDU packets for PVSTP are transmitted in tagged packets.
2. Enable PVSTP.

```
(Netgear Switch) #config
(Netgear Switch) (Config)#spanning-tree mode pvst
```

### 3. Verify the PVSTP status.

```
(Netgear Switch) #show spanning-tree vlan 1002
```

```
VLAN 1002
Spanning-tree enabled protocol pvst
RootID    Priority      33770
          Address      6C:B0:CE:19:AE:3D
          Cost          0
          Port          This switch is the root
          Hello Time 2 Sec Max Age 20 sec Forward Delay 15 sec
BridgeID   Priority      33770 (priority 32768 sys-id-ext 1002)
          Address      6C:B0:CE:19:AE:3D
          Hello Time 2 Sec Max Age 20 sec Forward Delay 15 sec
          Aging Time 300 sec
```

| Interface | Role       | Sts        | Cost  | Prio.Nbr |
|-----------|------------|------------|-------|----------|
| 1/0/1     | Designated | Forwarding | 20000 | 128.1    |
| 1/0/2     | Designated | Forwarding | 20000 | 128.     |

### 4. Enable the FastUplink and FastBackbone features to speed up the selection of a new root and indirect ports, respectively.

```
(Netgear Switch) (Config)#spanning-tree uplinkfast
(Netgear Switch) (Config)#spanning-tree backbonefast
```

## Local Browser Interface: Configure PVSTP

You must configure PVSTP on Switch 1 and Switch 2. This example assumes that all switches can support PVSTP.

### Local Browser Interface: Configure PVSTP on Switch 1

1. Ensure that ports 1/0/1 and 1/0/2 are in VLAN 1002 in tagged mode because BPDU packets for PVSTP are transmitted in tagged packets.
2. Enable PVSTP.
  - a. Select **Switching > STP > Basic > STP Configuration**.

A screen similar to the following displays.

| System | Switching | Routing | QoS | Security  | Monitoring | Maintenance   | Help  | Index |      |     |
|--------|-----------|---------|-----|-----------|------------|---------------|-------|-------|------|-----|
| VLAN   | Auto-VoIP | iSCSI   | STP | Multicast | MVR        | Address Table | Ports | LAG   | MLAG | MRP |

STP

• Basic

• STP Configuration

• Advanced

Spanning Tree Admin Mode

Force Protocol Version

Configuration Name

Configuration Revision Level

Forward BPDU while STP Disabled

BPDU Guard

BPDU Filter

Configuration Digest Key

Configuration Format Selector

Fast Backbone

Fast Uplink

Max Update Rate

☐ Disable ☒ Enable

☒ IEEE 802.1d ☐ IEEE 802.1w ☐ IEEE 802.1s ☒ PVST ☐ RPVST

(0 to 65535)

☒ Disable ☐ Enable

☒ Disable ☐ Enable

☒ Disable ☐ Enable

☒ Disabled ☐ Enabled

☒ Disabled ☐ Enabled

(0 to 32000 packets/sec. Default: 150.)

**b.** Configure the following settings:

- For Spanning Tree Admin Mode, select the **Enable** radio button.
- For Force Protocol Version, select the **PVST** radio button.

**c.** Click **Apply**.

**Note:** After you enable PVST globally, PVST is applied to VLANs automatically.

**3.** Display the PVST status for port 1/0/1 and 1/0/2 in VLAN 1002.

**a.** Select **Switching > STP > Advanced > PVST Interface**.

A screen similar to the following displays.

| Interface | Priority | Cost  | Role      | Status     |
|-----------|----------|-------|-----------|------------|
| 1/0/1     | 128      | 20000 | Root      | Forwarding |
| 1/0/2     | 128      | 20000 | Alternate | Discarding |
| 1/0/3     | 128      | 0     |           |            |
| 1/0/4     | 128      | 0     |           |            |
| 1/0/5     | 128      | 0     |           |            |
| 1/0/6     | 128      | 0     |           |            |
| 1/0/7     | 128      | 0     |           |            |
| 1/0/8     | 128      | 0     |           |            |
| 1/0/9     | 128      | 0     |           |            |
| 1/0/10    | 128      | 0     |           |            |
| 1/0/11    | 128      | 0     |           |            |
| 1/0/12    | 128      | 0     |           |            |
| 1/0/13    | 128      | 0     |           |            |

b. From the **VLAN ID** menu, select **1002**.

The roles of ports 1/0/1 and 1/0/2 display.

4. To enable the switch to be elected as the root, change the PVST priority to lower value (for example, 0).

a. Select **Switching > STP > Advanced > PVST VLAN**.

A screen similar to the following displays.

| VLAN ID | Root | Hello Time | Forward Time | Max Age | Priority |
|---------|------|------------|--------------|---------|----------|
| 1002    | None | 2          | 15           | 20      | 0        |
| 1       | None | 2          | 15           | 20      | 32768    |
| 1002    | None | 2          | 15           | 20      | 32768    |

b. Select the **1002** check box for VLAN ID 1002.

The settings for VLAN ID 1002 display in the fields in the table heading.

- c. In the **Priority** field, enter **0**.
- d. Click **Apply**.

### Local Browser Interface: Configure PVSTP on Switch 2

1. Ensure that ports 1/0/1 and 1/0/2 are in VLAN 1002 in tagged mode because BPDU packets for PVSTP are transmitted in tagged packets.
2. Enable PVSTP.
  - a. Select **Switching > STP > Basic > STP Configuration**.

A screen similar to the following displays.

| System | Switching | Routing | QoS | Security  | Monitoring | Maintenance   | Help  | Index |
|--------|-----------|---------|-----|-----------|------------|---------------|-------|-------|
| VLAN   | Auto-VoIP | iSCSI   | STP | Multicast | MVR        | Address Table | Ports | LAG   |
|        |           |         |     |           |            |               |       | MLAG  |
|        |           |         |     |           |            |               |       | MRP   |

| STP                 | STP Configuration   |
|---------------------|---|
| • Basic             | Spanning Tree Admin Mode <input checked="" type="radio"/> Disable <input checked="" type="radio"/> Enable   |
| • STP Configuration | Force Protocol Version <input checked="" type="radio"/> IEEE 802.1d <input type="radio"/> IEEE 802.1w <input type="radio"/> IEEE 802.1s <input checked="" type="radio"/> PVST <input type="radio"/> RPVST |
| • Advanced          | Configuration Name <input type="text" value="6C-B0-CE-19-AE-3D"/>   |
|                     | Configuration Revision Level <input type="text" value="0"/> (0 to 65535)  |
|                     | Forward BPDU while STP Disabled <input checked="" type="radio"/> Disable <input type="radio"/> Enable   |
|                     | BPDU Guard <input checked="" type="radio"/> Disable <input type="radio"/> Enable  |
|                     | BPDU Filter <input checked="" type="radio"/> Disable <input type="radio"/> Enable   |
|                     | Configuration Digest Key <input type="text" value="0xac36177f50283cd4b83821d8ab26de62"/>  |
|                     | Configuration Format Selector <input type="text" value="0"/>  |
|                     | Fast Backbone <input checked="" type="radio"/> Disabled <input type="radio"/> Enabled   |
|                     | Fast Uplink <input checked="" type="radio"/> Disabled <input type="radio"/> Enabled   |
|                     | Max Update Rate <input type="text" value="150"/> (0 to 32000 packets/sec. Default: 150.)  |

- b. Configure the following settings:
  - For Spanning Tree Admin Mode, select the **Enable** radio button.
  - For Force Protocol Version, select the **PVST** radio button.
- c. Click **Apply**.

**Note:** After you enable PVST globally, PVST is applied to VLANs automatically.

3. Display the PVST status for ports 1/0/1 and 1/0/2 in VLAN 1002.
  - a. Select **Switching > STP > Advanced > PVST Interface**.

A screen similar to the following displays.

The screenshot shows the 'PVST/RPVST Interface Configuration' page for VLAN ID 1002. The left sidebar lists various STP configuration options, with 'PVST Interface' highlighted. The main content area displays a table of port configurations for the selected VLAN.

| Interface | Priority | Cost  | Role       | Status     |
|-----------|----------|-------|------------|------------|
| 1/0/1     | 128      | 20000 | Designated | Forwarding |
| 1/0/2     | 128      | 20000 | Designated | Forwarding |
| 1/0/3     | 128      | 0     |            |            |
| 1/0/4     | 128      | 0     |            |            |
| 1/0/5     | 128      | 0     |            |            |
| 1/0/6     | 128      | 0     |            |            |
| 1/0/7     | 128      | 0     |            |            |
| 1/0/8     | 128      | 0     |            |            |
| 1/0/9     | 128      | 0     |            |            |
| 1/0/10    | 128      | 0     |            |            |
| 1/0/11    | 128      | 0     |            |            |
| 1/0/12    | 128      | 0     |            |            |
| 1/0/13    | 128      | 0     |            |            |

- b.** From the **VLAN ID** menu, select **1002**.  
The roles of ports 1/0/1 and 1/0/2 display.

# 28

## 28 Tunnels for IPv6

---

### 6in4 tunnels and 6to4 tunnels

This chapter includes the following sections:

- [Tunnel Concepts](#)
- [Create a 6in4 Tunnel](#)
- [Create a 6to4 Tunnel](#)

# Tunnel Concepts

Two methods exist for IPv6 sites to communicate with each other over the IPv4 network: 6in4 tunnel and 6to4 tunnel. The 6in4 tunnel encapsulates IPv6 traffic over an explicitly configured IPv4 destination or end point of the tunnel with the IP protocol number set to 41. The 6to4 tunnel IPv6 prefix is constructed by prepending 2002 (hexadecimal) to the global IPv4 address. For example, if the IPv4 address is 4.4.4.1, the tunnel IPv6 prefix would be 2002:404:401::/16.

The 6to4 tunnels are automatically formed IPv4 tunnels carrying IPv6 traffic. The automatic tunnel's IPv4 destination address is derived from the 6to4 IPv6 address of the tunnel's next hop. A 6to4 tunnel supports the functionality of a 6to4 border router that connects a 6to4 site to a 6to4 domain. With 6to4 tunnels, routers in a 6to4 domain, including other 6to4 border routers and 6to4 relay routers, can send and receive tunneled traffic from each other.

## Create a 6in4 Tunnel

In the example, you create a 6in4 tunnel between Switch 1 and Switch 2. The tunnel carries IPv6 packets over IPv4 packets.



**Figure 57. 6in4 tunnel configuration**



## CLI: Create a 6in4 Tunnel

You must configure Switch 1 and Switch 2.

### CLI: Create a 6in4 Tunnel on Switch 1

```
(Netgear Switch) #config
(Netgear Switch) (Config)#ip routing
(Netgear Switch) (Config)#ipv6 unicast-routing
(Netgear Switch) (Config)#interface 1/0/1
(Netgear Switch) (Interface 1/0/1)#routing
(Netgear Switch) (Interface 1/0/1)#ip address 192.168.1.1 255.255.255.0
(Netgear Switch) (Interface 1/0/1)#exit
(Netgear Switch) (Config)#interface tunnel 0
(Netgear Switch) (Interface tunnel 0)#ipv6 enable
(Netgear Switch) (Interface tunnel 0)#ipv6 address 2000::1/64
(Netgear Switch) (Interface tunnel 0)#tunnel mode ipv6ip
(Netgear Switch) (Interface tunnel 0)#tunnel source 192.168.1.1
(Netgear Switch) (Interface tunnel 0)#tunnel destination 192.1.168.1.2
(Netgear Switch) (Interface tunnel 0)#exit
(Netgear Switch) (Config)#exit
(Netgear Switch) #show interface tunnel 0

Interface Link Status..... Up
IPv6 is enabled
IPv6 Prefix is ..... FE80::C0A8:101/128
                        2000::1/64
MTU size..... 1280 bytes

(Netgear Switch) #show interface tunnel

TunnelId      Interface      TunnelMode      SourceAddress      DestinationAddress
-----
0   tunnel    0              6 in 4 Configured  192.168.1.1        192.168.1.2

(Netgear Switch) # ping ipv6 2000::2
Send count=3, Receive count=3 from 2000::2
Average round trip time = 1.00 ms
```

## CLI: Create a 6in4 Tunnel on Switch 2

```
(Netgear Switch) #config
(Netgear Switch) (Config)#ip routing
(Netgear Switch) (Config)#ipv6 unicast-routing
(Netgear Switch) (Config)#interface 1/0/13
(Netgear Switch) (Interface 1/0/13)#routing
(Netgear Switch) (Interface 1/0/13)#ip address 192.168.1.2 255.255.255.0
(Netgear Switch) (Interface 1/0/13)#exit

(Netgear Switch) (Config)#interface tunnel 0
(Netgear Switch) (Interface tunnel 0)#ipv6 enable
(Netgear Switch) (Interface tunnel 0)#ipv6 address 2000::2/64
(Netgear Switch) (Interface tunnel 0)#tunnel mode ipv6ip
(Netgear Switch) (Interface tunnel 0)#tunnel source 192.168.1.2
(Netgear Switch) (Interface tunnel 0)#tunnel destination 192.168.1.1
(Netgear Switch) (Interface tunnel 0)#exit
(Netgear Switch) (Config)#exit
(Netgear Switch) #show interface tunnel
```

| TunnelId | Interface | TunnelMode        | SourceAddress | DestinationAddress |
|----------|-----------|-------------------|---------------|--------------------|
| 0 tunnel | 0         | 6 in 4 Configured | 192.168.1.2   | 192.168.1.1        |

## Local Browser Interface: Create a 6in4 Tunnel

You must configure Switch 1 and Switch 2.

### Local Browser Interface: Create a 6in4 Tunnel on Switch 1

1. Enable IP routing on the switch.
  - a. Select **Routing > IP > Basic > IP Configuration**.

A screen similar to the following displays.



- b. For Routing Mode, select the **Enable** radio button.
  - c. Click **Apply**.
2. Enable IPv6 forwarding and unicast routing on the switch.

a. Select **Routing > IPv6 > Basic > Global Configuration**.

A screen similar to the following displays.

| System   | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|--|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table  | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |
| IPv6   |           |         |      |          |            |             |        |                  |      |           |                |
| IPv6 Global Configuration  |           |         |      |          |            |             |        |                  |      |           |                |
| IPv6 Unicast Routing <input type="radio"/> Disable <input checked="" type="radio"/> Enable |           |         |      |          |            |             |        |                  |      |           |                |
| Hop Limit <input type="text" value="64"/> (1 to 255)                                       |           |         |      |          |            |             |        |                  |      |           |                |
| ICMPv6 Rate Limit Error Interval <input type="text" value="1000"/> (0 to 2147483647 msecs) |           |         |      |          |            |             |        |                  |      |           |                |
| ICMPv6 Rate Limit Burst Size <input type="text" value="100"/> (1 to 200)                   |           |         |      |          |            |             |        |                  |      |           |                |

b. For IPv6 Unicast Routing, select the **Enable** radio button.

c. For IPv6 Forwarding, select the **Enable** radio button.

d. Click **Apply**.

3. Create a routing interface and assign an IP address to it.

a. Select **Routing > IP > Advanced > IP Interface Configuration**.

A screen similar to the following displays.

| System   | Switching   | Routing | QoS                             | Security    | Monitoring    | Maintenance  | Help                | Index            |      |           |                |      |             |         |                                 |            |             |              |                     |   |  |  |        |             |               |        |        |                                |  |  |      |         |         |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
|--|-------------|---------|---------------------------------|-------------|---------------|--------------|---------------------|------------------|------|-----------|----------------|------|-------------|---------|---------------------------------|------------|-------------|--------------|---------------------|---|--|--|--------|-------------|---------------|--------|--------|--------------------------------|--|--|------|---------|---------|--------|--------|--------------------------------|--|--|------|---------|---------|---------|--------|--------------------------------|--|--|------|---------|---------|---------|--------|
| Routing Table  | IP          | IPv6    | VLAN                            | ARP         | RIP           | OSPF         | OSPFv3              | Router Discovery | VRRP | Multicast | IPv6 Multicast |      |             |         |                                 |            |             |              |                     |   |  |  |        |             |               |        |        |                                |  |  |      |         |         |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| IP   |             |         |                                 |             |               |              |                     |                  |      |           |                |      |             |         |                                 |            |             |              |                     |   |  |  |        |             |               |        |        |                                |  |  |      |         |         |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| IP Interface Configuration   |             |         |                                 |             |               |              |                     |                  |      |           |                |      |             |         |                                 |            |             |              |                     |   |  |  |        |             |               |        |        |                                |  |  |      |         |         |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| 1 2 3 VLANs All  |             |         |                                 |             |               |              |                     |                  |      |           |                |      |             |         |                                 |            |             |              |                     |   |  |  |        |             |               |        |        |                                |  |  |      |         |         |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <table border="1"> <thead> <tr> <th>Port</th> <th>Description</th> <th>VLAN ID</th> <th>IP Address Configuration Method</th> <th>IP Address</th> <th>Subnet Mask</th> <th>Routing Mode</th> <th>Administrative Mode</th> </tr> </thead> <tbody> <tr> <td><input checked="" type="checkbox"/> 1/0/1</td> <td></td> <td></td> <td>Manual</td> <td>192.168.1.1</td> <td>255.255.255.0</td> <td>Enable</td> <td>Enable</td> </tr> <tr> <td><input type="checkbox"/> 1/0/2</td> <td></td> <td></td> <td>None</td> <td>0.0.0.0</td> <td>0.0.0.0</td> <td>Enable</td> <td>Enable</td> </tr> <tr> <td><input type="checkbox"/> 1/0/3</td> <td></td> <td></td> <td>None</td> <td>0.0.0.0</td> <td>0.0.0.0</td> <td>Disable</td> <td>Enable</td> </tr> <tr> <td><input type="checkbox"/> 1/0/3</td> <td></td> <td></td> <td>None</td> <td>0.0.0.0</td> <td>0.0.0.0</td> <td>Disable</td> <td>Enable</td> </tr> </tbody> </table> |             |         |                                 |             |               |              |                     |                  |      |           |                | Port | Description | VLAN ID | IP Address Configuration Method | IP Address | Subnet Mask | Routing Mode | Administrative Mode | <input checked="" type="checkbox"/> 1/0/1 |  |  | Manual | 192.168.1.1 | 255.255.255.0 | Enable | Enable | <input type="checkbox"/> 1/0/2 |  |  | None | 0.0.0.0 | 0.0.0.0 | Enable | Enable | <input type="checkbox"/> 1/0/3 |  |  | None | 0.0.0.0 | 0.0.0.0 | Disable | Enable | <input type="checkbox"/> 1/0/3 |  |  | None | 0.0.0.0 | 0.0.0.0 | Disable | Enable |
| Port   | Description | VLAN ID | IP Address Configuration Method | IP Address  | Subnet Mask   | Routing Mode | Administrative Mode |                  |      |           |                |      |             |         |                                 |            |             |              |                     |   |  |  |        |             |               |        |        |                                |  |  |      |         |         |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input checked="" type="checkbox"/> 1/0/1  |             |         | Manual                          | 192.168.1.1 | 255.255.255.0 | Enable       | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |   |  |  |        |             |               |        |        |                                |  |  |      |         |         |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input type="checkbox"/> 1/0/2   |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Enable       | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |   |  |  |        |             |               |        |        |                                |  |  |      |         |         |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input type="checkbox"/> 1/0/3   |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |   |  |  |        |             |               |        |        |                                |  |  |      |         |         |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input type="checkbox"/> 1/0/3   |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |   |  |  |        |             |               |        |        |                                |  |  |      |         |         |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |

b. Under IP Interface Configuration, scroll down and select the Port **1/0/1** check box. Now 1/0/1 appears in the Interface field at the top.

• In the **IP Address** field, enter **192.168.1.1**.

• In the **Subnet Mask** field, enter **255.255.255.0**.

• In the **Routing Mode** field, select **Enable**.

c. Click **Apply**.

4. Create a 6-in-4 tunnel interface.

a. Select **Routing > IPv6 > Advanced > Tunnel Configuration**.

A screen similar to the following displays.

| Tunnel ID | Mode              | IPv6 Mode | IPv6 Unreachables | IPv6 Address/Prefix Length | EUI64 | Source Address | Source Interface | Destination Address | Inte |
|-----------|-------------------|-----------|-------------------|----------------------------|-------|----------------|------------------|---------------------|------|
| 0         | 6-in-4-configured | Enable    | Enable            | 2000::1/64                 |       | 192.168.1.1    |                  | 192.168.1.2         |      |

- b. In the **Tunnel ID** list, select **0**.
- c. In the **Mode** field, select **6-in-4-configured**.
- d. In the **Source Address** field, enter **192.168.1.1**.
- e. In the **IPv6 Mode** field, select **Enable**.
- f. In the **IPv6 Address/Prefix Length** field, enter **2000::1/64**.
- g. In the **Destination Address** field, enter **192.168.1.2**.
- h. Click **Apply**.

## Local Browser Interface: Create a 6in4 Tunnel on Switch 2

1. Enable IP routing on the switch.
  - a. Select **Routing > IP > Basic > IP Configuration**.

A screen similar to the following displays.

| Default Time to Live | Routing Mode | ICMP Echo Replies | ICMP Redirects | ICMP Rate Limit Interval | ICMP Rate Limit Burst Size | Maximum Next Hops |
|----------------------|--------------|-------------------|----------------|--------------------------|----------------------------|-------------------|
| 64                   | Enable       | Enable            | Enable         | 1000                     | 100                        | 4                 |

- b. For Routing Mode, select the **Enable** radio button.
- c. Click **Apply**.
2. Enable IPv6 forwarding and unicast routing on the switch.
  - a. Select **Routing > IPv6 > Basic > Global Configuration**.

A screen similar to the following displays.

| System  | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table   | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |
| <div>IPv6</div> <div>IPv6 Global Configuration</div> <div> <div>Basic</div> <div>Global Configuration</div> <div>Route Table</div> <div>Advanced</div> </div> <div> <div>IPv6 Unicast Routing</div> <div> <div>Disable</div> <div>Enable</div> </div> <div> <div>Hop Limit</div> <div>64</div> <div>(1 to 255)</div> </div> <div> <div>ICMPv6 Rate Limit Error Interval</div> <div>1000</div> <div>(0 to 2147483647 msec)</div> </div> <div> <div>ICMPv6 Rate Limit Burst Size</div> <div>100</div> <div>(1 to 200)</div> </div> </div> |           |         |      |          |            |             |        |                  |      |           |                |

- b. For IPv6 Unicast Routing, select the **Enable** radio button.
  - c. For IPv6 Forwarding, select the **Enable** radio button.
  - d. Click **Apply**.
3. Create a routing interface and assign an IP address to it.
  - a. Select **Routing > IP > Advanced > IP Interface Configuration**.

A screen similar to the following displays.

| System  | Switching   | Routing | QoS                             | Security    | Monitoring    | Maintenance  | Help                | Index            |      |           |                |      |             |         |                                 |            |             |              |                     |  |  |  |        |             |               |        |        |                                |  |  |      |         |         |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
|---|-------------|---------|---------------------------------|-------------|---------------|--------------|---------------------|------------------|------|-----------|----------------|------|-------------|---------|---------------------------------|------------|-------------|--------------|---------------------|--|--|--|--------|-------------|---------------|--------|--------|--------------------------------|--|--|------|---------|---------|--------|--------|--------------------------------|--|--|------|---------|---------|---------|--------|--------------------------------|--|--|------|---------|---------|---------|--------|
| Routing Table   | IP          | IPv6    | VLAN                            | ARP         | RIP           | OSPF         | OSPFv3              | Router Discovery | VRRP | Multicast | IPv6 Multicast |      |             |         |                                 |            |             |              |                     |  |  |  |        |             |               |        |        |                                |  |  |      |         |         |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <div>IP</div> <div>IP Interface Configuration</div> <div> <div>Basic</div> <div>Advanced</div> <div>IP Configuration</div> <div>Statistics</div> <div>IP Interface Configuration</div> <div>Secondary IP</div> </div> <div> <div>1 2 3 VLANs All</div> <table border="1"> <thead> <tr> <th>Port</th> <th>Description</th> <th>VLAN ID</th> <th>IP Address Configuration Method</th> <th>IP Address</th> <th>Subnet Mask</th> <th>Routing Mode</th> <th>Administrative Mode</th> </tr> </thead> <tbody> <tr> <td><input checked="" type="checkbox"/> 1/0/13</td> <td></td> <td></td> <td>Manual</td> <td>192.168.1.2</td> <td>255.255.255.0</td> <td>Enable</td> <td>Enable</td> </tr> <tr> <td><input type="checkbox"/> 1/0/1</td> <td></td> <td></td> <td>None</td> <td>0.0.0.0</td> <td>0.0.0.0</td> <td>Enable</td> <td>Enable</td> </tr> <tr> <td><input type="checkbox"/> 1/0/2</td> <td></td> <td></td> <td>None</td> <td>0.0.0.0</td> <td>0.0.0.0</td> <td>Disable</td> <td>Enable</td> </tr> <tr> <td><input type="checkbox"/> 1/0/3</td> <td></td> <td></td> <td>None</td> <td>0.0.0.0</td> <td>0.0.0.0</td> <td>Disable</td> <td>Enable</td> </tr> </tbody> </table> </div> |             |         |                                 |             |               |              |                     |                  |      |           |                | Port | Description | VLAN ID | IP Address Configuration Method | IP Address | Subnet Mask | Routing Mode | Administrative Mode | <input checked="" type="checkbox"/> 1/0/13 |  |  | Manual | 192.168.1.2 | 255.255.255.0 | Enable | Enable | <input type="checkbox"/> 1/0/1 |  |  | None | 0.0.0.0 | 0.0.0.0 | Enable | Enable | <input type="checkbox"/> 1/0/2 |  |  | None | 0.0.0.0 | 0.0.0.0 | Disable | Enable | <input type="checkbox"/> 1/0/3 |  |  | None | 0.0.0.0 | 0.0.0.0 | Disable | Enable |
| Port  | Description | VLAN ID | IP Address Configuration Method | IP Address  | Subnet Mask   | Routing Mode | Administrative Mode |                  |      |           |                |      |             |         |                                 |            |             |              |                     |  |  |  |        |             |               |        |        |                                |  |  |      |         |         |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input checked="" type="checkbox"/> 1/0/13  |             |         | Manual                          | 192.168.1.2 | 255.255.255.0 | Enable       | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |  |  |  |        |             |               |        |        |                                |  |  |      |         |         |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input type="checkbox"/> 1/0/1  |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Enable       | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |  |  |  |        |             |               |        |        |                                |  |  |      |         |         |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input type="checkbox"/> 1/0/2  |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |  |  |  |        |             |               |        |        |                                |  |  |      |         |         |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input type="checkbox"/> 1/0/3  |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |  |  |  |        |             |               |        |        |                                |  |  |      |         |         |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |

- b. Under IP Interface Configuration, scroll down and select the Port **1/0/13** check box. Now 1/0/1 appears in the Port field at the top.
    - In the **IP Address** field, enter **192.168.1.2**.
    - In the **Subnet Mask** field, enter **255.255.255.0**.
    - In the **Routing Mode** field, select **Enable**.
  - c. Click **Apply**.
4. Create a 6-in-4 tunnel interface.
  - a. Select **Routing > IPv6 > Advanced > Tunnel Configuration**.

A screen similar to the following displays.

- b. In the **Tunnel Id** list, select **0**.
- c. In the **Mode** list, select **6-in-4-configured**.
- d. In the **IPv6 Address/Prefix Length** field, enter **2000::2/64**.
- e. In the **Source Address** field, enter **192.168.1.2**.
- f. In the **Destination Address** field, enter **192.168.1.1**.
- g. Click **Apply**.

## Create a 6to4 Tunnel

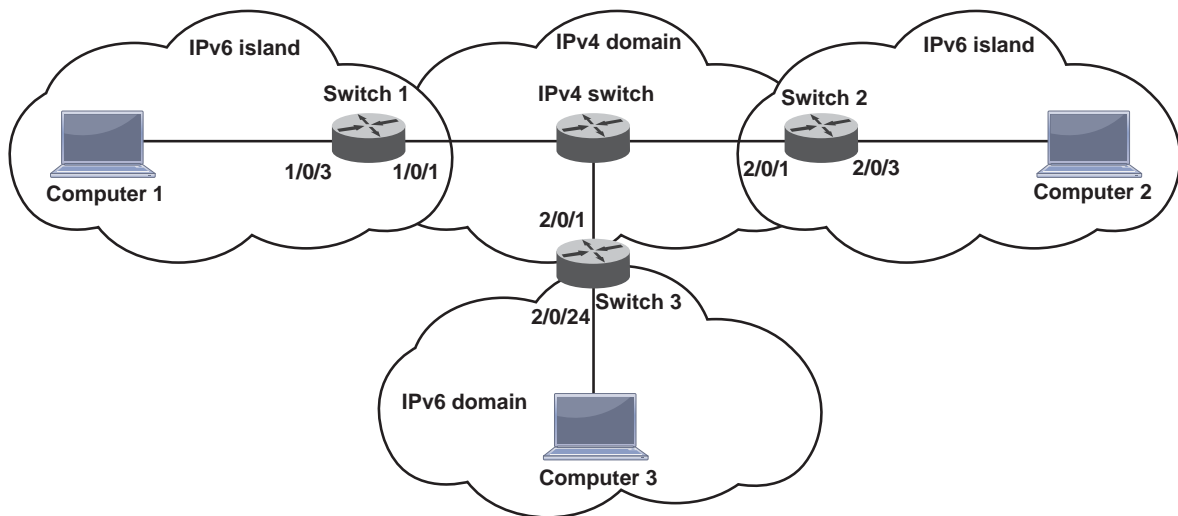
An IPv6 tunnel in 6to4 mode connects an isolated IPv6 domain (that is, an 6to4 island) over an IPv4 domain to remote IPv6 domains or to another 6to4 island. An IPv6 tunnel in 6to4 mode is also called an automatic 6to4 tunnel. Unlike a 6in4 tunnel, which is a point-to-point tunnel, a 6to4 tunnel is a point-to-multipoint tunnel. In a 6to4 tunnel, the IPv6 tunnel destination is determined by the IPv4 address, which is extracted from IPv6 destination address with the prefix 2002::V4ADDR::/48.

A NETGEAR switch behaves as a 6to4 border router that connects 6to4 islands (in the following figure, Switch 1 and Switch 2) to an IPv6 domain (in the following figure, Switch 3). This means the following:

The NETGEAR switch forwards traffic from an IPv6 domain (with a non-2002:: address) to a 6to4 island (with a 2002:: address) and the other way around. (In the following figure, this type of forwarding refers to the traffic between Switch 1 and Switch 3 and the traffic between Switch 2 and Switch 3).

The NETGEAR switch forwards traffic from one 6to4 island to another 6to4 island (in the following figure, the traffic between Switch 1 and Switch 2).

The NETGEAR switch does not forward traffic from one IPv6 domain (with a non-2002:: address) to other IPv6 domain (also with a non-2002:: address).



**Figure 58. 6to4 tunnel configuration**

---

**Note:** The following examples do not include the configuration of the IPv4 switch because the 6to4 configuration occurs only in the IPv6 island. The switch in IPv4 domain does not require any special configuration.

---

## CLI: Create a 6to4 Tunnel

You must configure Switch1, Switch2, and Switch 3.

CLI: Create a 6to4 Tunnel on Switch 1

**1.** Enable routing and IPv6 routing on Switch 1.

```
(Netgear Switch) # config
(Netgear Switch) (Config)#ipv6 unicast-routing
(Netgear Switch) (Config)#ip routing
```

**2.** Configure IPv4 address on routing port 1/0/1.

```
(Netgear Switch) (Config)#interface 1/0/1
(Netgear Switch) (Interface 1/0/1)#routing
(Netgear Switch) (Interface 1/0/1)#ip address 195.1.3.2 255.255.255.0
(Netgear Switch) (Interface 1/0/1)#exit
```



3. Configure the IPv6 address on the 6to4 tunnel in the format 2002:V4ADDR::Host/16, in which where V4ADDR is the source IPv4 address of the tunnel. The prefix length for the tunnel must be 16.

```
(Netgear Switch) (Config)#interface tunnel 0
(Netgear Switch) (Interface tunnel 0)#ipv6 address 2002:c301:302::1/16
(Netgear Switch) (Interface tunnel 0)#ipv6 enable
(Netgear Switch) (Interface tunnel 0)#tunnel mode ipv6ip 6to4
(Netgear Switch) (Interface tunnel 0)#tunnel source 195.1.3.2
(Netgear Switch) (Interface tunnel 0)#exit
```

4. Configure the IPv6 address for routing port 1/0/3. The IPv6 address format is 2002:V4ADDR:Subnet::Host/64, in which V4ADDR is the source IPv4 address of the tunnel and Subnet is the subnet of 2002:V4ADDR::/64.

```
(Netgear Switch) (Config)#interface 1/0/3
(Netgear Switch) (Interface 1/0/3)#routing
(Netgear Switch) (Interface 1/0/3)#ipv6 address 2002:c301:302:1::1/64
(Netgear Switch) (Interface 1/0/3)#ipv6 enable
(Netgear Switch) (Interface 1/0/3)#exit
```

5. Create a static IPv4 route to ensure that Switch 1 can reach Switch 2 and Switch 3. You can also use a routing protocol such as RIP or OSPF to let Switch 1 learn the routes from Switch 2 and Switch 3.

```
(Netgear Switch) (Config)#ip route 195.1.4.0 255.255.255.0 195.1.3.1
(Netgear Switch) (Config)#ip route 195.1.5.0 255.255.255.0 195.1.3.1
```

6. Because Switch 1 cannot detect the route for IPv6 address 8888::/16 (of port 2/0/24 on Switch 3), create a static IPv6 route for Switch 1 with the tunnel address of Switch 3 as the next hop.

```
(Netgear Switch) (Config)#ipv6 route 8888::/16 2002:c301:502::1
```



## 7. Verify the configuration.

```
(Netgear Switch) #show ipv6 route
IPv6 Routing Table - 5 entries
Codes: C - connected, S - static, 6To4 - 6to4 Route, B - BGP Derived
       O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF Ext 1, OE2 - OSPF Ext 2
       ON1 - OSPF NSSA Ext Type 1, ON2 - OSPF NSSA Ext Type 2
C    2002::/16 [0/0]
    via ::,    tunnel 0
C    2002:c301:302:1::/64 [0/0]
    via ::,    1/0/3
6To4 2002:c301:402::/48 [1/0]
    via fe80::c301:301,    01h:25m:23s,    tunnel 0
6To4 2002:c301:502::/48 [1/0]
    via fe80::c301:301,    00h:44m:11s,    tunnel 0
S    8888::/16 [1/0]
    via 2002:c301:502::1,    tunnel 0
```

## CLI: Create a 6to4 Tunnel on Switch 2

### 1. Enable routing and IPv6 routing on Switch 2.

```
(Netgear Switch) # config
(Netgear Switch) (Config)#ipv6 unicast-routing
(Netgear Switch) (Config)#ip routing
```

### 2. Configure the IPv4 address on routing port 2/0/1.

```
(Netgear Switch) (Config)# interface 2/0/1
(Netgear Switch) (Interface 2/0/1)#routing
(Netgear Switch) (Interface 2/0/1)#ip address 195.1.4.2 255.255.255.0
(Netgear Switch) (Interface 2/0/1)#exit
```

### 3. Configure the IPv6 address on the 6to4 tunnel in the format 2002:V4ADDR::Host/16, in which where V4ADDR is the source IPv4 address of the tunnel. The prefix length for the tunnel must be 16.

```
(Netgear Switch) (Config)#interface tunnel 0
(Netgear Switch) (Interface tunnel 0)#ipv6 address 2002:c301:402::1/16
(Netgear Switch) (Interface tunnel 0)#ipv6 enable
(Netgear Switch) (Interface tunnel 0)#tunnel mode ipv6ip 6to4
(Netgear Switch) (Interface tunnel 0)#tunnel source 195.1.4.2
(Netgear Switch) (Interface tunnel 0)#exit
```

4. Configure the IPv6 address for routing port 2/0/3. The IPv6 address format is 2002:V4ADDR:Subnet::Host/64, in which V4ADDR is the source IPv4 address of the tunnel and Subnet is the subnet of 2002:V4ADDR::/64.

```
(Netgear Switch) (Config)#interface 2/0/3
(Netgear Switch) (Interface 2/0/3)#routing
(Netgear Switch) (Interface 2/0/3)#ipv6 address 2002:c301:402:1::1/64
(Netgear Switch) (Interface 2/0/3)#ipv6 enable
(Netgear Switch) (Interface 2/0/3)#exit
```

5. Create a static IPv4 route to ensure that Switch 2 can reach Switch 1. You can also use a routing protocol such as RIP or OSPF to let Switch 2 learn the route from Switch 1.

```
(Netgear Switch) (Config)#ip route 195.1.3.0 255.255.255.0 195.1.4.1
```

6. Verify the configuration.

```
(Netgear Switch) #show ipv6 route
IPv6 Routing Table - 3 entries
Codes: C - connected, S - static, 6to4 - 6to4 Route, B - BGP Derived
       O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF Ext 1, OE2 - OSPF Ext 2
       ON1 - OSPF NSSA Ext Type 1, ON2 - OSPF NSSA Ext Type 2
C       2002::/16 [0/0]
       via ::, tunnel 0
6to4    2002:c301:302::/48 [1/0]
       via fe80::c301:401, 01h:32m:28s, tunnel 0
C       2002:c301:402:1::/64 [0/0]
       via ::, 2/0/3
```

## CLI: Create a 6to4 Tunnel on Switch 3

1. Enable routing and IPv6 routing on Switch 3.

```
(Netgear Switch) # config
(Netgear Switch) (Config)#ipv6 unicast-routing
(Netgear Switch) (Config)#ip routing
```

2. Configure IPv4 address on routing port 2/0/1.

```
(Netgear Switch) (Config)# interface 2/0/1
(Netgear Switch) (Interface 2/0/1)#routing
(Netgear Switch) (Interface 2/0/1)#ip address 195.1.5.2 255.255.255.0
(Netgear Switch) (Interface 2/0/1)#exit
```

3. Configure the IPv6 address on the 6to4 tunnel in the format 2002:V4ADDR::Host/16, in which where V4ADDR is the source IPv4 address of the tunnel. The prefix length for the tunnel must be 16.

```
(Netgear Switch) (Config)#interface tunnel 0
(Netgear Switch) (Interface tunnel 0)#ipv6 address 2002:c301:502::1/16
(Netgear Switch) (Interface tunnel 0)#ipv6 enable
(Netgear Switch) (Interface tunnel 0)#tunnel mode ipv6ip 6to4
(Netgear Switch) (Interface tunnel 0)#tunnel source 195.1.5.2
(Netgear Switch) (Interface tunnel 0)#exit
```

4. Configure a global IPv6 address on routing port 2/0/1.

```
(Netgear Switch) (Config)#interface 2/0/24
(Netgear Switch) (Interface 2/0/24)#routing
(Netgear Switch) (Interface 2/0/24)#ipv6 address 8888::1/64
(Netgear Switch) (Interface 2/0/24)#ipv6 enable
(Netgear Switch) (Interface 2/0/24)#exit
```

5. Create a static IPv4 route to ensure that Switch 3 can reach Switch 1. You can also use a routing protocol such as RIP or OSPF to let Switch 3 learn the route from Switch 1.

```
(Netgear Switch) (Config)#ip route 195.1.3.0 255.255.255.0 195.1.5.1
```

6. Verify the configuration.

```
(Netgear Switch) #show ipv6 route
IPv6 Routing Table - 3 entries
Codes: C - connected, S - static, 6To4 - 6to4 Route, B - BGP Derived
       O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF Ext 1, OE2 - OSPF Ext 2
       ON1 - OSPF NSSA Ext Type 1, ON2 - OSPF NSSA Ext Type 2
C       2002::/16 [0/0]
        via ::,    tunnel 0
6To4 2002:c301:302::/48 [1/0]
        via fe80::c301:501,    00h:50m:06s,    tunnel 0
C       8888::/64 [0/0]
        via ::,    2/0/24
```

## Local Browser Interface: Create a 6to4 Tunnel

You must configure Switch1, Switch2, and Switch 3.

### Local Browser Interface: Create a 6to4 Tunnel on Switch 1

1. Enable IP routing on Switch 1.
  - a. Select **Routing > IP > Basic > IP Configuration**.

A screen similar to the following displays.

| System  | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table   | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |
| <div> <div>IP</div> <div>IP Configuration</div> </div> <div> <div> <ul style="list-style-type: none"> <li>Basic</li> <li><b>IP Configuration</b></li> <li>Statistics</li> <li>Advanced</li> </ul> </div> <div> <p>Default Time to Live: 64</p> <p>Routing Mode: <input checked="" type="radio"/> Enable <input type="radio"/> Disable</p> <p>ICMP Echo Replies: <input checked="" type="radio"/> Enable <input type="radio"/> Disable</p> <p>ICMP Redirects: <input type="radio"/> Enable <input checked="" type="radio"/> Disable</p> <p>ICMP Rate Limit Interval: <input type="text" value="1000"/> (0 to 2147483647 ms)</p> <p>ICMP Rate Limit Burst Size: <input type="text" value="100"/> (1 to 200)</p> <p>Maximum Next Hops: 16</p> <p>Maximum Routes: 12288</p> <p>Maximum Static Routes: 512</p> <p>Select to configure Global Default Gateway: <input type="checkbox"/></p> <p>Global Default Gateway: <input type="text" value="0.0.0.0"/></p> </div> </div> |           |         |      |          |            |             |        |                  |      |           |                |

- b. For Routing Mode, select the **Enable** radio button.
  - c. Click **Apply**.
2. Enable IPv6 forwarding and unicast routing on Switch 1.
  - a. Select **Routing > IPv6 > Basic > Global Configuration**.

A screen similar to the following displays.

| System   | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|--|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table  | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |
| <div> <div>IPv6</div> <div>IPv6 Global Configuration</div> </div> <div> <div> <ul style="list-style-type: none"> <li>Basic</li> <li><b>Global Configuration</b></li> <li>Route Table</li> <li>Advanced</li> </ul> </div> <div> <p>IPv6 Unicast Routing: <input type="radio"/> Disable <input checked="" type="radio"/> Enable</p> <p>Hop Limit: <input type="text" value="64"/> (1 to 255)</p> <p>ICMPv6 Rate Limit Error Interval: <input type="text" value="1000"/> (0 to 2147483647 msecs)</p> <p>ICMPv6 Rate Limit Burst Size: <input type="text" value="100"/> (1 to 200)</p> </div> </div> |           |         |      |          |            |             |        |                  |      |           |                |

- b. For IPv6 Unicast Routing, select the **Enable** radio button.
  - c. Click **Apply**.
3. Create a routing interface and assign an IP address to it.

a. Select **Routing > IP > Advanced > IP Interface Configuration**.

A screen similar to the following displays.

| System                       | Switching | Routing                                   | QoS         | Security | Monitoring                      | Maintenance | Help          | Index            |                     |           |                |
|------------------------------|-----------|---|-------------|----------|---------------------------------|-------------|---------------|------------------|---------------------|-----------|----------------|
| Routing Table                | IP        | IPv6                                      | VLAN        | ARP      | RIP                             | OSPF        | OSPFv3        | Router Discovery | VRRP                | Multicast | IPv6 Multicast |
| IP Interface Configuration   |           |   |             |          |                                 |             |               |                  |                     |           |                |
| IP                           |           | 1 2 3 All                                 |             |          |                                 |             |               |                  |                     |           |                |
| • Basic                      | ⌵         |   |             |          |                                 |             |               |                  |                     |           |                |
| • Advanced                   | ⌵         |   |             |          |                                 |             |               |                  |                     |           |                |
| • IP Configuration           |           | <input type="checkbox"/> Port             | Description | VLAN ID  | IP Address Configuration Method | IP Address  | Subnet Mask   | Routing Mode     | Administrative Mode |           |                |
| • Statistics                 |           | <input type="checkbox"/> 1/0/1            |             |          | Manual                          | 195.1.3.2   | 255.255.255.0 | Enable           | Enable              |           |                |
| • IP Interface Configuration |           | <input checked="" type="checkbox"/> 1/0/1 |             |          | None                            | 0.0.0.0     | 0.0.0.0       | Disable          | Enable              |           |                |
| • Secondary IP               |           | <input type="checkbox"/> 1/0/2            |             |          | None                            | 0.0.0.0     | 0.0.0.0       | Disable          | Enable              |           |                |
|                              |           | <input type="checkbox"/> 1/0/3            |             |          | None                            | 0.0.0.0     | 0.0.0.0       | Disable          | Enable              |           |                |
|                              |           | <input type="checkbox"/> 1/0/4            |             |          | None                            | 0.0.0.0     | 0.0.0.0       | Disable          | Enable              |           |                |
|                              |           | <input type="checkbox"/> 1/0/5            |             |          | None                            | 0.0.0.0     | 0.0.0.0       | Disable          | Enable              |           |                |

b. Select the **1/0/1** check box for port 1/0/1.

The settings for port 1/0/1 display in the fields in the table heading.

c. Configure the following settings:

- In the **IP Address Configuration Method** field, select **Manual**.
- In the **IP Address** field, enter **195.1.3.2**.
- In the **Subnet Mask** field, enter **255.255.255.0**.
- In the **Routing Mode** field, select **Enable**.

d. Click **Apply**.

4. Create an IPv6 routing interface.

a. Select **Routing > IPv6 > Advanced > Interface Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  |     |     | Security | Monitoring | Maintenance      | Help | Index     |                |
|---------------|-----------|---------|------|-----|-----|----------|------------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP | RIP | OSPF     | OSPFv3     | Router Discovery | VRRP | Multicast | IPv6 Multicast |

IPv6

• Basic

• Advanced

• Global Configuration

• Interface Configuration

• Prefix Configuration

• Statistics

• Neighbour Table

• Static Route Configuration












• Route Table

• Route Preference

• Tunnel Configuration

IPv6 Interface Configuration

123All

|  | Interface | IPv6 Mode | DHCPv6 Client Mode | Stateless Address AutoConfig Mode | Routing Mode | Admin Mode | Operational Mode | MTU  |
|---|-----------|-----------|--------------------|-----------------------------------|--------------|------------|------------------|------|
|   | 1/0/3     | Enable    | Disable            | Disable                           | Enable       | Enable     | Disable          | 1500 |
|  | 1/0/1     | Disable   | Disable            | Disable                           | Enable       | Enable     | Disable          | 1500 |
|  | 1/0/2     | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500 |
|  | 1/0/3     | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500 |
|  | 1/0/4     | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500 |
|  | 1/0/5     | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500 |
|  | 1/0/6     | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500 |
|  | 1/0/7     | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500 |
|  | 1/0/8     | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500 |
|  | 1/0/9     | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500 |
|  | 1/0/10    | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500 |

b. Select the **1/0/3** check box for port 1/0/3.

The settings for port 1/0/3 display in the fields in the table heading.

- c. Configure the following settings:
  - In the **IPv6 Mode** field, select **Enable**.
  - In the **Routing Mode** field, select **Enable**.
- d. Click **Apply**.
5. Configure the IPv6 address for IPv6 routing interface 1/0/3.
  - a. Select **Routing > IPv6 > Advanced > Prefix Configuration**.

A screen similar to the following displays.

| Ipv6 Prefix  | Prefix Length | EUI64   | Valid Life Time | Preferred Life Time |
|--|---------------|---------|-----------------|---------------------|
| 2002:c301:302:1::1                                 | 64            |         |                 |                     |
| <input type="checkbox"/> fe80::6eb0:ceff:fe19:ae40 | 64            | Disable |                 |                     |

- b. From the **Interface** menu, select **1/0/3**.
 

The settings for port 1/0/3 display in the fields in the table heading.
- c. Configure the following settings:
  - In the **Ipv6 Prefix** field, enter **2002:c301:302:1::1**.
  - In the **Prefix Length** field, enter **64**.
  - In the **EUI64** field, select **Disable**.
- d. Click **Add**.
6. Create a 6to4 tunnel interface.
  - a. Select **Routing > IPv6 > Advanced > Tunnel Configuration**.

A screen similar to the following displays.



| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

| IPv6                         |   | Tunnel Configuration |        |           |                   |                            |         |                |
|------------------------------|---|----------------------|--------|-----------|-------------------|----------------------------|---------|----------------|
| • Basic                      | ▼ | Tunnel ID            | Mode   | IPv6 Mode | IPv6 Unreachables | IPv6 Address/Prefix Length | EUI64   | Source Address |
| • Advanced                   | ▲ | 0                    | 6-to-4 | Enable    |                   | 2002:c301:302::1/16        | Disable | 195.1.3.2      |
| • Global Configuration       |   |                      |        |           |                   |                            |         |                |
| • Interface Configuration    |   |                      |        |           |                   |                            |         |                |
| • Prefix Configuration       |   |                      |        |           |                   |                            |         |                |
| • Statistics                 |   |                      |        |           |                   |                            |         |                |
| • Neighbour Table            |   |                      |        |           |                   |                            |         |                |
| • Static Route Configuration |   |                      |        |           |                   |                            |         |                |
| • Route Table                |   |                      |        |           |                   |                            |         |                |
| • Route Preference           |   |                      |        |           |                   |                            |         |                |
| • Tunnel Configuration       |   |                      |        |           |                   |                            |         |                |

b. Configure the following tunnel settings:

- In the **Tunnel ID** field, select **0**.
- In the **Mode** field, select **6-to-4**.
- In the **IPv6 Mode** field, select **Enable**.
- In the **IPv6 Address/Prefix Length** field, enter **2002:c301:302::1/16**.
- In the **EUI64** field, select **Disable**.
- In the **Source Address** field, enter **195.1.3.2**.

c. Click **Add**.

7. Create a default route for nonnative IPv6 addresses.

a. Select **Routing > IPv6 > Advanced > Static Route Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

| IPv6                         |   | Configure Routes |               |                            |                       |           |            |
|------------------------------|---|------------------|---------------|----------------------------|-----------------------|-----------|------------|
| • Basic                      | ▼ | IPv6 Prefix      | Prefix Length | Next Hop IPv6 Address Type | Next Hop IPv6 Address | Interface | Preference |
| • Advanced                   | ▲ | 8888::           | 16            | Global                     | 2002:c301:502::1      |           |            |
| • Global Configuration       |   |                  |               |                            |                       |           |            |
| • Interface Configuration    |   |                  |               |                            |                       |           |            |
| • Prefix Configuration       |   |                  |               |                            |                       |           |            |
| • Statistics                 |   |                  |               |                            |                       |           |            |
| • Neighbour Table            |   |                  |               |                            |                       |           |            |
| • Static Route Configuration |   |                  |               |                            |                       |           |            |
| • Route Table                |   |                  |               |                            |                       |           |            |
| • Route Preference           |   |                  |               |                            |                       |           |            |
| • Tunnel Configuration       |   |                  |               |                            |                       |           |            |

b. Configure the following route settings:

- In the **IPv6 Prefix** field, enter **8888::**.
- In the **Prefix Length** field, enter **16**.
- In the **Next Hop IPv6 Address Type** field, select **Global**.

- In the **Next Hop IPv6 Address** field, enter **2002:c301:502::1**.
  - c. Click **Add**.
8. Create a static route for subnet 195.1.4.0/24.
- a. Select **Routing > Routing Table > Advanced > Route Configuration**.

A screen similar to the following displays.

| System           | Switching     | Routing         | QoS           | Security           | Monitoring       | Maintenance | Help   | Index            |      |           |                |
|------------------|---------------|-----------------|---------------|--------------------|------------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table    | IP            | IPv6            | VLAN          | ARP                | RIP              | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |
| Configure Routes |               |                 |               |                    |                  |             |        |                  |      |           |                |
| Route Type       |               | Network Address | Subnet Mask   | Next Hop Address   | Preference       | Description |        |                  |      |           |                |
| Static           |               | 195.1.4.0       | 255.255.255.0 | 195.1.3.1          |                  |             |        |                  |      |           |                |
| Learned Routes   |               |                 |               |                    |                  |             |        |                  |      |           |                |
| Network Address  | Subnet Mask   | Protocol        | Route Type    | Next Hop Interface | Next Hop Address | Preference  | Metric |                  |      |           |                |
| 195.1.3.0        | 255.255.255.0 | Local           | Connected     | 1/0/1              | 195.1.3.2        | 0           | 1      |                  |      |           |                |

- b. Configure the following route settings:
- In the **Network Address** field, enter **195.1.4.0**.
  - In the **Subnet Mask** field, enter **255.255.255.0**.
  - In the **Next Hop Address** field, enter **195.1.3.1**.
- c. Click **Add**.
9. Create a static route for 195.1.5.0/24.
- a. Select **Routing > Routing Table > Advanced > Route Configuration**.

A screen similar to the following displays.

| System           | Switching     | Routing         | QoS           | Security           | Monitoring       | Maintenance | Help   | Index            |      |           |                |
|------------------|---------------|-----------------|---------------|--------------------|------------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table    | IP            | IPv6            | VLAN          | ARP                | RIP              | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |
| Configure Routes |               |                 |               |                    |                  |             |        |                  |      |           |                |
| Route Type       |               | Network Address | Subnet Mask   | Next Hop Address   | Preference       | Description |        |                  |      |           |                |
| Static           |               | 195.1.5.0       | 255.255.255.0 | 195.1.3.1          |                  |             |        |                  |      |           |                |
| Static           |               | 195.1.4.0       | 255.255.255.0 | 195.1.3.1          | 1                |             |        |                  |      |           |                |
| Learned Routes   |               |                 |               |                    |                  |             |        |                  |      |           |                |
| Network Address  | Subnet Mask   | Protocol        | Route Type    | Next Hop Interface | Next Hop Address | Preference  | Metric |                  |      |           |                |
| 195.1.3.0        | 255.255.255.0 | Local           | Connected     | 1/0/1              | 195.1.3.2        | 0           | 1      |                  |      |           |                |
| 195.1.4.0        | 255.255.255.0 | Static          | Static        | 1/0/1              | 195.1.3.1        | 1           | 0      |                  |      |           |                |

- b. Configure the following route settings:
- In the **Network Address** field, enter **195.1.5.0**.
  - In the **Subnet Mask** field, enter **255.255.255.0**.
  - In the **Next Hop Address** field, enter **195.1.3.1**.
- c. Click **Add**.



## Local Browser Interface: Create a 6to4 Tunnel on Switch 2

## 1. Enable IP routing on Switch 2.

a. Select **Routing > IP > Basic > IP Configuration**.

A screen similar to the following displays.

| System  | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table   | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |
| <div> <div>IP</div> <div>IP Configuration</div> </div> <div> <div> <ul style="list-style-type: none"> <li>Basic</li> <li><b>IP Configuration</b></li> <li>Statistics</li> <li>Advanced</li> </ul> </div> <div> <p>Default Time to Live: 64</p> <p>Routing Mode: <input checked="" type="radio"/> Enable <input type="radio"/> Disable</p> <p>ICMP Echo Replies: <input checked="" type="radio"/> Enable <input type="radio"/> Disable</p> <p>ICMP Redirects: <input type="radio"/> Enable <input checked="" type="radio"/> Disable</p> <p>ICMP Rate Limit Interval: <input type="text" value="1000"/> (0 to 2147483647 ms)</p> <p>ICMP Rate Limit Burst Size: <input type="text" value="100"/> (1 to 200)</p> <p>Maximum Next Hops: 16</p> <p>Maximum Routes: 12288</p> <p>Maximum Static Routes: 512</p> <p>Select to configure Global Default Gateway: <input type="checkbox"/></p> <p>Global Default Gateway: <input type="text" value="0.0.0.0"/></p> </div> </div> |           |         |      |          |            |             |        |                  |      |           |                |

b. For Routing Mode, select the **Enable** radio button.c. Click **Apply**.

## 2. Enable IPv6 forwarding and unicast routing on Switch 2.

a. Select **Routing > IPv6 > Basic > Global Configuration**.

A screen similar to the following displays.

| System   | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|--|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table  | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |
| <div> <div>IPv6</div> <div>IPv6 Global Configuration</div> </div> <div> <div> <ul style="list-style-type: none"> <li>Basic</li> <li><b>Global Configuration</b></li> <li>Route Table</li> <li>Advanced</li> </ul> </div> <div> <p>IPv6 Unicast Routing: <input type="radio"/> Disable <input checked="" type="radio"/> Enable</p> <p>Hop Limit: <input type="text" value="64"/> (1 to 255)</p> <p>ICMPv6 Rate Limit Error Interval: <input type="text" value="1000"/> (0 to 2147483647 msecs)</p> <p>ICMPv6 Rate Limit Burst Size: <input type="text" value="100"/> (1 to 200)</p> </div> </div> |           |         |      |          |            |             |        |                  |      |           |                |

b. For IPv6 Unicast Routing, select the **Enable** radio button.c. Click **Apply**.

## 3. Create a routing interface and assign an IP address to it.

a. Select **Routing > IP > Advanced > IP Interface Configuration**.

A screen similar to the following displays.

| System                                  | Switching | Routing     | QoS     | Security                        | Monitoring | Maintenance   | Help         | Index               |                      |                 |                |
|---|-----------|-------------|---------|---------------------------------|------------|---------------|--------------|---------------------|----------------------|-----------------|----------------|
| Routing Table                           | IP        | IPv6        | VLAN    | ARP                             | RIP        | OSPF          | OSPFv3       | Router Discovery    | VRRP                 | Multicast       | IPv6 Multicast |
| <div>UpdateDeleteCancelApply</div>      |           |             |         |                                 |            |               |              |                     |                      |                 |                |
| IP Interface Configuration              |           |             |         |                                 |            |               |              |                     |                      |                 |                |
| Go To Interface <input type="text"/> Go |           |             |         |                                 |            |               |              |                     |                      |                 |                |
| • Basic                                 | 1 2 All   |             |         |                                 |            |               |              |                     |                      |                 |                |
| • Advanced                              |           |             |         |                                 |            |               |              |                     |                      |                 |                |
| • IP Configuration                      |           |             |         |                                 |            |               |              |                     |                      |                 |                |
| • Statistics                            |           |             |         |                                 |            |               |              |                     |                      |                 |                |
| • IP Interface Configuration            |           |             |         |                                 |            |               |              |                     |                      |                 |                |
| • Secondary IP                          |           |             |         |                                 |            |               |              |                     |                      |                 |                |
| <input type="checkbox"/>                | Port      | Description | VLAN ID | IP Address Configuration Method | IP Address | Subnet Mask   | Routing Mode | Administrative Mode | Link Speed Data Rate | OSPF Admin Mode | For Bmt        |
| <input checked="" type="checkbox"/>     | 2/0/1     |             |         | Manual                          | 195.14.2   | 255.255.255.0 | Enable       | Enable              | 10G Full             | Disable         | Dis            |
| <input checked="" type="checkbox"/>     | 2/0/2     |             |         | None                            | 0.0.0.0    | 0.0.0.0       | Enable       | Enable              | 10G Full             | Disable         | Dis            |
| <input type="checkbox"/>                | 2/0/3     |             |         | None                            | 0.0.0.0    | 0.0.0.0       | Disable      | Enable              | 1000 Mbps            | Disable         | Dis            |
| <input type="checkbox"/>                | 2/0/4     |             |         | None                            | 0.0.0.0    | 0.0.0.0       | Disable      | Enable              | Unknown              | Disable         | Dis            |
| <input type="checkbox"/>                | 2/0/5     |             |         | None                            | 0.0.0.0    | 0.0.0.0       | Disable      | Enable              | Unknown              | Disable         | Dis            |
| <input type="checkbox"/>                | 2/0/6     |             |         | None                            | 0.0.0.0    | 0.0.0.0       | Disable      | Enable              | Unknown              | Disable         | Dis            |
| <input type="checkbox"/>                | 2/0/7     |             |         | None                            | 0.0.0.0    | 0.0.0.0       | Disable      | Enable              | Unknown              | Disable         | Dis            |
| <input type="checkbox"/>                | 2/0/8     |             |         | None                            | 0.0.0.0    | 0.0.0.0       | Disable      | Enable              | Unknown              | Disable         | Dis            |
| <input type="checkbox"/>                | 2/0/9     |             |         | None                            | 0.0.0.0    | 0.0.0.0       | Disable      | Enable              | Unknown              | Disable         | Dis            |
| <input type="checkbox"/>                | 2/0/10    |             |         | None                            | 0.0.0.0    | 0.0.0.0       | Disable      | Enable              | Unknown              | Disable         | Dis            |
| <input type="checkbox"/>                | 2/0/11    |             |         | None                            | 0.0.0.0    | 0.0.0.0       | Disable      | Enable              | Unknown              | Disable         | Dis            |
| <input type="checkbox"/>                | 2/0/12    |             |         | None                            | 0.0.0.0    | 0.0.0.0       | Disable      | Enable              | Unknown              | Disable         | Dis            |
| <input type="checkbox"/>                | 2/0/13    |             |         | None                            | 0.0.0.0    | 0.0.0.0       | Disable      | Enable              | Unknown              | Disable         | Dis            |

b. Above the table heading, Under IP Interface Configuration, click **2**.

c. Select the **2/0/1** check box for port 2/0/1.

The settings for port 2/0/1 display in the fields in the table heading.

d. Configure the following settings:

- In the **IP Address Configuration Method** field, select **Manual**.
- In the **IP Address** field, enter **195.14.2**.
- In the **Subnet Mask** field, enter **255.255.255.0**.
- In the **Routing Mode** field, select **Enable**.

e. Click **Apply**.

4. Create an IPv6 routing interface.

a. Select **Routing > IPv6 > Advanced > Interface Configuration**.

A screen similar to the following displays.

| System                       | Switching | Routing                      | QoS       | Security           | Monitoring                        | Maintenance  | Help       | Index            |      |                                       |                    |                 |                        |    |  |
|------------------------------|-----------|------------------------------|-----------|--------------------|-----------------------------------|--------------|------------|------------------|------|---------------------------------------|--------------------|-----------------|------------------------|----|--|
| Routing Table                | IP        | IPv6                         | VLAN      | ARP                | RIP                               | OSPF         | OSPFv3     | Router Discovery | VRRP | Multicast                             | IPv6 Multicast     |                 |                        |    |  |
|                              |           |                              |           |                    |                                   |              |            |                  |      |                                       |                    | Cancel          | Apply                  |    |  |
| IPv6                         |           | IPv6 Interface Configuration |           |                    |                                   |              |            |                  |      |                                       |                    |                 |                        |    |  |
| + Basic                      |           | 1 2 3 TUNNELS All            |           |                    |                                   |              |            |                  |      |                                       |                    | Go To Interface |                        | Go |  |
| + Advanced                   |           |                              |           |                    |                                   |              |            |                  |      |                                       |                    |                 |                        |    |  |
| + Global Configuration       |           |                              |           |                    |                                   |              |            |                  |      |                                       |                    |                 |                        |    |  |
| + Interface Configuration    |           |                              |           |                    |                                   |              |            |                  |      |                                       |                    |                 |                        |    |  |
| + Prefix Configuration       |           |                              |           |                    |                                   |              |            |                  |      |                                       |                    |                 |                        |    |  |
| + Statistics                 |           |                              |           |                    |                                   |              |            |                  |      |                                       |                    |                 |                        |    |  |
| + Neighbour Table            |           |                              |           |                    |                                   |              |            |                  |      |                                       |                    |                 |                        |    |  |
| + Static Route Configuration |           |                              |           |                    |                                   |              |            |                  |      |                                       |                    |                 |                        |    |  |
| + Route Table                |           |                              |           |                    |                                   |              |            |                  |      |                                       |                    |                 |                        |    |  |
| + Route Preference           |           |                              |           |                    |                                   |              |            |                  |      |                                       |                    |                 |                        |    |  |
| + Tunnel Configuration       |           |                              |           |                    |                                   |              |            |                  |      |                                       |                    |                 |                        |    |  |
|                              |           | Interface                    | IPv6 Mode | DHCPv6 Client Mode | Stateless Address AutoConfig Mode | Routing Mode | Admin Mode | Operational Mode | MTU  | Duplicate Address Detection Transmits | Life Time Interval | Adv NS Interval | Adv Reachable Interval |    |  |
|                              |           | 2/0/3                        | Enable    | Disable            | Disable                           | Enable       | Enable     | Disable          | 1500 | 1                                     | 1800               | 0               | 0                      |    |  |
|                              |           | 2/0/1                        | Disable   | Disable            | Disable                           | Enable       | Disable    | Disable          | 1500 | 1                                     | 1800               | 0               | 0                      |    |  |
|                              |           | 2/0/2                        | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500 | 1                                     | 1800               | 0               | 0                      |    |  |
|                              |           | 2/0/3                        | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500 | 1                                     | 1800               | 0               | 0                      |    |  |
|                              |           | 2/0/4                        | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500 | 1                                     | 1800               | 0               | 0                      |    |  |
|                              |           | 2/0/5                        | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500 | 1                                     | 1800               | 0               | 0                      |    |  |
|                              |           | 2/0/6                        | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500 | 1                                     | 1800               | 0               | 0                      |    |  |
|                              |           | 2/0/7                        | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500 | 1                                     | 1800               | 0               | 0                      |    |  |
|                              |           | 2/0/8                        | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500 | 1                                     | 1800               | 0               | 0                      |    |  |
|                              |           | 2/0/9                        | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500 | 1                                     | 1800               | 0               | 0                      |    |  |
|                              |           | 2/0/10                       | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500 | 1                                     | 1800               | 0               | 0                      |    |  |

b. Above the table heading, Under IP Interface Configuration, click **2**.

c. Select the **2/0/3** check box for port 2/0/3.

The settings for port 2/0/3 display in the fields in the table heading.

- d. Configure the following settings:
  - In the **IPv6 Mode** field, select **Enable**.
  - In the **Routing Mode** field, select **Enable**.
- e. Click **Apply**.
5. Configure an IPv6 address for routing interface 2/0/3.
  - a. Select **Routing > IPv6 > Advanced > Prefix Configuration**.

A screen similar to the following displays.

| IPv6 Prefix | Prefix Length | EUI64   | Valid Life Time | Preferred Life Time | Onlink Flag | Autonomous Flag | Current State |
|-------------|---------------|---------|-----------------|---------------------|-------------|-----------------|---------------|
| 8888::1     | 64            | Disable |                 |                     |             |                 | [ACTIVE]      |

- b. From the **Interface** menu, select **2/0/3**.  
The settings for port 2/0/3 display in the fields in the table heading.
- c. Configure the following settings:
  - In the **Ipv6 Prefix** field, enter **2002:c301:402:1::1**.
  - In the **Prefix Length** field, enter **64**.
  - In the **EUI64** field, select **Disable**.
- d. Click **Add**.
6. Create a 6to4 tunnel interface.
  - a. Select **Routing > IPv6 > Advanced > Tunnel Configuration**.

A screen similar to the following displays.

| Tunnel ID | Mode   | IPv6 Mode | IPv6 Unreachables | IPv6 Address/Prefix Length | EUI64 | Source Address | Source Interface | Destination Address | Interface |
|-----------|--------|-----------|-------------------|----------------------------|-------|----------------|------------------|---------------------|-----------|
| 0         | 6-to-4 | Enable    |                   | 2002:c301:402::1/16        |       | 195.1.4.2      |                  |                     |           |

b. Configure the following tunnel settings:

- In the **Tunnel ID** field, select **0**.
- In the **Mode** field, select **6-to-4**.
- In the **IPv6 Mode** field, select **Enable**.
- In the **IPv6 Address/Prefix Length** field, enter **2002:c301:402::1/16**.
- In the **EUI64** field, select **Disable**.
- In the **Source Address** field, enter **195.1.4.2**.

c. Click **Add**.

7. Create a static route for subnet 195.1.3.0/24.

a. Select **Routing > Routing Table > Advanced > Route Configuration**.

A screen similar to the following displays.

| Route Type | Network Address | Subnet Mask   | Next Hop Address | Preference | Description |
|------------|-----------------|---------------|------------------|------------|-------------|
| Static     | 195.1.3.0       | 255.255.255.0 | 195.1.4.1        |            |             |

| Network Address | Subnet Mask   | Protocol | Route Type | Next Hop Interface | Next Hop Address | Preference | Metric |
|-----------------|---------------|----------|------------|--------------------|------------------|------------|--------|
| 195.1.4.0       | 255.255.255.0 | Local    | Connected  | 2/0/1              | 195.1.4.2        | 0          | 1      |

b. Configure the following route settings:

- In the **Network Address** field, enter **195.1.3.0**.
- In the **Subnet Mask** field, enter **255.255.255.0**.
- In the **Next Hop Address** field, enter **195.1.4.1**.

c. Click **Add**.

Local Browser Interface: Create a 6to4 Tunnel on Switch 3

1. Enable IP routing on Switch 3.

a. Select **Routing > IP > Basic > IP Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

| IP                        | IP Configuration  |
|---------------------------|---|
| • Basic                   | Default Time to Live 64   |
| • <b>IP Configuration</b> | Routing Mode <input checked="" type="radio"/> Enable <input type="radio"/> Disable      |
| • Statistics              | ICMP Echo Replies <input checked="" type="radio"/> Enable <input type="radio"/> Disable |
| • Advanced                | ICMP Redirects <input type="radio"/> Enable <input checked="" type="radio"/> Disable    |
|                           | ICMP Rate Limit Interval 1000 (0 to 2147483647 ms)                                      |
|                           | ICMP Rate Limit Burst Size 100 (1 to 200)   |
|                           | Maximum Next Hops 16  |
|                           | Maximum Routes 12288  |
|                           | Maximum Static Routes 512   |
|                           | Select to configure Global Default Gateway <input type="checkbox"/>                     |
|                           | Global Default Gateway 0.0.0.0  |

- b. For Routing Mode, select the **Enable** radio button.
  - c. Click **Apply**.
2. Enable IPv6 forwarding and unicast routing on Switch 3.
    - a. Select **Routing > IPv6 > Basic > Global Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

| IPv6                          | IPv6 Global Configuration  |
|-------------------------------|--|
| • Basic                       | IPv6 Unicast Routing <input type="radio"/> Disable <input checked="" type="radio"/> Enable |
| • <b>Global Configuration</b> | Hop Limit 64 (1 to 255)  |
| • Route Table                 | ICMPv6 Rate Limit Error Interval 1000 (0 to 2147483647 msecs)                              |
| • Advanced                    | ICMPv6 Rate Limit Burst Size 100 (1 to 200)  |

- b. For IPv6 Unicast Routing, select the **Enable** radio button.
  - c. Click **Apply**.
3. Create a routing interface and assign an IP address to it.
    - a. Select **Routing > IP > Advanced > IP Interface Configuration**.

A screen similar to the following displays.



|                                    |  |  |       |             |         |                                 |            |               |              |                     |                      |                 |         |        |  |                  |  |      |  |           |  |                |  |
|------------------------------------|--|--|-------|-------------|---------|---------------------------------|------------|---------------|--------------|---------------------|----------------------|-----------------|---------|--------|--|------------------|--|------|--|-----------|--|----------------|--|
| System                             |  | Switching  |       | Routing     |         | QoS                             |            | Security      |              | Monitoring          |                      | Maintenance     |         | Help   |  | Index            |  |      |  |           |  |                |  |
| Routing Table                      |  | IP   |       | IPv6        |         | VLAN                            |            | ARP           |              | RIP                 |                      | OSPF            |         | OSPFv3 |  | Router Discovery |  | VRRP |  | Multicast |  | IPv6 Multicast |  |
| <div>UpdateDeleteCancelApply</div> |  |  |       |             |         |                                 |            |               |              |                     |                      |                 |         |        |  |                  |  |      |  |           |  |                |  |
| IP                                 |  | IP Interface Configuration   |       |             |         |                                 |            |               |              |                     |                      |                 |         |        |  |                  |  |      |  |           |  |                |  |
| • Basic                            |  | 1 2 All  |       |             |         |                                 |            |               |              |                     |                      |                 |         |        |  |                  |  |      |  |           |  |                |  |
| • Advanced                         |  | Go To Interface <input type="text"/> <input type="button" value="Go"/> |       |             |         |                                 |            |               |              |                     |                      |                 |         |        |  |                  |  |      |  |           |  |                |  |
| • IP Configuration                 |  |  |       |             |         |                                 |            |               |              |                     |                      |                 |         |        |  |                  |  |      |  |           |  |                |  |
| • Statistics                       |  |  |       |             |         |                                 |            |               |              |                     |                      |                 |         |        |  |                  |  |      |  |           |  |                |  |
| • IP Interface Configuration       |  |  |       |             |         |                                 |            |               |              |                     |                      |                 |         |        |  |                  |  |      |  |           |  |                |  |
| • Secondary IP                     |  |  |       |             |         |                                 |            |               |              |                     |                      |                 |         |        |  |                  |  |      |  |           |  |                |  |
|                                    |  | <input type="checkbox"/>   | Port  | Description | VLAN ID | IP Address Configuration Method | IP Address | Subnet Mask   | Routing Mode | Administrative Mode | Link Speed Data Rate | OSPF Admin Mode | For Bro |        |  |                  |  |      |  |           |  |                |  |
|                                    |  | <input checked="" type="checkbox"/>                                    | 2/0/1 |             |         | Manual                          | 195.1.5.2  | 255.255.255.0 | Enable       | Enable              | 10G Full             | Disable         | Dis     |        |  |                  |  |      |  |           |  |                |  |
|                                    |  | <input type="checkbox"/>   | 2/0/2 |             | None    | 0.0.0.0                         | 0.0.0.0    | Disable       | Enable       | 10G Full            | Disable              | Dis             | Dis     |        |  |                  |  |      |  |           |  |                |  |
|                                    |  | <input type="checkbox"/>   | 2/0/3 |             | None    | 0.0.0.0                         | 0.0.0.0    | Disable       | Enable       | Unknown             | Disable              | Dis             | Dis     |        |  |                  |  |      |  |           |  |                |  |
|                                    |  | <input type="checkbox"/>   | 2/0/4 |             | None    | 0.0.0.0                         | 0.0.0.0    | Disable       | Enable       | Unknown             | Disable              | Dis             | Dis     |        |  |                  |  |      |  |           |  |                |  |
|                                    |  | <input type="checkbox"/>   | 2/0/5 |             | None    | 0.0.0.0                         | 0.0.0.0    | Disable       | Enable       | Unknown             | Disable              | Dis             | Dis     |        |  |                  |  |      |  |           |  |                |  |
|                                    |  | <input type="checkbox"/>   | 2/0/6 |             | None    | 0.0.0.0                         | 0.0.0.0    | Disable       | Enable       | Unknown             | Disable              | Dis             | Dis     |        |  |                  |  |      |  |           |  |                |  |
|                                    |  | <input type="checkbox"/>   | 2/0/7 |             | None    | 0.0.0.0                         | 0.0.0.0    | Disable       | Enable       | Unknown             | Disable              | Dis             | Dis     |        |  |                  |  |      |  |           |  |                |  |
|                                    |  | <input type="checkbox"/>   | 2/0/8 |             | None    | 0.0.0.0                         | 0.0.0.0    | Disable       | Enable       | Unknown             | Disable              | Dis             | Dis     |        |  |                  |  |      |  |           |  |                |  |

b. Above the table heading, Under IP Interface Configuration, click **2**.

c. Select the **2/0/1** check box for port 2/0/1.

The settings for port 2/0/1 display in the fields in the table heading.

d. Configure the following settings:

- In the **IP Address Configuration Method** field, select **Manual**.
- In the **IP Address** field, enter **195.1.5.2**.
- In the **Subnet Mask** field, enter **255.255.255.0**.
- In the **Routing Mode** field, select **Enable**.

e. Click **Apply**.

4. Create an IPv6 routing interface.

a. Select **Routing > IPv6 > Advanced > Interface Configuration**.

A screen similar to the following displays.

| System | Switching | Routing | QoS | Security | Monitoring | Maintenance | Help | Index |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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b. Above the table heading, Under IP Interface Configuration, click **2**.

c. Select the **2/0/24** check box for port 2/0/24.

The settings for port 2/0/24 display in the fields in the table heading.

d. Configure the following settings:

- In the **IPv6 Mode** field, select **Enable**.
- In the **Routing Mode** field, select **Enable**.

e. Click **Apply**.

5. Configure the IPv6 address for the IPv6 routing interface 2/0/24.

a. Select **Routing > IPv6 > Advanced > Prefix Configuration**.

A screen similar to the following displays.

b. From the **Interface** menu, select **2/0/24**.

The settings for port 2/0/24 display in the fields in the table heading.

c. Configure the following settings:

- In the **IPv6 Prefix** field, enter **8888::1**.
- In the **Prefix Length** field, enter **64**.
- In the **EUI64** field, select **Disable**.

d. Click **Add**.

6. Create a 6to4 tunnel interface.

a. Select **Routing > IPv6 > Advanced > Tunnel Configuration**.

A screen similar to the following displays.

b. Configure the following tunnel settings:

- In the **Tunnel ID** field, select **0**.
- In the **Mode** field, select **6-to-4**.
- In the **IPv6 Mode** field, select **Enable**.
- In the **IPv6 Address/Prefix Length** field, enter **2002::c301:402::1/16**.



- In the **EUI64** field, select **Disable**.
  - In the **Source Address** field, enter **195.1.4.2**.
- c. Click **Add**.
- d. Configure the following tunnel settings:
- In the **Tunnel ID** field, select **0**.
  - In the **Mode** field, select **6-to-4**.
  - In the **IPv6 Mode** field, select **Enable**.
  - In the **IPv6 Address/Prefix Length** field, enter **2002:c301:502::1/16**.
  - In the **EUI64** field, select **Disable**.
  - In the **Source Address** field, enter **195.1.5.2**.
- e. Click **Add**.
7. Create a static route for subnet 195.1.3.0/24.
- a. Select **Routing > Routing Table > Advanced > Route Configuration**.
- A screen similar to the following displays.

| Route Type | Network Address | Subnet Mask   | Next Hop Address | Preference | Description |
|------------|-----------------|---------------|------------------|------------|-------------|
| Static     | 195.1.3.0       | 255.255.255.0 | 195.1.5.1        |            |             |

| Network Address | Subnet Mask   | Protocol | Route Type | Next Hop Interface | Next Hop Address | Preference | Metric |
|-----------------|---------------|----------|------------|--------------------|------------------|------------|--------|
| 195.1.5.0       | 255.255.255.0 | Local    | Connected  | 2/0/1              | 195.1.5.2        | 0          | 1      |

- b. Configure the following route settings:
- In the **Network Address** field, enter **195.1.3.0**.
  - In the **Subnet Mask** field, enter **255.255.255.0**.
  - In the **Next Hop Address** field, enter **195.1.5.1**.
- c. Click **Add**.

# 29

## IPv6 Interface Configuration

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### IPv6 routing and routing VLANs

This chapter includes the following sections:

- [Create an IPv6 Routing Interface](#)
- [Create an IPv6 Routing VLAN](#)
- [Configure DHCPv6 Mode on the Routing Interface](#)

# Create an IPv6 Routing Interface

The example is shown as CLI commands and as a local browser interface procedure.

## CLI: Create an IPv6 Routing Interface

1. Enable IPV6 forwarding and unicast routing on the switch.

```
(Netgear Switch) (Config)#ipv6 forwarding
(Netgear Switch) (Config)#ipv6 unicast-routing
```

2. Assign an IPv6 address to interface 1/0/1.

```
(Netgear Switch) (Config)#interface 1/0/1
(Netgear Switch) (Interface 1/0/1)#ipv6 enable
(Netgear Switch) (Interface 1/0/1)#ipv6 address 2000::2/64
(Netgear Switch) (Interface 1/0/1)#routing
(Netgear Switch) (Interface 1/0/1)#exit
(Netgear Switch) #ping ipv6 2000::2
Send count=3, Receive count=3 from 2000::2
Average round trip time = 1.00 ms
(Netgear Switch) #show ipv6 brief
IPv6 Forwarding Mode..... Enable
IPv6 Unicast Routing Mode..... Enable
IPv6 Hop Limit..... 0
ICMPv6 Rate Limit Error Interval..... 1000 msec
ICMPv6 Rate Limit Burst Size..... 100 messages
Maximum Routes..... 12
```

```

(Netgear Switch) #show ipv6 interface 1/0/1
IPv6 is enabled
IPv6 Prefix is ..... FE80::21E:2AFF:FED9:249B/128
                                                    2000::2/64 [TENT]

Routing Mode..... Enabled
Administrative Mode..... Enabled
IPv6 Routing Operational Mode..... Enabled
Bandwidth..... 1000000 kbps
Interface Maximum Transmit Unit..... 1500
Router Duplicate Address Detection Transmits... 1
Router Advertisement NS Interval..... 0
Router Advertisement Lifetime..... 1800
Router Advertisement Reachable Time..... 0
Router Advertisement Interval..... 600
Router Advertisement Managed Config Flag..... Disabled
Router Advertisement Other Config Flag..... Disabled
Router Advertisement Suppress Flag..... Disabled
IPv6 Destination Unreachables..... Enabled

Prefix 2000::2/64
Preferred Lifetime..... 604800
Valid Lifetime..... 2592000
Onlink Flag..... Enabled
Autonomous Flag..... Enabled

```

## Local Browser Interface: Create an IPv6 Routing Interface

1. Enable IPv6 forwarding and unicast routing on the switch.
  - a. Select **Routing > IPv6 > Basic > Global Configuration**.

A screen similar to the following displays.

| System   | Switching | Routing  | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|--|-----------|--|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table  | IP        | IPv6   | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |
| <div> <div>IPv6</div> <div>IPv6 Global Configuration</div> </div>  |           |  |      |          |            |             |        |                  |      |           |                |
| <div> <div>Basic</div> <div>Global Configuration</div> <div>Route Table</div> <div>Advanced</div> </div> |           | <div> <div>IPv6 Unicast Routing</div> <div> <input type="radio"/> Disable <input checked="" type="radio"/> Enable           </div> <div>Hop Limit</div> <div> <input type="text" value="64"/> (1 to 255)           </div> <div>ICMPv6 Rate Limit Error Interval</div> <div> <input type="text" value="1000"/> (0 to 2147483647 msecs)           </div> <div>ICMPv6 Rate Limit Burst Size</div> <div> <input type="text" value="100"/> (1 to 200)           </div> </div> |      |          |            |             |        |                  |      |           |                |

- b. For IPv6 Unicast Routing, select the **Enable** radio button.
  - c. For IPv6 Forwarding, select the **Enable** radio button.
  - d. Click **Apply**.
2. Enable IPv6 routing on interface 1/0/1.
  - a. Select **Routing > IPv6 > Advanced > Interface Configuration**.

A screen similar to the following displays.

| Interface | IPv6 Mode | DHCPv6 Client Mode | Stateless Address AutoConfig Mode | Routing Mode | Admin Mode | Operational Mode | MTU  | Duplicate Address Detection | Transmits | Life Time Interval | Adv MS Interval |
|-----------|-----------|--------------------|-----------------------------------|--------------|------------|------------------|------|-----------------------------|-----------|--------------------|-----------------|
| 1/0/1     | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500 | 1                           |           | 1800               | 0               |
| 1/0/2     | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500 | 1                           |           | 1800               | 0               |
| 1/0/3     | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500 | 1                           |           | 1800               | 0               |
| 1/0/4     | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500 | 1                           |           | 1800               | 0               |
| 1/0/5     | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500 | 1                           |           | 1800               | 0               |
| 1/0/6     | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500 | 1                           |           | 1800               | 0               |
| 1/0/7     | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500 | 1                           |           | 1800               | 0               |
| 1/0/8     | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500 | 1                           |           | 1800               | 0               |
| 1/0/9     | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500 | 1                           |           | 1800               | 0               |

- b. Under IPv6 Interface Configuration, scroll down and select the Interface **1/0/1** check box.

Now 1/0/1 appears in the Interface field at the top.

- c. In the IPv6 Mode field, select **Enable**.

- d. Click **Apply** to save the settings.

3. Assign an IPv6 address to the routing interface.

- a. Select **Routing > IPv6 > Advanced > Prefix Configuration**.

A screen similar to the following displays.

| IPv6 Prefix | Prefix Length | EUI64   | Valid Life Time | Preferred Life Time |
|-------------|---------------|---------|-----------------|---------------------|
| 2000::2     | 64            | Disable |                 |                     |

- b. In the Interface list, select **1/0/1**.
- c. In the IPv6 Prefix field, enter **2000::2**.
- d. In the Length field, enter **64**.
- e. In the EUI64 field, select **Disable**.
- f. Click **Add**.

# Create an IPv6 Routing VLAN

The example is shown as CLI commands and as a local browser interface procedure.

## CLI: Create an IPv6 Routing VLAN

1. Create a routing VLAN with VLAN ID 500.

```
Netgear Switch) (Vlan)#vlan 500
Netgear Switch) (Vlan)#vlan routing 500
Netgear Switch) (Vlan)#exit
```

2. Add interface 1/0/1 to VLAN 500.

```
Netgear Switch) #config
Netgear Switch) (Config)#interface 1/0/1
Netgear Switch) (Interface 1/0/1)#vlan participation include 500
Netgear Switch) (Interface 1/0/1)#vlan participation pvid 500
Netgear Switch) (Interface 1/0/1)#exit
```

3. Assign IPv6 address 2000::1/64 to VLAN 500 and enable IPv6 routing.

```
Netgear Switch) (Config)#interface vlan 0/4/1
Netgear Switch) (Interface 0/4/1)#routing
Netgear Switch) (Interface 0/4/1)#ipv6 enable
Netgear Switch) (Interface 0/4/1)#ipv6 address 2000::1/64
Netgear Switch) (Interface 0/4/1)#exit
```

**4. Enable IPV6 forwarding and unicast routing on the switch.**

```

(Netgear Switch) (Config)#ipv6 forwarding
(Netgear Switch) (Config)#ipv6 unicast-routing
(Netgear Switch) #ping ipv6 2000::2
Send count=3, Receive count=3 from 2000::2
Average round trip time = 1.00 ms
(Netgear Switch) #show ipv6 brief
IPv6 Forwarding Mode..... Enable
IPv6 Unicast Routing Mode..... Enable
IPv6 Hop Limit..... 0
ICMPv6 Rate Limit Error Interval..... 1000 msec
ICMPv6 Rate Limit Burst Size..... 100 messages
Maximum Routes..... 128
(Netgear Switch) #show ipv6 interface 0/4/1
IPv6 is enabled
IPv6 Prefix is ..... FE80::21E:2AFF:FED9:249B/128
                        2000::1/64

Routing Mode..... Enabled
Administrative Mode..... Enabled
IPv6 Routing Operational Mode..... Enabled
Bandwidth..... 10000 kbps
Interface Maximum Transmit Unit..... 1500
Router Duplicate Address Detection Transmits... 1
Router Advertisement NS Interval..... 0
Router Advertisement Lifetime..... 1800
Router Advertisement Reachable Time..... 0
Router Advertisement Interval..... 600
Router Advertisement Managed Config Flag..... Disabled
Router Advertisement Other Config Flag..... Disabled
Router Advertisement Suppress Flag..... Disabled
IPv6 Destination Unreachables..... Enabled
Prefix 2000::1/64
Preferred Lifetime..... 604800
Valid Lifetime..... 2592000
Onlink Flag..... Enabled
Autonomous Flag..... Enabled

```



# Local Browser Interface: Create an IPv6 VLAN Routing Interface

1. Create VLAN 500.
  - a. Select **Switching > VLAN > Basic > VLAN Configuration**.

A screen similar to the following displays.

| VLAN ID | VLAN Name | VLAN Type | Make Static                         |
|---------|-----------|-----------|-------------------------------------|
| 500     |           | Static    | <input checked="" type="checkbox"/> |

- b. In the **VLAN ID** field, enter **500**.
  - c. In the **VLAN Type** field, select **Static**.
  - d. Click **Add**.
2. Add ports to VLAN 500.
  - a. Select **Switching > VLAN > Advanced > VLAN Membership**.

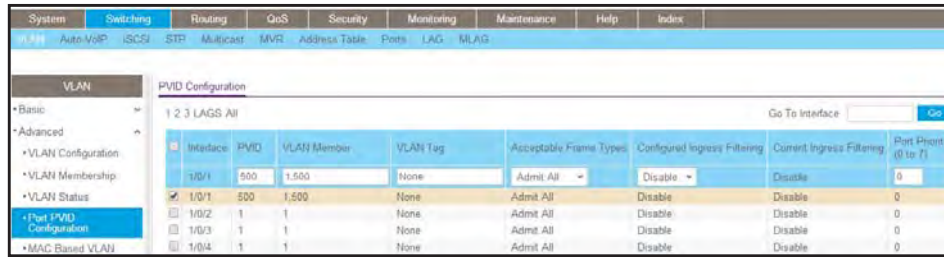
A screen similar to the following displays.

| Unit   | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 |
|--------|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Unit 1 | U |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |

- b. In the **VLAN ID** list, select **500**.
  - c. Click **Unit 1**. The ports display.
  - d. Click the gray box under port **1** until **U** displays, indicating that the egress packet is untagged for the port.
  - e. Click **Apply**.
3. Specify the PVID on port 1/0/1.

- a. Select **Switching > VLAN > Advanced > Port PVID Configuration**.

A screen similar to the following displays.



- b. Under PVID Configuration, scroll down and select the Interface **1/0/1** check box.  
 c. In the **PVID (1 to 4093)** field, enter **500**.  
 d. Click **Apply** to save the settings.

4. Enable IPv6 forwarding and unicast routing on the switch.

- a. Select **Routing > IPv6 > Basic > Global Configuration**.

A screen similar to the following displays.

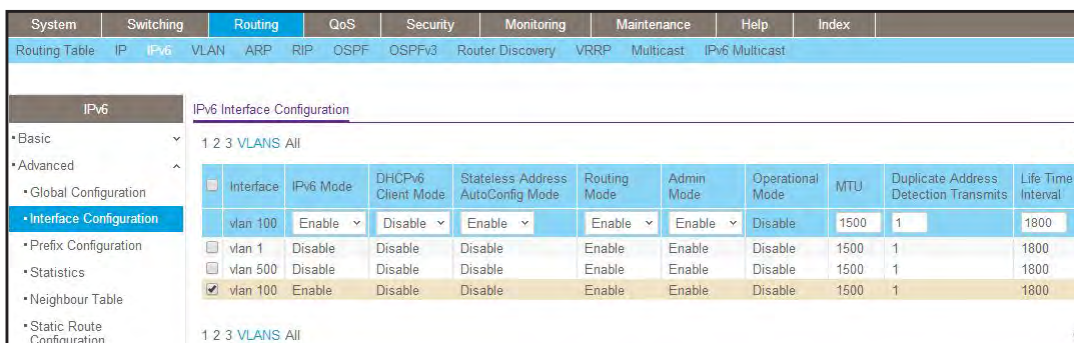


- b. For IPv6 Unicast Routing, select the **Enable** radio button.  
 c. For IPv6 Forwarding, select the **Enable** radio button.  
 d. Click **Apply**.

5. Enable IPv6 routing on the VLAN.

- a. Select **Routing > IPv6 > Advanced > Interface Configuration**.

A screen similar to the following displays.



- b. Click **VLANS**. The logical VLAN interface 0/4/2 displays.  
 c. Select the **0/4/2** check box.

- d. Under IPv6 Interface Configuration, in the **IPv6 Mode** field, select **Enable**.
  - e. Click **Apply**.
6. Assign an IPv6 address to the routing VLAN.
- a. Select **Routing > IPv6 > Advanced > Prefix Configuration**.

A screen similar to the following displays.

| IPv6 Prefix               | Prefix Length | EUI64   | Valid Life Time | Preferred Life Time |
|---------------------------|---------------|---------|-----------------|---------------------|
| 2000::1                   | 64            | Disable |                 |                     |
| fe80::220c:c8ff:fe4d:9575 | 64            | Disable |                 |                     |

- b. In the **Interface** field, select **0/4/2**.
- c. In the **IPv6 Prefix** field, enter **2000::1**.
- d. In the **Length** field, enter **64**.
- e. In the **EUI64** field, select **Disable**.
- f. Click **Add**.

## Configure DHCPv6 Mode on the Routing Interface

The routing interface supports DHCPv6 mode, which can get the IPv6 address from a DHCPv6 server (address allocation).

---

**Note:** Before you enable DHCPv6 mode, you must disable IPv6 unicast mode globally.

---

## CLI: Configure DHCPv6 mode on routing interface

### 1. Enable IPv6 unicast globally.

```
(Netgear Switch) (Config)#ipv6 unicast-routing
```

### 2. Enable DHCPv6 on the interface 1/0/23.

```
(Netgear Switch) (Config)#interface 1/0/23
(Netgear Switch) (Interface 1/0/23)#routing
(Netgear Switch) (Interface 1/0/23)#ipv6 enable
(Netgear Switch) (Interface 1/0/23)#ipv6 address dhcp
(Netgear Switch) (Interface 1/0/23)
```

### 3. Show the ipv6 address assigned from 1/0/23.

```
(Netgear Switch) #show ipv6 interface 1/0/23
IPv6 is enabled
IPv6 Prefix is ..... FE80::E291:F5FF:FE06:2BF6/128
                  2000::1D5C:7CFE:828F:8144/128 [DHCP]
Routing Mode..... Enabled
IPv6 Enable Mode..... Enabled
Administrative Mode..... Enabled
IPv6 Operational Mode..... Enabled
Bandwidth..... 1000000 kbps
Interface Maximum Transmit Unit..... 1500
Router Duplicate Address Detection Transmits... 1
Address DHCP Mode..... Enabled
Router Advertisement NS Interval..... 0
Router Advertisement Lifetime..... 1800
Router Advertisement Reachable Time..... 0
Router Advertisement Interval..... 600
Router Advertisement Managed Config Flag..... Disabled
Router Advertisement Other Config Flag..... Disabled
Router Advertisement Router Preference..... medium
Router Advertisement Suppress Flag..... Disabled
IPv6 Destination Unreachables..... Enabled
```

## Local Browser Interface: Configure DHCPv6 mode on routing interface

1. Enable IPv6 unicast globally.
  - a. Select **Routing > IPv6 > Basic > Global Configuration**.

A screen similar to the following displays.

| System  | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |     |           |                |
|---|-----------|---------|------|----------|------------|-------------|--------|------------------|-----|-----------|----------------|
| Routing Table   | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRP | Multicast | IPv6 Multicast |
| <div>IPv6</div> <div>IPv6 Global Configuration</div> <div>           *Basic           <div>IPv6 Unicast Routing</div> <div> <input type="radio"/> Disable               <input checked="" type="radio"/> Enable             </div> </div> <div>           *Global Configuration           <div>Hop Limit</div> <div> <input type="text" value="64"/> <div>(1 to 255)</div> </div> </div> <div>           *Route Table           <div>ICMPv6 Rate Limit Error Interval</div> <div> <input type="text" value="1000"/> <div>(0 to 2147483647 msecs)</div> </div> </div> <div>           *Advanced           <div>ICMPv6 Rate Limit Burst Size</div> <div> <input type="text" value="100"/> <div>(1 to 200)</div> </div> </div> |           |         |      |          |            |             |        |                  |     |           |                |

- b. For IPv6 Unicast Routing, select the **Enable** radio button.
  - c. Click **Apply** to apply the setting.
2. Enable DHCPv6 on the interface 1/0/23.
  - a. Select **Routing > IPv6 > Advanced > Interface Configuration**.

A screen similar to the following displays.

| System  | Switching | Routing            | QoS                               | Security     | Monitoring | Maintenance      | Help   | Index                                 |                    |                    |                |           |           |                    |                                   |              |            |                  |     |                                       |                    |                    |        |        |        |         |         |        |         |      |   |      |   |       |        |         |         |        |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |        |        |         |      |   |      |   |
|---|-----------|--------------------|-----------------------------------|--------------|------------|------------------|--------|---------------------------------------|--------------------|--------------------|----------------|-----------|-----------|--------------------|-----------------------------------|--------------|------------|------------------|-----|---------------------------------------|--------------------|--------------------|--------|--------|--------|---------|---------|--------|---------|------|---|------|---|-------|--------|---------|---------|--------|--------|---------|------|---|------|---|-------|---------|---------|---------|---------|--------|---------|------|---|------|---|-------|---------|---------|---------|---------|--------|---------|------|---|------|---|-------|---------|---------|---------|---------|--------|---------|------|---|------|---|-------|---------|---------|---------|---------|--------|---------|------|---|------|---|-------|---------|---------|---------|---------|--------|---------|------|---|------|---|-------|---------|---------|---------|---------|--------|---------|------|---|------|---|-------|---------|---------|---------|---------|--------|---------|------|---|------|---|-------|---------|---------|---------|--------|--------|---------|------|---|------|---|
| Routing Table   | IP        | IPv6               | VLAN                              | ARP          | RIP        | OSPF             | OSPFv3 | Router Discovery                      | VRP                | Multicast          | IPv6 Multicast |           |           |                    |                                   |              |            |                  |     |                                       |                    |                    |        |        |        |         |         |        |         |      |   |      |   |       |        |         |         |        |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |        |        |         |      |   |      |   |
| <div>IPv6</div> <div>IPv6 Interface Configuration</div> <div>           1 2 3 VLANs All           <div>Go To Interface</div> </div> <table border="1"> <thead> <tr> <th>Interface</th> <th>IPv6 Mode</th> <th>DHCPv6 Client Mode</th> <th>Stateless Address AutoConfig Mode</th> <th>Routing Mode</th> <th>Admin Mode</th> <th>Operational Mode</th> <th>MTU</th> <th>Duplicate Address Detection Transmits</th> <th>Link Time Interval</th> <th>Advertise Interval</th> </tr> </thead> <tbody> <tr> <td>1/0/23</td> <td>Enable</td> <td>Enable</td> <td>Disable</td> <td>Disable</td> <td>Enable</td> <td>Disable</td> <td>1500</td> <td>1</td> <td>1800</td> <td>0</td> </tr> <tr> <td>1/0/1</td> <td>Enable</td> <td>Disable</td> <td>Disable</td> <td>Enable</td> <td>Enable</td> <td>Disable</td> <td>1500</td> <td>1</td> <td>1800</td> <td>0</td> </tr> <tr> <td>1/0/2</td> <td>Disable</td> <td>Disable</td> <td>Disable</td> <td>Disable</td> <td>Enable</td> <td>Disable</td> <td>1500</td> <td>1</td> <td>1800</td> <td>0</td> </tr> <tr> <td>1/0/3</td> <td>Disable</td> <td>Disable</td> <td>Disable</td> <td>Disable</td> <td>Enable</td> <td>Disable</td> <td>1500</td> <td>1</td> <td>1800</td> <td>0</td> </tr> <tr> <td>1/0/4</td> <td>Disable</td> <td>Disable</td> <td>Disable</td> <td>Disable</td> <td>Enable</td> <td>Disable</td> <td>1500</td> <td>1</td> <td>1800</td> <td>0</td> </tr> <tr> <td>1/0/5</td> <td>Disable</td> <td>Disable</td> <td>Disable</td> <td>Disable</td> <td>Enable</td> <td>Disable</td> <td>1500</td> <td>1</td> <td>1800</td> <td>0</td> </tr> <tr> <td>1/0/6</td> <td>Disable</td> <td>Disable</td> <td>Disable</td> <td>Disable</td> <td>Enable</td> <td>Disable</td> <td>1500</td> <td>1</td> <td>1800</td> <td>0</td> </tr> <tr> <td>1/0/7</td> <td>Disable</td> <td>Disable</td> <td>Disable</td> <td>Disable</td> <td>Enable</td> <td>Disable</td> <td>1500</td> <td>1</td> <td>1800</td> <td>0</td> </tr> <tr> <td>1/0/8</td> <td>Disable</td> <td>Disable</td> <td>Disable</td> <td>Disable</td> <td>Enable</td> <td>Disable</td> <td>1500</td> <td>1</td> <td>1800</td> <td>0</td> </tr> <tr> <td>1/0/9</td> <td>Disable</td> <td>Disable</td> <td>Disable</td> <td>Enable</td> <td>Enable</td> <td>Disable</td> <td>1500</td> <td>1</td> <td>1800</td> <td>0</td> </tr> </tbody> </table> |           |                    |                                   |              |            |                  |        |                                       |                    |                    |                | Interface | IPv6 Mode | DHCPv6 Client Mode | Stateless Address AutoConfig Mode | Routing Mode | Admin Mode | Operational Mode | MTU | Duplicate Address Detection Transmits | Link Time Interval | Advertise Interval | 1/0/23 | Enable | Enable | Disable | Disable | Enable | Disable | 1500 | 1 | 1800 | 0 | 1/0/1 | Enable | Disable | Disable | Enable | Enable | Disable | 1500 | 1 | 1800 | 0 | 1/0/2 | Disable | Disable | Disable | Disable | Enable | Disable | 1500 | 1 | 1800 | 0 | 1/0/3 | Disable | Disable | Disable | Disable | Enable | Disable | 1500 | 1 | 1800 | 0 | 1/0/4 | Disable | Disable | Disable | Disable | Enable | Disable | 1500 | 1 | 1800 | 0 | 1/0/5 | Disable | Disable | Disable | Disable | Enable | Disable | 1500 | 1 | 1800 | 0 | 1/0/6 | Disable | Disable | Disable | Disable | Enable | Disable | 1500 | 1 | 1800 | 0 | 1/0/7 | Disable | Disable | Disable | Disable | Enable | Disable | 1500 | 1 | 1800 | 0 | 1/0/8 | Disable | Disable | Disable | Disable | Enable | Disable | 1500 | 1 | 1800 | 0 | 1/0/9 | Disable | Disable | Disable | Enable | Enable | Disable | 1500 | 1 | 1800 | 0 |
| Interface   | IPv6 Mode | DHCPv6 Client Mode | Stateless Address AutoConfig Mode | Routing Mode | Admin Mode | Operational Mode | MTU    | Duplicate Address Detection Transmits | Link Time Interval | Advertise Interval |                |           |           |                    |                                   |              |            |                  |     |                                       |                    |                    |        |        |        |         |         |        |         |      |   |      |   |       |        |         |         |        |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |        |        |         |      |   |      |   |
| 1/0/23  | Enable    | Enable             | Disable                           | Disable      | Enable     | Disable          | 1500   | 1                                     | 1800               | 0                  |                |           |           |                    |                                   |              |            |                  |     |                                       |                    |                    |        |        |        |         |         |        |         |      |   |      |   |       |        |         |         |        |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |        |        |         |      |   |      |   |
| 1/0/1   | Enable    | Disable            | Disable                           | Enable       | Enable     | Disable          | 1500   | 1                                     | 1800               | 0                  |                |           |           |                    |                                   |              |            |                  |     |                                       |                    |                    |        |        |        |         |         |        |         |      |   |      |   |       |        |         |         |        |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |        |        |         |      |   |      |   |
| 1/0/2   | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500   | 1                                     | 1800               | 0                  |                |           |           |                    |                                   |              |            |                  |     |                                       |                    |                    |        |        |        |         |         |        |         |      |   |      |   |       |        |         |         |        |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |        |        |         |      |   |      |   |
| 1/0/3   | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500   | 1                                     | 1800               | 0                  |                |           |           |                    |                                   |              |            |                  |     |                                       |                    |                    |        |        |        |         |         |        |         |      |   |      |   |       |        |         |         |        |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |        |        |         |      |   |      |   |
| 1/0/4   | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500   | 1                                     | 1800               | 0                  |                |           |           |                    |                                   |              |            |                  |     |                                       |                    |                    |        |        |        |         |         |        |         |      |   |      |   |       |        |         |         |        |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |        |        |         |      |   |      |   |
| 1/0/5   | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500   | 1                                     | 1800               | 0                  |                |           |           |                    |                                   |              |            |                  |     |                                       |                    |                    |        |        |        |         |         |        |         |      |   |      |   |       |        |         |         |        |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |        |        |         |      |   |      |   |
| 1/0/6   | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500   | 1                                     | 1800               | 0                  |                |           |           |                    |                                   |              |            |                  |     |                                       |                    |                    |        |        |        |         |         |        |         |      |   |      |   |       |        |         |         |        |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |        |        |         |      |   |      |   |
| 1/0/7   | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500   | 1                                     | 1800               | 0                  |                |           |           |                    |                                   |              |            |                  |     |                                       |                    |                    |        |        |        |         |         |        |         |      |   |      |   |       |        |         |         |        |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |        |        |         |      |   |      |   |
| 1/0/8   | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500   | 1                                     | 1800               | 0                  |                |           |           |                    |                                   |              |            |                  |     |                                       |                    |                    |        |        |        |         |         |        |         |      |   |      |   |       |        |         |         |        |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |        |        |         |      |   |      |   |
| 1/0/9   | Disable   | Disable            | Disable                           | Enable       | Enable     | Disable          | 1500   | 1                                     | 1800               | 0                  |                |           |           |                    |                                   |              |            |                  |     |                                       |                    |                    |        |        |        |         |         |        |         |      |   |      |   |       |        |         |         |        |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |        |        |         |      |   |      |   |

- b. Scroll down and select the **interface 1/0/23** check box.

Now 1/0/23 appears in the Interface field at the top.
- c. Enter the following information:
    - In the IPv6 Mode field, select **Enable**.
    - In the Routing Mode field, select **Enable**.
    - In the DHCPv6 Client Mode field, select **Enable**.
  - d. Click **Apply** to apply the settings.
3. Show the ipv6 address assigned from 1/0/23.
  - a. Select **Routing > IPv6 > Advanced > Prefix Configuration**.

A screen similar to the following displays.

| IPv6 Prefix               | Prefix Length | EUI64   | Valid Life Time | Preferred Life Time |
|---------------------------|---------------|---------|-----------------|---------------------|
| fe80::220c:c8ff:fe4d:9575 | 64            | Disable |                 |                     |

- b. Scroll down and select the **interface 1/0/23**. You can see the IPv6 address assigned by the DHCPv6 server.

# 30

## 30 PIM

---

### Protocol Independent Multicast

This chapter includes the following sections:

- Protocol Independent Multicast Concepts
- PIM-DM
- PIM-SM



# Protocol Independent Multicast Concepts

The PIM protocol can be configured to operate on IPv4 and IPv6 networks. Separate CLI commands are provided for IPv4 and IPv6 operation; however, most configuration options are common to both protocols. Therefore, this section describes only IPv4 configuration; IPv6 configuration is similar to IPv4.

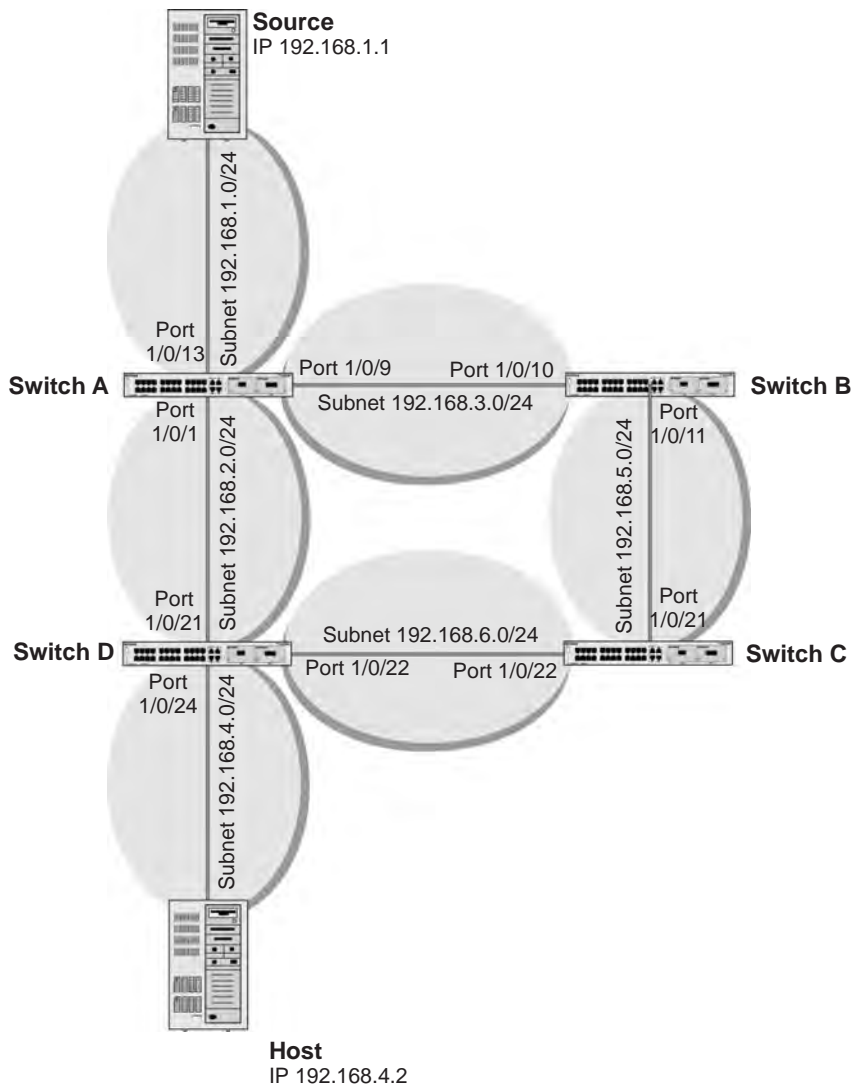
Multicast protocols are used to deliver multicast packets from one source to multiple receivers. They facilitate better bandwidth utilization, and use less host and router processing, making them ideal for usage in applications such as video and audio conferencing, whiteboard tools, and stock distribution tickers. PIM is a widely used multicast routing protocol. Protocol Independent Multicast (PIM) is a standard multicast routing protocol that provides scalable inter-domain multicast routing across the Internet, independent of the mechanisms provided by any particular unicast routing protocol. There are two types of PIM:

- PIM-Dense Mode (PIM-DM)
- PIM-Sparse Mode (PIM-SM)

## PIM-DM

PIM-DM is appropriate for:

- Densely distributed receivers
- A ratio of few senders to many receivers (due to frequent flooding)
- High volume of multicast traffic
- Constant stream of traffic



**Figure 59. Configuring and Using PIM-DM**

PIM-DM uses the existing unicast routing table and join, prune, and graft mechanism to build a tree. PIM-DM creates source-based shortest-path distribution trees that use reverse path forwarding (RPF). PIM-DM cannot be used to build a shared distribution tree, as PIM-SM can. PIM-DM assumes that when a sender starts sending data, all downstream routers and hosts want to receive a multicast datagram. PIM-DM initially floods multicast traffic throughout the network. Routers that do not have any downstream neighbors prune back the unwanted traffic. Apart from prune messages, PIM-DM uses two other types of messages: graft messages and assert messages. Graft messages are used whenever a new host wants to join the group. Assert messages are used to shut off duplicate flows onto the same multi-access network.

To minimize the repeated flooding of datagrams and subsequent pruning associated with a particular (S,G) pair, PIM-DM uses a state refresh message. This message is sent by the routers directly connected to the source and is propagated throughout the network. When

received by a router on its RPF interface, the state refresh message causes an existing prune state to be refreshed. State refresh messages are generated periodically by the router directly attached to the source. There are two versions of PIM-DM. Version 2 does not use IGMP messages; instead, it uses a message that is encapsulated in IP packets with protocol number 103. In version 2, the Hello message is introduced in place of the query message.

## CLI: Configure PIM-DM

### PIM-DM on Switch A

1. Enable IP routing on the switch.

```
(Netgear Switch) #configure  
(Netgear Switch) (Config)#ip routing
```

2. Enable pimdm on the switch.

```
(Netgear Switch) (Config)#ip pim dense
```

3. Enable IP multicast forwarding on the switch.

```
(Netgear Switch) (Config)#ip multicast
```

4. Enable RIP to build the unicast IP routing table.

```
(Netgear Switch) (Config)#interface 1/0/1  
(Netgear Switch) (Interface 1/0/1)#routing  
(Netgear Switch) (Interface 1/0/1)#ip address 192.168.2.2 255.255.255.0  
(Netgear Switch) (Interface 1/0/1)#ip rip
```

## 5. Enable PIM-DM on the interface.

```
(Netgear Switch) (Interface 1/0/1)#ip pim
(Netgear Switch) (Interface 1/0/1)#exit

(Netgear Switch) (Config)#interface 1/0/9
(Netgear Switch) (Interface 1/0/9)#routing
(Netgear Switch) (Interface 1/0/9)#ip address 192.168.3.1 255.255.255.0
(Netgear Switch) (Interface 1/0/9)#ip rip
(Netgear Switch) (Interface 1/0/9)#ip pim
(Netgear Switch) (Interface 1/0/9)#exit

(Netgear Switch) (Config)#interface 1/0/13
(Netgear Switch) (Interface 1/0/13)#routing
(Netgear Switch) (Interface 1/0/13)#ip address 192.168.1.2 255.255.255.0
(Netgear Switch) (Interface 1/0/13)#ip rip
(Netgear Switch) (Interface 1/0/13)#ip pim
(Netgear Switch) (Interface 1/0/13)#exit
```

## PIM-DM on Switch B

```
(Netgear Switch) #configure
(Netgear Switch) (Config)#ip routing
(Netgear Switch) (Config)#ip pim
(Netgear Switch) (Config)#ip multicast
(Netgear Switch) (Config)#interface 1/0/10
(Netgear Switch) (Interface 1/0/10)#routing
(Netgear Switch) (Interface 1/0/10)#ip address 192.168.3.2 255.255.255.0
(Netgear Switch) (Interface 1/0/10)#ip rip
(Netgear Switch) (Interface 1/0/10)#ip pim
(Netgear Switch) (Interface 1/0/10)#exit
(Netgear Switch) (Config)#interface 1/0/11
(Netgear Switch) (Interface 1/0/11)#routing
(Netgear Switch) (Interface 1/0/11)#ip address 192.168.5.1 255.255.255.0
(Netgear Switch) (Interface 1/0/11)#ip rip
(Netgear Switch) (Interface 1/0/11)#ip pim
(Netgear Switch) (Interface 1/0/11)#exit
```

## PIM-DM on Switch C

```
(Netgear Switch) #configure
(Netgear Switch) (Config)#ip routing
(Netgear Switch) (Config)#ip pim dense
(Netgear Switch) (Config)#ip multicast
(Netgear Switch) (Config)#interface 1/0/21
(Netgear Switch) (Interface 1/0/21)#routing
(Netgear Switch) (Interface 1/0/21)#ip address 192.168.5.2 255.255.255.0
(Netgear Switch) (Interface 1/0/21)#ip rip
(Netgear Switch) (Interface 1/0/21)#ip pim
(Netgear Switch) (Interface 1/0/21)#exit
(Netgear Switch) (Config)#interface 1/0/22
(Netgear Switch) (Interface 1/0/22)#routing
(Netgear Switch) (Interface 1/0/22)#ip address 192.168.6.1 255.255.255.0
(Netgear Switch) (Interface 1/0/22)#ip rip
(Netgear Switch) (Interface 1/0/22)#ip pim
(Netgear Switch) (Interface 1/0/22)#exit
```

## PIM-DM on Switch D

### 1. Enable IGMP on the switch.

```
(Netgear Switch) #configure
(Netgear Switch) (Config)#ip routing
(Netgear Switch) (Config)#ip pim dense
(Netgear Switch) (Config)#ip igmp
```

```
(Netgear Switch) (Config)#ip multicast
(Netgear Switch) (Config)#interface 1/0/21
(Netgear Switch) (Interface 1/0/21)#routing
(Netgear Switch) (Interface 1/0/21)#ip address 192.168.2.1 255.255.255.0
(Netgear Switch) (Interface 1/0/21)#ip rip
(Netgear Switch) (Interface 1/0/21)#ip pim
(Netgear Switch) (Interface 1/0/21)#exit

(Netgear Switch) (Config)#interface 1/0/22
(Netgear Switch) (Interface 1/0/22)#routing
(Netgear Switch) (Interface 1/0/22)#ip address 192.168.6.2 255.255.255.0
(Netgear Switch) (Interface 1/0/22)#ip rip
(Netgear Switch) (Interface 1/0/22)#ip pim
(Netgear Switch) (Interface 1/0/22)#exit
```

**2. Enable IGMP on port 1/0/24.**

```
(Netgear Switch) (Config)#interface 1/0/24
(Netgear Switch) (Interface 1/0/24)#routing
(Netgear Switch) (Interface 1/0/24)#ip pim
(Netgear Switch) (Interface 1/0/24)#ip igmp
(Netgear Switch) (Interface 1/0/24)#ip rip
(Netgear Switch) (Interface 1/0/24)#ip address 192.168.4.1 255.255.255.0
(Netgear Switch) (Interface 1/0/24)#exit
```

**3. PIM-DM builds the multicast routes table on each switch.**

```
(A) #show ip mcast mroute summary
      Multicast Route Table Summary
      Incoming      Outgoing
Source IP      Group IP      Protocol      Interface      Interface List
-----
192.168.1.1    225.1.1.1    PIMDM        1/0/13        1/0/1

(B) #show ip mcast mroute summary
      Multicast Route Table Summary
      Incoming      Outgoing
Source IP      Group IP      Protocol      Interface      Interface List
-----
192.168.1.1    225.1.1.1    PIMDM        1/0/10

(C) #show ip mcast mroute summary
      Multicast Route Table Summary
      Incoming      Outgoing
Source IP      Group IP      Protocol      Interface      Interface List
-----
192.168.1.1    225.1.1.1    PIMDM        1/0/21

(D) #show ip mcast mroute summary
      Multicast Route Table Summary
      Incoming      Outgoing
Source IP      Group IP      Protocol      Interface      Interface List
-----
192.168.1.1    225.1.1.1    PIMDM        7/0/21        7/0/24
```

# Local Browser Interface: Configure PIM-DM

## PIM-DM on Switch A

### 1. Enable IP routing on the switch.

#### a. Select **Routing > IP > Basic > IP Configuration**.

A screen similar to the following displays.

| System  | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table   | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |
| <div> <div>IP</div> <div>IP Configuration</div> </div>  |           |         |      |          |            |             |        |                  |      |           |                |
| <div> <div>Basic</div> <div>Default Time to Live</div> <div>64</div> </div>   |           |         |      |          |            |             |        |                  |      |           |                |
| <div> <div>IP Configuration</div> <div>Routing Mode</div> <div> <input type="radio"/> Enable           <input checked="" type="radio"/> Disable         </div> </div> |           |         |      |          |            |             |        |                  |      |           |                |
| <div> <div>Statistics</div> <div>ICMP Echo Replies</div> <div> <input type="radio"/> Enable           <input checked="" type="radio"/> Disable         </div> </div>  |           |         |      |          |            |             |        |                  |      |           |                |
| <div> <div>Advanced</div> <div>ICMP Redirects</div> <div> <input type="radio"/> Enable           <input checked="" type="radio"/> Disable         </div> </div>       |           |         |      |          |            |             |        |                  |      |           |                |
| <div> <div>ICMP Rate Limit Interval</div> <div>1000</div> <div>(0 to 2147483647 ms)</div> </div>  |           |         |      |          |            |             |        |                  |      |           |                |
| <div> <div>ICMP Rate Limit Burst Size</div> <div>100</div> <div>(1 to 200)</div> </div>   |           |         |      |          |            |             |        |                  |      |           |                |

#### b. For Routing Mode, select the **Enable** radio button.

#### c. Click **Apply**.

### 2. Configure 1/0/1 as a routing port and assign an IP address to it.

#### a. Select **Routing > IP > Advanced > IP Interface Configuration**.

A screen similar to the following displays.

| System   | Switching   | Routing | QoS                             | Security    | Monitoring    | Maintenance  | Help                | Index            |      |           |                |      |             |         |                                 |            |             |              |                     |       |  |  |        |             |               |        |        |   |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
|--|-------------|---------|---------------------------------|-------------|---------------|--------------|---------------------|------------------|------|-----------|----------------|------|-------------|---------|---------------------------------|------------|-------------|--------------|---------------------|-------|--|--|--------|-------------|---------------|--------|--------|---|--|--|------|---------|---------|---------|--------|--------------------------------|--|--|------|---------|---------|---------|--------|
| Routing Table  | IP          | IPv6    | VLAN                            | ARP         | RIP           | OSPF         | OSPFv3              | Router Discovery | VRRP | Multicast | IPv6 Multicast |      |             |         |                                 |            |             |              |                     |       |  |  |        |             |               |        |        |   |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <div> <div>IP</div> <div>IP Interface Configuration</div> </div>   |             |         |                                 |             |               |              |                     |                  |      |           |                |      |             |         |                                 |            |             |              |                     |       |  |  |        |             |               |        |        |   |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <div> <div>Basic</div> <div>1 2 3 VLANs All</div> </div>   |             |         |                                 |             |               |              |                     |                  |      |           |                |      |             |         |                                 |            |             |              |                     |       |  |  |        |             |               |        |        |   |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <div> <div>Advanced</div> <div> <table border="1"> <thead> <tr> <th>Port</th> <th>Description</th> <th>VLAN ID</th> <th>IP Address Configuration Method</th> <th>IP Address</th> <th>Subnet Mask</th> <th>Routing Mode</th> <th>Administrative Mode</th> </tr> </thead> <tbody> <tr> <td>1/0/1</td> <td></td> <td></td> <td>Manual</td> <td>192.168.2.2</td> <td>255.255.255.0</td> <td>Enable</td> <td>Enable</td> </tr> <tr> <td><input checked="" type="checkbox"/> 1/0/1</td> <td></td> <td></td> <td>None</td> <td>0.0.0.0</td> <td>0.0.0.0</td> <td>Disable</td> <td>Enable</td> </tr> <tr> <td><input type="checkbox"/> 1/0/2</td> <td></td> <td></td> <td>None</td> <td>0.0.0.0</td> <td>0.0.0.0</td> <td>Disable</td> <td>Enable</td> </tr> </tbody> </table> </div> </div> |             |         |                                 |             |               |              |                     |                  |      |           |                | Port | Description | VLAN ID | IP Address Configuration Method | IP Address | Subnet Mask | Routing Mode | Administrative Mode | 1/0/1 |  |  | Manual | 192.168.2.2 | 255.255.255.0 | Enable | Enable | <input checked="" type="checkbox"/> 1/0/1 |  |  | None | 0.0.0.0 | 0.0.0.0 | Disable | Enable | <input type="checkbox"/> 1/0/2 |  |  | None | 0.0.0.0 | 0.0.0.0 | Disable | Enable |
| Port   | Description | VLAN ID | IP Address Configuration Method | IP Address  | Subnet Mask   | Routing Mode | Administrative Mode |                  |      |           |                |      |             |         |                                 |            |             |              |                     |       |  |  |        |             |               |        |        |   |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| 1/0/1  |             |         | Manual                          | 192.168.2.2 | 255.255.255.0 | Enable       | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |       |  |  |        |             |               |        |        |   |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input checked="" type="checkbox"/> 1/0/1  |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |       |  |  |        |             |               |        |        |   |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input type="checkbox"/> 1/0/2   |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |       |  |  |        |             |               |        |        |   |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <div> <div>IP Interface Configuration</div> </div>   |             |         |                                 |             |               |              |                     |                  |      |           |                |      |             |         |                                 |            |             |              |                     |       |  |  |        |             |               |        |        |   |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |

#### b. Under IP Interface Configuration, scroll down and select the Port **1/0/1** check box. Now 1/0/1 appears in the Port field at the top.

#### c. Enter the following information:

- In the **IP Address** field, enter **192.168.2.2**.
- In the **Subnet Mask** field, enter **255.255.255.0**.
- In the **Routing Mode** field, select **Enable**.

#### d. Click **Apply** to save the settings.

### 3. Configure 1/0/9 as a routing port and assign an IP address to it.

#### a. Select **Routing > IP > Advanced > IP Interface Configuration**.



A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

| IP                           |                 | IP Interface Configuration |  |  |  |  |  |  |
|------------------------------|-----------------|----------------------------|--|--|--|--|--|--|
| • Basic                      | 1 2 3 VLANs All |                            |  |  |  |  |  |  |
| • Advanced                   |                 |                            |  |  |  |  |  |  |
| • IP Configuration           |                 |                            |  |  |  |  |  |  |
| • Statistics                 |                 |                            |  |  |  |  |  |  |
| • IP Interface Configuration |                 |                            |  |  |  |  |  |  |
| • Secondary IP               |                 |                            |  |  |  |  |  |  |

| Port                                      | Description | VLAN ID | IP Address Configuration Method | IP Address  | Subnet Mask   | Routing Mode | Administrative Mode |
|---|-------------|---------|---------------------------------|-------------|---------------|--------------|---------------------|
| <input checked="" type="checkbox"/> 1/0/9 |             |         | Manual                          | 192.168.3.1 | 255.255.255.0 | Enable       | Enable              |
| <input type="checkbox"/> 1/0/1            |             |         | Manual                          | 192.168.2.2 | 255.255.255.0 | Enable       | Enable              |
| <input type="checkbox"/> 1/0/2            |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 1/0/3            |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 1/0/4            |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 1/0/5            |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 1/0/6            |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 1/0/7            |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 1/0/8            |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |
| <input checked="" type="checkbox"/> 1/0/9 |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |

- b. Scroll down and select the Port **1/0/9** check box.

Now 1/0/9 appears in the Port field at the top.

- c. Enter the following information:

- In the **IP Address** field, enter **192.168.3.1**.
- In the **Subnet Mask** field, enter **255.255.255.0**.
- In the **Routing Mode** field, select **Enable**.

- d. Click **Apply**.

4. Configure 1/0/13 as a routing port and assign an IP address to it.

- a. Select **Routing > IP > Advanced > IP Interface Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

| IP                           |        | IP Interface Configuration |  |  |  |  |  |  |
|------------------------------|--------|----------------------------|--|--|--|--|--|--|
| • Basic                      | 1/0/13 |                            |  |  |  |  |  |  |
| • Advanced                   |        |                            |  |  |  |  |  |  |
| • IP Configuration           |        |                            |  |  |  |  |  |  |
| • Statistics                 |        |                            |  |  |  |  |  |  |
| • IP Interface Configuration |        |                            |  |  |  |  |  |  |
| • Secondary IP               |        |                            |  |  |  |  |  |  |

| Port                                       | Description | VLAN ID | IP Address Configuration Method | IP Address  | Subnet Mask   | Routing Mode | Administrative Mode |
|--|-------------|---------|---------------------------------|-------------|---------------|--------------|---------------------|
| <input checked="" type="checkbox"/> 1/0/13 |             |         | Manual                          | 192.168.1.2 | 255.255.255.0 | Enable       | Enable              |
| <input type="checkbox"/> 1/0/1             |             |         | Manual                          | 192.168.2.2 | 255.255.255.0 | Enable       | Enable              |
| <input type="checkbox"/> 1/0/2             |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 1/0/3             |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 1/0/4             |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 1/0/5             |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 1/0/6             |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 1/0/7             |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 1/0/8             |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 1/0/9             |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 1/0/10            |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 1/0/11            |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 1/0/12            |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |
| <input checked="" type="checkbox"/> 1/0/13 |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |

- b. Under IP Interface Configuration, scroll down and select the Port **1/0/13** check box.

Now 1/0/13 appears in the Port field at the top.

- c. Enter the following information:

- In the **IP Address** field, enter **192.168.1.2**.
- In the **Subnet Mask** field, enter **255.255.255.0**.
- In the **Routing Mode** field, select **Enable**.

- d. Click **Apply** to save the settings.
5. Enable RIP on the interface 1/0/1.
  - a. Select **Routing > RIP > Advanced > Interface Configuration**.

A screen similar to the following displays.

| System  | Switching    | Routing         | QoS      | Security            | Monitoring         | Maintenance           | Help   | Index            |      |           |                |           |              |                 |          |                     |                    |                       |                                |       |       |        |      |  |   |   |       |      |         |      |  |   |                                |       |      |         |      |  |   |
|---|--------------|-----------------|----------|---------------------|--------------------|-----------------------|--------|------------------|------|-----------|----------------|-----------|--------------|-----------------|----------|---------------------|--------------------|-----------------------|--------------------------------|-------|-------|--------|------|--|---|---|-------|------|---------|------|--|---|--------------------------------|-------|------|---------|------|--|---|
| Routing Table   | IP           | IPv6            | VLAN     | ARP                 | RIP                | OSPF                  | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |           |              |                 |          |                     |                    |                       |                                |       |       |        |      |  |   |   |       |      |         |      |  |   |                                |       |      |         |      |  |   |
| <div> <div>RIP</div> <div>RIP Interface Configuration</div> </div>  |              |                 |          |                     |                    |                       |        |                  |      |           |                |           |              |                 |          |                     |                    |                       |                                |       |       |        |      |  |   |   |       |      |         |      |  |   |                                |       |      |         |      |  |   |
| <div> <div>1 2 3 VLANs All</div> <table border="1"> <thead> <tr> <th>Interface</th> <th>Send Version</th> <th>Receive Version</th> <th>RIP Mode</th> <th>Authentication Type</th> <th>Authentication Key</th> <th>Authentication Key ID</th> </tr> </thead> <tbody> <tr> <td><input type="checkbox"/> 1/0/1</td> <td>RIP-2</td> <td>RIP-2</td> <td>Enable</td> <td>None</td> <td></td> <td>0</td> </tr> <tr> <td><input checked="" type="checkbox"/> 1/0/1</td> <td>RIP-2</td> <td>Both</td> <td>Disable</td> <td>None</td> <td></td> <td>0</td> </tr> <tr> <td><input type="checkbox"/> 1/0/2</td> <td>RIP-2</td> <td>Both</td> <td>Disable</td> <td>None</td> <td></td> <td>0</td> </tr> </tbody> </table> </div> |              |                 |          |                     |                    |                       |        |                  |      |           |                | Interface | Send Version | Receive Version | RIP Mode | Authentication Type | Authentication Key | Authentication Key ID | <input type="checkbox"/> 1/0/1 | RIP-2 | RIP-2 | Enable | None |  | 0 | <input checked="" type="checkbox"/> 1/0/1 | RIP-2 | Both | Disable | None |  | 0 | <input type="checkbox"/> 1/0/2 | RIP-2 | Both | Disable | None |  | 0 |
| Interface   | Send Version | Receive Version | RIP Mode | Authentication Type | Authentication Key | Authentication Key ID |        |                  |      |           |                |           |              |                 |          |                     |                    |                       |                                |       |       |        |      |  |   |   |       |      |         |      |  |   |                                |       |      |         |      |  |   |
| <input type="checkbox"/> 1/0/1  | RIP-2        | RIP-2           | Enable   | None                |                    | 0                     |        |                  |      |           |                |           |              |                 |          |                     |                    |                       |                                |       |       |        |      |  |   |   |       |      |         |      |  |   |                                |       |      |         |      |  |   |
| <input checked="" type="checkbox"/> 1/0/1   | RIP-2        | Both            | Disable  | None                |                    | 0                     |        |                  |      |           |                |           |              |                 |          |                     |                    |                       |                                |       |       |        |      |  |   |   |       |      |         |      |  |   |                                |       |      |         |      |  |   |
| <input type="checkbox"/> 1/0/2  | RIP-2        | Both            | Disable  | None                |                    | 0                     |        |                  |      |           |                |           |              |                 |          |                     |                    |                       |                                |       |       |        |      |  |   |   |       |      |         |      |  |   |                                |       |      |         |      |  |   |

- b. In the **Interface** list, select **1/0/1**.
- c. For RIP Admin Mode, select the **Enable** radio button.
- d. Click **Apply**.
6. Enable RIP on interface 1/0/9.
  - a. Select **Routing > RIP > Advanced > Interface Configuration**.

A screen similar to the following displays.

| System  | Switching    | Routing         | QoS      | Security            | Monitoring         | Maintenance           | Help   | Index            |      |           |                |           |              |                 |          |                     |                    |                       |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |   |       |      |         |      |  |   |
|---|--------------|-----------------|----------|---------------------|--------------------|-----------------------|--------|------------------|------|-----------|----------------|-----------|--------------|-----------------|----------|---------------------|--------------------|-----------------------|--------------------------------|-------|------|---------|------|--|---|--------------------------------|-------|------|---------|------|--|---|--------------------------------|-------|------|---------|------|--|---|--------------------------------|-------|------|---------|------|--|---|--------------------------------|-------|------|---------|------|--|---|--------------------------------|-------|------|---------|------|--|---|--------------------------------|-------|------|---------|------|--|---|--------------------------------|-------|------|---------|------|--|---|---|-------|------|---------|------|--|---|
| Routing Table   | IP           | IPv6            | VLAN     | ARP                 | RIP                | OSPF                  | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |           |              |                 |          |                     |                    |                       |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |   |       |      |         |      |  |   |
| <div> <div>RIP</div> <div>RIP Interface Configuration</div> </div>  |              |                 |          |                     |                    |                       |        |                  |      |           |                |           |              |                 |          |                     |                    |                       |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |   |       |      |         |      |  |   |
| <div> <div>1 2 3 VLANs All</div> <table border="1"> <thead> <tr> <th>Interface</th> <th>Send Version</th> <th>Receive Version</th> <th>RIP Mode</th> <th>Authentication Type</th> <th>Authentication Key</th> <th>Authentication Key ID</th> </tr> </thead> <tbody> <tr> <td><input type="checkbox"/> 1/0/1</td> <td>RIP-2</td> <td>Both</td> <td>Disable</td> <td>None</td> <td></td> <td>0</td> </tr> <tr> <td><input type="checkbox"/> 1/0/2</td> <td>RIP-2</td> <td>Both</td> <td>Disable</td> <td>None</td> <td></td> <td>0</td> </tr> <tr> <td><input type="checkbox"/> 1/0/3</td> <td>RIP-2</td> <td>Both</td> <td>Disable</td> <td>None</td> <td></td> <td>0</td> </tr> <tr> <td><input type="checkbox"/> 1/0/4</td> <td>RIP-2</td> <td>Both</td> <td>Disable</td> <td>None</td> <td></td> <td>0</td> </tr> <tr> <td><input type="checkbox"/> 1/0/5</td> <td>RIP-2</td> <td>Both</td> <td>Disable</td> <td>None</td> <td></td> <td>0</td> </tr> <tr> <td><input type="checkbox"/> 1/0/6</td> <td>RIP-2</td> <td>Both</td> <td>Disable</td> <td>None</td> <td></td> <td>0</td> </tr> <tr> <td><input type="checkbox"/> 1/0/7</td> <td>RIP-2</td> <td>Both</td> <td>Disable</td> <td>None</td> <td></td> <td>0</td> </tr> <tr> <td><input type="checkbox"/> 1/0/8</td> <td>RIP-2</td> <td>Both</td> <td>Disable</td> <td>None</td> <td></td> <td>0</td> </tr> <tr> <td><input checked="" type="checkbox"/> 1/0/9</td> <td>RIP-2</td> <td>Both</td> <td>Disable</td> <td>None</td> <td></td> <td>0</td> </tr> </tbody> </table> </div> |              |                 |          |                     |                    |                       |        |                  |      |           |                | Interface | Send Version | Receive Version | RIP Mode | Authentication Type | Authentication Key | Authentication Key ID | <input type="checkbox"/> 1/0/1 | RIP-2 | Both | Disable | None |  | 0 | <input type="checkbox"/> 1/0/2 | RIP-2 | Both | Disable | None |  | 0 | <input type="checkbox"/> 1/0/3 | RIP-2 | Both | Disable | None |  | 0 | <input type="checkbox"/> 1/0/4 | RIP-2 | Both | Disable | None |  | 0 | <input type="checkbox"/> 1/0/5 | RIP-2 | Both | Disable | None |  | 0 | <input type="checkbox"/> 1/0/6 | RIP-2 | Both | Disable | None |  | 0 | <input type="checkbox"/> 1/0/7 | RIP-2 | Both | Disable | None |  | 0 | <input type="checkbox"/> 1/0/8 | RIP-2 | Both | Disable | None |  | 0 | <input checked="" type="checkbox"/> 1/0/9 | RIP-2 | Both | Disable | None |  | 0 |
| Interface   | Send Version | Receive Version | RIP Mode | Authentication Type | Authentication Key | Authentication Key ID |        |                  |      |           |                |           |              |                 |          |                     |                    |                       |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |   |       |      |         |      |  |   |
| <input type="checkbox"/> 1/0/1  | RIP-2        | Both            | Disable  | None                |                    | 0                     |        |                  |      |           |                |           |              |                 |          |                     |                    |                       |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |   |       |      |         |      |  |   |
| <input type="checkbox"/> 1/0/2  | RIP-2        | Both            | Disable  | None                |                    | 0                     |        |                  |      |           |                |           |              |                 |          |                     |                    |                       |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |   |       |      |         |      |  |   |
| <input type="checkbox"/> 1/0/3  | RIP-2        | Both            | Disable  | None                |                    | 0                     |        |                  |      |           |                |           |              |                 |          |                     |                    |                       |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |   |       |      |         |      |  |   |
| <input type="checkbox"/> 1/0/4  | RIP-2        | Both            | Disable  | None                |                    | 0                     |        |                  |      |           |                |           |              |                 |          |                     |                    |                       |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |   |       |      |         |      |  |   |
| <input type="checkbox"/> 1/0/5  | RIP-2        | Both            | Disable  | None                |                    | 0                     |        |                  |      |           |                |           |              |                 |          |                     |                    |                       |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |   |       |      |         |      |  |   |
| <input type="checkbox"/> 1/0/6  | RIP-2        | Both            | Disable  | None                |                    | 0                     |        |                  |      |           |                |           |              |                 |          |                     |                    |                       |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |   |       |      |         |      |  |   |
| <input type="checkbox"/> 1/0/7  | RIP-2        | Both            | Disable  | None                |                    | 0                     |        |                  |      |           |                |           |              |                 |          |                     |                    |                       |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |   |       |      |         |      |  |   |
| <input type="checkbox"/> 1/0/8  | RIP-2        | Both            | Disable  | None                |                    | 0                     |        |                  |      |           |                |           |              |                 |          |                     |                    |                       |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |   |       |      |         |      |  |   |
| <input checked="" type="checkbox"/> 1/0/9   | RIP-2        | Both            | Disable  | None                |                    | 0                     |        |                  |      |           |                |           |              |                 |          |                     |                    |                       |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |   |       |      |         |      |  |   |

- b. In the **Interface** field, select **1/0/9**.
- c. For RIP Admin Mode, select the **Enable** radio button.
- d. Click **Apply**.
7. Enable RIP on interface 1/0/13.
  - a. Select **Routing > RIP > Advanced > Interface Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

| RIP  |                 | RIP Interface Configuration |          |                     |                    |                       |  |  |
|--|-----------------|-----------------------------|----------|---------------------|--------------------|-----------------------|--|--|
| • Basic                                    | 1 2 3 VLANs All |                             |          |                     |                    |                       |  |  |
| • Advanced                                 |                 |                             |          |                     |                    |                       |  |  |
| • RIP Configuration                        |                 |                             |          |                     |                    |                       |  |  |
| • Interface Configuration                  |                 |                             |          |                     |                    |                       |  |  |
| • Route Redistribution                     |                 |                             |          |                     |                    |                       |  |  |
| Interface                                  | Send Version    | Receive Version             | RIP Mode | Authentication Type | Authentication Key | Authentication Key ID |  |  |
| <input checked="" type="checkbox"/> 1/0/13 | RIP-2           | RIP-2                       | Enable   | None                |                    | 0                     |  |  |
| <input type="checkbox"/> 1/0/1             | RIP-2           | Both                        | Disable  | None                |                    | 0                     |  |  |
| <input type="checkbox"/> 1/0/2             | RIP-2           | Both                        | Disable  | None                |                    | 0                     |  |  |
| <input type="checkbox"/> 1/0/3             | RIP-2           | Both                        | Disable  | None                |                    | 0                     |  |  |
| <input type="checkbox"/> 1/0/4             | RIP-2           | Both                        | Disable  | None                |                    | 0                     |  |  |
| <input type="checkbox"/> 1/0/5             | RIP-2           | Both                        | Disable  | None                |                    | 0                     |  |  |
| <input type="checkbox"/> 1/0/6             | RIP-2           | Both                        | Disable  | None                |                    | 0                     |  |  |
| <input type="checkbox"/> 1/0/7             | RIP-2           | Both                        | Disable  | None                |                    | 0                     |  |  |
| <input type="checkbox"/> 1/0/8             | RIP-2           | Both                        | Disable  | None                |                    | 0                     |  |  |
| <input type="checkbox"/> 1/0/9             | RIP-2           | Both                        | Disable  | None                |                    | 0                     |  |  |
| <input type="checkbox"/> 1/0/10            | RIP-2           | Both                        | Disable  | None                |                    | 0                     |  |  |
| <input type="checkbox"/> 1/0/11            | RIP-2           | Both                        | Disable  | None                |                    | 0                     |  |  |
| <input type="checkbox"/> 1/0/12            | RIP-2           | Both                        | Disable  | None                |                    | 0                     |  |  |

- b. In the **Interface** list, select **1/0/13**.
- c. For RIP Admin Mode, select the **Enable** radio button.
- d. Click **Apply**.

8. Enable multicast globally.

- a. Select **Routing > Multicast > Global Configuration**.

A screen similar to the following displays.

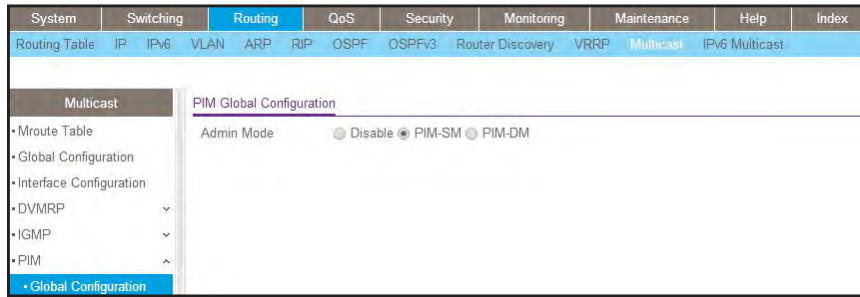
| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

| Multicast                      |                           | Global Configuration  |  |
|--------------------------------|---------------------------|---|--|
| • Route Table                  | Admin Mode                | <input type="radio"/> Disable <input checked="" type="radio"/> Enable |  |
| • Global Configuration         | Protocol State            | Non-Operational   |  |
| • Interface Configuration      | Table Maximum Entry Count | 2048  |  |
| • DVMRP                        | Protocol                  | No Protocol Enabled   |  |
| • IGMP                         | Table Entry Count         | 0   |  |
| • PIM                          |                           |   |  |
| • Static Routes Configuration  |                           |   |  |
| • Admin Boundary Configuration |                           |   |  |

- b. For Admin Mode, select the **Enable** radio button.
  - c. Click **Apply**.
9. Enable PIM-DM globally.
- a. Select **Routing > Multicast > PIM > Global Configuration**.

A screen similar to the following displays.



- b. For PIM Protocol Type, select the **PIM-DM** radio button.
  - c. For Admin Mode, select the **Enable** radio button.
  - d. Click **Apply**.
10. Enable PIM-DM on interfaces 1/0/1, 1/0/9, and 1/0/13.
- a. Select **Routing > Multicast > PIM > Interface Configuration**.

A screen similar to the following displays.

| Interface | Admin Mode | Protocol State  | IP Address  | Hello Interval | Join/Prune Interval | BSR Timer | DR Priority | Designated Router | Neighbor Count |
|-----------|------------|-----------------|-------------|----------------|---------------------|-----------|-------------|-------------------|----------------|
| 1/0/1     | Disable    | Non-Operational | 192.168.2.2 | 30             | 60                  | Disable   | 1           |                   |                |
| 1/0/2     | Disable    | Non-Operational | 0.0.0.0     | 30             | 60                  | Disable   | 1           |                   |                |
| 1/0/3     | Disable    | Non-Operational | 0.0.0.0     | 30             | 60                  | Disable   | 1           |                   |                |
| 1/0/4     | Disable    | Non-Operational | 0.0.0.0     | 30             | 60                  | Disable   | 1           |                   |                |
| 1/0/5     | Disable    | Non-Operational | 0.0.0.0     | 30             | 60                  | Disable   | 1           |                   |                |
| 1/0/6     | Disable    | Non-Operational | 0.0.0.0     | 30             | 60                  | Disable   | 1           |                   |                |
| 1/0/7     | Disable    | Non-Operational | 0.0.0.0     | 30             | 60                  | Disable   | 1           |                   |                |
| 1/0/8     | Disable    | Non-Operational | 0.0.0.0     | 30             | 60                  | Disable   | 1           |                   |                |
| 1/0/9     | Disable    | Non-Operational | 192.168.3.1 | 30             | 60                  | Disable   | 1           |                   |                |
| 1/0/10    | Disable    | Non-Operational | 0.0.0.0     | 30             | 60                  | Disable   | 1           |                   |                |
| 1/0/11    | Disable    | Non-Operational | 0.0.0.0     | 30             | 60                  | Disable   | 1           |                   |                |
| 1/0/12    | Disable    | Non-Operational | 0.0.0.0     | 30             | 60                  | Disable   | 1           |                   |                |
| 1/0/13    | Disable    | Non-Operational | 192.168.1.2 | 30             | 60                  | Disable   | 1           |                   |                |
| 1/0/14    | Disable    | Non-Operational | 0.0.0.0     | 30             | 60                  | Disable   | 1           |                   |                |

- b. Under PIM Interface Configuration, scroll down and select the **1/0/1**, **1/0/9**, and **1/0/13** check boxes.
- c. In the **Admin Mode** field, select **Enable**.
- d. Click **Apply** to save the settings.

PIM-DM on Switch B:

1. Enable IP routing on the switch.
  - a. Select **Routing > IP > Basic > IP Configuration**.



A screen similar to the following displays.

| System  | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table   | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |
| <div> <div>IP</div> <div>IP Configuration</div> </div> <div> <div>• Basic</div> <div>• IP Configuration</div> <div>• Statistics</div> <div>• Advanced</div> </div> <div> <div>Default Time to Live</div> <div>64</div> </div> <div> <div>Routing Mode</div> <div> <input checked="" type="radio"/> Enable           <input type="radio"/> Disable         </div> </div> <div> <div>ICMP Echo Replies</div> <div> <input checked="" type="radio"/> Enable           <input type="radio"/> Disable         </div> </div> <div> <div>ICMP Redirects</div> <div> <input checked="" type="radio"/> Enable           <input type="radio"/> Disable         </div> </div> <div> <div>ICMP Rate Limit Interval</div> <div> <input type="text" value="1000"/> <small>(0 to 2147483647 ms)</small> </div> </div> <div> <div>ICMP Rate Limit Burst Size</div> <div> <input type="text" value="100"/> <small>(1 to 200)</small> </div> </div> |           |         |      |          |            |             |        |                  |      |           |                |

b. For Routing Mode, select the **Enable** radio button.

c. Click **Apply**.

2. Configure 1/0/10 as a routing port and assign an IP address to it.

a. Select **Routing > IP > Advanced > IP Interface Configuration**.

A screen similar to the following displays.

| System  | Switching   | Routing | QoS                             | Security    | Monitoring    | Maintenance  | Help                | Index            |      |           |                |      |             |         |                                 |            |             |              |                     |  |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
|---|-------------|---------|---------------------------------|-------------|---------------|--------------|---------------------|------------------|------|-----------|----------------|------|-------------|---------|---------------------------------|------------|-------------|--------------|---------------------|--|--|--|--------|-------------|---------------|--------|--------|--------------------------------|--|--|------|---------|---------|---------|--------|--------------------------------|--|--|------|---------|---------|---------|--------|--------------------------------|--|--|------|---------|---------|---------|--------|
| Routing Table   | IP          | IPv6    | VLAN                            | ARP         | RIP           | OSPF         | OSPFv3              | Router Discovery | VRRP | Multicast | IPv6 Multicast |      |             |         |                                 |            |             |              |                     |  |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <div> <div>IP</div> <div>IP Interface Configuration</div> </div> <div> <div>• Basic</div> <div>• Advanced</div> <div>• IP Configuration</div> <div>• Statistics</div> <div>• IP Interface Configuration</div> <div>• Secondary IP</div> </div> <div> <div>1 2 3 VLANs All</div> <table border="1"> <thead> <tr> <th>Port</th> <th>Description</th> <th>VLAN ID</th> <th>IP Address Configuration Method</th> <th>IP Address</th> <th>Subnet Mask</th> <th>Routing Mode</th> <th>Administrative Mode</th> </tr> </thead> <tbody> <tr> <td><input checked="" type="checkbox"/> 1/0/10</td> <td></td> <td></td> <td>Manual</td> <td>192.168.3.2</td> <td>255.255.255.0</td> <td>Enable</td> <td>Enable</td> </tr> <tr> <td><input type="checkbox"/> 1/0/1</td> <td></td> <td></td> <td>None</td> <td>0.0.0.0</td> <td>0.0.0.0</td> <td>Disable</td> <td>Enable</td> </tr> <tr> <td><input type="checkbox"/> 1/0/2</td> <td></td> <td></td> <td>None</td> <td>0.0.0.0</td> <td>0.0.0.0</td> <td>Disable</td> <td>Enable</td> </tr> <tr> <td><input type="checkbox"/> 1/0/3</td> <td></td> <td></td> <td>None</td> <td>0.0.0.0</td> <td>0.0.0.0</td> <td>Disable</td> <td>Enable</td> </tr> </tbody> </table> </div> |             |         |                                 |             |               |              |                     |                  |      |           |                | Port | Description | VLAN ID | IP Address Configuration Method | IP Address | Subnet Mask | Routing Mode | Administrative Mode | <input checked="" type="checkbox"/> 1/0/10 |  |  | Manual | 192.168.3.2 | 255.255.255.0 | Enable | Enable | <input type="checkbox"/> 1/0/1 |  |  | None | 0.0.0.0 | 0.0.0.0 | Disable | Enable | <input type="checkbox"/> 1/0/2 |  |  | None | 0.0.0.0 | 0.0.0.0 | Disable | Enable | <input type="checkbox"/> 1/0/3 |  |  | None | 0.0.0.0 | 0.0.0.0 | Disable | Enable |
| Port  | Description | VLAN ID | IP Address Configuration Method | IP Address  | Subnet Mask   | Routing Mode | Administrative Mode |                  |      |           |                |      |             |         |                                 |            |             |              |                     |  |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input checked="" type="checkbox"/> 1/0/10  |             |         | Manual                          | 192.168.3.2 | 255.255.255.0 | Enable       | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |  |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input type="checkbox"/> 1/0/1  |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |  |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input type="checkbox"/> 1/0/2  |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |  |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input type="checkbox"/> 1/0/3  |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |  |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |

b. Scroll down and select the Port **1/0/10** check box.

Now 1/0/10 appears in the Port field at the top.

c. Enter the following information:

- In the **IP Address** field, enter **192.168.3.2**.
- In the **Subnet Mask** field, enter **255.255.255.0**.
- In the **Routing Mode** field, select **Enable**.

d. Click **Apply** to save the settings.

3. Configure 1/0/11 as a routing port and assign an IP address to it.

a. Select **Routing > IP > Advanced > IP Interface Configuration**.

A screen similar to the following displays.

| System   | Switching   | Routing | QoS                             | Security    | Monitoring    | Maintenance  | Help                | Index            |      |           |                |      |             |         |                                 |            |             |              |                     |                                 |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
|--|-------------|---------|---------------------------------|-------------|---------------|--------------|---------------------|------------------|------|-----------|----------------|------|-------------|---------|---------------------------------|------------|-------------|--------------|---------------------|---------------------------------|--|--|--------|-------------|---------------|--------|--------|--------------------------------|--|--|------|---------|---------|---------|--------|--------------------------------|--|--|------|---------|---------|---------|--------|--------------------------------|--|--|------|---------|---------|---------|--------|
| Routing Table  | IP          | IPv6    | VLAN                            | ARP         | RIP           | OSPF         | OSPFv3              | Router Discovery | VRRP | Multicast | IPv6 Multicast |      |             |         |                                 |            |             |              |                     |                                 |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <div> <div>IP</div> <div>IP Interface Configuration</div> </div> <div> <div>• Basic</div> <div>• Advanced</div> <div>• IP Configuration</div> <div>• Statistics</div> <div>• IP Interface Configuration</div> <div>• Secondary IP</div> </div> <div> <div>1 2 3 VLANs All</div> <table border="1"> <thead> <tr> <th>Port</th> <th>Description</th> <th>VLAN ID</th> <th>IP Address Configuration Method</th> <th>IP Address</th> <th>Subnet Mask</th> <th>Routing Mode</th> <th>Administrative Mode</th> </tr> </thead> <tbody> <tr> <td><input type="checkbox"/> 1/0/11</td> <td></td> <td></td> <td>Manual</td> <td>192.168.5.1</td> <td>255.255.255.0</td> <td>Enable</td> <td>Enable</td> </tr> <tr> <td><input type="checkbox"/> 1/0/1</td> <td></td> <td></td> <td>None</td> <td>0.0.0.0</td> <td>0.0.0.0</td> <td>Disable</td> <td>Enable</td> </tr> <tr> <td><input type="checkbox"/> 1/0/2</td> <td></td> <td></td> <td>None</td> <td>0.0.0.0</td> <td>0.0.0.0</td> <td>Disable</td> <td>Enable</td> </tr> <tr> <td><input type="checkbox"/> 1/0/3</td> <td></td> <td></td> <td>None</td> <td>0.0.0.0</td> <td>0.0.0.0</td> <td>Disable</td> <td>Enable</td> </tr> </tbody> </table> </div> |             |         |                                 |             |               |              |                     |                  |      |           |                | Port | Description | VLAN ID | IP Address Configuration Method | IP Address | Subnet Mask | Routing Mode | Administrative Mode | <input type="checkbox"/> 1/0/11 |  |  | Manual | 192.168.5.1 | 255.255.255.0 | Enable | Enable | <input type="checkbox"/> 1/0/1 |  |  | None | 0.0.0.0 | 0.0.0.0 | Disable | Enable | <input type="checkbox"/> 1/0/2 |  |  | None | 0.0.0.0 | 0.0.0.0 | Disable | Enable | <input type="checkbox"/> 1/0/3 |  |  | None | 0.0.0.0 | 0.0.0.0 | Disable | Enable |
| Port   | Description | VLAN ID | IP Address Configuration Method | IP Address  | Subnet Mask   | Routing Mode | Administrative Mode |                  |      |           |                |      |             |         |                                 |            |             |              |                     |                                 |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input type="checkbox"/> 1/0/11  |             |         | Manual                          | 192.168.5.1 | 255.255.255.0 | Enable       | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |                                 |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input type="checkbox"/> 1/0/1   |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |                                 |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input type="checkbox"/> 1/0/2   |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |                                 |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input type="checkbox"/> 1/0/3   |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |                                 |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |

- b. Under IP Interface Configuration, scroll down and select the Port **1/0/11** check box.  
Now 1/0/11 appears in the Port field at the top.
  - c. Enter the following information:
    - In the **IP Address** field, enter **192.168.5.1**.
    - In the **Subnet Mask** field, enter **255.255.255.0**.
    - In the **Routing Mode** field, select **Enable**.
  - d. Click **Apply** to save the settings.
4. Enable RIP on interface 1/0/10.
    - a. Select **Routing > RIP > Advanced > Interface Configuration**.

A screen similar to the following displays.

| System                    | Switching |                                     | Routing   |              | QoS             | Security | Monitoring          | Maintenance        | Help                  | Index     |                |
|---------------------------|-----------|-------------------------------------|-----------|--------------|-----------------|----------|---------------------|--------------------|-----------------------|-----------|----------------|
| Routing Table             | IP        | IPv6                                | VLAN      | ARP          | RIP             | OSPF     | OSPFv3              | Router Discovery   | VRRP                  | Multicast | IPv6 Multicast |
|                           |           |                                     |           |              |                 |          |                     |                    |                       |           |                |
| RIP                       |           | RIP Interface Configuration         |           |              |                 |          |                     |                    |                       |           |                |
| • Basic                   |           | 1 2 3 VLANs All                     |           |              |                 |          |                     |                    |                       |           |                |
| • Advanced                |           |                                     |           |              |                 |          |                     |                    |                       |           |                |
| • RIP Configuration       |           |                                     |           |              |                 |          |                     |                    |                       |           |                |
| • Interface Configuration |           |                                     |           |              |                 |          |                     |                    |                       |           |                |
| • Route Redistribution    |           |                                     |           |              |                 |          |                     |                    |                       |           |                |
|                           |           | <input checked="" type="checkbox"/> | Interface | Send Version | Receive Version | RIP Mode | Authentication Type | Authentication Key | Authentication Key ID |           |                |
|                           |           | <input type="checkbox"/>            | 1/0/10    | RIP-2        | RIP-2           | Enable   | None                |                    | 0                     |           |                |
|                           |           | <input type="checkbox"/>            | 1/0/1     | RIP-2        | Both            | Disable  | None                |                    | 0                     |           |                |
|                           |           | <input type="checkbox"/>            | 1/0/2     | RIP-2        | Both            | Disable  | None                |                    | 0                     |           |                |
|                           |           | <input type="checkbox"/>            | 1/0/3     | RIP-2        | Both            | Disable  | None                |                    | 0                     |           |                |
|                           |           | <input type="checkbox"/>            | 1/0/4     | RIP-2        | Both            | Disable  | None                |                    | 0                     |           |                |
|                           |           | <input type="checkbox"/>            | 1/0/5     | RIP-2        | Both            | Disable  | None                |                    | 0                     |           |                |
|                           |           | <input type="checkbox"/>            | 1/0/6     | RIP-2        | Both            | Disable  | None                |                    | 0                     |           |                |
|                           |           | <input type="checkbox"/>            | 1/0/7     | RIP-2        | Both            | Disable  | None                |                    | 0                     |           |                |
|                           |           | <input type="checkbox"/>            | 1/0/8     | RIP-2        | Both            | Disable  | None                |                    | 0                     |           |                |
|                           |           | <input type="checkbox"/>            | 1/0/9     | RIP-2        | Both            | Disable  | None                |                    | 0                     |           |                |
|                           |           | <input checked="" type="checkbox"/> | 1/0/10    | RIP-2        | Both            | Disable  | None                |                    | 0                     |           |                |

- b. In the **Interface** list, select **1/0/10**.
  - c. For RIP Admin Mode, select the **Enable** radio button.
  - d. Click **Apply**.
5. Enable RIP on interface 1/0/11.
    - a. Select **Routing > RIP > Advanced > Interface Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

RIP

• Basic

• Advanced

RIP Configuration

Interface Configuration

Route Redistribution

RIP Interface Configuration

123 VLANs All

|  | Interface | Send Version | Receive Version | RIP Mode | Authentication Type | Authentication Key | Authentication Key ID |
|--|-----------|--------------|-----------------|----------|---------------------|--------------------|-----------------------|
|  | 1/0/11    | RIP-2        | RIP-2           | Enable   | None                |                    | 0                     |
|  | 1/0/1     | RIP-2        | Both            | Disable  | None                |                    | 0                     |
|  | 1/0/2     | RIP-2        | Both            | Disable  | None                |                    | 0                     |
|  | 1/0/3     | RIP-2        | Both            | Disable  | None                |                    | 0                     |
|  | 1/0/4     | RIP-2        | Both            | Disable  | None                |                    | 0                     |
|  | 1/0/5     | RIP-2        | Both            | Disable  | None                |                    | 0                     |
|  | 1/0/6     | RIP-2        | Both            | Disable  | None                |                    | 0                     |
|  | 1/0/7     | RIP-2        | Both            | Disable  | None                |                    | 0                     |
|  | 1/0/8     | RIP-2        | Both            | Disable  | None                |                    | 0                     |
|  | 1/0/9     | RIP-2        | Both            | Disable  | None                |                    | 0                     |
|  | 1/0/10    | RIP-2        | Both            | Disable  | None                |                    | 0                     |
|  | 1/0/11    | RIP-2        | Both            | Disable  | None                |                    | 0                     |

- b. In the **Interface** list, select **1/0/11**.

- c. For RIP Admin Mode, select the **Enable** radio button.
  - d. Click **Apply**.
6. Enable multicast globally.
- a. Select **Routing > Multicast > Global Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |     |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|-----|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRP | Multicast | IPv6 Multicast |

| Multicast                 | Global Configuration   |
|---------------------------|--|
| • Route Table             | Admin Mode <input type="radio"/> Disable <input checked="" type="radio"/> Enable |
| • Global Configuration    | Protocol State Non-Operational   |
| • Interface Configuration | Table Maximum Entry Count 2048   |
| • DVMRP                   | Protocol No Protocol Enabled   |
| • IGMP                    | Table Entry Count 0  |
| • PIM                     |  |

- b. For Admin Mode, select the **Enable** radio button.
  - c. Click **Apply**.
7. Enable PIM-DM globally.
- a. Select **Routing > Multicast > PIM > Global Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |     |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|-----|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRP | Multicast | IPv6 Multicast |

| Multicast                 | PIM Global Configuration  |
|---------------------------|---|
| • Route Table             | Admin Mode <input type="radio"/> Disable <input type="radio"/> PIM-SM <input checked="" type="radio"/> PIM-DM |
| • Global Configuration    |   |
| • Interface Configuration |   |
| • DVMRP                   |   |
| • IGMP                    |   |
| • PIM                     |   |
| • Global Configuration    |   |

- b. For PIM Protocol Type, select the **PIM-DM** radio button.
  - c. For Admin Mode, select the **Enable** radio button.
  - d. Click **Apply**.
8. Enable PIM-SM on interfaces 1/0/10 and 1/0/11.
- a. Select **Routing > Multicast > PIM > Interface Configuration**.



A screen similar to the following displays.

| Interface | Admin Mode | Protocol State  | IP Address  | Hello Interval | Join/Prune Interval | BSR Border | DR Priority | Designated Router | Neighbor Count |
|-----------|------------|-----------------|-------------|----------------|---------------------|------------|-------------|-------------------|----------------|
| 1/0/1     | Disable    | Non-Operational | 0.0.0.0     | 30             | 60                  | Disable    | 1           |                   |                |
| 1/0/2     | Disable    | Non-Operational | 0.0.0.0     | 30             | 60                  | Disable    | 1           |                   |                |
| 1/0/3     | Disable    | Non-Operational | 0.0.0.0     | 30             | 60                  | Disable    | 1           |                   |                |
| 1/0/4     | Disable    | Non-Operational | 0.0.0.0     | 30             | 60                  | Disable    | 1           |                   |                |
| 1/0/5     | Disable    | Non-Operational | 0.0.0.0     | 30             | 60                  | Disable    | 1           |                   |                |
| 1/0/6     | Disable    | Non-Operational | 0.0.0.0     | 30             | 60                  | Disable    | 1           |                   |                |
| 1/0/7     | Disable    | Non-Operational | 0.0.0.0     | 30             | 60                  | Disable    | 1           |                   |                |
| 1/0/8     | Disable    | Non-Operational | 0.0.0.0     | 30             | 60                  | Disable    | 1           |                   |                |
| 1/0/9     | Disable    | Non-Operational | 0.0.0.0     | 30             | 60                  | Disable    | 1           |                   |                |
| 1/0/10    | Disable    | Non-Operational | 192.168.3.2 | 30             | 60                  | Disable    | 1           |                   |                |
| 1/0/11    | Disable    | Non-Operational | 192.168.5.1 | 30             | 60                  | Disable    | 1           |                   |                |
| 1/0/12    | Disable    | Non-Operational | 0.0.0.0     | 30             | 60                  | Disable    | 1           |                   |                |

- b. Scroll down and select the Interface **1/0/10** and **1/0/11** check box.
- c. In the **Admin Mode** field, select **Enable**.
- d. Click **Apply** to save the settings.

## PIM-DM on Switch C

1. Enable IP routing on the switch.

- a. Select **Routing > IP > Basic > IP Configuration**.

A screen similar to the following displays.

- b. For Routing Mode, select the **Enable** radio button.
- c. Click **Apply**.
2. Configure 1/0/21 as a routing port and assign an IP address to it.
  - a. Select **Routing > IP > Advanced > IP Interface Configuration**.

A screen similar to the following displays.

| Port  | Description | VLAN ID | IP Address Configuration Method | IP Address  | Subnet Mask   | Routing Mode | Administrative Mode |
|-------|-------------|---------|---------------------------------|-------------|---------------|--------------|---------------------|
| 1/0/1 |             |         | Manual                          | 192.168.5.2 | 255.255.255.0 | Enable       | Enable              |
| 1/0/2 |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |
| 1/0/3 |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |

- b. Scroll down select the Port **1/0/21** check box.

Now 1/0/21 appears in the Interface field at the top.

c. Enter the following information:

- In the **IP Address** field, enter **192.168.5.2**.
- In the **Subnet Mask** field, enter **255.255.255.0**.
- In the **Routing Mode** field, select **Enable**.

d. Click **Apply** to save the settings.

3. Configure 1/0/22 as a routing port and assign an IP address to it.

a. Select **Routing > IP > Advanced > IP Interface Configuration**.

A screen similar to the following displays.

| System        | Switching |      | Routing |     | QoS | Security | Monitoring | Maintenance      | Help | Index     |                |
|---------------|-----------|------|---------|-----|-----|----------|------------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6 | VLAN    | ARP | RIP | OSPF     | OSPFv3     | Router Discovery | VRRP | Multicast | IPv6 Multicast |

IP

• Basic

• Advanced

• IP Configuration

• Statistics

• IP Interface Configuration

• Secondary IP

1

2

3

VLANs

All

| Port                                       | Description | VLAN ID | IP Address Configuration Method | IP Address  | Subnet Mask   | Routing Mode | Administrative Mode |
|--|-------------|---------|---------------------------------|-------------|---------------|--------------|---------------------|
| <input checked="" type="checkbox"/> 1/0/22 |             |         | Manual                          | 192.168.6.1 | 255.255.255.0 | Enable       | Enable              |
| <input type="checkbox"/> 1/0/1             |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 1/0/2             |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 1/0/3             |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |

b. Scroll down and select the Port **1/0/22** check box.

Now 1/0/22 appears in the Port field at the top.

c. Enter the following information:

- In the **IP Address** field, enter **192.168.6.1**.
- In the **Subnet Mask** field, enter **255.255.255.0**.
- In the **Routing Mode** field, select **Enable**.

d. Click **Apply** to save the settings.

4. Enable RIP on interface 1/0/21.

a. Select **Routing > RIP > Advanced > Interface Configuration**.

A screen similar to the following displays.

| System   | Switching    |                 | Routing  |                     | QoS                | Security              | Monitoring | Maintenance      | Help | Index     |                |
|--|--------------|-----------------|----------|---------------------|--------------------|-----------------------|------------|------------------|------|-----------|----------------|
| Routing Table  | IP           | IPv6            | VLAN     | ARP                 | RIP                | OSPF                  | OSPFv3     | Router Discovery | VRRP | Multicast | IPv6 Multicast |
| RIP  |              |                 |          |                     |                    |                       |            |                  |      |           |                |
| RIP Interface Configuration  |              |                 |          |                     |                    |                       |            |                  |      |           |                |
| 1 2 3 VLANs All  |              |                 |          |                     |                    |                       |            |                  |      |           |                |
| <div><div>RIP</div><div><div>Basic</div><div>Advanced</div><div>RIP Configuration</div><div>Interface Configuration</div><div>Route Redistribution</div></div></div> |              |                 |          |                     |                    |                       |            |                  |      |           |                |
| Interface  | Send Version | Receive Version | RIP Mode | Authentication Type | Authentication Key | Authentication Key ID |            |                  |      |           |                |
| 1/0/21   | RIP-2        | RIP-2           | Enable   | None                |                    | 0                     |            |                  |      |           |                |
| 1/0/1  | RIP-2        | Both            | Disable  | None                |                    | 0                     |            |                  |      |           |                |
| 1/0/2  | RIP-2        | Both            | Disable  | None                |                    | 0                     |            |                  |      |           |                |

b. In the **Interface** list, select **1/0/21**.

c. For RIP Admin Mode, select the **Enable** radio button.

d. Click **Apply**.

5. Enable RIP on interface 1/0/22.

- a. Select **Routing > RIP > Advanced > Interface Configuration**.

A screen similar to the following displays.

| System  | Switching    | Routing         | QoS      | Security            | Monitoring         | Maintenance           | Help   | Index            |      |           |                |           |              |                 |          |                     |                    |                       |  |       |       |        |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |
|---|--------------|-----------------|----------|---------------------|--------------------|-----------------------|--------|------------------|------|-----------|----------------|-----------|--------------|-----------------|----------|---------------------|--------------------|-----------------------|--|-------|-------|--------|------|--|---|--------------------------------|-------|------|---------|------|--|---|--------------------------------|-------|------|---------|------|--|---|
| Routing Table   | IP           | IPv6            | VLAN     | ARP                 | RIP                | OSPF                  | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |           |              |                 |          |                     |                    |                       |  |       |       |        |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |
| <div> <div>RIP</div> <div>RIP Interface Configuration</div> </div>  |              |                 |          |                     |                    |                       |        |                  |      |           |                |           |              |                 |          |                     |                    |                       |  |       |       |        |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |
| <div> <div> <ul style="list-style-type: none"> <li>Basic</li> <li>Advanced               <ul style="list-style-type: none"> <li>RIP Configuration</li> <li><b>Interface Configuration</b></li> <li>Route Redistribution</li> </ul> </li> </ul> </div> <div> <div>1 2 3 VLANs All</div> <table border="1"> <thead> <tr> <th>Interface</th> <th>Send Version</th> <th>Receive Version</th> <th>RIP Mode</th> <th>Authentication Type</th> <th>Authentication Key</th> <th>Authentication Key ID</th> </tr> </thead> <tbody> <tr> <td><input checked="" type="checkbox"/> 1/0/22</td> <td>RIP-2</td> <td>RIP-2</td> <td>Enable</td> <td>None</td> <td></td> <td>0</td> </tr> <tr> <td><input type="checkbox"/> 1/0/1</td> <td>RIP-2</td> <td>Both</td> <td>Disable</td> <td>None</td> <td></td> <td>0</td> </tr> <tr> <td><input type="checkbox"/> 1/0/2</td> <td>RIP-2</td> <td>Both</td> <td>Disable</td> <td>None</td> <td></td> <td>0</td> </tr> </tbody> </table> </div> </div> |              |                 |          |                     |                    |                       |        |                  |      |           |                | Interface | Send Version | Receive Version | RIP Mode | Authentication Type | Authentication Key | Authentication Key ID | <input checked="" type="checkbox"/> 1/0/22 | RIP-2 | RIP-2 | Enable | None |  | 0 | <input type="checkbox"/> 1/0/1 | RIP-2 | Both | Disable | None |  | 0 | <input type="checkbox"/> 1/0/2 | RIP-2 | Both | Disable | None |  | 0 |
| Interface   | Send Version | Receive Version | RIP Mode | Authentication Type | Authentication Key | Authentication Key ID |        |                  |      |           |                |           |              |                 |          |                     |                    |                       |  |       |       |        |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |
| <input checked="" type="checkbox"/> 1/0/22  | RIP-2        | RIP-2           | Enable   | None                |                    | 0                     |        |                  |      |           |                |           |              |                 |          |                     |                    |                       |  |       |       |        |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |
| <input type="checkbox"/> 1/0/1  | RIP-2        | Both            | Disable  | None                |                    | 0                     |        |                  |      |           |                |           |              |                 |          |                     |                    |                       |  |       |       |        |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |
| <input type="checkbox"/> 1/0/2  | RIP-2        | Both            | Disable  | None                |                    | 0                     |        |                  |      |           |                |           |              |                 |          |                     |                    |                       |  |       |       |        |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |

- b. In the **Interface** list, select **1/0/22**.
- c. For RIP Admin Mode, select the **Enable** radio button.
- d. Click **Apply**.
6. Enable multicast globally.
- a. Select **Routing > Multicast > Global Configuration**.

A screen similar to the following displays.

| System  | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table   | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |
| <div> <div>Multicast</div> <div>Global Configuration</div> </div>   |           |         |      |          |            |             |        |                  |      |           |                |
| <div> <div> <ul style="list-style-type: none"> <li>Route Table</li> <li><b>Global Configuration</b></li> <li>Interface Configuration</li> <li>DVMRP</li> <li>IGMP</li> <li>PIM</li> <li>Static Routes Configuration</li> <li>Admin Boundary Configuration</li> </ul> </div> <div> <div>Admin Mode</div> <div> <input type="radio"/> Disable               <input checked="" type="radio"/> Enable             </div> <div>Protocol State</div> <div>Non-Operational</div> <div>Table Maximum Entry Count</div> <div>2048</div> <div>Protocol</div> <div>No Protocol Enabled</div> <div>Table Entry Count</div> <div>0</div> </div> </div> |           |         |      |          |            |             |        |                  |      |           |                |

- b. For Admin Mode, select the **Enable** radio button.
- c. Click **Apply**.
7. Enable PIM-DM globally.
- a. Select **Routing > Multicast > PIM > Global Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

Multicast

- Route Table
- Global Configuration
- Interface Configuration
- DVMRP
- IGMP
- PIM
- Global Configuration**
- SSM Configuration
- Interface Configuration

PIM Global Configuration

Admin Mode ☒ Disable ☐ PIM-DM ☒ PIM-DM

- b. For PIM Protocol Type, select the **PIM-DM** radio button.
  - c. For Admin Mode, select the **Enable** radio button.
  - d. Click **Apply**.
8. Enable PIM-DM on interfaces 1/0/21 and 1/0/22.
  - a. Select **Routing > Multicast > PIM > Interface Configuration**.

A screen similar to the following displays.

| Interface | Admin Mode | Protocol State  | IP Address | Hello Interval | Join/Prune Interval | BSR Border | DR Priority | Designated Router | Neighbor Count |
|-----------|------------|-----------------|------------|----------------|---------------------|------------|-------------|-------------------|----------------|
| 1/0/1     | Disable    | Non-Operational | 0.0.0.0    | 30             | 60                  | Disable    | 1           |                   |                |
| 1/0/2     | Disable    | Non-Operational | 0.0.0.0    | 30             | 60                  | Disable    | 1           |                   |                |
| 1/0/3     | Disable    | Non-Operational | 0.0.0.0    | 30             | 60                  | Disable    | 1           |                   |                |
| 1/0/4     | Disable    | Non-Operational | 0.0.0.0    | 30             | 60                  | Disable    | 1           |                   |                |
| 1/0/5     | Disable    | Non-Operational | 0.0.0.0    | 30             | 60                  | Disable    | 1           |                   |                |
| 1/0/6     | Disable    | Non-Operational | 0.0.0.0    | 30             | 60                  | Disable    | 1           |                   |                |
| 1/0/7     | Disable    | Non-Operational | 0.0.0.0    | 30             | 60                  | Disable    | 1           |                   |                |
| 1/0/8     | Disable    | Non-Operational | 0.0.0.0    | 30             | 60                  | Disable    | 1           |                   |                |

- b. Scroll down and select the **1/0/21** and **1/0/22** check boxes.
  - c. In the PIM Interface Configuration, in the **Admin Mode** field, select **Enable**.
  - d. Click **Apply** to save the settings.

PIM-DM on Switch D:

1. Enable IP routing on the switch.
  - a. Select **Routing > IP > Basic > IP Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

IP

- Basic
- IP Configuration**
- Statistics
- Advanced

IP Configuration

Default Time to Live: 64

Routing Mode: ☒ Enable ☐ Disable

ICMP Echo Replies: ☒ Enable ☐ Disable

ICMP Redirects: ☒ Enable ☐ Disable

ICMP Rate Limit Interval: 1000 (0 to 2147483647 ms)

ICMP Rate Limit Burst Size: 100 (1 to 200)



- b. For Routing Mode, select the **Enable** radio button.
  - c. Click **Apply**.
2. Configure 1/0/21 as a routing port and assign an IP address to it.
  - a. Select **Routing > IP > Advanced > IP Interface Configuration**.

A screen similar to the following displays.

| System  | Switching   | Routing | QoS                             | Security    | Monitoring    | Maintenance  | Help                | Index            |      |           |                |      |             |         |                                 |            |             |              |                     |  |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
|---|-------------|---------|---------------------------------|-------------|---------------|--------------|---------------------|------------------|------|-----------|----------------|------|-------------|---------|---------------------------------|------------|-------------|--------------|---------------------|--|--|--|--------|-------------|---------------|--------|--------|--------------------------------|--|--|------|---------|---------|---------|--------|--------------------------------|--|--|------|---------|---------|---------|--------|--------------------------------|--|--|------|---------|---------|---------|--------|
| Routing Table   | IP          | IPv6    | VLAN                            | ARP         | RIP           | OSPF         | OSPFv3              | Router Discovery | VRRP | Multicast | IPv6 Multicast |      |             |         |                                 |            |             |              |                     |  |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <div> <div>IP</div> <div>IP Interface Configuration</div> </div>  |             |         |                                 |             |               |              |                     |                  |      |           |                |      |             |         |                                 |            |             |              |                     |  |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <div> <div> <div>Basic</div> <div>Advanced</div> <div>IP Configuration</div> <div>Statistics</div> <div>IP Interface Configuration</div> <div>Secondary IP</div> </div> <div> <div>1 2 3 VLANs All</div> <table border="1"> <thead> <tr> <th>Port</th> <th>Description</th> <th>VLAN ID</th> <th>IP Address Configuration Method</th> <th>IP Address</th> <th>Subnet Mask</th> <th>Routing Mode</th> <th>Administrative Mode</th> </tr> </thead> <tbody> <tr> <td><input checked="" type="checkbox"/> 1/0/21</td> <td></td> <td></td> <td>Manual</td> <td>192.168.2.1</td> <td>255.255.255.0</td> <td>Enable</td> <td>Enable</td> </tr> <tr> <td><input type="checkbox"/> 1/0/1</td> <td></td> <td></td> <td>None</td> <td>0.0.0.0</td> <td>0.0.0.0</td> <td>Disable</td> <td>Enable</td> </tr> <tr> <td><input type="checkbox"/> 1/0/2</td> <td></td> <td></td> <td>None</td> <td>0.0.0.0</td> <td>0.0.0.0</td> <td>Disable</td> <td>Enable</td> </tr> <tr> <td><input type="checkbox"/> 1/0/3</td> <td></td> <td></td> <td>None</td> <td>0.0.0.0</td> <td>0.0.0.0</td> <td>Disable</td> <td>Enable</td> </tr> </tbody> </table> </div> </div> |             |         |                                 |             |               |              |                     |                  |      |           |                | Port | Description | VLAN ID | IP Address Configuration Method | IP Address | Subnet Mask | Routing Mode | Administrative Mode | <input checked="" type="checkbox"/> 1/0/21 |  |  | Manual | 192.168.2.1 | 255.255.255.0 | Enable | Enable | <input type="checkbox"/> 1/0/1 |  |  | None | 0.0.0.0 | 0.0.0.0 | Disable | Enable | <input type="checkbox"/> 1/0/2 |  |  | None | 0.0.0.0 | 0.0.0.0 | Disable | Enable | <input type="checkbox"/> 1/0/3 |  |  | None | 0.0.0.0 | 0.0.0.0 | Disable | Enable |
| Port  | Description | VLAN ID | IP Address Configuration Method | IP Address  | Subnet Mask   | Routing Mode | Administrative Mode |                  |      |           |                |      |             |         |                                 |            |             |              |                     |  |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input checked="" type="checkbox"/> 1/0/21  |             |         | Manual                          | 192.168.2.1 | 255.255.255.0 | Enable       | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |  |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input type="checkbox"/> 1/0/1  |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |  |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input type="checkbox"/> 1/0/2  |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |  |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input type="checkbox"/> 1/0/3  |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |  |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |

- b. Scroll down and select the Port **1/0/21** check box.

Now 1/0/21 appears in the Port field at the top.
  - c. Enter the following information in the IP Interface Configuration.
    - In the **IP Address** field, enter **192.168.2.1**.
    - In the **Subnet Mask** field, enter **255.255.255.0**.
    - In the **Routing Mode** field, select **Enable**.
  - d. Click **Apply** to save the settings.
3. Configure 1/0/22 as a routing port and assign an IP address to it.
    - a. Select **Routing > IP > Advanced > IP Interface Configuration**.

A screen similar to the following displays.

| System  | Switching   | Routing | QoS                             | Security    | Monitoring    | Maintenance  | Help                | Index            |      |           |                |      |             |         |                                 |            |             |              |                     |  |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
|---|-------------|---------|---------------------------------|-------------|---------------|--------------|---------------------|------------------|------|-----------|----------------|------|-------------|---------|---------------------------------|------------|-------------|--------------|---------------------|--|--|--|--------|-------------|---------------|--------|--------|--------------------------------|--|--|------|---------|---------|---------|--------|--------------------------------|--|--|------|---------|---------|---------|--------|--------------------------------|--|--|------|---------|---------|---------|--------|
| Routing Table   | IP          | IPv6    | VLAN                            | ARP         | RIP           | OSPF         | OSPFv3              | Router Discovery | VRRP | Multicast | IPv6 Multicast |      |             |         |                                 |            |             |              |                     |  |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <div> <div>IP</div> <div>IP Interface Configuration</div> </div>  |             |         |                                 |             |               |              |                     |                  |      |           |                |      |             |         |                                 |            |             |              |                     |  |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <div> <div> <div>Basic</div> <div>Advanced</div> <div>IP Configuration</div> <div>Statistics</div> <div>IP Interface Configuration</div> <div>Secondary IP</div> </div> <div> <div>1 2 3 VLANs All</div> <table border="1"> <thead> <tr> <th>Port</th> <th>Description</th> <th>VLAN ID</th> <th>IP Address Configuration Method</th> <th>IP Address</th> <th>Subnet Mask</th> <th>Routing Mode</th> <th>Administrative Mode</th> </tr> </thead> <tbody> <tr> <td><input checked="" type="checkbox"/> 1/0/22</td> <td></td> <td></td> <td>Manual</td> <td>192.168.6.2</td> <td>255.255.255.0</td> <td>Enable</td> <td>Enable</td> </tr> <tr> <td><input type="checkbox"/> 1/0/1</td> <td></td> <td></td> <td>None</td> <td>0.0.0.0</td> <td>0.0.0.0</td> <td>Disable</td> <td>Enable</td> </tr> <tr> <td><input type="checkbox"/> 1/0/2</td> <td></td> <td></td> <td>None</td> <td>0.0.0.0</td> <td>0.0.0.0</td> <td>Disable</td> <td>Enable</td> </tr> <tr> <td><input type="checkbox"/> 1/0/3</td> <td></td> <td></td> <td>None</td> <td>0.0.0.0</td> <td>0.0.0.0</td> <td>Disable</td> <td>Enable</td> </tr> </tbody> </table> </div> </div> |             |         |                                 |             |               |              |                     |                  |      |           |                | Port | Description | VLAN ID | IP Address Configuration Method | IP Address | Subnet Mask | Routing Mode | Administrative Mode | <input checked="" type="checkbox"/> 1/0/22 |  |  | Manual | 192.168.6.2 | 255.255.255.0 | Enable | Enable | <input type="checkbox"/> 1/0/1 |  |  | None | 0.0.0.0 | 0.0.0.0 | Disable | Enable | <input type="checkbox"/> 1/0/2 |  |  | None | 0.0.0.0 | 0.0.0.0 | Disable | Enable | <input type="checkbox"/> 1/0/3 |  |  | None | 0.0.0.0 | 0.0.0.0 | Disable | Enable |
| Port  | Description | VLAN ID | IP Address Configuration Method | IP Address  | Subnet Mask   | Routing Mode | Administrative Mode |                  |      |           |                |      |             |         |                                 |            |             |              |                     |  |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input checked="" type="checkbox"/> 1/0/22  |             |         | Manual                          | 192.168.6.2 | 255.255.255.0 | Enable       | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |  |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input type="checkbox"/> 1/0/1  |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |  |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input type="checkbox"/> 1/0/2  |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |  |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input type="checkbox"/> 1/0/3  |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |  |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |

- b. Scroll down and select the Port **1/0/22** check box.

Now 1/0/22 appears in the Interface field at the top.
- c. Enter the following information:
  - In the **IP Address** field, enter **192.168.6.2**.
  - In the **Subnet Mask** field, enter **255.255.255.0**.
  - In the **Routing Mode** field, select **Enable**.
- d. Click **Apply** to save the settings.

4. Configure 1/0/24 as a routing port and assign an IP address to it.
  - a. Select **Routing > IP > Advanced > IP Interface Configuration**.

A screen similar to the following displays.

| System  | Switching   | Routing | QoS                             | Security    | Monitoring    | Maintenance  | Help                | Index            |      |           |                |      |             |         |                                 |            |             |              |                     |  |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
|---|-------------|---------|---------------------------------|-------------|---------------|--------------|---------------------|------------------|------|-----------|----------------|------|-------------|---------|---------------------------------|------------|-------------|--------------|---------------------|--|--|--|--------|-------------|---------------|--------|--------|--------------------------------|--|--|------|---------|---------|---------|--------|--------------------------------|--|--|------|---------|---------|---------|--------|--------------------------------|--|--|------|---------|---------|---------|--------|
| Routing Table   | IP          | IPv6    | VLAN                            | ARP         | RIP           | OSPF         | OSPFv3              | Router Discovery | VRRP | Multicast | IPv6 Multicast |      |             |         |                                 |            |             |              |                     |  |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <div> <div>IP</div> <div>IP Interface Configuration</div> </div>  |             |         |                                 |             |               |              |                     |                  |      |           |                |      |             |         |                                 |            |             |              |                     |  |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <div> <div> <div>Basic</div> <div>Advanced</div> <div>Statistics</div> <div>IP Interface Configuration</div> <div>Secondary IP</div> </div> <div> <div>1 2 3 VLANs All</div> <table border="1"> <thead> <tr> <th>Port</th> <th>Description</th> <th>VLAN ID</th> <th>IP Address Configuration Method</th> <th>IP Address</th> <th>Subnet Mask</th> <th>Routing Mode</th> <th>Administrative Mode</th> </tr> </thead> <tbody> <tr> <td><input checked="" type="checkbox"/> 1/0/24</td> <td></td> <td></td> <td>Manual</td> <td>192.168.4.1</td> <td>255.255.255.0</td> <td>Enable</td> <td>Enable</td> </tr> <tr> <td><input type="checkbox"/> 1/0/1</td> <td></td> <td></td> <td>None</td> <td>0.0.0.0</td> <td>0.0.0.0</td> <td>Disable</td> <td>Enable</td> </tr> <tr> <td><input type="checkbox"/> 1/0/2</td> <td></td> <td></td> <td>None</td> <td>0.0.0.0</td> <td>0.0.0.0</td> <td>Disable</td> <td>Enable</td> </tr> <tr> <td><input type="checkbox"/> 1/0/3</td> <td></td> <td></td> <td>None</td> <td>0.0.0.0</td> <td>0.0.0.0</td> <td>Disable</td> <td>Enable</td> </tr> </tbody> </table> </div> </div> |             |         |                                 |             |               |              |                     |                  |      |           |                | Port | Description | VLAN ID | IP Address Configuration Method | IP Address | Subnet Mask | Routing Mode | Administrative Mode | <input checked="" type="checkbox"/> 1/0/24 |  |  | Manual | 192.168.4.1 | 255.255.255.0 | Enable | Enable | <input type="checkbox"/> 1/0/1 |  |  | None | 0.0.0.0 | 0.0.0.0 | Disable | Enable | <input type="checkbox"/> 1/0/2 |  |  | None | 0.0.0.0 | 0.0.0.0 | Disable | Enable | <input type="checkbox"/> 1/0/3 |  |  | None | 0.0.0.0 | 0.0.0.0 | Disable | Enable |
| Port  | Description | VLAN ID | IP Address Configuration Method | IP Address  | Subnet Mask   | Routing Mode | Administrative Mode |                  |      |           |                |      |             |         |                                 |            |             |              |                     |  |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input checked="" type="checkbox"/> 1/0/24  |             |         | Manual                          | 192.168.4.1 | 255.255.255.0 | Enable       | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |  |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input type="checkbox"/> 1/0/1  |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |  |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input type="checkbox"/> 1/0/2  |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |  |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input type="checkbox"/> 1/0/3  |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |  |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |

- b. Scroll down and select the Port **1/0/24** check box.

Now 1/0/24 appears in the Interface field at the top.

- c. Enter the following information:
    - In the **IP Address** field, enter **192.168.4.1**.
    - In the **Subnet Mask** field, enter **255.255.255.0**.
    - In the **Routing Mode** field, select **Enable**.
  - d. Click **Apply** to save the settings.

5. Enable RIP on interface 1/0/21.

- a. Select **Routing > RIP > Advanced > Interface Configuration**.

A screen similar to the following displays.

| System   | Switching    | Routing         | QoS      | Security            | Monitoring         | Maintenance           | Help   | Index            |      |           |                |           |              |                 |          |                     |                    |                       |  |       |       |        |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |
|--|--------------|-----------------|----------|---------------------|--------------------|-----------------------|--------|------------------|------|-----------|----------------|-----------|--------------|-----------------|----------|---------------------|--------------------|-----------------------|--|-------|-------|--------|------|--|---|--------------------------------|-------|------|---------|------|--|---|--------------------------------|-------|------|---------|------|--|---|--------------------------------|-------|------|---------|------|--|---|
| Routing Table  | IP           | IPv6            | VLAN     | ARP                 | RIP                | OSPF                  | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |           |              |                 |          |                     |                    |                       |  |       |       |        |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |
| <div> <div>RIP</div> <div>RIP Interface Configuration</div> </div>   |              |                 |          |                     |                    |                       |        |                  |      |           |                |           |              |                 |          |                     |                    |                       |  |       |       |        |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |
| <div> <div> <div>Basic</div> <div>Advanced</div> <div>Statistics</div> <div>Interface Configuration</div> <div>Route Redistribution</div> </div> <div> <div>1 2 3 VLANs All</div> <table border="1"> <thead> <tr> <th>Interface</th> <th>Send Version</th> <th>Receive Version</th> <th>RIP Mode</th> <th>Authentication Type</th> <th>Authentication Key</th> <th>Authentication Key ID</th> </tr> </thead> <tbody> <tr> <td><input checked="" type="checkbox"/> 1/0/21</td> <td>RIP-2</td> <td>RIP-2</td> <td>Enable</td> <td>None</td> <td></td> <td>0</td> </tr> <tr> <td><input type="checkbox"/> 1/0/1</td> <td>RIP-2</td> <td>Both</td> <td>Disable</td> <td>None</td> <td></td> <td>0</td> </tr> <tr> <td><input type="checkbox"/> 1/0/2</td> <td>RIP-2</td> <td>Both</td> <td>Disable</td> <td>None</td> <td></td> <td>0</td> </tr> <tr> <td><input type="checkbox"/> 1/0/3</td> <td>RIP-2</td> <td>Both</td> <td>Disable</td> <td>None</td> <td></td> <td>0</td> </tr> </tbody> </table> </div> </div> |              |                 |          |                     |                    |                       |        |                  |      |           |                | Interface | Send Version | Receive Version | RIP Mode | Authentication Type | Authentication Key | Authentication Key ID | <input checked="" type="checkbox"/> 1/0/21 | RIP-2 | RIP-2 | Enable | None |  | 0 | <input type="checkbox"/> 1/0/1 | RIP-2 | Both | Disable | None |  | 0 | <input type="checkbox"/> 1/0/2 | RIP-2 | Both | Disable | None |  | 0 | <input type="checkbox"/> 1/0/3 | RIP-2 | Both | Disable | None |  | 0 |
| Interface  | Send Version | Receive Version | RIP Mode | Authentication Type | Authentication Key | Authentication Key ID |        |                  |      |           |                |           |              |                 |          |                     |                    |                       |  |       |       |        |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |
| <input checked="" type="checkbox"/> 1/0/21   | RIP-2        | RIP-2           | Enable   | None                |                    | 0                     |        |                  |      |           |                |           |              |                 |          |                     |                    |                       |  |       |       |        |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |
| <input type="checkbox"/> 1/0/1   | RIP-2        | Both            | Disable  | None                |                    | 0                     |        |                  |      |           |                |           |              |                 |          |                     |                    |                       |  |       |       |        |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |
| <input type="checkbox"/> 1/0/2   | RIP-2        | Both            | Disable  | None                |                    | 0                     |        |                  |      |           |                |           |              |                 |          |                     |                    |                       |  |       |       |        |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |
| <input type="checkbox"/> 1/0/3   | RIP-2        | Both            | Disable  | None                |                    | 0                     |        |                  |      |           |                |           |              |                 |          |                     |                    |                       |  |       |       |        |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |

- b. In the **Interface** list, select t **1/0/21**.
  - c. For RIP Admin Mode, select the **Enable** radio button.
  - d. Click **Apply**.
6. Enable RIP on interface 1/0/22.
  - a. Select **Routing > RIP > Advanced > Interface Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

| RIP                     | RIP Interface Configuration |
|-------------------------|-----------------------------|
| Basic                   | 1 2 3 VLANs All             |
| Advanced                |                             |
| RIP Configuration       |                             |
| Interface Configuration |                             |
| Route Redistribution    |                             |

| Interface | Send Version | Receive Version | RIP Mode | Authentication Type | Authentication Key | Authentication Key ID |
|-----------|--------------|-----------------|----------|---------------------|--------------------|-----------------------|
| 1/0/22    | RIP-2        | RIP-2           | Enable   | None                |                    | 0                     |
| 1/0/1     | RIP-2        | Both            | Disable  | None                |                    | 0                     |
| 1/0/2     | RIP-2        | Both            | Disable  | None                |                    | 0                     |
| 1/0/3     | RIP-2        | Both            | Disable  | None                |                    | 0                     |

b. In the **Interface** list, select **1/0/22**.

c. For RIP Admin Mode, select the **Enable** radio button.

d. Click **Apply**.

7. Enable RIP on interface 1/0/24.

a. Select **Routing > RIP > Advanced > Interface Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

| RIP                     | RIP Interface Configuration |
|-------------------------|-----------------------------|
| Basic                   | 1 2 3 VLANs All             |
| Advanced                |                             |
| RIP Configuration       |                             |
| Interface Configuration |                             |
| Route Redistribution    |                             |

| Interface | Send Version | Receive Version | RIP Mode | Authentication Type | Authentication Key | Authentication Key ID |
|-----------|--------------|-----------------|----------|---------------------|--------------------|-----------------------|
| 1/0/24    | RIP-2        | RIP-2           | Enable   | None                |                    | 0                     |
| 1/0/1     | RIP-2        | Both            | Disable  | None                |                    | 0                     |
| 1/0/2     | RIP-2        | Both            | Disable  | None                |                    | 0                     |
| 1/0/3     | RIP-2        | Both            | Disable  | None                |                    | 0                     |

b. In the **Interface** list, select **1/0/24**.

c. For RIP Admin Mode, select the **Enable** radio button.

d. Click **Apply**.

8. Enable multicast globally.

a. Select **Routing > Multicast > Global Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

| Multicast                    | Global Configuration   |
|------------------------------|--|
| Mroute Table                 | Admin Mode <input checked="" type="radio"/> Disable <input type="radio"/> Enable |
| Global Configuration         | Protocol State Non-Operational   |
| Interface Configuration      | Table Maximum Entry Count 2048   |
| DVMRP                        | Protocol No Protocol Enabled   |
| IGMP                         | Table Entry Count 0  |
| PIM                          |  |
| Static Routes Configuration  |  |
| Admin Boundary Configuration |  |

b. For Admin Mode, select the **Enable** radio button.

c. Click **Apply**.



## 9. Enable PIM-DM globally.

a. Select **Routing > Multicast > PIM > Global Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

Multicast

- Route Table
- Global Configuration
- Interface Configuration
- DVMRP
- IGMP
- PIM
- Global Configuration**

PIM Global Configuration

Admin Mode ☐ Disable ☐ PIM-SM ☒ PIM-DM

b. For PIM Protocol Type, select the **PIM-SM** radio button.c. For Admin Mode, select the **Enable** radio button.d. Click **Apply**.

## 10. Enable PIM-DM on interfaces 1/0/21, 1/0/22, and 1/0/24.

a. Select **Routing > Multicast > PIM > Interface Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

Multicast

- Route Table
- Global Configuration
- Interface Configuration
- DVMRP
- IGMP
- PIM
- Global Configuration
- SSM Configuration
- Interface Configuration**
- PIM Neighbor

PIM Interface Configuration

1 2 3 VLANs All

Go To Interface

| Interface | Admin Mode | Protocol State  | IP Address | Hello Interval | Join/Prune Interval | BSR Border | DR Priority | Designated Router | Neighbor Count |
|-----------|------------|-----------------|------------|----------------|---------------------|------------|-------------|-------------------|----------------|
| 1/0/1     | Disable    | Non-Operational | 0.0.0.0    | 30             | 60                  | Disable    | 1           |                   |                |
| 1/0/2     | Disable    | Non-Operational | 0.0.0.0    | 30             | 60                  | Disable    | 1           |                   |                |
| 1/0/3     | Disable    | Non-Operational | 0.0.0.0    | 30             | 60                  | Disable    | 1           |                   |                |
| 1/0/4     | Disable    | Non-Operational | 0.0.0.0    | 30             | 60                  | Disable    | 1           |                   |                |
| 1/0/5     | Disable    | Non-Operational | 0.0.0.0    | 30             | 60                  | Disable    | 1           |                   |                |
| 1/0/6     | Disable    | Non-Operational | 0.0.0.0    | 30             | 60                  | Disable    | 1           |                   |                |
| 1/0/7     | Disable    | Non-Operational | 0.0.0.0    | 30             | 60                  | Disable    | 1           |                   |                |
| 1/0/8     | Disable    | Non-Operational | 0.0.0.0    | 30             | 60                  | Disable    | 1           |                   |                |

b. Scroll down and select the Interface **1/0/21**, **1/0/22**, and **1/0/24** check boxes.c. In the **Admin Mode** field, select **Enable**.d. Click **Apply** to save the settings.

## 11. Enable IGMP globally.

a. Select **Routing > Multicast > IGMP > Global Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

Multicast

- Route Table
- Global Configuration
- Interface Configuration
- DVMRP
- IGMP
- PIM
- Global Configuration
- SSM Configuration
- Interface Configuration
- PIM Neighbor

IGMP Global Configuration

Admin Mode ☐ Disable ☒ Enable

b. For Admin Mode, select the **Enable** radio button.

c. Click **Apply**.

12. Enable IGMP on interface 1/0/24.

a. Select **Routing > Multicast > IGMP > Interface Configuration**.

A screen similar to the following displays.

| IGMP Routing Interface Configuration       |            |         |            |                |                         |                        |                     |                            |                         |  |
|--|------------|---------|------------|----------------|-------------------------|------------------------|---------------------|----------------------------|-------------------------|--|
| 1 2 3 VLANs All                            |            |         |            |                |                         |                        |                     |                            |                         |  |
| Interface                                  | Admin Mode | Version | Robustness | Query Interval | Query Max Response Time | Startup Query Interval | Startup Query Count | Last Member Query Interval | Last Member Query Count |  |
| <input checked="" type="checkbox"/> 1/0/24 | Enable     | V3      | 2          | 125            | 100                     | 31                     | 2                   | 10                         | 2                       |  |
| <input type="checkbox"/> 1/0/1             | Disable    | V3      | 2          | 125            | 100                     | 31                     | 2                   | 10                         | 2                       |  |
| <input type="checkbox"/> 1/0/2             | Disable    | V3      | 2          | 125            | 100                     | 31                     | 2                   | 10                         | 2                       |  |
| <input type="checkbox"/> 1/0/3             | Disable    | V3      | 2          | 125            | 100                     | 31                     | 2                   | 10                         | 2                       |  |
| <input type="checkbox"/> 1/0/4             | Disable    | V3      | 2          | 125            | 100                     | 31                     | 2                   | 10                         | 2                       |  |

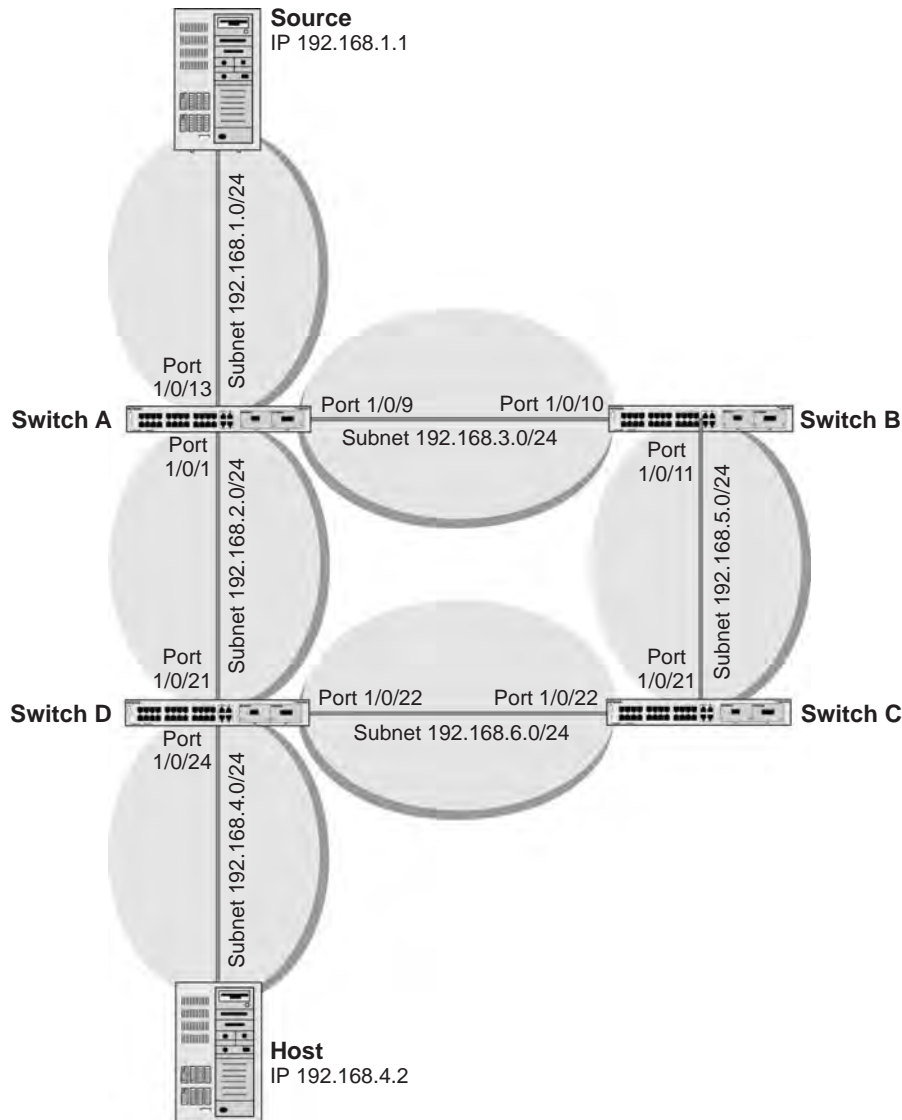
b. Scroll down and select the interface **1/0/24** check box.

c. In the **Admin Mode** field, select **Enable**.

d. Click **Apply** to save the settings.

# PIM-SM

Protocol-independent multicast sparse mode (PIM-SM) is used to efficiently route multicast traffic to multicast groups that can span wide area networks where bandwidth is a constraint.



**Figure 60. PIM-SM**

PIM-SM uses shared trees by default and implements source-based trees for efficiency; it assumes that no hosts want the multicast traffic unless they specifically ask for it. It creates a shared distribution tree centered on a defined rendezvous point (RP). Traffic from this source is relayed to the receivers. Senders first send the multicast data to the RP, which in turn sends the data down the shared tree to the receivers. Shared trees centered on an RP do not necessarily provide the shortest, most optimal path. In such cases PIM-SM provides a means

to switch to more efficient source-specific trees. A data threshold rate is defined for toggling between trees. PIM-SM uses a bootstrap router (BSR), which advertises information to other multicast routers about the RP. In a given network, a set of routers can be administratively enabled as candidate bootstrap routers. If it is not apparent which router should be the BSR, the candidates flood the domain with advertisements. The router with the highest priority is elected. If all the priorities are equal, then the candidate with the highest IP address becomes the BSR. PIM-SM is defined in RFC 4601.

The following example describes how to configure and use PIM-SM. In this case, set the switch B,C,D as RP-candidate and BSR-candidate. Switch B will become the BSR because it has the highest priority. Switch D will become the RP after RP election.

## CLI: Configure PIM-SM

### PIM-SM on Switch A

1. Enable IP routing on the switch.

```
(Netgear Switch)#configure  
(Netgear Switch) (Config)#ip routing
```

2. Enable PIM-SM on the switch.

```
(Netgear Switch) (Config)#ip pim sparse
```

3. Enable IP multicast forwarding on the switch.

```
(Netgear Switch) (Config)#ip multicast
```

4. Enable RIP to build a unicast IP routing table.

```
(Netgear Switch) (Config)#interface 1/0/1  
(Netgear Switch) (Interface 1/0/1)#routing  
(Netgear Switch) (Interface 1/0/1)#ip address 192.168.2.2 255.255.255.0  
(Netgear Switch) (Interface 1/0/1)#ip rip
```

```
(Netgear Switch) (Interface 1/0/1)#ip pim
(Netgear Switch) (Interface 1/0/1)#exit

(Netgear Switch) (Config)#interface 1/0/9
(Netgear Switch) (Interface 1/0/9)#routing
(Netgear Switch) (Interface 1/0/9)#ip address 192.168.3.1 255.255.255.0
(Netgear Switch) (Interface 1/0/9)#ip rip
(Netgear Switch) (Interface 1/0/9)#ip pim
(Netgear Switch) (Interface 1/0/9)#exit

(Netgear Switch) (Config)#interface 1/0/13
(Netgear Switch) (Interface 1/0/13)#routing
(Netgear Switch) (Interface 1/0/13)#ip address 192.168.1.2 255.255.255.0
(Netgear Switch) (Interface 1/0/13)#ip rip
(Netgear Switch) (Interface 1/0/13)#ip pim
(Netgear Switch) (Interface 1/0/13)#exit
```

## PIM-SM on Switch B

1. Enable the switch to advertise itself as a PIM candidate rendezvous point (RP) to the bootstrap router (BSR).

```
(Netgear Switch)#configure
(Netgear Switch) (Config)#ip routing
(Netgear Switch) (Config)#ip pim spars
(Netgear Switch) (Config)#ip multicast
(Netgear Switch) (Config)#ip pim rp-candidate interface 1/0/11 225.1.1.1
255.255.255.0
```

## 2. Enable the switch to announce its candidacy as a bootstrap router (BSR).

```
(Netgear Switch) (Config)#ip pim bsr-candidate interface 1/0/10 30 7

(Netgear Switch) (Config)#interface 1/0/10
(Netgear Switch) (Interface 1/0/10)#routing
(Netgear Switch) (Interface 1/0/10)#ip address 192.168.3.2 255.255.255.0
(Netgear Switch) (Interface 1/0/10)#ip rip
(Netgear Switch) (Interface 1/0/10)#ip pim
(Netgear Switch) (Interface 1/0/10)#exit

(Netgear Switch) (Config)#interface 1/0/11
(Netgear Switch) (Interface 1/0/11)#routing
(Netgear Switch) (Interface 1/0/11)#ip address 192.168.5.1 255.255.255.0
(Netgear Switch) (Interface 1/0/11)#ip rip
(Netgear Switch) (Interface 1/0/11)#ip pim
(Netgear Switch) (Interface 1/0/11)#exit
```

## PIM-SM on Switch C

```
(Netgear Switch)#configure
(Netgear Switch) (Config)#ip routing
(Netgear Switch) (Config)#ip pim sparse
(Netgear Switch) (Config)#ip multicast
(Netgear Switch) (Config)#ip pim rp-candidate interface 1/0/22 225.1.1.1
255.255.255.0
(Netgear Switch) (Config)#ip pim bsr-candidate interface 1/0/21 30 5
(Netgear Switch) (Config)#interface 1/0/21
(Netgear Switch) (Interface 1/0/21)#routing
(Netgear Switch) (Interface 1/0/21)#ip address 192.168.5.2 255.255.255.0
(Netgear Switch) (Interface 1/0/21)#ip rip
(Netgear Switch) (Interface 1/0/21)#ip pim
(Netgear Switch) (Interface 1/0/21)#exit
(Netgear Switch) (Config)#interface 1/0/22
(Netgear Switch) (Interface 1/0/22)#routing
(Netgear Switch) (Interface 1/0/22)#ip address 192.168.6.1 255.255.255.0
(Netgear Switch) (Interface 1/0/22)#ip rip
(Netgear Switch) (Interface 1/0/22)#ip pim
(Netgear Switch) (Interface 1/0/22)#exit
```

## PIM-SM on Switch D

```
(Netgear Switch)#configure
(Netgear Switch) (Config)#ip multicast
(Netgear Switch) (Config)#ip routing
(Netgear Switch) (Config)#ip igmp
(Netgear Switch) (Config)#ip pim
(Netgear Switch) (Config)#ip pim rp-candidate interface 1/0/22 225.1.1.1
255.255.255.0
(Netgear Switch) (Config)#ip pim bsr-candidate interface 1/0/22 30 3
(Netgear Switch) (Config)#interface 1/0/21
(Netgear Switch) (Interface 1/0/21)#routing
(Netgear Switch) (Interface 1/0/21)#ip address 192.168.2.1 255.255.255.0
(Netgear Switch) (Interface 1/0/21)#ip rip
(Netgear Switch) (Interface 1/0/21)#ip pim
(Netgear Switch) (Interface 1/0/21)#exit
(Netgear Switch) (Config)#interface 1/0/22
(Netgear Switch) (Interface 1/0/22)#routing
(Netgear Switch) (Interface 1/0/22)#ip address 192.168.6.2 255.255.255.0
(Netgear Switch) (Interface 1/0/22)#ip rip
(Netgear Switch) (Interface 1/0/22)#ip pim
(Netgear Switch) (Interface 1/0/22)#exit
```

```
(Netgear Switch) (Config)#interface 1/0/24
(Netgear Switch) (Interface 1/0/24)#routing
(Netgear Switch) (Interface 1/0/24)#ip address 192.168.4.1 255.255.255.0
(Netgear Switch) (Interface 1/0/24)#ip rip
(Netgear Switch) (Interface 1/0/24)#ip igmp
(Netgear Switch) (Interface 1/0/24)#ip pim
(Netgear Switch) (Interface 1/0/24)#exit
```



PIM-SM builds the multicast route table on each switch. The following tables show the routes that are built after PIM-SM switches to the source-specific tree from the shared tree.

|                                   |           |          |                    |                         |
|-----------------------------------|-----------|----------|--------------------|-------------------------|
| (A) #show ip mcast mroute summary |           |          |                    |                         |
| Multicast Route Table Summary     |           |          |                    |                         |
| Source IP                         | Group IP  | Protocol | Incoming Interface | Outgoing Interface List |
| -----                             | -----     | -----    | -----              | -----                   |
| 192.168.1.1                       | 225.1.1.1 | PIMSM    | 1/0/13             | 1/0/1                   |
| (B) #show ip mcast mroute summary |           |          |                    |                         |
| Multicast Route Table Summary     |           |          |                    |                         |
| Source IP                         | Group IP  | Protocol | Incoming Interface | Outgoing Interface List |
| -----                             | -----     | -----    | -----              | -----                   |
| 192.168.1.1                       | 225.1.1.1 | PIMSM    | 1/0/10             |                         |
| (C) #show ip mcast mroute summary |           |          |                    |                         |
| Multicast Route Table Summary     |           |          |                    |                         |
| Source IP                         | Group IP  | Protocol | Incoming Interface | Outgoing Interface List |
| -----                             | -----     | -----    | -----              | -----                   |
| *                                 | 225.1.1.1 | PIMSM    | 1/0/22             |                         |
| 192.168.1.1                       | 225.1.1.1 | PIMSM    | 1/0/21             |                         |
| (D) #show ip mcast mroute summary |           |          |                    |                         |
| Multicast Route Table Summary     |           |          |                    |                         |
| Source IP                         | Group IP  | Protocol | Incoming Interface | Outgoing Interface List |
| -----                             | -----     | -----    | -----              | -----                   |
| *                                 | 225.1.1.1 | PIMSM    | 1/0/22             | 1/0/24                  |
| 192.168.1.1                       | 225.1.1.1 | PIMSM    | 1/0/21             | 1/0/24                  |

# Local Browser Interface: Configure PIM-SM

## PIM-SM on Switch A

### 1. Enable IP routing on the switch.

#### a. Select **Routing > IP > Basic > IP Configuration**.

A screen similar to the following displays.

| System  | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table   | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRPP | Multicast | IPv6 Multicast |
| <div> <div>IP</div> <div>IP Configuration</div> </div>  |           |         |      |          |            |             |        |                  |      |           |                |
| <div> <div> <div>• Basic</div> <div>• IP Configuration</div> <div>• Statistics</div> <div>• Advanced</div> </div> <div> <div>Default Time to Live</div> <div>64</div> </div> <div> <div>Routing Mode</div> <div> <input checked="" type="radio"/> Enable           <input type="radio"/> Disable         </div> </div> <div> <div>ICMP Echo Replies</div> <div> <input checked="" type="radio"/> Enable           <input type="radio"/> Disable         </div> </div> <div> <div>ICMP Redirects</div> <div> <input checked="" type="radio"/> Enable           <input type="radio"/> Disable         </div> </div> <div> <div>ICMP Rate Limit Interval</div> <div> <input type="text" value="1000"/> <small>(0 to 2147483647 ms)</small> </div> </div> <div> <div>ICMP Rate Limit Burst Size</div> <div> <input type="text" value="100"/> <small>(1 to 200)</small> </div> </div> </div> |           |         |      |          |            |             |        |                  |      |           |                |

#### b. For Routing Mode, select the **Enable** radio button.

#### c. Click **Apply**.

### 2. Configure 1/0/1 as a routing port and assign an IP address to it.

#### a. Select **Routing > IP > Advanced > IP Interface Configuration**.

A screen similar to the following displays.

| System   | Switching   | Routing | QoS                             | Security    | Monitoring    | Maintenance  | Help                | Index            |      |           |                |      |             |         |                                 |            |             |              |                     |   |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |
|--|-------------|---------|---------------------------------|-------------|---------------|--------------|---------------------|------------------|------|-----------|----------------|------|-------------|---------|---------------------------------|------------|-------------|--------------|---------------------|---|--|--|--------|-------------|---------------|--------|--------|--------------------------------|--|--|------|---------|---------|---------|--------|
| Routing Table  | IP          | IPv6    | VLAN                            | ARP         | RIP           | OSPF         | OSPFv3              | Router Discovery | VRPP | Multicast | IPv6 Multicast |      |             |         |                                 |            |             |              |                     |   |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |
| <div> <div>IP</div> <div>IP Interface Configuration</div> </div>   |             |         |                                 |             |               |              |                     |                  |      |           |                |      |             |         |                                 |            |             |              |                     |   |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |
| <div> <div> <div>• Basic</div> <div>• Advanced</div> <div>• IP Configuration</div> <div>• Statistics</div> <div>• IP Interface Configuration</div> </div> <div> <div>1 2 3 VLANs All</div> <table border="1"> <thead> <tr> <th>Port</th> <th>Description</th> <th>VLAN ID</th> <th>IP Address Configuration Method</th> <th>IP Address</th> <th>Subnet Mask</th> <th>Routing Mode</th> <th>Administrative Mode</th> </tr> </thead> <tbody> <tr> <td><input checked="" type="checkbox"/> 1/0/1</td> <td></td> <td></td> <td>Manual</td> <td>192.168.2.2</td> <td>255.255.255.0</td> <td>Enable</td> <td>Enable</td> </tr> <tr> <td><input type="checkbox"/> 1/0/2</td> <td></td> <td></td> <td>None</td> <td>0.0.0.0</td> <td>0.0.0.0</td> <td>Disable</td> <td>Enable</td> </tr> </tbody> </table> </div> </div> |             |         |                                 |             |               |              |                     |                  |      |           |                | Port | Description | VLAN ID | IP Address Configuration Method | IP Address | Subnet Mask | Routing Mode | Administrative Mode | <input checked="" type="checkbox"/> 1/0/1 |  |  | Manual | 192.168.2.2 | 255.255.255.0 | Enable | Enable | <input type="checkbox"/> 1/0/2 |  |  | None | 0.0.0.0 | 0.0.0.0 | Disable | Enable |
| Port   | Description | VLAN ID | IP Address Configuration Method | IP Address  | Subnet Mask   | Routing Mode | Administrative Mode |                  |      |           |                |      |             |         |                                 |            |             |              |                     |   |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |
| <input checked="" type="checkbox"/> 1/0/1  |             |         | Manual                          | 192.168.2.2 | 255.255.255.0 | Enable       | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |   |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |
| <input type="checkbox"/> 1/0/2   |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |   |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |

#### b. Scroll down and select the interface **1/0/1** check box.

Now 1/0/1 appears in the Interface field at the top.

#### c. Enter the following information:

- In the **IP Address** field, enter **192.168.2.2**.
- In the **Subnet Mask** field, enter **255.255.255.0**.
- In the **Routing Mode** field, select **Enable**.

#### d. Click **Apply** to save the settings.

### 3. Configure 1/0/9 as a routing port and assign an IP address to it.

#### a. Select **Routing > IP > Advanced > IP Interface Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

| IP  |             | IP Interface Configuration |                                 |             |               |              |                     |  |  |  |
|---|-------------|----------------------------|---------------------------------|-------------|---------------|--------------|---------------------|--|--|--|
|   |             | 1 2 3 VLANs All            |                                 |             |               |              |                     |  |  |  |
| • Basic                                   | ▼           |                            |                                 |             |               |              |                     |  |  |  |
| • Advanced                                | ▲           |                            |                                 |             |               |              |                     |  |  |  |
| • IP Configuration                        |             |                            |                                 |             |               |              |                     |  |  |  |
| • Statistics                              |             |                            |                                 |             |               |              |                     |  |  |  |
| • IP Interface Configuration              |             |                            |                                 |             |               |              |                     |  |  |  |
| • Secondary IP                            |             |                            |                                 |             |               |              |                     |  |  |  |
| Port                                      | Description | VLAN ID                    | IP Address Configuration Method | IP Address  | Subnet Mask   | Routing Mode | Administrative Mode |  |  |  |
| <input checked="" type="checkbox"/> 1/0/9 |             |                            | Manual ▼                        | 192.168.3.1 | 255.255.255.0 | Enable ▼     | Enable ▼            |  |  |  |
| <input type="checkbox"/> 1/0/1            |             |                            | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |  |  |  |
| <input type="checkbox"/> 1/0/2            |             |                            | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |  |  |  |
| <input type="checkbox"/> 1/0/3            |             |                            | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |  |  |  |
| <input type="checkbox"/> 1/0/4            |             |                            | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |  |  |  |
| <input type="checkbox"/> 1/0/5            |             |                            | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |  |  |  |
| <input type="checkbox"/> 1/0/6            |             |                            | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |  |  |  |
| <input type="checkbox"/> 1/0/7            |             |                            | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |  |  |  |
| <input type="checkbox"/> 1/0/8            |             |                            | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |  |  |  |
| <input checked="" type="checkbox"/> 1/0/9 |             |                            | None                            | 0.0.0.0     | 0.0.0.0       | Enable       | Enable              |  |  |  |

- b. Scroll down and select the interface **1/0/9** check box.

Now 1/0/9 appears in the Interface field at the top.

- c. Enter the following information:

- In the **IP Address** field, enter **192.168.3.1**.
- In the **Subnet Mask** field, enter **255.255.255.0**.
- In the **Routing Mode** field, select **Enable**.

- d. Click **Apply**.

4. Configure 1/0/13 as a routing port and assign an IP address to it.

- a. Select **Routing > IP > Advanced > IP Interface Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

| IP   |             | IP Interface Configuration |                                 |             |               |              |                     |  |  |  |
|--|-------------|----------------------------|---------------------------------|-------------|---------------|--------------|---------------------|--|--|--|
|  |             | 1 2 3 VLANs All            |                                 |             |               |              |                     |  |  |  |
| • Basic                                    | ▼           |                            |                                 |             |               |              |                     |  |  |  |
| • Advanced                                 | ▲           |                            |                                 |             |               |              |                     |  |  |  |
| • IP Configuration                         |             |                            |                                 |             |               |              |                     |  |  |  |
| • Statistics                               |             |                            |                                 |             |               |              |                     |  |  |  |
| • IP Interface Configuration               |             |                            |                                 |             |               |              |                     |  |  |  |
| • Secondary IP                             |             |                            |                                 |             |               |              |                     |  |  |  |
| Port                                       | Description | VLAN ID                    | IP Address Configuration Method | IP Address  | Subnet Mask   | Routing Mode | Administrative Mode |  |  |  |
| <input checked="" type="checkbox"/> 1/0/13 |             |                            | Manual ▼                        | 192.168.1.2 | 255.255.255.0 | Enable ▼     | Enable ▼            |  |  |  |
| <input type="checkbox"/> 1/0/1             |             |                            | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |  |  |  |
| <input type="checkbox"/> 1/0/2             |             |                            | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |  |  |  |
| <input type="checkbox"/> 1/0/3             |             |                            | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |  |  |  |
| <input type="checkbox"/> 1/0/4             |             |                            | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |  |  |  |

- b. Scroll down and select the interface **1/0/13** check box.

Now 1/0/13 appears in the Interface field at the top.

- c. Enter the following information:

- In the **IP Address** field, enter **192.168.1.2**.
- In the **Subnet Mask** field, enter **255.255.255.0**.
- In the **Routing Mode** field, select **Enable**.

- d. Click **Apply** to save the settings.

5. Enable RIP on interface 1/0/1.

- a. Select **Routing > RIP > Advanced > Interface Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

| RIP                              |   | RIP Interface Configuration               |              |                 |          |                     |                    |                       |
|----------------------------------|---|---|--------------|-----------------|----------|---------------------|--------------------|-----------------------|
|                                  |   | 1 2 3 VLANs All                           |              |                 |          |                     |                    |                       |
| • Basic                          | ▼ |   |              |                 |          |                     |                    |                       |
| • Advanced                       | ▲ |   |              |                 |          |                     |                    |                       |
| • RIP Configuration              |   |   |              |                 |          |                     |                    |                       |
| • <b>Interface Configuration</b> |   |   |              |                 |          |                     |                    |                       |
| • Route Redistribution           |   |   |              |                 |          |                     |                    |                       |
|                                  |   | <input type="checkbox"/> Interface        | Send Version | Receive Version | RIP Mode | Authentication Type | Authentication Key | Authentication Key ID |
|                                  |   | <input checked="" type="checkbox"/> 1/0/1 | RIP-2        | Both            | Enable   | None                |                    | 0                     |
|                                  |   | <input type="checkbox"/> 1/0/2            | RIP-2        | Both            | Disable  | None                |                    | 0                     |

- b. In the **Interface** field, select **1/0/1**.
- c. For RIP Admin Mode, select the **Enable** radio button.
- d. Click **Apply**.

6. Enable RIP on interface 1/0/9.

- a. Select **Routing > RIP > Advanced > Interface Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

| RIP                              |   | RIP Interface Configuration               |              |                 |          |                     |                    |                       |
|----------------------------------|---|---|--------------|-----------------|----------|---------------------|--------------------|-----------------------|
|                                  |   | 1 2 3 VLANs All                           |              |                 |          |                     |                    |                       |
| • Basic                          | ▼ |   |              |                 |          |                     |                    |                       |
| • Advanced                       | ▲ |   |              |                 |          |                     |                    |                       |
| • RIP Configuration              |   |   |              |                 |          |                     |                    |                       |
| • <b>Interface Configuration</b> |   |   |              |                 |          |                     |                    |                       |
| • Route Redistribution           |   |   |              |                 |          |                     |                    |                       |
|                                  |   | <input type="checkbox"/> Interface        | Send Version | Receive Version | RIP Mode | Authentication Type | Authentication Key | Authentication Key ID |
|                                  |   | <input checked="" type="checkbox"/> 1/0/9 | RIP-2        | Both            | Enable   | None                |                    | 0                     |
|                                  |   | <input type="checkbox"/> 1/0/1            | RIP-2        | Both            | Disable  | None                |                    | 0                     |
|                                  |   | <input type="checkbox"/> 1/0/2            | RIP-2        | Both            | Disable  | None                |                    | 0                     |
|                                  |   | <input type="checkbox"/> 1/0/3            | RIP-2        | Both            | Disable  | None                |                    | 0                     |

- b. In the **Interface** field, select **1/0/9**.
- c. For RIP Admin Mode, select the **Enable** radio button.
- d. Click **Apply**.

7. Enable RIP on interface 1/0/13.

- a. Select **Routing > RIP > Advanced > Interface Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

| RIP                              |   | RIP Interface Configuration                |              |                 |          |                     |                    |                       |
|----------------------------------|---|--|--------------|-----------------|----------|---------------------|--------------------|-----------------------|
|                                  |   | 1 2 3 VLANs All                            |              |                 |          |                     |                    |                       |
| • Basic                          | ▼ |  |              |                 |          |                     |                    |                       |
| • Advanced                       | ▲ |  |              |                 |          |                     |                    |                       |
| • RIP Configuration              |   |  |              |                 |          |                     |                    |                       |
| • <b>Interface Configuration</b> |   |  |              |                 |          |                     |                    |                       |
| • Route Redistribution           |   |  |              |                 |          |                     |                    |                       |
|                                  |   | <input type="checkbox"/> Interface         | Send Version | Receive Version | RIP Mode | Authentication Type | Authentication Key | Authentication Key ID |
|                                  |   | <input checked="" type="checkbox"/> 1/0/13 | RIP-2        | Both            | Enable   | None                |                    | 0                     |
|                                  |   | <input type="checkbox"/> 1/0/1             | RIP-2        | Both            | Disable  | None                |                    | 0                     |
|                                  |   | <input type="checkbox"/> 1/0/2             | RIP-2        | Both            | Disable  | None                |                    | 0                     |
|                                  |   | <input type="checkbox"/> 1/0/3             | RIP-2        | Both            | Disable  | None                |                    | 0                     |

- b. Select **1/0/13** in the **Interface** field.
- c. For RIP Admin Mode, select the **Enable** radio button.
- d. Click **Apply**.

## 8. Enable multicast globally.

a. Select **Routing > Multicast > Global Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

| Multicast                     | Global Configuration   |
|-------------------------------|--|
| • Multicast Table             | Admin Mode <input type="radio"/> Disable <input checked="" type="radio"/> Enable |
| • <b>Global Configuration</b> | Protocol State Non-Operational   |
| • Interface Configuration     | Table Maximum Entry Count 2048   |
| • DVMRP                       | Protocol No Protocol Enabled   |
| • IGMP                        | Table Entry Count 0  |
| • PIM                         |  |

b. For Admin Mode, select the **Enable** radio button.c. Click **Apply**.

## 9. Enable PIM-SM globally.

a. Select **Routing > Multicast > PIM > Global Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

| Multicast                     | PIM Global Configuration  |
|-------------------------------|---|
| • Multicast Table             | Admin Mode <input type="radio"/> Disable <input checked="" type="radio"/> PIM-SM <input type="radio"/> PIM-DM |
| • Global Configuration        |   |
| • Interface Configuration     |   |
| • DVMRP                       |   |
| • IGMP                        |   |
| • PIM                         |   |
| • <b>Global Configuration</b> |   |
| • SSM Configuration           |   |

b. For PIM Protocol Type, select the **PIM-SM** radio button.c. For Admin Mode, select the **Enable** radio button.d. Click **Apply**.

## 10. Enable PIM-SM on interfaces 1/0/1, 1/0/9, and 1/0/13.

a. Select **Routing > Multicast > PIM > Interface Configuration**.



A screen similar to the following displays.

| Interface | Admin Mode | Protocol State  | IP Address  | Hello Interval | Join/Purge Interval | BSR Border | DR Priority | Designated Router | Neighbor Count |
|-----------|------------|-----------------|-------------|----------------|---------------------|------------|-------------|-------------------|----------------|
| 1/0/1     | Disable    | Non-Operational | 192.168.2.2 | 30             | 60                  | Disable    | 1           |                   |                |
| 1/0/2     | Disable    | Non-Operational | 0.0.0.0     | 30             | 60                  | Disable    | 1           |                   |                |
| 1/0/3     | Disable    | Non-Operational | 0.0.0.0     | 30             | 60                  | Disable    | 1           |                   |                |
| 1/0/4     | Disable    | Non-Operational | 0.0.0.0     | 30             | 60                  | Disable    | 1           |                   |                |
| 1/0/5     | Disable    | Non-Operational | 0.0.0.0     | 30             | 60                  | Disable    | 1           |                   |                |
| 1/0/6     | Disable    | Non-Operational | 0.0.0.0     | 30             | 60                  | Disable    | 1           |                   |                |
| 1/0/7     | Disable    | Non-Operational | 0.0.0.0     | 30             | 60                  | Disable    | 1           |                   |                |
| 1/0/8     | Disable    | Non-Operational | 0.0.0.0     | 30             | 60                  | Disable    | 1           |                   |                |
| 1/0/9     | Disable    | Non-Operational | 192.168.3.1 | 30             | 60                  | Disable    | 1           |                   |                |
| 1/0/10    | Disable    | Non-Operational | 0.0.0.0     | 30             | 60                  | Disable    | 1           |                   |                |
| 1/0/11    | Disable    | Non-Operational | 0.0.0.0     | 30             | 60                  | Disable    | 1           |                   |                |
| 1/0/12    | Disable    | Non-Operational | 0.0.0.0     | 30             | 60                  | Disable    | 1           |                   |                |
| 1/0/13    | Disable    | Non-Operational | 192.168.1.2 | 30             | 60                  | Disable    | 1           |                   |                |

- b. Scroll down and select the Interface **1/0/1**, **1/0/9**, and **1/0/13** check boxes.
- c. In the **Admin Mode** field, select **Enable**.
- d. Click **Apply** to save the settings.

PIM-SM on Switch B:

1. Enable IP routing on the switch.
  - a. Select **Routing > IP > Basic > IP Configuration**.

A screen similar to the following displays.

| Field                      | Value                       |
|----------------------------|-----------------------------|
| Default Time to Live       | 64                          |
| Routing Mode               | Enable (selected) / Disable |
| ICMP Echo Replies          | Enable (selected) / Disable |
| ICMP Redirects             | Enable (selected) / Disable |
| ICMP Rate Limit Interval   | 1000 (0 to 2147483647 ms)   |
| ICMP Rate Limit Burst Size | 100 (1 to 200)              |

- b. For Routing Mode, select the **Enable** radio button.
- c. Click **Apply**.
2. Configure 1/0/10 as a routing port and assign an IP address to it.
  - a. Select **Routing > IP > Advanced > IP Interface Configuration**.

A screen similar to the following displays.

| Port   | Description | VLAN ID | IP Address Configuration Method | IP Address  | Subnet Mask   | Routing Mode | Administrative Mode |
|--------|-------------|---------|---------------------------------|-------------|---------------|--------------|---------------------|
| 1/0/10 |             |         | Manual                          | 192.168.3.2 | 255.255.255.0 | Enable       | Enable              |
| 1/0/1  |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |
| 1/0/2  |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |
| 1/0/3  |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |

- b. Scroll down and select the interface **1/0/10** check box.

Now 1/0/10 appears in the Interface field at the top.

- c. Enter the following information:

- In the **IP Address** field, enter **192.168.3.2**.
- In the **Subnet Mask** field, enter **255.255.255.0**.
- In the **Routing Mode** field, select **Enable**.

- d. Click **Apply** to save the settings.

3. Configure 1/0/11 as a routing port and assign an IP address to it.

- a. Select **Routing > IP > Advanced > IP Interface Configuration**.

A screen similar to the following displays.

| System  | Switching   | Routing | QoS                             | Security    | Monitoring    | Maintenance  | Help                | Index            |      |           |                |      |             |         |                                 |            |             |              |                     |  |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
|---|-------------|---------|---------------------------------|-------------|---------------|--------------|---------------------|------------------|------|-----------|----------------|------|-------------|---------|---------------------------------|------------|-------------|--------------|---------------------|--|--|--|--------|-------------|---------------|--------|--------|--------------------------------|--|--|------|---------|---------|---------|--------|--------------------------------|--|--|------|---------|---------|---------|--------|--------------------------------|--|--|------|---------|---------|---------|--------|
| Routing Table   | IP          | IPv6    | VLAN                            | ARP         | RIP           | OSPF         | OSPFv3              | Router Discovery | VRRP | Multicast | IPv6 Multicast |      |             |         |                                 |            |             |              |                     |  |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <div>IP</div> <div>IP Interface Configuration</div> <div>1 2 3 VLANs All</div> <table border="1"> <thead> <tr> <th>Port</th> <th>Description</th> <th>VLAN ID</th> <th>IP Address Configuration Method</th> <th>IP Address</th> <th>Subnet Mask</th> <th>Routing Mode</th> <th>Administrative Mode</th> </tr> </thead> <tbody> <tr> <td><input checked="" type="checkbox"/> 1/0/11</td> <td></td> <td></td> <td>Manual</td> <td>192.168.5.1</td> <td>255.255.255.0</td> <td>Enable</td> <td>Enable</td> </tr> <tr> <td><input type="checkbox"/> 1/0/1</td> <td></td> <td></td> <td>None</td> <td>0.0.0.0</td> <td>0.0.0.0</td> <td>Disable</td> <td>Enable</td> </tr> <tr> <td><input type="checkbox"/> 1/0/2</td> <td></td> <td></td> <td>None</td> <td>0.0.0.0</td> <td>0.0.0.0</td> <td>Disable</td> <td>Enable</td> </tr> <tr> <td><input type="checkbox"/> 1/0/3</td> <td></td> <td></td> <td>None</td> <td>0.0.0.0</td> <td>0.0.0.0</td> <td>Disable</td> <td>Enable</td> </tr> </tbody> </table> |             |         |                                 |             |               |              |                     |                  |      |           |                | Port | Description | VLAN ID | IP Address Configuration Method | IP Address | Subnet Mask | Routing Mode | Administrative Mode | <input checked="" type="checkbox"/> 1/0/11 |  |  | Manual | 192.168.5.1 | 255.255.255.0 | Enable | Enable | <input type="checkbox"/> 1/0/1 |  |  | None | 0.0.0.0 | 0.0.0.0 | Disable | Enable | <input type="checkbox"/> 1/0/2 |  |  | None | 0.0.0.0 | 0.0.0.0 | Disable | Enable | <input type="checkbox"/> 1/0/3 |  |  | None | 0.0.0.0 | 0.0.0.0 | Disable | Enable |
| Port  | Description | VLAN ID | IP Address Configuration Method | IP Address  | Subnet Mask   | Routing Mode | Administrative Mode |                  |      |           |                |      |             |         |                                 |            |             |              |                     |  |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input checked="" type="checkbox"/> 1/0/11  |             |         | Manual                          | 192.168.5.1 | 255.255.255.0 | Enable       | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |  |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input type="checkbox"/> 1/0/1  |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |  |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input type="checkbox"/> 1/0/2  |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |  |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input type="checkbox"/> 1/0/3  |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |  |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |

- b. Scroll down and select the Port **1/0/11** check box.

Now 1/0/11 appears in the Port field at the top.

- c. Enter the following information:

- In the **IP Address** field, enter **192.168.5.1**.
- In the **Subnet Mask** field, enter **255.255.255.0**.
- In the **Routing Mode** field, select **Enable**.

- d. Click **Apply** to save the settings.

4. Enable RIP on interface 1/0/10.

- a. Select **Routing > RIP > Advanced > Interface Configuration**.

A screen similar to the following displays.

| System  | Switching    | Routing         | QoS      | Security            | Monitoring         | Maintenance           | Help   | Index            |      |           |                |           |              |                 |          |                     |                    |                       |  |       |       |        |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |
|---|--------------|-----------------|----------|---------------------|--------------------|-----------------------|--------|------------------|------|-----------|----------------|-----------|--------------|-----------------|----------|---------------------|--------------------|-----------------------|--|-------|-------|--------|------|--|---|--------------------------------|-------|------|---------|------|--|---|--------------------------------|-------|------|---------|------|--|---|
| Routing Table   | IP           | IPv6            | VLAN     | ARP                 | RIP                | OSPF                  | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |           |              |                 |          |                     |                    |                       |  |       |       |        |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |
| <div>RIP</div> <div>RIP Interface Configuration</div> <div>1 2 3 VLANs All</div> <table border="1"> <thead> <tr> <th>Interface</th> <th>Send Version</th> <th>Receive Version</th> <th>RIP Mode</th> <th>Authentication Type</th> <th>Authentication Key</th> <th>Authentication Key ID</th> </tr> </thead> <tbody> <tr> <td><input checked="" type="checkbox"/> 1/0/10</td> <td>RIP-2</td> <td>RIP-2</td> <td>Enable</td> <td>None</td> <td></td> <td>0</td> </tr> <tr> <td><input type="checkbox"/> 1/0/1</td> <td>RIP-2</td> <td>Both</td> <td>Disable</td> <td>None</td> <td></td> <td>0</td> </tr> <tr> <td><input type="checkbox"/> 1/0/2</td> <td>RIP-2</td> <td>Both</td> <td>Disable</td> <td>None</td> <td></td> <td>0</td> </tr> </tbody> </table> |              |                 |          |                     |                    |                       |        |                  |      |           |                | Interface | Send Version | Receive Version | RIP Mode | Authentication Type | Authentication Key | Authentication Key ID | <input checked="" type="checkbox"/> 1/0/10 | RIP-2 | RIP-2 | Enable | None |  | 0 | <input type="checkbox"/> 1/0/1 | RIP-2 | Both | Disable | None |  | 0 | <input type="checkbox"/> 1/0/2 | RIP-2 | Both | Disable | None |  | 0 |
| Interface   | Send Version | Receive Version | RIP Mode | Authentication Type | Authentication Key | Authentication Key ID |        |                  |      |           |                |           |              |                 |          |                     |                    |                       |  |       |       |        |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |
| <input checked="" type="checkbox"/> 1/0/10  | RIP-2        | RIP-2           | Enable   | None                |                    | 0                     |        |                  |      |           |                |           |              |                 |          |                     |                    |                       |  |       |       |        |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |
| <input type="checkbox"/> 1/0/1  | RIP-2        | Both            | Disable  | None                |                    | 0                     |        |                  |      |           |                |           |              |                 |          |                     |                    |                       |  |       |       |        |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |
| <input type="checkbox"/> 1/0/2  | RIP-2        | Both            | Disable  | None                |                    | 0                     |        |                  |      |           |                |           |              |                 |          |                     |                    |                       |  |       |       |        |      |  |   |                                |       |      |         |      |  |   |                                |       |      |         |      |  |   |

- b. In the **Interface** field, select **1/0/10**.

- c. For RIP Admin Mode, select the **Enable** radio button.

- d. Click **Apply**.



5. Enable RIP on interface 1/0/11.

a. Select **Routing > RIP > Advanced > Interface Configuration**.

A screen similar to the following displays.

| System  | Switching    | Routing         | QoS      | Security            | Monitoring         | Maintenance           | Help   | Index            |      |           |                |           |              |                 |          |                     |                    |                       |        |       |       |        |      |  |   |       |       |      |         |      |  |   |       |       |      |         |      |  |   |       |       |      |         |      |  |   |
|---|--------------|-----------------|----------|---------------------|--------------------|-----------------------|--------|------------------|------|-----------|----------------|-----------|--------------|-----------------|----------|---------------------|--------------------|-----------------------|--------|-------|-------|--------|------|--|---|-------|-------|------|---------|------|--|---|-------|-------|------|---------|------|--|---|-------|-------|------|---------|------|--|---|
| Routing Table   | IP           | IPv6            | VLAN     | ARP                 | RIP                | OSPF                  | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |           |              |                 |          |                     |                    |                       |        |       |       |        |      |  |   |       |       |      |         |      |  |   |       |       |      |         |      |  |   |       |       |      |         |      |  |   |
| RIP   |              |                 |          |                     |                    |                       |        |                  |      |           |                |           |              |                 |          |                     |                    |                       |        |       |       |        |      |  |   |       |       |      |         |      |  |   |       |       |      |         |      |  |   |       |       |      |         |      |  |   |
| RIP Interface Configuration   |              |                 |          |                     |                    |                       |        |                  |      |           |                |           |              |                 |          |                     |                    |                       |        |       |       |        |      |  |   |       |       |      |         |      |  |   |       |       |      |         |      |  |   |       |       |      |         |      |  |   |
| 1 2 3 VLANs All   |              |                 |          |                     |                    |                       |        |                  |      |           |                |           |              |                 |          |                     |                    |                       |        |       |       |        |      |  |   |       |       |      |         |      |  |   |       |       |      |         |      |  |   |       |       |      |         |      |  |   |
| <div> <div>Basic</div> <div>Advanced</div> <div>RIP Configuration</div> <div><b>Interface Configuration</b></div> <div>Route Redistribution</div> </div>  |              |                 |          |                     |                    |                       |        |                  |      |           |                |           |              |                 |          |                     |                    |                       |        |       |       |        |      |  |   |       |       |      |         |      |  |   |       |       |      |         |      |  |   |       |       |      |         |      |  |   |
| <table border="1"> <thead> <tr> <th>Interface</th> <th>Send Version</th> <th>Receive Version</th> <th>RIP Mode</th> <th>Authentication Type</th> <th>Authentication Key</th> <th>Authentication Key ID</th> </tr> </thead> <tbody> <tr> <td>1/0/11</td> <td>RIP-2</td> <td>RIP-2</td> <td>Enable</td> <td>None</td> <td></td> <td>0</td> </tr> <tr> <td>1/0/1</td> <td>RIP-2</td> <td>Both</td> <td>Disable</td> <td>None</td> <td></td> <td>0</td> </tr> <tr> <td>1/0/2</td> <td>RIP-2</td> <td>Both</td> <td>Disable</td> <td>None</td> <td></td> <td>0</td> </tr> <tr> <td>1/0/3</td> <td>RIP-2</td> <td>Both</td> <td>Disable</td> <td>None</td> <td></td> <td>0</td> </tr> </tbody> </table> |              |                 |          |                     |                    |                       |        |                  |      |           |                | Interface | Send Version | Receive Version | RIP Mode | Authentication Type | Authentication Key | Authentication Key ID | 1/0/11 | RIP-2 | RIP-2 | Enable | None |  | 0 | 1/0/1 | RIP-2 | Both | Disable | None |  | 0 | 1/0/2 | RIP-2 | Both | Disable | None |  | 0 | 1/0/3 | RIP-2 | Both | Disable | None |  | 0 |
| Interface   | Send Version | Receive Version | RIP Mode | Authentication Type | Authentication Key | Authentication Key ID |        |                  |      |           |                |           |              |                 |          |                     |                    |                       |        |       |       |        |      |  |   |       |       |      |         |      |  |   |       |       |      |         |      |  |   |       |       |      |         |      |  |   |
| 1/0/11  | RIP-2        | RIP-2           | Enable   | None                |                    | 0                     |        |                  |      |           |                |           |              |                 |          |                     |                    |                       |        |       |       |        |      |  |   |       |       |      |         |      |  |   |       |       |      |         |      |  |   |       |       |      |         |      |  |   |
| 1/0/1   | RIP-2        | Both            | Disable  | None                |                    | 0                     |        |                  |      |           |                |           |              |                 |          |                     |                    |                       |        |       |       |        |      |  |   |       |       |      |         |      |  |   |       |       |      |         |      |  |   |       |       |      |         |      |  |   |
| 1/0/2   | RIP-2        | Both            | Disable  | None                |                    | 0                     |        |                  |      |           |                |           |              |                 |          |                     |                    |                       |        |       |       |        |      |  |   |       |       |      |         |      |  |   |       |       |      |         |      |  |   |       |       |      |         |      |  |   |
| 1/0/3   | RIP-2        | Both            | Disable  | None                |                    | 0                     |        |                  |      |           |                |           |              |                 |          |                     |                    |                       |        |       |       |        |      |  |   |       |       |      |         |      |  |   |       |       |      |         |      |  |   |       |       |      |         |      |  |   |

b. In the **Interface** list, select **1/0/11**.

c. For RIP Admin Mode, select the **Enable** radio button.

d. Click **Apply**.

6. Enable multicast globally.

a. Select **Routing > Multicast > Global Configuration**.

A screen similar to the following displays.

| System  | Switching   | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |            |   |                |                 |                           |      |          |                     |                   |   |
|---|---|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|------------|---|----------------|-----------------|---------------------------|------|----------|---------------------|-------------------|---|
| Routing Table   | IP  | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |            |   |                |                 |                           |      |          |                     |                   |   |
| Multicast   |   |         |      |          |            |             |        |                  |      |           |                |            |   |                |                 |                           |      |          |                     |                   |   |
| Global Configuration  |   |         |      |          |            |             |        |                  |      |           |                |            |   |                |                 |                           |      |          |                     |                   |   |
| <div> <div>Route Table</div> <div><b>Global Configuration</b></div> <div>Interface Configuration</div> <div>DVMRP</div> <div>IGMP</div> <div>PIM</div> <div>Static Routes Configuration</div> <div>Admin Boundary Configuration</div> </div>  |   |         |      |          |            |             |        |                  |      |           |                |            |   |                |                 |                           |      |          |                     |                   |   |
| <table border="1"> <tbody> <tr> <td>Admin Mode</td> <td> <input type="radio"/> Disable           <input checked="" type="radio"/> Enable         </td> </tr> <tr> <td>Protocol State</td> <td>Non-Operational</td> </tr> <tr> <td>Table Maximum Entry Count</td> <td>2048</td> </tr> <tr> <td>Protocol</td> <td>No Protocol Enabled</td> </tr> <tr> <td>Table Entry Count</td> <td>0</td> </tr> </tbody> </table> |   |         |      |          |            |             |        |                  |      |           |                | Admin Mode | <input type="radio"/> Disable <input checked="" type="radio"/> Enable | Protocol State | Non-Operational | Table Maximum Entry Count | 2048 | Protocol | No Protocol Enabled | Table Entry Count | 0 |
| Admin Mode  | <input type="radio"/> Disable <input checked="" type="radio"/> Enable |         |      |          |            |             |        |                  |      |           |                |            |   |                |                 |                           |      |          |                     |                   |   |
| Protocol State  | Non-Operational   |         |      |          |            |             |        |                  |      |           |                |            |   |                |                 |                           |      |          |                     |                   |   |
| Table Maximum Entry Count   | 2048  |         |      |          |            |             |        |                  |      |           |                |            |   |                |                 |                           |      |          |                     |                   |   |
| Protocol  | No Protocol Enabled   |         |      |          |            |             |        |                  |      |           |                |            |   |                |                 |                           |      |          |                     |                   |   |
| Table Entry Count   | 0   |         |      |          |            |             |        |                  |      |           |                |            |   |                |                 |                           |      |          |                     |                   |   |

b. For Admin Mode, select the **Enable** radio button.

c. Click **Apply**.

7. Enable PIM-SM globally.

a. Select **Routing > Multicast > PIM > Global Configuration**.

A screen similar to the following displays.

| System   | Switching  | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |            |  |
|--|--|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|------------|--|
| Routing Table  | IP   | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |            |  |
| Multicast  |  |         |      |          |            |             |        |                  |      |           |                |            |  |
| PIM Global Configuration   |  |         |      |          |            |             |        |                  |      |           |                |            |  |
| <div> <div>Route Table</div> <div>Global Configuration</div> <div>Interface Configuration</div> <div>DVMRP</div> <div>IGMP</div> <div><b>PIM</b></div> <div>Global Configuration</div> <div>SSM Configuration</div> </div> |  |         |      |          |            |             |        |                  |      |           |                |            |  |
| <table border="1"> <tbody> <tr> <td>Admin Mode</td> <td> <input type="radio"/> Disable           <input checked="" type="radio"/> PIM-SM           <input type="radio"/> PIM-DM         </td> </tr> </tbody> </table>      |  |         |      |          |            |             |        |                  |      |           |                | Admin Mode | <input type="radio"/> Disable <input checked="" type="radio"/> PIM-SM <input type="radio"/> PIM-DM |
| Admin Mode   | <input type="radio"/> Disable <input checked="" type="radio"/> PIM-SM <input type="radio"/> PIM-DM |         |      |          |            |             |        |                  |      |           |                |            |  |

- b. For PIM Protocol Type, select the **PIM-SM** radio button.
  - c. For Admin Mode, select the **Enable** radio button.
  - d. Click **Apply**.
8. Enable PIM-SM on interfaces 1/0/10 and 1/0/11.
  - a. Select **Routing > Multicast > PIM > Interface Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

Multicast

•Route Table

•Global Configuration

•Interface Configuration

•DVMRP

•IGMP

•PIM

•Global Configuration

•SSM Configuration

•Interface Configuration

•PIM Neighbor

•Candidate RP Configuration

•BSR Candidate Configuration

PIM Interface Configuration

1 2 3 VLANs All

Go To Interface

| Interface                                  | Admin Mode | Protocol State  | IP Address  | Hello Interval | Join/Prune Interval | BSR Router | DH Priority | Designated Router | Neighbor Count |
|--|------------|-----------------|-------------|----------------|---------------------|------------|-------------|-------------------|----------------|
| <input type="checkbox"/> 1/0/1             | Disable    | Non-Operational | 0.0.0.0     | 30             | 60                  | Disable    | 1           |                   |                |
| <input type="checkbox"/> 1/0/2             | Disable    | Non-Operational | 0.0.0.0     | 30             | 60                  | Disable    | 1           |                   |                |
| <input type="checkbox"/> 1/0/3             | Disable    | Non-Operational | 0.0.0.0     | 30             | 60                  | Disable    | 1           |                   |                |
| <input type="checkbox"/> 1/0/4             | Disable    | Non-Operational | 0.0.0.0     | 30             | 60                  | Disable    | 1           |                   |                |
| <input type="checkbox"/> 1/0/5             | Disable    | Non-Operational | 0.0.0.0     | 30             | 60                  | Disable    | 1           |                   |                |
| <input type="checkbox"/> 1/0/6             | Disable    | Non-Operational | 0.0.0.0     | 30             | 60                  | Disable    | 1           |                   |                |
| <input type="checkbox"/> 1/0/7             | Disable    | Non-Operational | 0.0.0.0     | 30             | 60                  | Disable    | 1           |                   |                |
| <input type="checkbox"/> 1/0/8             | Disable    | Non-Operational | 0.0.0.0     | 30             | 60                  | Disable    | 1           |                   |                |
| <input type="checkbox"/> 1/0/9             | Disable    | Non-Operational | 0.0.0.0     | 30             | 60                  | Disable    | 1           |                   |                |
| <input checked="" type="checkbox"/> 1/0/10 | Disable    | Non-Operational | 192.168.3.2 | 30             | 60                  | Disable    | 1           |                   |                |
| <input checked="" type="checkbox"/> 1/0/11 | Disable    | Non-Operational | 192.168.5.1 | 30             | 60                  | Disable    | 1           |                   |                |
| <input type="checkbox"/> 1/0/12            | Disable    | Non-Operational | 0.0.0.0     | 30             | 60                  | Disable    | 1           |                   |                |

- b. Scroll down and select the Interface **1/0/10** and **1/0/11** check boxes.
  - c. In the **Admin Mode** field, select **Enable**.
  - d. Click **Apply** to save the settings.
9. Set up the candidate RP configuration.
  - a. Select **Routing > Multicast > PIM > Candidate RP Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

|           |  |   |  |                             |  |  |  |  |  |  |  |
|-----------|--|---|--|-----------------------------|--|--|--|--|--|--|--|
| Multicast |  | PIM Interface Selection                       |  |                             |  |  |  |  |  |  |  |
|           |  | Interface <input type="text" value="1/0/11"/> |  |                             |  |  |  |  |  |  |  |
|           |  | PIM Candidate RP Configuration                |  |                             |  |  |  |  |  |  |  |
|           |  | <input type="checkbox"/> Group Address        | Group Mask                                 | C-RP Advertisement Interval |  |  |  |  |  |  |  |
|           |  | <input type="text" value="255.1.1.1"/>        | <input type="text" value="255.255.255.0"/> | <input type="text"/>        |  |  |  |  |  |  |  |

- b. In the **Interface** list, select **1/0/11**.
  - c. In the **Group IP** field, enter **225.1.1.1**.
  - d. In the **Group Mask** field, enter **255.255.255.0**.
  - e. Click **Add**.
10. Set up the BSR candidate configuration.
  - a. Select **Routing > Multicast > PIM > BSR Candidate Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

| Multicast                     | PIM BSR Candidate Configuration  |
|-------------------------------|--|
| • Route Table                 | Interface <input type="text" value="1/0/10"/>                              |
| • Global Configuration        | Hash Mask Length <input type="text" value="30"/> (0 to 32)                 |
| • Interface Configuration     | BSR Expiry Time (hh:mm:ss)   |
| • DVMRP                       | Priority <input type="text" value="7"/> (0 to 255)                         |
| • IGMP                        | IP Address   |
| • PIM                         | Next bootstrap Message(hh:mm:ss)   |
| • Global Configuration        | Next Candidate RP Advertisement(hh:mm:ss)                                  |
| • SSM Configuration           | Advertisement Interval (secs) <input type="text" value="60"/> (1 to 16383) |
| • Interface Configuration     |  |
| • PIM Neighbor                |  |
| • Candidate RP Configuration  |  |
| • BSR Candidate Configuration |  |
| • Static RP Configuration     |  |

- b. In the **Interface** list, select the **1/0/10**.
- c. In the **Hash Mask Length** field, enter **30**.
- d. In the **Priority** field, enter **7**.
- e. Click **Apply**.

PIM-SM on Switch C:

1. Enable IP routing on the switch.
  - a. Select **Routing > IP > Basic > IP Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

| IP                 | IP Configuration  |
|--------------------|---|
| • Basic            | Default Time to Live <input type="text" value="64"/>                                    |
| • IP Configuration | Routing Mode <input checked="" type="radio"/> Enable <input type="radio"/> Disable      |
| • Statistics       | ICMP Echo Replies <input checked="" type="radio"/> Enable <input type="radio"/> Disable |
| • Advanced         | ICMP Redirects <input checked="" type="radio"/> Enable <input type="radio"/> Disable    |
|                    | ICMP Rate Limit Interval <input type="text" value="1000"/> (0 to 2147483647 ms)         |
|                    | ICMP Rate Limit Burst Size <input type="text" value="100"/> (1 to 200)                  |

- b. For Routing Mode, select the **Enable** radio button.
- c. Click **Apply**.
2. Configure 1/0/21 as a routing port and assign an IP address to it.
  - a. Select **Routing > IP > Advanced > IP Interface Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

| IP                           |   | IP Interface Configuration |  |  |  |  |  |  |  |  |  |
|------------------------------|---|----------------------------|--|--|--|--|--|--|--|--|--|
| • Basic                      | ▼ | 1 2 3 VLANs All            |  |  |  |  |  |  |  |  |  |
| • Advanced                   | ▲ |                            |  |  |  |  |  |  |  |  |  |
| • IP Configuration           |   |                            |  |  |  |  |  |  |  |  |  |
| • Statistics                 |   |                            |  |  |  |  |  |  |  |  |  |
| • IP Interface Configuration |   |                            |  |  |  |  |  |  |  |  |  |
| • Secondary IP               |   |                            |  |  |  |  |  |  |  |  |  |

| Port                                       | Description | VLAN ID | IP Address Configuration Method | IP Address  | Subnet Mask   | Routing Mode | Administrative Mode |
|--|-------------|---------|---------------------------------|-------------|---------------|--------------|---------------------|
| <input checked="" type="checkbox"/> 1/0/21 |             |         | Manual ▼                        | 192.168.5.2 | 255.255.255.0 | Enable ▼     | Enable ▼            |
| <input type="checkbox"/> 1/0/1             |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 1/0/2             |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 1/0/3             |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |

- b. Scroll down and select the Port **1/0/21** check box.

Now 1/0/21 appears in the Interface field at the top.

- c. Enter the following information:

- In the **IP address**, enter **192.168.5.2**.
- In the **Subnet Mask** field, enter **255.255.255.0**.
- In the **Routing Mode** field, select **Enable**.

- d. Click **Apply** to save the settings.

3. Configure 1/0/22 as a routing port and assign an IP address to it.

- a. Select **Routing > IP > Advanced > IP Interface Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

| IP                           |   | IP Interface Configuration |  |  |  |  |  |  |  |  |  |
|------------------------------|---|----------------------------|--|--|--|--|--|--|--|--|--|
| • Basic                      | ▼ | 1 2 3 VLANs All            |  |  |  |  |  |  |  |  |  |
| • Advanced                   | ▲ |                            |  |  |  |  |  |  |  |  |  |
| • IP Configuration           |   |                            |  |  |  |  |  |  |  |  |  |
| • Statistics                 |   |                            |  |  |  |  |  |  |  |  |  |
| • IP Interface Configuration |   |                            |  |  |  |  |  |  |  |  |  |
| • Secondary IP               |   |                            |  |  |  |  |  |  |  |  |  |

| Port                            | Description | VLAN ID | IP Address Configuration Method | IP Address  | Subnet Mask   | Routing Mode | Administrative Mode |
|---------------------------------|-------------|---------|---------------------------------|-------------|---------------|--------------|---------------------|
| <input type="checkbox"/> 1/0/22 |             |         | Manual ▼                        | 192.168.6.1 | 255.255.255.0 | Enable ▼     | Enable ▼            |
| <input type="checkbox"/> 1/0/1  |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 1/0/2  |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 1/0/3  |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |

- b. Scroll down and select the **1/0/22** check box.

Now 1/0/22 appears in the Interface field at the top.

- c. Enter the following information:

- In the **IP Address** field, enter **192.168.6.1**.
- In the **Subnet Mask** field, enter **255.255.255.0**.
- In the **Routing Mode** field, select **Enable**.

- d. Click **Apply** to save the settings.

4. Enable RIP on the interface 1/0/21.

- a. Select **Routing > RIP > Advanced > Interface Configuration**.

A screen similar to the following displays.

| System   | Switching    | Routing         | QoS      | Security            | Monitoring         | Maintenance           | Help   | Index            |      |           |                |           |              |                 |          |                     |                    |                       |        |       |       |        |      |  |   |       |       |      |         |      |  |   |       |       |      |         |      |  |   |
|--|--------------|-----------------|----------|---------------------|--------------------|-----------------------|--------|------------------|------|-----------|----------------|-----------|--------------|-----------------|----------|---------------------|--------------------|-----------------------|--------|-------|-------|--------|------|--|---|-------|-------|------|---------|------|--|---|-------|-------|------|---------|------|--|---|
| Routing Table  | IP           | IPv6            | VLAN     | ARP                 | RIP                | OSPF                  | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |           |              |                 |          |                     |                    |                       |        |       |       |        |      |  |   |       |       |      |         |      |  |   |       |       |      |         |      |  |   |
| RIP Interface Configuration  |              |                 |          |                     |                    |                       |        |                  |      |           |                |           |              |                 |          |                     |                    |                       |        |       |       |        |      |  |   |       |       |      |         |      |  |   |       |       |      |         |      |  |   |
| 1 2 3 VLANs All  |              |                 |          |                     |                    |                       |        |                  |      |           |                |           |              |                 |          |                     |                    |                       |        |       |       |        |      |  |   |       |       |      |         |      |  |   |       |       |      |         |      |  |   |
| <table border="1"> <thead> <tr> <th>Interface</th> <th>Send Version</th> <th>Receive Version</th> <th>RIP Mode</th> <th>Authentication Type</th> <th>Authentication Key</th> <th>Authentication Key ID</th> </tr> </thead> <tbody> <tr> <td>1/0/21</td> <td>RIP-2</td> <td>RIP-2</td> <td>Enable</td> <td>None</td> <td></td> <td>0</td> </tr> <tr> <td>1/0/1</td> <td>RIP-2</td> <td>Both</td> <td>Disable</td> <td>None</td> <td></td> <td>0</td> </tr> <tr> <td>1/0/2</td> <td>RIP-2</td> <td>Both</td> <td>Disable</td> <td>None</td> <td></td> <td>0</td> </tr> </tbody> </table> |              |                 |          |                     |                    |                       |        |                  |      |           |                | Interface | Send Version | Receive Version | RIP Mode | Authentication Type | Authentication Key | Authentication Key ID | 1/0/21 | RIP-2 | RIP-2 | Enable | None |  | 0 | 1/0/1 | RIP-2 | Both | Disable | None |  | 0 | 1/0/2 | RIP-2 | Both | Disable | None |  | 0 |
| Interface  | Send Version | Receive Version | RIP Mode | Authentication Type | Authentication Key | Authentication Key ID |        |                  |      |           |                |           |              |                 |          |                     |                    |                       |        |       |       |        |      |  |   |       |       |      |         |      |  |   |       |       |      |         |      |  |   |
| 1/0/21   | RIP-2        | RIP-2           | Enable   | None                |                    | 0                     |        |                  |      |           |                |           |              |                 |          |                     |                    |                       |        |       |       |        |      |  |   |       |       |      |         |      |  |   |       |       |      |         |      |  |   |
| 1/0/1  | RIP-2        | Both            | Disable  | None                |                    | 0                     |        |                  |      |           |                |           |              |                 |          |                     |                    |                       |        |       |       |        |      |  |   |       |       |      |         |      |  |   |       |       |      |         |      |  |   |
| 1/0/2  | RIP-2        | Both            | Disable  | None                |                    | 0                     |        |                  |      |           |                |           |              |                 |          |                     |                    |                       |        |       |       |        |      |  |   |       |       |      |         |      |  |   |       |       |      |         |      |  |   |

- b. In the **Interface** field, select **1/0/21**.
  - c. For RIP Admin Mode, select the **Enable** radio button.
  - d. Click **Apply**.
5. Enable RIP on interface 1/0/22.
- a. Select **Routing > RIP > Advanced > Interface Configuration**.

A screen similar to the following displays.

| System   | Switching    | Routing         | QoS      | Security            | Monitoring         | Maintenance           | Help   | Index            |      |           |                |           |              |                 |          |                     |                    |                       |        |       |       |        |      |  |   |       |       |      |         |      |  |   |       |       |      |         |      |  |   |
|--|--------------|-----------------|----------|---------------------|--------------------|-----------------------|--------|------------------|------|-----------|----------------|-----------|--------------|-----------------|----------|---------------------|--------------------|-----------------------|--------|-------|-------|--------|------|--|---|-------|-------|------|---------|------|--|---|-------|-------|------|---------|------|--|---|
| Routing Table  | IP           | IPv6            | VLAN     | ARP                 | RIP                | OSPF                  | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |           |              |                 |          |                     |                    |                       |        |       |       |        |      |  |   |       |       |      |         |      |  |   |       |       |      |         |      |  |   |
| RIP Interface Configuration  |              |                 |          |                     |                    |                       |        |                  |      |           |                |           |              |                 |          |                     |                    |                       |        |       |       |        |      |  |   |       |       |      |         |      |  |   |       |       |      |         |      |  |   |
| 1 2 3 VLANs All  |              |                 |          |                     |                    |                       |        |                  |      |           |                |           |              |                 |          |                     |                    |                       |        |       |       |        |      |  |   |       |       |      |         |      |  |   |       |       |      |         |      |  |   |
| <table border="1"> <thead> <tr> <th>Interface</th> <th>Send Version</th> <th>Receive Version</th> <th>RIP Mode</th> <th>Authentication Type</th> <th>Authentication Key</th> <th>Authentication Key ID</th> </tr> </thead> <tbody> <tr> <td>1/0/22</td> <td>RIP-2</td> <td>RIP-2</td> <td>Enable</td> <td>None</td> <td></td> <td>0</td> </tr> <tr> <td>1/0/1</td> <td>RIP-2</td> <td>Both</td> <td>Disable</td> <td>None</td> <td></td> <td>0</td> </tr> <tr> <td>1/0/2</td> <td>RIP-2</td> <td>Both</td> <td>Disable</td> <td>None</td> <td></td> <td>0</td> </tr> </tbody> </table> |              |                 |          |                     |                    |                       |        |                  |      |           |                | Interface | Send Version | Receive Version | RIP Mode | Authentication Type | Authentication Key | Authentication Key ID | 1/0/22 | RIP-2 | RIP-2 | Enable | None |  | 0 | 1/0/1 | RIP-2 | Both | Disable | None |  | 0 | 1/0/2 | RIP-2 | Both | Disable | None |  | 0 |
| Interface  | Send Version | Receive Version | RIP Mode | Authentication Type | Authentication Key | Authentication Key ID |        |                  |      |           |                |           |              |                 |          |                     |                    |                       |        |       |       |        |      |  |   |       |       |      |         |      |  |   |       |       |      |         |      |  |   |
| 1/0/22   | RIP-2        | RIP-2           | Enable   | None                |                    | 0                     |        |                  |      |           |                |           |              |                 |          |                     |                    |                       |        |       |       |        |      |  |   |       |       |      |         |      |  |   |       |       |      |         |      |  |   |
| 1/0/1  | RIP-2        | Both            | Disable  | None                |                    | 0                     |        |                  |      |           |                |           |              |                 |          |                     |                    |                       |        |       |       |        |      |  |   |       |       |      |         |      |  |   |       |       |      |         |      |  |   |
| 1/0/2  | RIP-2        | Both            | Disable  | None                |                    | 0                     |        |                  |      |           |                |           |              |                 |          |                     |                    |                       |        |       |       |        |      |  |   |       |       |      |         |      |  |   |       |       |      |         |      |  |   |

- b. In the **Interface** list, select **1/0/22**.
  - c. For RIP Admin Mode, select the **Enable** radio button.
  - d. Click **Apply**.
6. Enable multicast globally.
- a. Select **Routing > Multicast > Global Configuration**.

A screen similar to the following displays.

| System   | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|--|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table  | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |
| Multicast Global Configuration   |           |         |      |          |            |             |        |                  |      |           |                |
| Admin Mode <input type="radio"/> Disable <input checked="" type="radio"/> Enable |           |         |      |          |            |             |        |                  |      |           |                |
| Protocol State Non-Operational   |           |         |      |          |            |             |        |                  |      |           |                |
| Table Maximum Entry Count 2048   |           |         |      |          |            |             |        |                  |      |           |                |
| Protocol No Protocol Enabled   |           |         |      |          |            |             |        |                  |      |           |                |
| Table Entry Count 0  |           |         |      |          |            |             |        |                  |      |           |                |

- b. For Admin Mode, select the **Enable** radio button.
  - c. Click **Apply**.
7. Enable PIM-SM globally.



a. Select **Routing > Multicast > PIM > Global Configuration**.

A screen similar to the following displays.

The screenshot shows the 'PIM Global Configuration' page. On the left, a sidebar lists various configuration options under the 'Multicast' category, with 'Global Configuration' highlighted. The main content area is titled 'PIM Global Configuration' and contains two radio buttons: 'Admin Mode' (selected) and 'Disable'. Below these, there are three radio buttons for the PIM protocol type: 'PIM-SM' (selected), 'PIM-DM', and 'PIM-DM'.

b. For PIM Protocol Type, select the **PIM-SM** radio button.

c. For Admin Mode, select the **Enable** radio button.

d. Click **Apply**.

8. Enable PIM-SM on interfaces 1/0/21 and 1/0/22.

a. Select **Routing > Multicast > PIM > Interface Configuration**.

A screen similar to the following displays.

The screenshot shows the 'PIM Interface Configuration' page. On the left, a sidebar lists various configuration options under the 'Multicast' category, with 'Interface Configuration' highlighted. The main content area is titled 'PIM Interface Configuration' and displays a table of interfaces. The table has columns for Interface, Admin Mode, Protocol Status, IP Address, Hello Interval, Join/Prune Interval, BSR Router, DR Priority, Designated Router, and Neighbor Count. The 'Admin Mode' column is set to 'Enable'.

| Interface | Admin Mode | Protocol Status | IP Address | Hello Interval | Join/Prune Interval | BSR Router | DR Priority | Designated Router | Neighbor Count |
|-----------|------------|-----------------|------------|----------------|---------------------|------------|-------------|-------------------|----------------|
| 1/0/1     | Disable    | Non-Operational | 0.0.0.0    | 30             | 60                  | Disable    | 1           |                   |                |
| 1/0/2     | Disable    | Non-Operational | 0.0.0.0    | 30             | 60                  | Disable    | 1           |                   |                |
| 1/0/3     | Disable    | Non-Operational | 0.0.0.0    | 30             | 60                  | Disable    | 1           |                   |                |
| 1/0/4     | Disable    | Non-Operational | 0.0.0.0    | 30             | 60                  | Disable    | 1           |                   |                |
| 1/0/5     | Disable    | Non-Operational | 0.0.0.0    | 30             | 60                  | Disable    | 1           |                   |                |
| 1/0/6     | Disable    | Non-Operational | 0.0.0.0    | 30             | 60                  | Disable    | 1           |                   |                |
| 1/0/7     | Disable    | Non-Operational | 0.0.0.0    | 30             | 60                  | Disable    | 1           |                   |                |
| 1/0/8     | Disable    | Non-Operational | 0.0.0.0    | 30             | 60                  | Disable    | 1           |                   |                |

b. Scroll down and select the Interface **1/0/21** and **1/0/22** check boxes.

c. In the **Admin Mode** field, select **Enable**.

d. Click **Apply** to save the settings.

9. Candidate RP Configuration.

a. Select **Routing > Multicast > PIM > Candidate RP Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

| Multicast  | PIM Interface Selection   |                             |            |                             |  |  |                      |
|--|---|-----------------------------|------------|-----------------------------|--|--|----------------------|
| <ul style="list-style-type: none"> <li>• Route Table</li> <li>• Global Configuration</li> <li>• Interface Configuration</li> <li>• DVMRP</li> <li>• IGMP</li> <li>• PIM               <ul style="list-style-type: none"> <li>• Global Configuration</li> <li>• SSM Configuration</li> <li>• Interface Configuration</li> <li>• PIM Neighbor</li> <li>• Candidate RP Configuration</li> </ul> </li> </ul> | Interface <input type="text" value="1/0/22"/><br><br>PIM Candidate RP Configuration <table border="1"> <thead> <tr> <th>Group Address</th> <th>Group Mask</th> <th>C-RP Advertisement Interval</th> </tr> </thead> <tbody> <tr> <td><input type="text" value="225.1.1.1"/></td> <td><input type="text" value="255.255.255.0"/></td> <td><input type="text"/></td> </tr> </tbody> </table> | Group Address               | Group Mask | C-RP Advertisement Interval | <input type="text" value="225.1.1.1"/> | <input type="text" value="255.255.255.0"/> | <input type="text"/> |
| Group Address  | Group Mask  | C-RP Advertisement Interval |            |                             |  |  |                      |
| <input type="text" value="225.1.1.1"/>   | <input type="text" value="255.255.255.0"/>  | <input type="text"/>        |            |                             |  |  |                      |

- b. In the **Interface** list, select **1/0/22**.
- c. In the **Group IP** field, enter **225.1.1.1**.
- d. In the **Group Mask** field, enter **255.255.255.0**.
- e. Click **Add**.

#### 10. BSR Candidate Configuration.

- a. Select **Routing > Multicast > PIM > BSR Candidate Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

| Multicast   | PIM BSR Candidate Configuration  |
|---|--|
| <ul style="list-style-type: none"> <li>• Route Table</li> <li>• Global Configuration</li> <li>• Interface Configuration</li> <li>• DVMRP</li> <li>• IGMP</li> <li>• PIM               <ul style="list-style-type: none"> <li>• Global Configuration</li> <li>• SSM Configuration</li> <li>• Interface Configuration</li> <li>• PIM Neighbor</li> <li>• Candidate RP Configuration</li> <li>• BSR Candidate Configuration</li> </ul> </li> </ul> | Interface <input type="text" value="1/0/21"/><br>Hash Mask Length <input type="text" value="30"/> (0 to 32)<br>BSR Expiry Time (hh:mm:ss) <input type="text"/><br>Priority <input type="text" value="5"/> (0 to 255)<br>IP Address <input type="text"/><br>Next bootstrap Message(hh:mm:ss) <input type="text"/><br>Next Candidate RP Advertisement(hh:mm:ss) <input type="text"/><br>Advertisement Interval (secs) <input type="text" value="60"/> (1 to 16383) |

- b. In the **Interface** list, select the **1/0/21**.
- c. In the **Hash Mask Length** field, enter **30**.
- d. In the **Priority** field, enter **5**.
- e. Click **Apply**.



## PIM-SM on Switch D

## 1. Enable IP routing on the switch.

a. Select **Routing > IP > Basic > IP Configuration**.

A screen similar to the following displays.

| System  | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table   | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |
| <div> <div>IP</div> <div>IP Configuration</div> </div>  |           |         |      |          |            |             |        |                  |      |           |                |
| <div> <div> <div>Basic</div> <div>IP Configuration</div> <div>Statistics</div> <div>Advanced</div> </div> <div> <div>Default Time to Live</div> <div>64</div> </div> <div> <div>Routing Mode</div> <div> <input checked="" type="radio"/> Enable           <input type="radio"/> Disable         </div> </div> <div> <div>ICMP Echo Replies</div> <div> <input checked="" type="radio"/> Enable           <input type="radio"/> Disable         </div> </div> <div> <div>ICMP Redirects</div> <div> <input checked="" type="radio"/> Enable           <input type="radio"/> Disable         </div> </div> <div> <div>ICMP Rate Limit Interval</div> <div> <input type="text" value="1000"/> <small>(0 to 2147483647 ms)</small> </div> </div> <div> <div>ICMP Rate Limit Burst Size</div> <div> <input type="text" value="100"/> <small>(1 to 200)</small> </div> </div> </div> |           |         |      |          |            |             |        |                  |      |           |                |

b. For Routing Mode, select the **Enable** radio button.c. Click **Apply**.

## 2. Configure 1/0/21 as a routing port and assign an IP address to it.

a. Select **Routing > IP > Advanced > IP Interface Configuration**.

A screen similar to the following displays.

| System  | Switching   | Routing | QoS                             | Security    | Monitoring    | Maintenance  | Help                | Index            |      |           |                |      |             |         |                                 |            |             |              |                     |  |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
|---|-------------|---------|---------------------------------|-------------|---------------|--------------|---------------------|------------------|------|-----------|----------------|------|-------------|---------|---------------------------------|------------|-------------|--------------|---------------------|--|--|--|--------|-------------|---------------|--------|--------|--------------------------------|--|--|------|---------|---------|---------|--------|--------------------------------|--|--|------|---------|---------|---------|--------|--------------------------------|--|--|------|---------|---------|---------|--------|
| Routing Table   | IP          | IPv6    | VLAN                            | ARP         | RIP           | OSPF         | OSPFv3              | Router Discovery | VRRP | Multicast | IPv6 Multicast |      |             |         |                                 |            |             |              |                     |  |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <div> <div>IP</div> <div>IP Interface Configuration</div> </div>  |             |         |                                 |             |               |              |                     |                  |      |           |                |      |             |         |                                 |            |             |              |                     |  |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <div> <div> <div>Basic</div> <div>Advanced</div> <div>IP Configuration</div> <div>Statistics</div> <div>IP Interface Configuration</div> <div>Secondary IP</div> </div> <div> <div>1 2 3 VLANs All</div> <table border="1"> <thead> <tr> <th>Port</th> <th>Description</th> <th>VLAN ID</th> <th>IP Address Configuration Method</th> <th>IP Address</th> <th>Subnet Mask</th> <th>Routing Mode</th> <th>Administrative Mode</th> </tr> </thead> <tbody> <tr> <td><input checked="" type="checkbox"/> 1/0/21</td> <td></td> <td></td> <td>Manual</td> <td>192.168.2.1</td> <td>255.255.255.0</td> <td>Enable</td> <td>Enable</td> </tr> <tr> <td><input type="checkbox"/> 1/0/1</td> <td></td> <td></td> <td>None</td> <td>0.0.0.0</td> <td>0.0.0.0</td> <td>Disable</td> <td>Enable</td> </tr> <tr> <td><input type="checkbox"/> 1/0/2</td> <td></td> <td></td> <td>None</td> <td>0.0.0.0</td> <td>0.0.0.0</td> <td>Disable</td> <td>Enable</td> </tr> <tr> <td><input type="checkbox"/> 1/0/3</td> <td></td> <td></td> <td>None</td> <td>0.0.0.0</td> <td>0.0.0.0</td> <td>Disable</td> <td>Enable</td> </tr> </tbody> </table> </div> </div> |             |         |                                 |             |               |              |                     |                  |      |           |                | Port | Description | VLAN ID | IP Address Configuration Method | IP Address | Subnet Mask | Routing Mode | Administrative Mode | <input checked="" type="checkbox"/> 1/0/21 |  |  | Manual | 192.168.2.1 | 255.255.255.0 | Enable | Enable | <input type="checkbox"/> 1/0/1 |  |  | None | 0.0.0.0 | 0.0.0.0 | Disable | Enable | <input type="checkbox"/> 1/0/2 |  |  | None | 0.0.0.0 | 0.0.0.0 | Disable | Enable | <input type="checkbox"/> 1/0/3 |  |  | None | 0.0.0.0 | 0.0.0.0 | Disable | Enable |
| Port  | Description | VLAN ID | IP Address Configuration Method | IP Address  | Subnet Mask   | Routing Mode | Administrative Mode |                  |      |           |                |      |             |         |                                 |            |             |              |                     |  |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input checked="" type="checkbox"/> 1/0/21  |             |         | Manual                          | 192.168.2.1 | 255.255.255.0 | Enable       | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |  |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input type="checkbox"/> 1/0/1  |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |  |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input type="checkbox"/> 1/0/2  |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |  |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input type="checkbox"/> 1/0/3  |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |  |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |

b. Scroll down and select the Interface **1/0/21** check box.

Now 1/0/21 appears in the Interface field at the top.

## c. Enter the following information:

- In the **IP Address** field, enter **192.168.2.1**.
- In the **Subnet Mask** field, enter **255.255.255.0**.
- In the **Routing Mode** field, select **Enable**.

d. Click **Apply** to save the settings.

## 3. Configure 1/0/22 as a routing port and assign an IP address to it.

a. Select **Routing > IP > Advanced > IP Interface Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

| IP                           | IP Interface Configuration |
|------------------------------|----------------------------|
| • Basic                      | 1 2 3 VLANs All            |
| • Advanced                   |                            |
| • IP Configuration           |                            |
| • Statistics                 |                            |
| • IP Interface Configuration |                            |
| • Secondary IP               |                            |

| Port                                       | Description | VLAN ID | IP Address Configuration Method | IP Address  | Subnet Mask   | Routing Mode | Administrative Mode |
|--|-------------|---------|---------------------------------|-------------|---------------|--------------|---------------------|
| <input checked="" type="checkbox"/> 1/0/22 |             |         | Manual                          | 192.168.6.2 | 255.255.255.0 | Enable       | Enable              |
| <input type="checkbox"/> 1/0/1             |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 1/0/2             |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 1/0/3             |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |

- b. Scroll down and select the Port **1/0/22** check box.

Now 1/0/22 appears in the Port field at the top.

- c. Enter the following information:

- In the **IP Address** field, enter **192.168.6.2**.
- In the **Subnet Mask** field, enter **255.255.255.0**.
- In the **Routing Mode** field, select **Enable**.

- d. Click **Apply** to save the settings.

4. Configure 1/0/24 as a routing port and assign an IP address to it.

- a. Select **Routing > IP > Advanced > IP Interface Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

| IP                           | IP Interface Configuration |
|------------------------------|----------------------------|
| • Basic                      | 1 2 3 VLANs All            |
| • Advanced                   |                            |
| • IP Configuration           |                            |
| • Statistics                 |                            |
| • IP Interface Configuration |                            |
| • Secondary IP               |                            |

| Port                                       | Description | VLAN ID | IP Address Configuration Method | IP Address  | Subnet Mask   | Routing Mode | Administrative Mode |
|--|-------------|---------|---------------------------------|-------------|---------------|--------------|---------------------|
| <input checked="" type="checkbox"/> 1/0/24 |             |         | Manual                          | 192.168.4.1 | 255.255.255.0 | Enable       | Enable              |
| <input type="checkbox"/> 1/0/1             |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 1/0/2             |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |
| <input type="checkbox"/> 1/0/3             |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |

- b. Scroll down and select the Interface **1/0/24** check box.

Now 1/0/24 appears in the Interface field at the top.

- c. Enter the following information:

- In the **IP Address** field, enter **192.168.4.1**.
- In the **Subnet Mask** field, enter **255.255.255.0**.
- In the **Routing Mode** field, select **Enable**.

- d. Click **Apply** to save the settings.

5. Enable RIP on interface 1/0/21.

- a. Select **Routing > RIP > Advanced > Interface Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

| RIP                       |              | RIP Interface Configuration |          |                     |                    |                       |  |  |
|---------------------------|--------------|-----------------------------|----------|---------------------|--------------------|-----------------------|--|--|
| 1 2 3 VLANs All           |              |                             |          |                     |                    |                       |  |  |
| • Basic                   | ▼            |                             |          |                     |                    |                       |  |  |
| • Advanced                | ▲            |                             |          |                     |                    |                       |  |  |
| • RIP Configuration       |              |                             |          |                     |                    |                       |  |  |
| • Interface Configuration |              |                             |          |                     |                    |                       |  |  |
| • Route Redistribution    |              |                             |          |                     |                    |                       |  |  |
| Interface                 | Send Version | Receive Version             | RIP Mode | Authentication Type | Authentication Key | Authentication Key ID |  |  |
| 1/0/21                    | RIP-2        | RIP-2                       | Enable   | None                |                    | 0                     |  |  |
| 1/0/1                     | RIP-2        | Both                        | Disable  | None                |                    | 0                     |  |  |
| 1/0/2                     | RIP-2        | Both                        | Disable  | None                |                    | 0                     |  |  |

b. In the **Interface** list, select **1/0/21**.

c. For RIP Admin Mode, select the **Enable** radio button.

d. Click **Apply**.

6. Enable RIP on interface 1/0/22.

a. Select **Routing > RIP > Advanced > Interface Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

| RIP                       |              | RIP Interface Configuration |          |                     |                    |                       |  |  |
|---------------------------|--------------|-----------------------------|----------|---------------------|--------------------|-----------------------|--|--|
| 1 2 3 VLANs All           |              |                             |          |                     |                    |                       |  |  |
| • Basic                   | ▼            |                             |          |                     |                    |                       |  |  |
| • Advanced                | ▲            |                             |          |                     |                    |                       |  |  |
| • RIP Configuration       |              |                             |          |                     |                    |                       |  |  |
| • Interface Configuration |              |                             |          |                     |                    |                       |  |  |
| • Route Redistribution    |              |                             |          |                     |                    |                       |  |  |
| Interface                 | Send Version | Receive Version             | RIP Mode | Authentication Type | Authentication Key | Authentication Key ID |  |  |
| 1/0/22                    | RIP-2        | RIP-2                       | Enable   | None                |                    | 0                     |  |  |
| 1/0/1                     | RIP-2        | Both                        | Disable  | None                |                    | 0                     |  |  |
| 1/0/2                     | RIP-2        | Both                        | Disable  | None                |                    | 0                     |  |  |
| 1/0/3                     | RIP-2        | Both                        | Disable  | None                |                    | 0                     |  |  |

b. In the **Interface** list, select **1/0/22**.

c. For RIP Admin Mode, select the **Enable** radio button.

d. Click **Apply**.

7. Enable RIP on interface 1/0/24.

a. Select **Routing > RIP > Advanced > Interface Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

| RIP                       |              | RIP Interface Configuration |          |                     |                    |                       |  |  |
|---------------------------|--------------|-----------------------------|----------|---------------------|--------------------|-----------------------|--|--|
| 1 2 3 VLANs All           |              |                             |          |                     |                    |                       |  |  |
| • Basic                   | ▼            |                             |          |                     |                    |                       |  |  |
| • Advanced                | ▲            |                             |          |                     |                    |                       |  |  |
| • RIP Configuration       |              |                             |          |                     |                    |                       |  |  |
| • Interface Configuration |              |                             |          |                     |                    |                       |  |  |
| • Route Redistribution    |              |                             |          |                     |                    |                       |  |  |
| Interface                 | Send Version | Receive Version             | RIP Mode | Authentication Type | Authentication Key | Authentication Key ID |  |  |
| 1/0/24                    | RIP-2        | RIP-2                       | Enable   | None                |                    | 0                     |  |  |
| 1/0/1                     | RIP-2        | Both                        | Disable  | None                |                    | 0                     |  |  |
| 1/0/2                     | RIP-2        | Both                        | Disable  | None                |                    | 0                     |  |  |
| 1/0/3                     | RIP-2        | Both                        | Disable  | None                |                    | 0                     |  |  |

b. In the **Interface** list, select **1/0/24**.

c. For RIP Admin Mode, select the **Enable** radio button.

d. Click **Apply**.

8. Enable multicast globally.

a. Select **Routing > Multicast > Global Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

| Multicast                      | Global Configuration   |
|--------------------------------|--|
| • Mroute Table                 | Admin Mode <input type="radio"/> Disable <input checked="" type="radio"/> Enable |
| • Global Configuration         | Protocol State <input type="radio"/> Operational                                 |
| • Interface Configuration      | Table Maximum Entry Count 2048   |
| • DVMRP                        | Protocol No Protocol Enabled   |
| • IGMP                         | Table Entry Count 0  |
| • PIM                          |  |
| • Static Routes Configuration  |  |
| • Admin Boundary Configuration |  |

b. For Admin Mode, select the **Enable** radio button.

c. Click **Apply**.

9. Enable PIM-SM globally.

a. Select **Routing > Multicast > PIM > Global Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

| Multicast                     | PIM Global Configuration  |
|-------------------------------|---|
| • Mroute Table                | Admin Mode <input type="radio"/> Disable <input type="radio"/> PIM-SM <input checked="" type="radio"/> PIM-DM |
| • Global Configuration        |   |
| • Interface Configuration     |   |
| • DVMRP                       |   |
| • IGMP                        |   |
| • PIM                         |   |
| • Global Configuration        |   |
| • SSM Configuration           |   |
| • Interface Configuration     |   |
| • PIM Neighbor                |   |
| • Candidate RP Configuration  |   |
| • BSR Candidate Configuration |   |
| • Static RP Configuration     |   |

b. For PIM Protocol Type, select the **PIM-SM** radio button.

c. For Admin Mode, select the **Enable** radio button.

d. Click **Apply**.

10. Enable PIM-SM on interfaces 1/0/21, 1/0/22, and 1/0/24.

a. Select **Routing > Multicast > PIM > Interface Configuration**.

A screen similar to the following displays.

| Interface | Admin Mode | Protocol State  | IP Address | Hello Interval | Join/Prune Interval | BSR Election | DR Priority | Designated Router | Neighbor Count |
|-----------|------------|-----------------|------------|----------------|---------------------|--------------|-------------|-------------------|----------------|
| 1/0/1     | Disable    | Non-Operational | 0.0.0.0    | 30             | 60                  | Disable      | 1           |                   |                |
| 1/0/2     | Disable    | Non-Operational | 0.0.0.0    | 30             | 60                  | Disable      | 1           |                   |                |
| 1/0/3     | Disable    | Non-Operational | 0.0.0.0    | 30             | 60                  | Disable      | 1           |                   |                |
| 1/0/4     | Disable    | Non-Operational | 0.0.0.0    | 30             | 60                  | Disable      | 1           |                   |                |
| 1/0/5     | Disable    | Non-Operational | 0.0.0.0    | 30             | 60                  | Disable      | 1           |                   |                |
| 1/0/6     | Disable    | Non-Operational | 0.0.0.0    | 30             | 60                  | Disable      | 1           |                   |                |
| 1/0/7     | Disable    | Non-Operational | 0.0.0.0    | 30             | 60                  | Disable      | 1           |                   |                |
| 1/0/8     | Disable    | Non-Operational | 0.0.0.0    | 30             | 60                  | Disable      | 1           |                   |                |

- b. Scroll down and select the Interface **1/0/21**, **1/0/22**, and **1/0/24** check boxes.
- c. In the **Admin Mode** field, select **Enable**.
- d. Click **Apply** to save the settings.

11. Set up Candidate RP configuration.

- a. Select **Routing > Multicast > PIM > Candidate RP Configuration**.

A screen similar to the following displays.

| Group Address | Group Mask    | C-RP Advertisement Interval |
|---------------|---------------|-----------------------------|
| 225.1.1.1     | 255.255.255.0 |                             |

- b. In the **Interface** list, select **1/0/22**.
- c. In the **Group IP** field, enter **225.1.1.1**.
- d. In the **Group Mask** field, enter **255.255.255.0**.
- e. Click **Add**.

12. Set up BSR Candidate configuration.

- a. Select **Routing > Multicast > PIM > BSR Candidate Configuration**.



A screen similar to the following displays.

The screenshot shows the 'PIM BSR Candidate Configuration' page. The left sidebar has a tree view with 'PIM' expanded, showing sub-items like 'Global Configuration', 'SSM Configuration', 'Interface Configuration', 'PIM Neighbor', 'Candidate RP Configuration', and 'BSR Candidate Configuration' (which is selected). The main content area has the following fields:

| Field                                     | Value  | Range        |
|---|--------|--------------|
| Interface                                 | 1/0/22 |              |
| Hash Mask Length                          | 30     | (0 to 32)    |
| BSR Expiry Time (hh:mm:ss)                |        |              |
| Priority                                  | 0      | (0 to 255)   |
| IP Address                                |        |              |
| Next bootstrap Message(hh:mm:ss)          |        |              |
| Next Candidate RP Advertisement(hh:mm:ss) |        |              |
| Advertisement Interval (secs)             | 60     | (1 to 16383) |

- b. In the **Interface** list, select **1/0/22**.
- c. In the **Hash Mask Length** field, enter **30**.
- d. In the **Priority** field, enter **3**.
- e. Click **Apply**.

**13. Enable IGMP globally.**

- a. Select **Routing > Multicast > IGMP > Global Configuration**.

A screen similar to the following displays.

The screenshot shows the 'IGMP Global Configuration' page. The left sidebar has a tree view with 'Multicast' expanded, showing sub-items like 'Global Configuration' (which is selected). The main content area has the following field:

| Field      | Value   |
|------------|---|
| Admin Mode | <input type="radio"/> Disable <input checked="" type="radio"/> Enable |

- b. For Admin Mode, select the **Enable** radio button.
- c. Click **Apply**.

**14. Enable IGMP on interface 1/0/24.**

- a. Select **Routing > Multicast > IGMP > Interface Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

| IGMP Routing Interface Configuration       |            |         |            |                |                         |                        |                     |                            |                         |  |
|--|------------|---------|------------|----------------|-------------------------|------------------------|---------------------|----------------------------|-------------------------|--|
| 1 2 3 VLANs All                            |            |         |            |                |                         |                        |                     |                            |                         |  |
| Interface                                  | Admin Mode | Version | Robustness | Query Interval | Query Max Response Time | Startup Query Interval | Startup Query Count | Last Member Query Interval | Last Member Query Count |  |
| <input checked="" type="checkbox"/> 1/0/24 | Enable     | V3      | 2          | 125            | 100                     | 31                     | 2                   | 10                         | 2                       |  |
| <input type="checkbox"/> 1/0/1             | Disable    | V3      | 2          | 125            | 100                     | 31                     | 2                   | 10                         | 2                       |  |
| <input type="checkbox"/> 1/0/2             | Disable    | V3      | 2          | 125            | 100                     | 31                     | 2                   | 10                         | 2                       |  |
| <input type="checkbox"/> 1/0/3             | Disable    | V3      | 2          | 125            | 100                     | 31                     | 2                   | 10                         | 2                       |  |
| <input type="checkbox"/> 1/0/4             | Disable    | V3      | 2          | 125            | 100                     | 31                     | 2                   | 10                         | 2                       |  |

- b. Under IGMP Routing Interface Configuration, scroll down and select the Interface **1/0/24** check box.
- c. In the **Admin Mode** field, select **Enable**.
- d. Click **Apply** to save the settings.



# 31

## 31 DHCP L2 Relay and L3 Relay

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### Dynamic Host Configuration Protocol relays

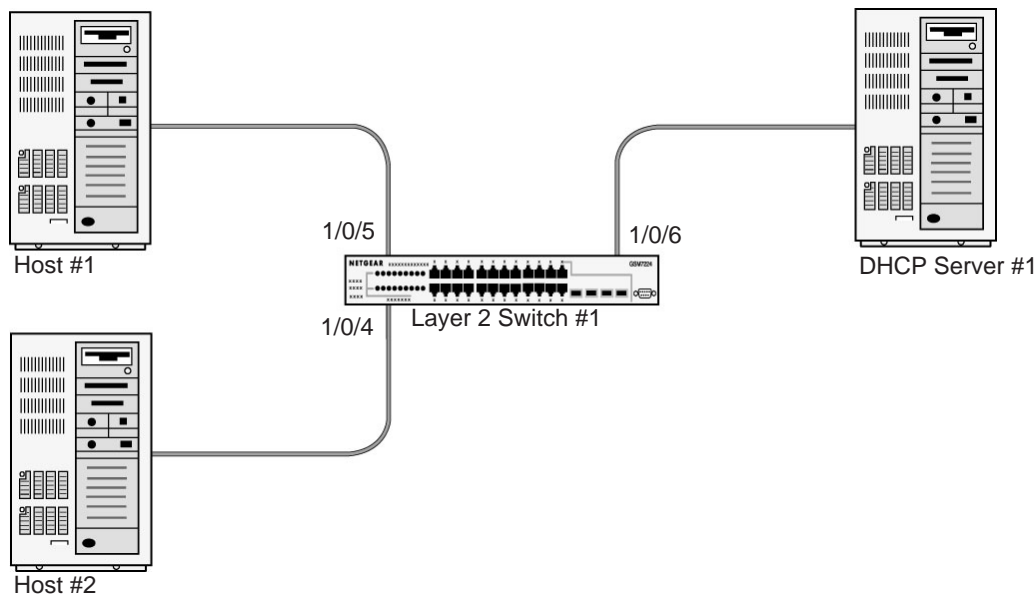
This chapter includes the following sections:

- [DHCP L2 Relay](#)
- [DHCP L3 Relay](#)
- [Configure a DHCP L3 Switch](#)

# DHCP L2 Relay

DHCP relay agents eliminate the need to have a DHCP server on each physical network. Relay agents populate the `giaddr` field and also append the `Relay Agent Information` option to the DHCP messages. DHCP servers use this option for IP addresses and other parameter assignment policies. These DHCP relay agents are typically IP routing-aware devices and are referred to as Layer 3 relay agents.

In some network configurations, Layer 2 devices can append the relay agent Information option as they are closer to the end hosts.



**Figure 61. DHCP L2 relay**

These Layer 2 devices typically operate only as bridges for the network and might not have an IPv4 address on the network. Lacking a valid IPv4 source address, they cannot relay packets directly to a DHCP server on another network. These Layer 2 devices append the Relay agent information option and broadcast the DHCP message. This section provides information about where a Layer 2 relay agent fits in and how it is used.

## CLI: Enable DHCP L2 Relay

1. Enter the following commands:

```
(Netgear Switch)#vlan database
(Netgear Switch)(Vlan)#vlan 200
(Netgear Switch)(Vlan)#exit
```

**2. Enable the DHCP L2 relay on the switch.**

```
(Netgear Switch) (Config)#dhcp l2relay  
(Netgear Switch) (Config)#dhcp l2relay vlan 200
```

**3. Enable the Option 82 Circuit ID field.**

```
(Netgear Switch) (Config)#dhcp l2relay circuit-id vlan 200
```

**4. Enable the Option 82 Remote ID field.**

```
(Netgear Switch) (Config)#dhcp l2relay remote-id rem_id vlan 200
```

**5. Enable DHCP L2 relay on port 1/0/4.**

```
(Netgear Switch) (Config)#interface 1/0/4  
(Netgear Switch) (Interface 1/0/4)# dhcp l2relay
```

```
(Netgear Switch) (Interface 1/0/4)# vlan pvid 200  
(Netgear Switch) (Interface 1/0/4)# vlan participation include 200  
(Netgear Switch) (Interface 1/0/4)# exit
```

**6. Enable DHCP L2 relay on port 1/0/5.**

```
(Netgear Switch) (Config)#interface 1/0/5  
(Netgear Switch) (Interface 1/0/5)# dhcp l2relay  
(Netgear Switch) (Interface 1/0/5)# vlan pvid 200  
(Netgear Switch) (Interface 1/0/5)# vlan participation include 200  
(Netgear Switch) (Interface 1/0/5)# exit
```

**7. Enable DHCP L2 relay on port 1/0/6.**

```
(Netgear Switch) (Config)#interface 1/0/6  
(Netgear Switch) (Interface 1/0/6)# dhcp l2relay
```

**8. Trust packets with option 82 received on port 1/0/6.**

```
(Netgear Switch) (Interface 1/0/6)# dhcp l2relay trust  
(Netgear Switch) (Interface 1/0/6)# vlan pvid 200  
(Netgear Switch) (Interface 1/0/6)# vlan participation include 200  
(Netgear Switch) (Interface 1/0/6)# exit
```

# Local Browser Interface: Enable DHCP L2 Relay

1. Create VLAN 200.
  - a. Select **Switching > VLAN > Basic > VLAN Configuration**.

A screen similar to the following displays.

| VLAN ID | VLAN Name | VLAN Type | Make Static |
|---------|-----------|-----------|-------------|
| 200     |           | Static    | Disable     |

- b. In the **VLAN ID** field, enter **200**.
  - c. In the **VLAN Type** field, select **Static**.
  - d. Click **Add**.
2. Add ports to VLAN 200.
  - a. Select **Switching > VLAN > Advanced > VLAN Membership**.

A screen similar to the following displays.

| Unit 1 | Ports   |
|--------|---|
| 1      | 1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47  |
| 2      | 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 |

- b. In the **VLAN ID** field, select **200**.
  - c. Click **Unit 1**. The ports display.
  - d. Click the gray boxes under ports **4**, **5**, and **6** until **U** displays.  
The U specifies that the egress packet is untagged for the port.
  - e. Click **Apply**.
3. Specify the PVID on ports 1/0/4, 1/0/5 and 1/0/6.
  - a. Select **Switching > VLAN > Advanced > Port PVID Configuration**.

A screen similar to the following displays.

| Interface                                 | PVID | VLAN Member | VLAN Tag | Acceptable Frame Types | Configured Ingress Filtering |
|---|------|-------------|----------|------------------------|------------------------------|
| <input type="checkbox"/> 1/0/1            | 1    | 1           | None     | Admit All              | Disable                      |
| <input type="checkbox"/> 1/0/2            | 1    | 1           | None     | Admit All              | Disable                      |
| <input type="checkbox"/> 1/0/3            | 1    | 1           | None     | Admit All              | Disable                      |
| <input checked="" type="checkbox"/> 1/0/4 | 1    | 1           | None     | Admit All              | Disable                      |
| <input checked="" type="checkbox"/> 1/0/5 | 1    | 1           | None     | Admit All              | Disable                      |
| <input checked="" type="checkbox"/> 1/0/6 | 1    | 1           | None     | Admit All              | Disable                      |

- b. Scroll down and select the Interface **1/0/4**, **1/0/5**, and **1/0/6** check boxes.
  - c. In the **PVID (1 to 4093)** field, enter **200**.
  - d. Click **Apply** to save the settings.
4. Enable DHCP L2 relay on VLAN 200.
- a. Select **System > Services > DHCP L2 Relay > DHCP L2 Relay Configuration**.

A screen similar to the following displays.

| VLAN ID                                 | Admin Mode | Circuit ID Mode | Remote ID String |
|---|------------|-----------------|------------------|
| <input checked="" type="checkbox"/> 200 | Disable    | Disable         |                  |
| <input type="checkbox"/> 1              | Disable    | Disable         |                  |
| <input checked="" type="checkbox"/> 200 | Disable    | Disable         |                  |

- b. For Admin Mode, select the **Enable** radio button.
  - c. Scroll down and select the VLAN ID **200** check box.
  - d. Enter the following information:
    - In the **Admin Mode** field, select **Enable**.
    - In the **Circuit ID Mode** field, select **Enable**.
    - In the **Remote ID String** field, enter **rmt\_id**.
  - e. Click **Apply** to save the settings.
5. Enable DHCP L2 Relay on interfaces 1/0/4, 1/0/5, and 1/0/6.
- a. Select **System > Services > DHCP L2 Relay > DHCP L2 Relay Interface Configuration**.

A screen similar to the following displays.

| Interface                                 | Admin Mode | 82 Option Trust Mode |
|---|------------|----------------------|
| <input type="checkbox"/> 1/0/1            | Disable    | Disable              |
| <input type="checkbox"/> 1/0/2            | Disable    | Disable              |
| <input type="checkbox"/> 1/0/3            | Disable    | Disable              |
| <input checked="" type="checkbox"/> 1/0/4 | Disable    | Disable              |
| <input checked="" type="checkbox"/> 1/0/5 | Disable    | Disable              |
| <input checked="" type="checkbox"/> 1/0/6 | Disable    | Disable              |

- b. Scroll down and select the **1/0/4**, **1/0/5**, and **1/0/6** check boxes.
  - c. In the **Admin Mode** field, select **Enable**.
  - d. Click **Apply** to save the settings.
6. Enable DHCP L2 relay trust on interface 1/0/6.
  - a. Select **System > Services > DHCP L2 Relay > DHCP L2 Relay Interface Configuration**.

A screen similar to the following displays.

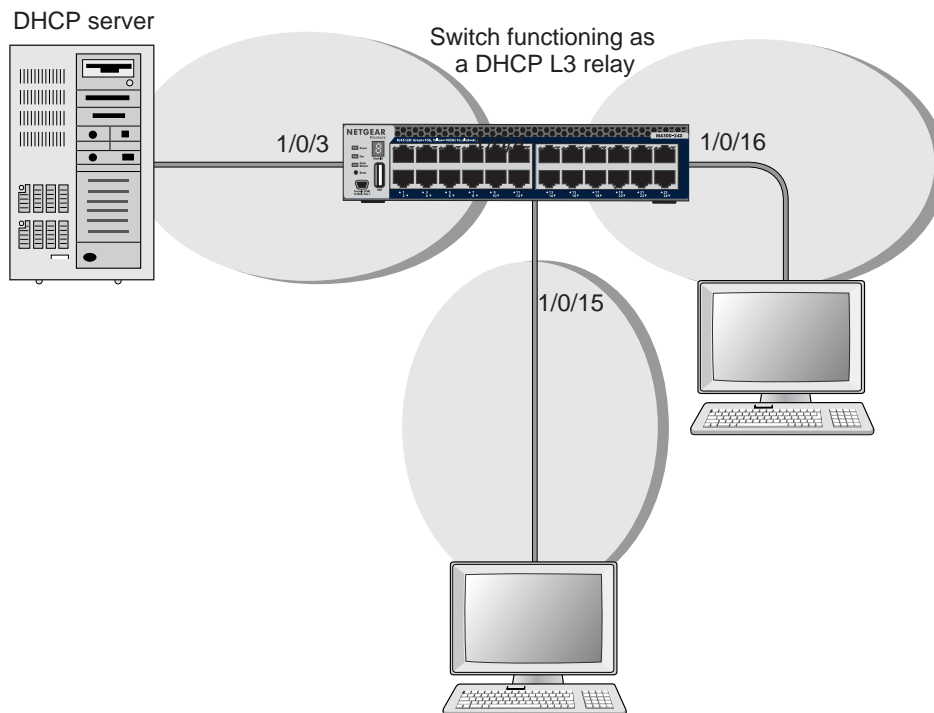
| Interface                                 | Admin Mode | 82 Option Trust Mode |
|---|------------|----------------------|
| <input type="checkbox"/> 1/0/1            | Disable    | Disable              |
| <input type="checkbox"/> 1/0/2            | Disable    | Disable              |
| <input type="checkbox"/> 1/0/3            | Disable    | Disable              |
| <input checked="" type="checkbox"/> 1/0/4 | Disable    | Disable              |
| <input checked="" type="checkbox"/> 1/0/5 | Disable    | Disable              |
| <input checked="" type="checkbox"/> 1/0/6 | Disable    | Enable               |

- b. Under DHCP L2 Relay Configuration, scroll down and select the Interface **1/0/6** check box.
  - c. In the **82 Option Trust Mode** field, select **Enable**.
  - d. Click **Apply** to save the settings.

# DHCP L3 Relay

This example consists of two steps:

- Use a Windows Server operating system to configure a DHCP L3 server.
- Use the CLI to configure a DHCP L3 relay through which a DHCP client can receive an IP address from a DHCP server.

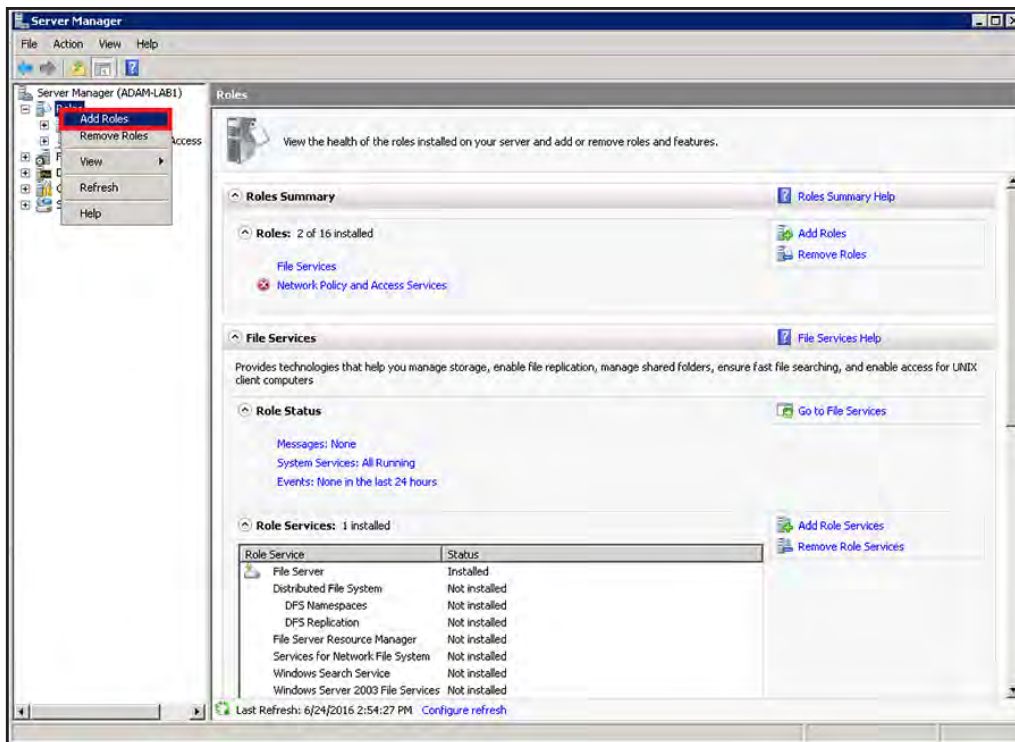


**Figure 62. DHCP L3 relay**

## Configure the DHCP L3 Server in a Windows Server Operating System

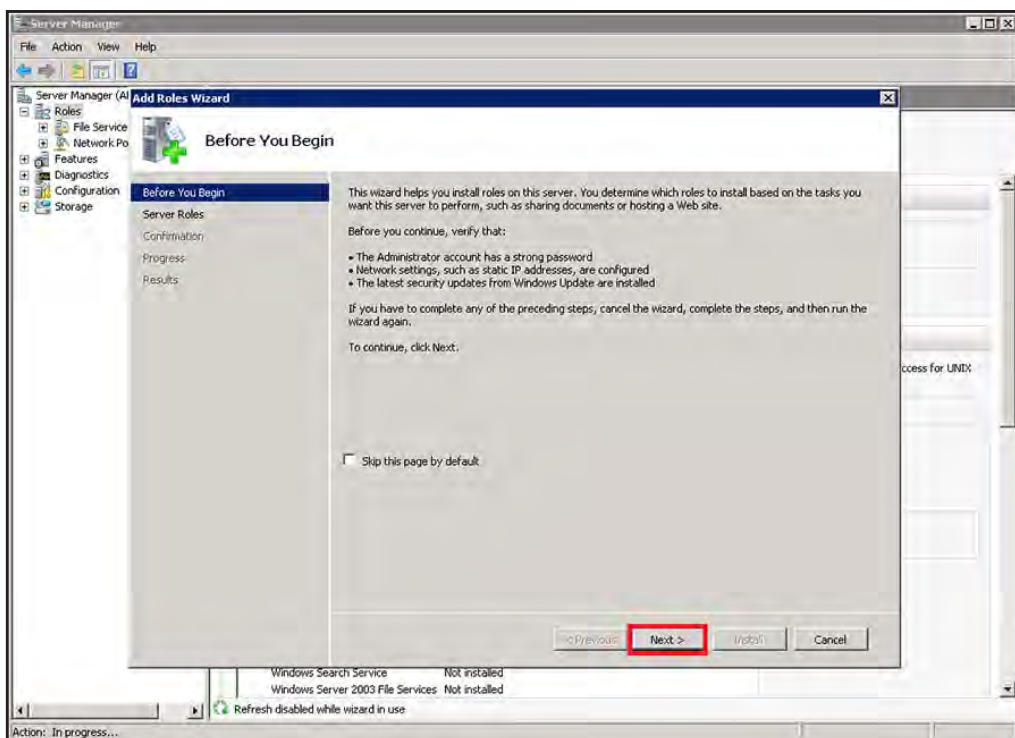
1. In the Windows Server operating system, open the Server Manager.
2. In the menu tree on the left, click **Roles**.



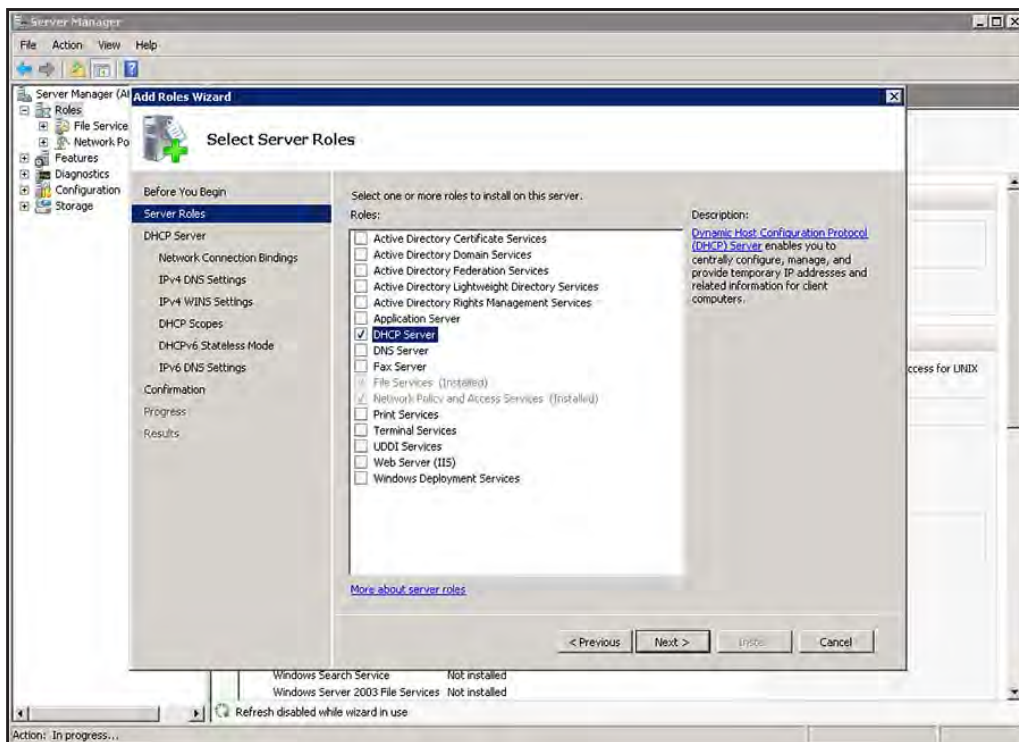


3. In the pop-up menu, select **Add Roles**.

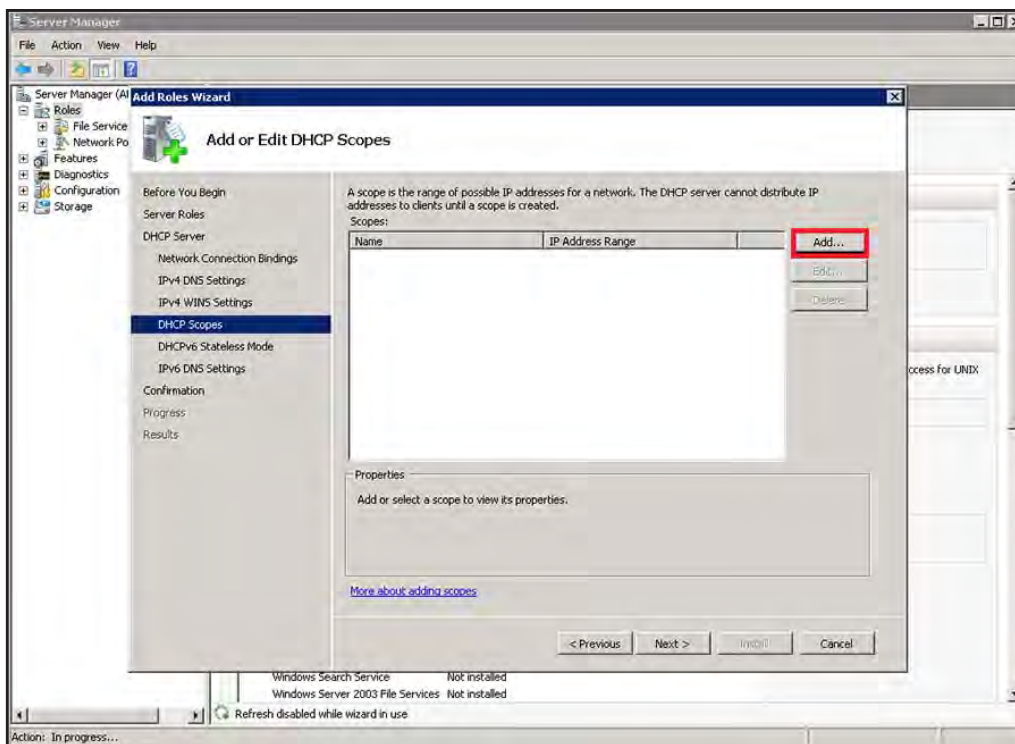
The Add Roles Wizard starts.



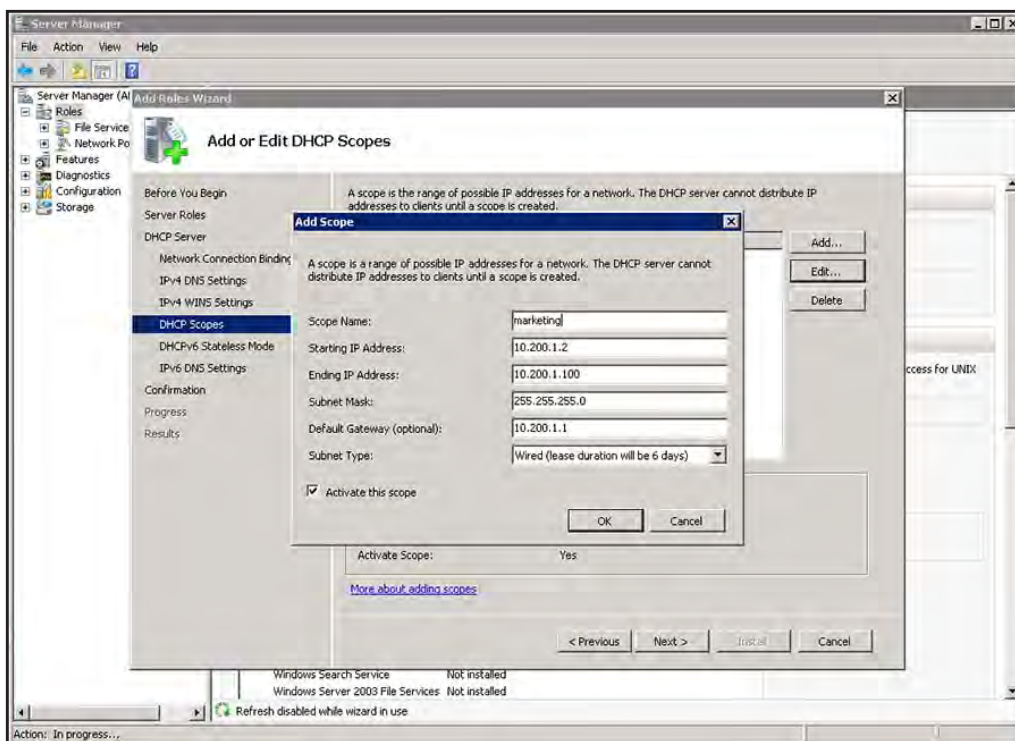
- Click the **Next** button.



- Select the **DHCP Server** check box.
- Click the **Next** button.
- From the menu on the left, select **DHCP scopes**.



8. Click the **Add** button.



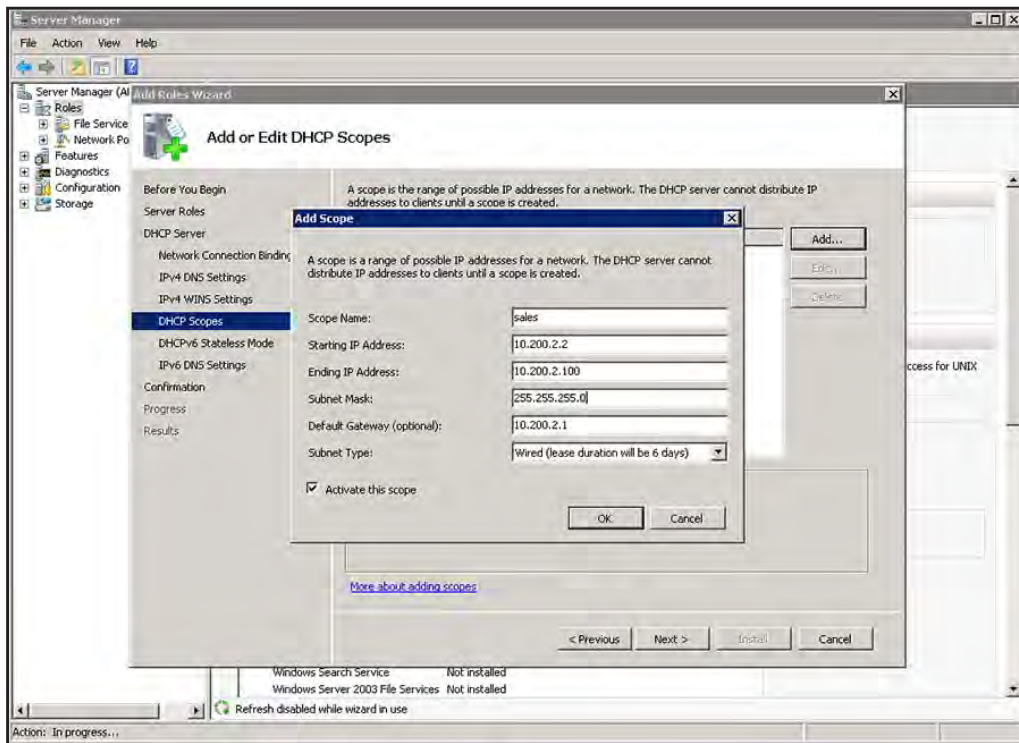
9. In the Add Scope pop-up window, enter the IP address scope information for a marketing scope.

In this example, an IP address range of 10.200.1.2–10.200.1.100 is used. In the **Default Gateway (optional)** field, an IP address of 10.200.1.1 is used, which is the IP address of the gateway for the DHCP client.

10. Click the **OK** button.

The scope information is saved.

11. Click the **Add** button.



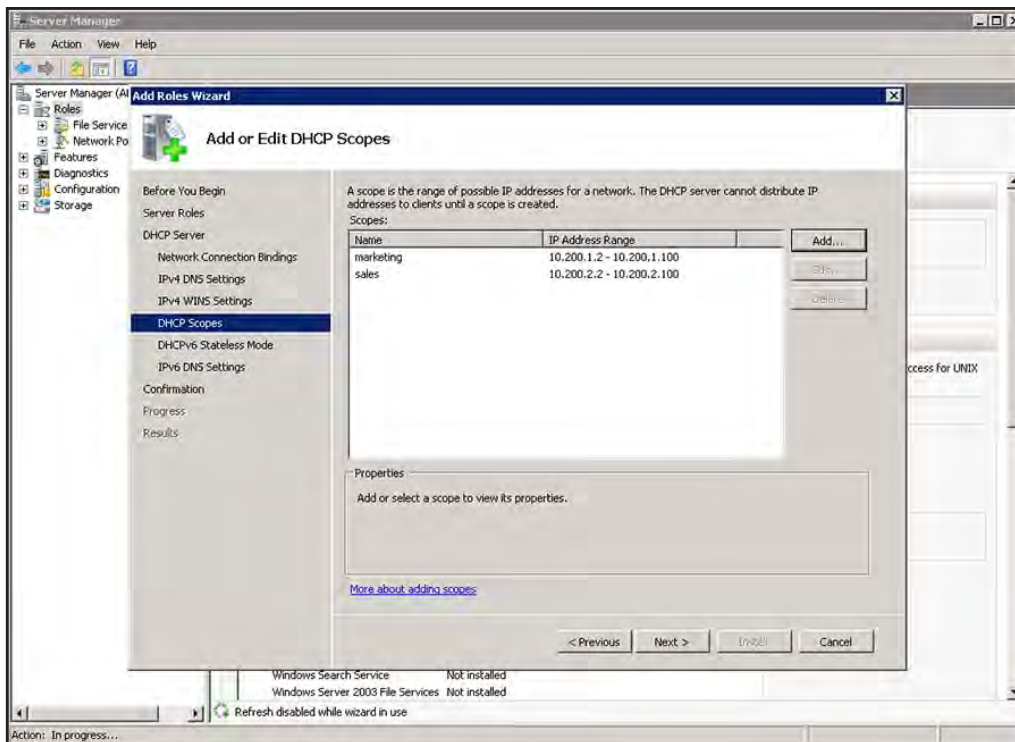
12. In the Add Scope pop-up window, enter the IP address scope information for a sales scope.

In this example, an IP address range of 10.200.2.2–10.200.2.100 is used. In the **Default Gateway (optional)** field, an IP address of 10.200.2.1 is used, which is the gateway for the DHCP client.

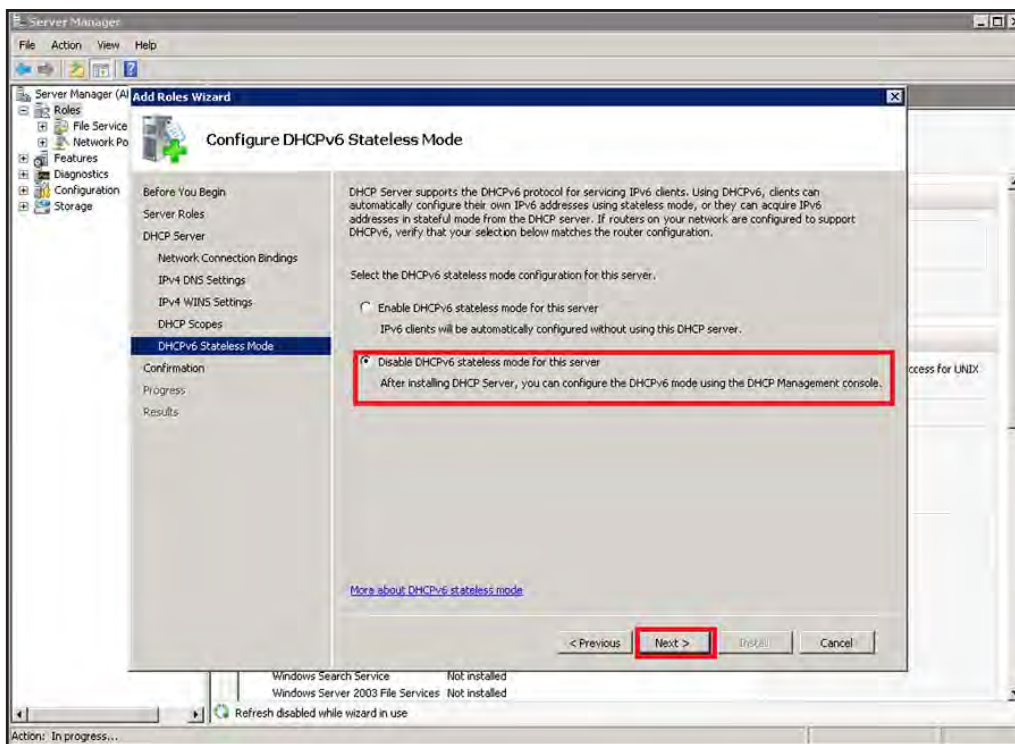
13. Click the **OK** button.

The scope information is saved.



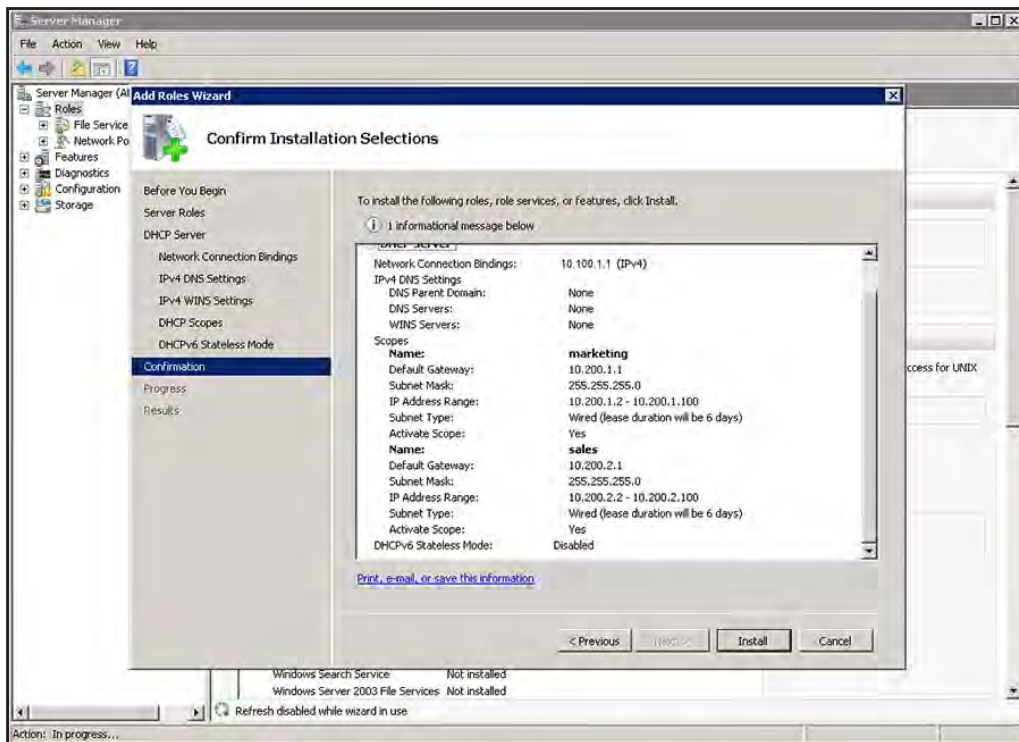


14. Click the **Next** button.

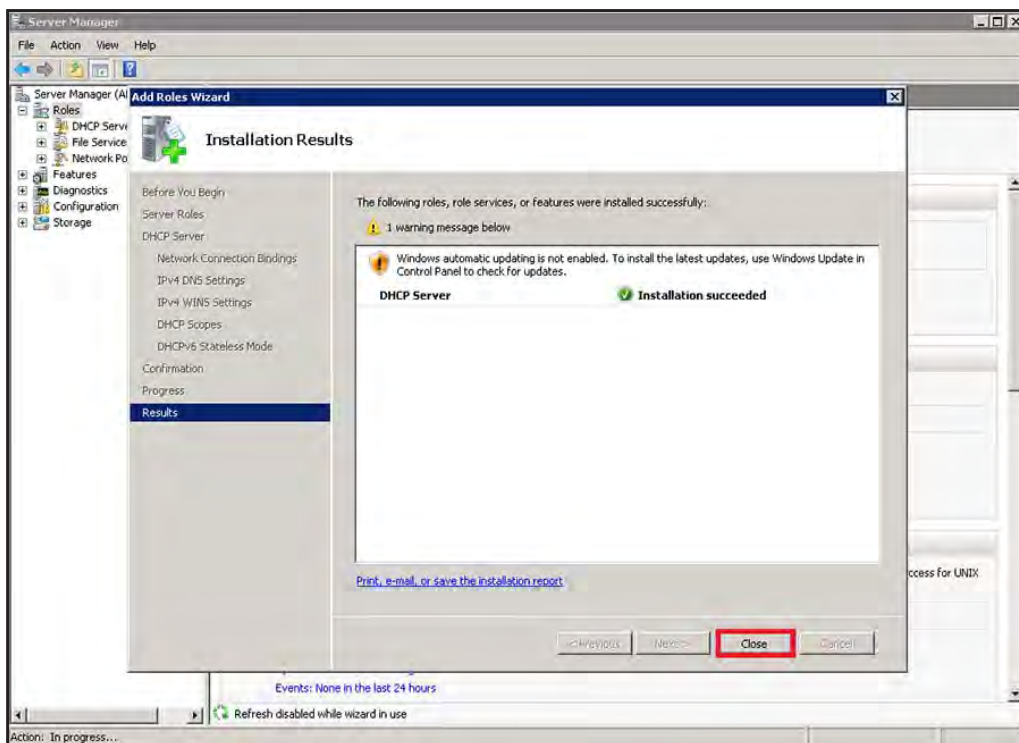


15. Select the **Disable DHCPv6 stateless mode for this server** radio button.

16. Click the **Next** button.

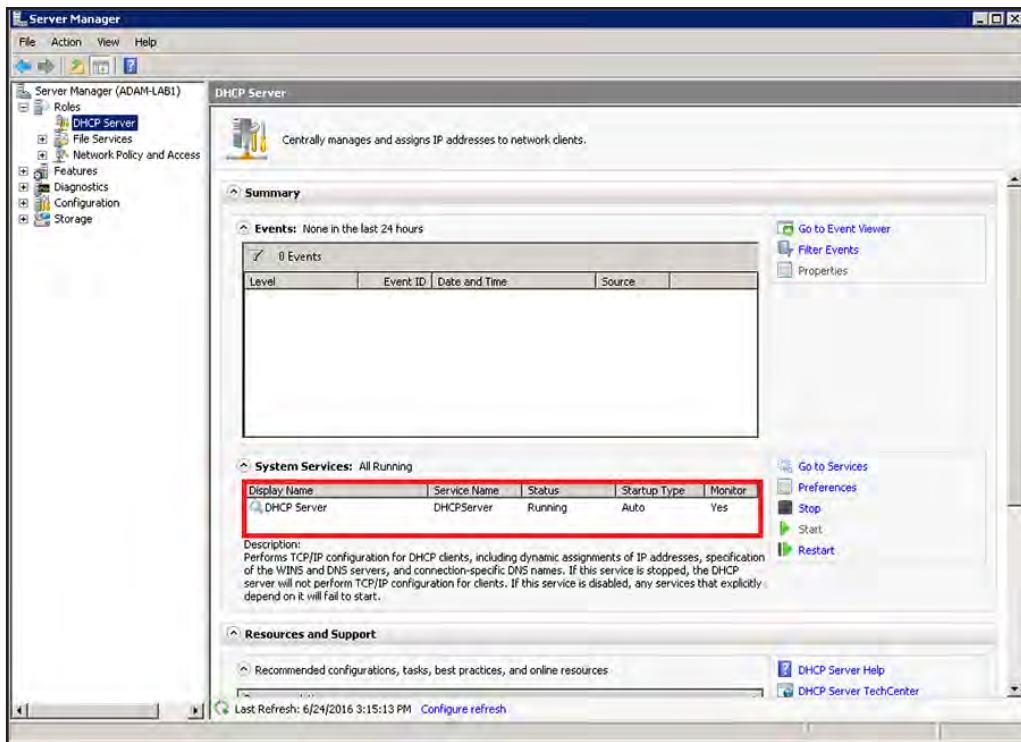


17. Click the **Install** button.



18. Wait for the DHCP server to be installed and the installation process to finish.

19. Click the **Close** button.



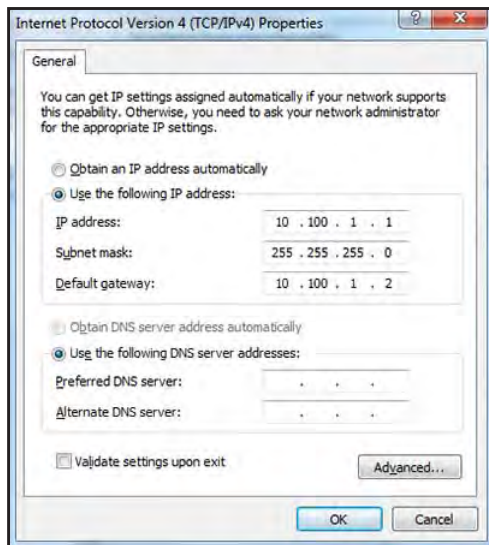
20. Make sure that in the Status column, the field for the DHCP server states Running.

If a computer in the network must receive an IP address in the marketing scope or sales scope, the computer must include a static IP address configuration with the IP address, subnet mask, and gateway address of the gateway that is used for the marketing scope or sales scope.

**To enable a computer with a Windows operating system to receive an IP address from the gateway for the marketing scope or sales scope, do the following:**

1. Navigate to the properties of the network interface card.
2. Open the Internet Protocol Version 4 (TCP/IPv4) Properties pop-up window.
3. Select the **Use the following IP address** radio button.
4. Configure the IP address, subnet mask, and gateway address for the marketing or sales scope.





## Configure a DHCP L3 Switch

### CLI: Configure a DHCP L3 Relay

#### 1. Enable routing on the switch.

```
(Netgear Switch) #config
(Netgear Switch) (Config)#ip routing
(Netgear Switch) (Config)#
```

#### 2. Create a routing interface and assign subnet 10.100.1.2/24 to it.

```
(Netgear Switch) (Config)#
(Netgear Switch) (Config)#interface 1/0/4
(Netgear Switch) (Interface 1/0/4)#routing
(Netgear Switch) (Interface 1/0/4)#ip address 10.100.1.2 255.255.255.0
(Netgear Switch) (Interface 1/0/4)#exit
```

### 3. Create a routing interface connecting to the client.

```
(Netgear Switch) (Config)#
(Netgear Switch) (Config)#Interface 1/0/15
(Netgear Switch) (Interface 1/0/15)#routing
(Netgear Switch) (Interface 1/0/15)#ip address 10.200.1.1 255.255.255.0
(Netgear Switch) (Interface 1/0/15)#exit
(Netgear Switch) (Config)#
(Netgear Switch) (Config)#interface 1/0/16
(Netgear Switch) (Interface 1/0/16)#routing
(Netgear Switch) (Interface 1/0/16)#ip address 10.200.2.1 255.255.255.0
(Netgear Switch) (Interface 1/0/16)#exit
```

### 4. Configure the DHCP Server IP address and enable the DHCP L3 relay.

```
(Netgear Switch) (Config)#ip helper-address 10.100.1.1 dhcp
(Netgear Switch) (Config)#ip helper enable
```

## Local Browser Interface: Configure a DHCP L3 Relay

### 1. Enable routing mode on the switch.

#### a. Select **Routing > IP > Basic > IP Configuration**.

A screen similar to the following displays.

| System   | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|--|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table  | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |
| <div> <div>IP</div> <div>IP Configuration</div> </div> <div> <div>• Basic</div> <div>• IP Configuration</div> <div>• Statistics</div> <div>• Advanced</div> </div> <div> <div>Default Time to Live</div> <div>64</div> </div> <div> <div>Routing Mode</div> <div> <input checked="" type="radio"/> Enable           <input type="radio"/> Disable         </div> </div> <div> <div>ICMP Echo Replies</div> <div> <input checked="" type="radio"/> Enable           <input type="radio"/> Disable         </div> </div> <div> <div>ICMP Redirects</div> <div> <input checked="" type="radio"/> Enable           <input type="radio"/> Disable         </div> </div> <div> <div>ICMP Rate Limit Interval</div> <div> <input type="text" value="1000"/> <small>(0 to 2147483647 ms)</small> </div> </div> <div> <div>ICMP Rate Limit Burst Size</div> <div> <input type="text" value="100"/> <small>(1 to 200)</small> </div> </div> <div> <div>Maximum Next Hops</div> <div>4</div> </div> |           |         |      |          |            |             |        |                  |      |           |                |

#### b. For Routing Mode, select the **Enable** radio button.

#### c. Click **Apply**.

### 2. Create a routing interface and assign 10.100.1.2/24 to it.

#### a. Select **Routing > IP > Advanced > IP Interface Configuration**.

A screen similar to the following displays.

| System  | Switching   | Routing | QoS                             | Security   | Monitoring    | Maintenance  | Help                | Index            |      |           |                |      |             |         |                                 |            |             |              |                     |   |  |  |        |            |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |   |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
|---|-------------|---------|---------------------------------|------------|---------------|--------------|---------------------|------------------|------|-----------|----------------|------|-------------|---------|---------------------------------|------------|-------------|--------------|---------------------|---|--|--|--------|------------|---------------|--------|--------|--------------------------------|--|--|------|---------|---------|---------|--------|--------------------------------|--|--|------|---------|---------|---------|--------|--------------------------------|--|--|------|---------|---------|---------|--------|---|--|--|------|---------|---------|---------|--------|--------------------------------|--|--|------|---------|---------|---------|--------|--------------------------------|--|--|------|---------|---------|---------|--------|
| Routing Table   | IP          | IPv6    | VLAN                            | ARP        | RIP           | OSPF         | OSPFv3              | Router Discovery | VRRP | Multicast | IPv6 Multicast |      |             |         |                                 |            |             |              |                     |   |  |  |        |            |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |   |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <div>IP</div> <table border="1"> <thead> <tr> <th>Port</th> <th>Description</th> <th>VLAN ID</th> <th>IP Address Configuration Method</th> <th>IP Address</th> <th>Subnet Mask</th> <th>Routing Mode</th> <th>Administrative Mode</th> </tr> </thead> <tbody> <tr> <td><input checked="" type="checkbox"/> 1/0/4</td> <td></td> <td></td> <td>Manual</td> <td>10.100.1.2</td> <td>255.255.255.0</td> <td>Enable</td> <td>Enable</td> </tr> <tr> <td><input type="checkbox"/> 1/0/1</td> <td></td> <td></td> <td>None</td> <td>0.0.0.0</td> <td>0.0.0.0</td> <td>Disable</td> <td>Enable</td> </tr> <tr> <td><input type="checkbox"/> 1/0/2</td> <td></td> <td></td> <td>None</td> <td>0.0.0.0</td> <td>0.0.0.0</td> <td>Disable</td> <td>Enable</td> </tr> <tr> <td><input type="checkbox"/> 1/0/3</td> <td></td> <td></td> <td>None</td> <td>0.0.0.0</td> <td>0.0.0.0</td> <td>Disable</td> <td>Enable</td> </tr> <tr> <td><input checked="" type="checkbox"/> 1/0/4</td> <td></td> <td></td> <td>None</td> <td>0.0.0.0</td> <td>0.0.0.0</td> <td>Disable</td> <td>Enable</td> </tr> <tr> <td><input type="checkbox"/> 1/0/5</td> <td></td> <td></td> <td>None</td> <td>0.0.0.0</td> <td>0.0.0.0</td> <td>Disable</td> <td>Enable</td> </tr> <tr> <td><input type="checkbox"/> 1/0/6</td> <td></td> <td></td> <td>None</td> <td>0.0.0.0</td> <td>0.0.0.0</td> <td>Disable</td> <td>Enable</td> </tr> </tbody> </table> |             |         |                                 |            |               |              |                     |                  |      |           |                | Port | Description | VLAN ID | IP Address Configuration Method | IP Address | Subnet Mask | Routing Mode | Administrative Mode | <input checked="" type="checkbox"/> 1/0/4 |  |  | Manual | 10.100.1.2 | 255.255.255.0 | Enable | Enable | <input type="checkbox"/> 1/0/1 |  |  | None | 0.0.0.0 | 0.0.0.0 | Disable | Enable | <input type="checkbox"/> 1/0/2 |  |  | None | 0.0.0.0 | 0.0.0.0 | Disable | Enable | <input type="checkbox"/> 1/0/3 |  |  | None | 0.0.0.0 | 0.0.0.0 | Disable | Enable | <input checked="" type="checkbox"/> 1/0/4 |  |  | None | 0.0.0.0 | 0.0.0.0 | Disable | Enable | <input type="checkbox"/> 1/0/5 |  |  | None | 0.0.0.0 | 0.0.0.0 | Disable | Enable | <input type="checkbox"/> 1/0/6 |  |  | None | 0.0.0.0 | 0.0.0.0 | Disable | Enable |
| Port  | Description | VLAN ID | IP Address Configuration Method | IP Address | Subnet Mask   | Routing Mode | Administrative Mode |                  |      |           |                |      |             |         |                                 |            |             |              |                     |   |  |  |        |            |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |   |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input checked="" type="checkbox"/> 1/0/4   |             |         | Manual                          | 10.100.1.2 | 255.255.255.0 | Enable       | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |   |  |  |        |            |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |   |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input type="checkbox"/> 1/0/1  |             |         | None                            | 0.0.0.0    | 0.0.0.0       | Disable      | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |   |  |  |        |            |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |   |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input type="checkbox"/> 1/0/2  |             |         | None                            | 0.0.0.0    | 0.0.0.0       | Disable      | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |   |  |  |        |            |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |   |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input type="checkbox"/> 1/0/3  |             |         | None                            | 0.0.0.0    | 0.0.0.0       | Disable      | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |   |  |  |        |            |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |   |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input checked="" type="checkbox"/> 1/0/4   |             |         | None                            | 0.0.0.0    | 0.0.0.0       | Disable      | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |   |  |  |        |            |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |   |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input type="checkbox"/> 1/0/5  |             |         | None                            | 0.0.0.0    | 0.0.0.0       | Disable      | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |   |  |  |        |            |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |   |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input type="checkbox"/> 1/0/6  |             |         | None                            | 0.0.0.0    | 0.0.0.0       | Disable      | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |   |  |  |        |            |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |   |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |

- b. Scroll down and select the Port **1/0/4** check box.
  - c. In the **IP Address** field, enter **10.100.1.2**.
  - d. In the **Subnet Mask** field, enter **255.255.255.0**.
  - e. In the **Routing Mode** field, select **Enable**.
  - f. Click **Apply** to save the settings.
3. Create a routing interface and assign 10.200.1.1/24 to it.
  - a. Select **Routing > IP > Advanced > IP Interface Configuration**.

A screen similar to the following displays.

| System  | Switching   | Routing | QoS                             | Security   | Monitoring  | Maintenance  | Help                | Index            |      |           |                |      |             |         |                                 |            |             |              |                     |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
|---|-------------|---------|---------------------------------|------------|-------------|--------------|---------------------|------------------|------|-----------|----------------|------|-------------|---------|---------------------------------|------------|-------------|--------------|---------------------|--------------------------------|--|--|------|---------|---------|---------|--------|--------------------------------|--|--|------|---------|---------|---------|--------|--------------------------------|--|--|------|---------|---------|---------|--------|--------------------------------|--|--|------|---------|---------|---------|--------|--------------------------------|--|--|------|---------|---------|---------|--------|--------------------------------|--|--|------|---------|---------|---------|--------|--------------------------------|--|--|------|---------|---------|---------|--------|--------------------------------|--|--|------|---------|---------|---------|--------|
| Routing Table   | IP          | IPv6    | VLAN                            | ARP        | RIP         | OSPF         | OSPFv3              | Router Discovery | VRRP | Multicast | IPv6 Multicast |      |             |         |                                 |            |             |              |                     |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <div>IP</div> <div>IP Interface Configuration</div> <table border="1"> <thead> <tr> <th>Port</th> <th>Description</th> <th>VLAN ID</th> <th>IP Address Configuration Method</th> <th>IP Address</th> <th>Subnet Mask</th> <th>Routing Mode</th> <th>Administrative Mode</th> </tr> </thead> <tbody> <tr> <td><input type="checkbox"/> 1/0/1</td> <td></td> <td></td> <td>None</td> <td>0.0.0.0</td> <td>0.0.0.0</td> <td>Disable</td> <td>Enable</td> </tr> <tr> <td><input type="checkbox"/> 1/0/2</td> <td></td> <td></td> <td>None</td> <td>0.0.0.0</td> <td>0.0.0.0</td> <td>Disable</td> <td>Enable</td> </tr> <tr> <td><input type="checkbox"/> 1/0/3</td> <td></td> <td></td> <td>None</td> <td>0.0.0.0</td> <td>0.0.0.0</td> <td>Disable</td> <td>Enable</td> </tr> <tr> <td><input type="checkbox"/> 1/0/4</td> <td></td> <td></td> <td>None</td> <td>0.0.0.0</td> <td>0.0.0.0</td> <td>Disable</td> <td>Enable</td> </tr> <tr> <td><input type="checkbox"/> 1/0/5</td> <td></td> <td></td> <td>None</td> <td>0.0.0.0</td> <td>0.0.0.0</td> <td>Disable</td> <td>Enable</td> </tr> <tr> <td><input type="checkbox"/> 1/0/6</td> <td></td> <td></td> <td>None</td> <td>0.0.0.0</td> <td>0.0.0.0</td> <td>Disable</td> <td>Enable</td> </tr> <tr> <td><input type="checkbox"/> 1/0/7</td> <td></td> <td></td> <td>None</td> <td>0.0.0.0</td> <td>0.0.0.0</td> <td>Disable</td> <td>Enable</td> </tr> <tr> <td><input type="checkbox"/> 1/0/8</td> <td></td> <td></td> <td>None</td> <td>0.0.0.0</td> <td>0.0.0.0</td> <td>Disable</td> <td>Enable</td> </tr> </tbody> </table> |             |         |                                 |            |             |              |                     |                  |      |           |                | Port | Description | VLAN ID | IP Address Configuration Method | IP Address | Subnet Mask | Routing Mode | Administrative Mode | <input type="checkbox"/> 1/0/1 |  |  | None | 0.0.0.0 | 0.0.0.0 | Disable | Enable | <input type="checkbox"/> 1/0/2 |  |  | None | 0.0.0.0 | 0.0.0.0 | Disable | Enable | <input type="checkbox"/> 1/0/3 |  |  | None | 0.0.0.0 | 0.0.0.0 | Disable | Enable | <input type="checkbox"/> 1/0/4 |  |  | None | 0.0.0.0 | 0.0.0.0 | Disable | Enable | <input type="checkbox"/> 1/0/5 |  |  | None | 0.0.0.0 | 0.0.0.0 | Disable | Enable | <input type="checkbox"/> 1/0/6 |  |  | None | 0.0.0.0 | 0.0.0.0 | Disable | Enable | <input type="checkbox"/> 1/0/7 |  |  | None | 0.0.0.0 | 0.0.0.0 | Disable | Enable | <input type="checkbox"/> 1/0/8 |  |  | None | 0.0.0.0 | 0.0.0.0 | Disable | Enable |
| Port  | Description | VLAN ID | IP Address Configuration Method | IP Address | Subnet Mask | Routing Mode | Administrative Mode |                  |      |           |                |      |             |         |                                 |            |             |              |                     |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input type="checkbox"/> 1/0/1  |             |         | None                            | 0.0.0.0    | 0.0.0.0     | Disable      | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input type="checkbox"/> 1/0/2  |             |         | None                            | 0.0.0.0    | 0.0.0.0     | Disable      | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input type="checkbox"/> 1/0/3  |             |         | None                            | 0.0.0.0    | 0.0.0.0     | Disable      | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input type="checkbox"/> 1/0/4  |             |         | None                            | 0.0.0.0    | 0.0.0.0     | Disable      | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input type="checkbox"/> 1/0/5  |             |         | None                            | 0.0.0.0    | 0.0.0.0     | Disable      | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input type="checkbox"/> 1/0/6  |             |         | None                            | 0.0.0.0    | 0.0.0.0     | Disable      | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input type="checkbox"/> 1/0/7  |             |         | None                            | 0.0.0.0    | 0.0.0.0     | Disable      | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input type="checkbox"/> 1/0/8  |             |         | None                            | 0.0.0.0    | 0.0.0.0     | Disable      | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |

- b. Under IP Interface Configuration, scroll down and select the Port **1/0/15** check box.
  - c. In the **IP Address Configuration Method** field, enter **Manual**.
  - d. In the **IP Address** field, enter **10.200.1.1**.
  - e. In the **Subnet Mask** field, enter **255.255.255.0**.
  - f. In the **Routing Mode** field, select **Enable**.
  - g. Click **Apply** to save the settings.
4. Create a routing interface and assign 10.200.2.1/24 to it.
  - a. Select **Routing > IP > Advanced > IP Interface Configuration**.

A screen similar to the following displays.

| Port                           | Description | VLAN ID | IP Address Configuration Method | IP Address | Subnet Mask | Routing Mode | Administrative Mode |
|--------------------------------|-------------|---------|---------------------------------|------------|-------------|--------------|---------------------|
| <input type="checkbox"/> 1/0/1 |             |         | None                            | 0.0.0.0    | 0.0.0.0     | Disable      | Enable              |
| <input type="checkbox"/> 1/0/2 |             |         | None                            | 0.0.0.0    | 0.0.0.0     | Disable      | Enable              |
| <input type="checkbox"/> 1/0/3 |             |         | None                            | 0.0.0.0    | 0.0.0.0     | Disable      | Enable              |
| <input type="checkbox"/> 1/0/4 |             |         | None                            | 0.0.0.0    | 0.0.0.0     | Disable      | Enable              |
| <input type="checkbox"/> 1/0/5 |             |         | None                            | 0.0.0.0    | 0.0.0.0     | Disable      | Enable              |
| <input type="checkbox"/> 1/0/6 |             |         | None                            | 0.0.0.0    | 0.0.0.0     | Disable      | Enable              |
| <input type="checkbox"/> 1/0/7 |             |         | None                            | 0.0.0.0    | 0.0.0.0     | Disable      | Enable              |
| <input type="checkbox"/> 1/0/8 |             |         | None                            | 0.0.0.0    | 0.0.0.0     | Disable      | Enable              |

- b. Under IP Interface Configuration, scroll down and select the Port **1/0/16** check box.
  - c. In the IP Address Configuration Method field, enter **Manual**.
  - d. In the IP Address field, enter **10.200.2.1**.
  - e. In the Subnet Mask field, enter **255.255.255.0**.
  - f. In the Routing Mode field, select **Enable**.
  - g. Click **Apply** to save the settings.
5. Enable DHCP L3 relay.
  - a. Select **System > Services > DHCP Relay**.

A screen similar to the following displays.

| Services            | DHCP Relay  |
|---------------------|---|
| • DHCP Server       | Maximum Hop Count: 4 (1 to 16)  |
| • <b>DHCP Relay</b> | Admin Mode: <input type="radio"/> Disable <input checked="" type="radio"/> Enable             |
| • DHCP L2 Relay     | Minimum Wait Time (secs): 0 (0 to 100)  |
| • UDP Relay         | Circuit ID Option Mode: <input checked="" type="radio"/> Disable <input type="radio"/> Enable |
| • DHCPv6 Server     |   |

| DHCP Relay Statistics |   |
|-----------------------|---|
| Requests Received     | 0 |
| Requests Relayed      | 0 |
| Packets Discarded     | 0 |

- b. For Admin Mode, select the **Enable** radio button.
  - c. Click **Apply** to save the settings.
6. Configure the DHCP server IP address.
  - a. Select **System > Services > UDP Relay**.

A screen similar to the following displays.

| System   | Switching   | Routing              | QoS       | Security | Monitoring | Maintenance | Help | Index          |                |          |                      |           |            |      |    |  |
|--|-------------|----------------------|-----------|----------|------------|-------------|------|----------------|----------------|----------|----------------------|-----------|------------|------|----|--|
| Management   | Device View | Services             | Chassis   | PoE      | SNMP       | LLDP        | ISDP | Timer Schedule |                |          |                      |           |            |      |    |  |
| <div> <div>Services</div> <div> <div>• DHCP Server</div> <div>• DHCP Relay</div> <div>• DHCP L2 Relay</div> <div>• UDP Relay</div> <div>• UDP Relay Global Configuration</div> <div>• UDP Relay Interface Configuration</div> <div>• DHCPv6 Server</div> </div> </div> <div> <div>UDP Relay Configuration</div> <div> <div>Admin Mode</div> <div> <input type="radio"/> Disable           <input checked="" type="radio"/> Enable         </div> </div> <div> <div>UDP Relay Global Configuration</div> <table border="1"> <thead> <tr> <th>Server Address</th> <th>UDP Port</th> <th>UDP Port Other Value</th> <th>Hit Count</th> </tr> </thead> <tbody> <tr> <td>10.100.1.1</td> <td>dhcp</td> <td>67</td> <td></td> </tr> </tbody> </table> </div> </div> |             |                      |           |          |            |             |      |                | Server Address | UDP Port | UDP Port Other Value | Hit Count | 10.100.1.1 | dhcp | 67 |  |
| Server Address   | UDP Port    | UDP Port Other Value | Hit Count |          |            |             |      |                |                |          |                      |           |            |      |    |  |
| 10.100.1.1   | dhcp        | 67                   |           |          |            |             |      |                |                |          |                      |           |            |      |    |  |

- b. In the **Server Address** field, enter **10.100.1.1**.
- c. In the **UDP Port** field, enter **dhcp**.
- d. Click **Add** to save the settings.

# 32

## 32 MLD

---

### Multicast Listener Discovery

This chapter includes the following sections:

- [Multicast Listener Discovery Concepts](#)
- [Configure MLD](#)
- [MLD Snooping](#)

# Multicast Listener Discovery Concepts

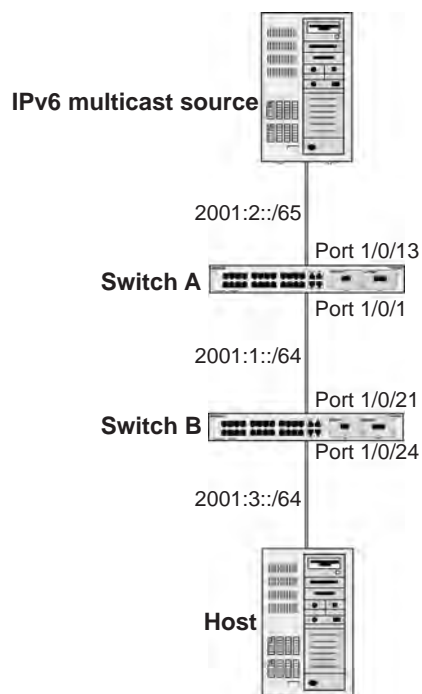
Multicast Listener Discovery (MLD) protocol enables IPv6 routers to discover multicast listeners, the nodes that are configured to receive multicast data packets, on its directly attached interfaces. The protocol specifically discovers which multicast addresses are of interest to its neighboring nodes and provides this information to the active multicast routing protocol that determines the flow of multicast data packets.

Periodically, the multicast router sends general queries requesting multicast address listener information from systems on an attached network. These queries are used to build and refresh the multicast address listener state on the attached networks. In response to the queries, multicast listeners reply with membership reports. These membership reports specify their multicast addresses listener state and their desired set of sources with current-state multicast address records.

The multicast router also processes unsolicited filter- mode-change records and source-list-change records from systems that want to indicate interest in receiving or not receiving traffic from particular sources.

## Configure MLD

In this case, PIM-DM is enabled on Switch A and Switch B, and MLD is enabled on Switch B's port 1/0/24 to discover the multicast listeners.



**Figure 63. Configure MLD**



## CLI: Configure MLD

### MLD on Switch A

```
(Netgear Switch) #configure
(Netgear Switch) (Config)#ipv6 router ospf
(Netgear Switch) (Config-rtr)#router-id 1.1.1.1
(Netgear Switch) (Config)#exit
```

```
(Netgear Switch) (Config)#ipv6 unicast-routing
(Netgear Switch) (Config)#ipv6 pim dense
(Netgear Switch) (Config)#ip routing
(Netgear Switch) (Config)#ip multicast
(Netgear Switch) (Config)#interface 1/0/1
(Netgear Switch) (Interface 1/0/1)#routing
(Netgear Switch) (Interface 1/0/1)#ipv6 address 2001:1::1/64
(Netgear Switch) (Interface 1/0/1)#ipv6 enable
(Netgear Switch) (Interface 1/0/1)#ipv6 pim
(Netgear Switch) (Interface 1/0/1)#ipv6 ospf
(Netgear Switch) (Interface 1/0/1)#exit

(Netgear Switch) (Config)#interface 1/0/13
(Netgear Switch) (Interface 1/0/13)#routing
(Netgear Switch) (Interface 1/0/13)#ipv6 address 2001:2::1/64
(Netgear Switch) (Interface 1/0/13)#ipv6 enable
(Netgear Switch) (Interface 1/0/13)#ipv6 pim
(Netgear Switch) (Interface 1/0/13)#ipv6 ospf
(Netgear Switch) (Interface 1/0/13)#exit
```

### MLD on Switch B

#### 1. Enable OSPFv3 to build a unicast route table.

```
(Netgear Switch)#configure
(Netgear Switch) (Config)#ipv6 router ospf
(Netgear Switch) (Config-rtr)#router-id 2.2.2.2
(Netgear Switch) (Config)#exit
```

#### 2. Enable IPV6 unicast routing on the switch.

```
(Netgear Switch) (Config)#ipv6 unicast-routing
```

**3. Enable IPV6 MLD on the switch.**

```
(Netgear Switch) (Config)#ipv6 mld router
```

**4. Enable IPV6 PIM-DM on the switch.**

```
(Netgear Switch) (Config)#ipv6 pim dense
```

**5. Enable IP multicast forwarding on the switch.**

```
(Netgear Switch) (Config)#ip routing
(Netgear Switch) (Config)#ip multicast
```

**6. Enable MLD on interface 1/0/24.**

```
(Netgear Switch) (Config)#interface 1/0/21
(Netgear Switch) (Interface 1/0/21)#routing
(Netgear Switch) (Interface 1/0/21)#ipv6 address 2001:1::2/64
(Netgear Switch) (Interface 1/0/21)#ipv6 enable
(Netgear Switch) (Interface 1/0/21)#ipv6 pim
(Netgear Switch) (Interface 1/0/21)#ipv6 ospf
(Netgear Switch) (Interface 1/0/21)#exit
(Netgear Switch) (Config)#interface 1/0/24
(Netgear Switch) (Interface 1/0/24)#routing
(Netgear Switch) (Interface 1/0/24)#ipv6 address 2001:3::1/64
(Netgear Switch) (Interface 1/0/24)#ipv6 enable
(Netgear Switch) (Interface 1/0/24)#ipv6 mld router
(Netgear Switch) (Interface 1/0/24)#ipv6 pim
(Netgear Switch) (Interface 1/0/24)#exit

The MLD group information on switch B:
(B) #show ipv6 mld groups ff32::1
Interface..... 71/1/24
Group Address..... FF32::1
Last Reporter..... FE80::200:4FF:FEE8:5EFC
Up Time (hh:mm:ss)..... 00:00:18
Expiry Time (hh:mm:ss)..... -----
Filter Mode..... Include
Version1 Host Timer..... -----
Group compat mode..... v2
Source Address      ExpiryTime
-----
2001:2::2          00:04:02
```

# Local Browser Interface: Configure MLD

## MLD on Switch A

### 1. Enable IP routing on the switch.

#### a. Select **Routing > IP > Basic > IP Configuration**.

A screen similar to the following displays.

| System  | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table   | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |
| <div> <div>IP</div> <div>IP Configuration</div> </div>  |           |         |      |          |            |             |        |                  |      |           |                |
| <div> <div>Basic</div> <div>Default Time to Live</div> <div>64</div> </div>   |           |         |      |          |            |             |        |                  |      |           |                |
| <div> <div>IP Configuration</div> <div>Routing Mode</div> <div> <input type="radio"/> Enable           <input checked="" type="radio"/> Disable         </div> </div> |           |         |      |          |            |             |        |                  |      |           |                |
| <div> <div>Statistics</div> <div>ICMP Echo Replies</div> <div> <input type="radio"/> Enable           <input checked="" type="radio"/> Disable         </div> </div>  |           |         |      |          |            |             |        |                  |      |           |                |
| <div> <div>Advanced</div> <div>ICMP Redirects</div> <div> <input type="radio"/> Enable           <input checked="" type="radio"/> Disable         </div> </div>       |           |         |      |          |            |             |        |                  |      |           |                |
| <div> <div>ICMP Rate Limit Interval</div> <div>1000</div> <div>(0 to 2147483647 ms)</div> </div>  |           |         |      |          |            |             |        |                  |      |           |                |
| <div> <div>ICMP Rate Limit Burst Size</div> <div>100</div> <div>(1 to 200)</div> </div>   |           |         |      |          |            |             |        |                  |      |           |                |
| <div> <div>Maximum Next Hops</div> <div>4</div> </div>  |           |         |      |          |            |             |        |                  |      |           |                |

#### b. For Routing Mode, select the **Enable** radio button.

#### c. Click **Apply**.

### 2. Enable IPv6 unicast routing on the switch.

#### a. Select **Routing > IPv6 > Basic > Global Configuration**.

A screen similar to the following displays.

| System   | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|--|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table  | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |
| <div> <div>IPv6</div> <div>IPv6 Global Configuration</div> </div>  |           |         |      |          |            |             |        |                  |      |           |                |
| <div> <div>Basic</div> <div>IPv6 Unicast Routing</div> <div> <input type="radio"/> Disable           <input checked="" type="radio"/> Enable         </div> </div> |           |         |      |          |            |             |        |                  |      |           |                |
| <div> <div>Global Configuration</div> <div>Hop Limit</div> <div>64</div> <div>(1 to 255)</div> </div>  |           |         |      |          |            |             |        |                  |      |           |                |
| <div> <div>Route Table</div> <div>ICMPv6 Rate Limit Error Interval</div> <div>1000</div> <div>(0 to 2147483647 msecs)</div> </div>                                 |           |         |      |          |            |             |        |                  |      |           |                |
| <div> <div>Advanced</div> <div>ICMPv6 Rate Limit Burst Size</div> <div>100</div> <div>(1 to 200)</div> </div>  |           |         |      |          |            |             |        |                  |      |           |                |

#### b. For IPv6 Unicast Routing, select the **Enable** radio button.

#### c. Click **Apply**.

### 3. Configure 1/0/1 and 1/0/13 as a IPv6 routing ports.

#### a. Select **Routing > IPv6 > Advanced > Interface Configuration**.

A screen similar to the following displays.

| System  | Switching | Routing            | QoS                               | Security     | Monitoring | Maintenance      | Help   | Index                                 |                    |                 |                |           |           |                    |                                   |              |            |                  |     |                                       |                    |                 |       |        |         |         |        |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |        |         |         |         |         |        |         |      |   |      |   |
|---|-----------|--------------------|-----------------------------------|--------------|------------|------------------|--------|---------------------------------------|--------------------|-----------------|----------------|-----------|-----------|--------------------|-----------------------------------|--------------|------------|------------------|-----|---------------------------------------|--------------------|-----------------|-------|--------|---------|---------|--------|--------|---------|------|---|------|---|-------|---------|---------|---------|---------|--------|---------|------|---|------|---|-------|---------|---------|---------|---------|--------|---------|------|---|------|---|-------|---------|---------|---------|---------|--------|---------|------|---|------|---|-------|---------|---------|---------|---------|--------|---------|------|---|------|---|-------|---------|---------|---------|---------|--------|---------|------|---|------|---|-------|---------|---------|---------|---------|--------|---------|------|---|------|---|-------|---------|---------|---------|---------|--------|---------|------|---|------|---|-------|---------|---------|---------|---------|--------|---------|------|---|------|---|--------|---------|---------|---------|---------|--------|---------|------|---|------|---|
| Routing Table   | IP        | IPv6               | VLAN                              | ARP          | RIP        | OSPF             | OSPFv3 | Router Discovery                      | VRRP               | Multicast       | IPv6 Multicast |           |           |                    |                                   |              |            |                  |     |                                       |                    |                 |       |        |         |         |        |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |        |         |         |         |         |        |         |      |   |      |   |
| <div> <div>IPv6</div> <div>IPv6 Interface Configuration</div> </div>  |           |                    |                                   |              |            |                  |        |                                       |                    |                 |                |           |           |                    |                                   |              |            |                  |     |                                       |                    |                 |       |        |         |         |        |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |        |         |         |         |         |        |         |      |   |      |   |
| <div> <div>Basic</div> <div>1 2 3 VLANs All</div> </div>  |           |                    |                                   |              |            |                  |        |                                       |                    |                 |                |           |           |                    |                                   |              |            |                  |     |                                       |                    |                 |       |        |         |         |        |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |        |         |         |         |         |        |         |      |   |      |   |
| <div> <div>Advanced</div> <div>Global Configuration</div> </div>  |           |                    |                                   |              |            |                  |        |                                       |                    |                 |                |           |           |                    |                                   |              |            |                  |     |                                       |                    |                 |       |        |         |         |        |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |        |         |         |         |         |        |         |      |   |      |   |
| <div> <div>Interface Configuration</div> <table border="1"> <thead> <tr> <th>Interface</th> <th>IPv6 Mode</th> <th>DHCPv6 Client Mode</th> <th>Stateless Address AutoConfig Mode</th> <th>Routing Mode</th> <th>Admin Mode</th> <th>Operational Mode</th> <th>MTU</th> <th>Duplicate Address Detection Transmits</th> <th>Life Time Interval</th> <th>Adi NS Interval</th> </tr> </thead> <tbody> <tr> <td>1/0/1</td> <td>Enable</td> <td>Disable</td> <td>Disable</td> <td>Enable</td> <td>Enable</td> <td>Disable</td> <td>1500</td> <td>1</td> <td>1800</td> <td>0</td> </tr> <tr> <td>1/0/2</td> <td>Disable</td> <td>Disable</td> <td>Disable</td> <td>Disable</td> <td>Enable</td> <td>Disable</td> <td>1500</td> <td>1</td> <td>1800</td> <td>0</td> </tr> <tr> <td>1/0/3</td> <td>Disable</td> <td>Disable</td> <td>Disable</td> <td>Disable</td> <td>Enable</td> <td>Disable</td> <td>1500</td> <td>1</td> <td>1800</td> <td>0</td> </tr> <tr> <td>1/0/4</td> <td>Disable</td> <td>Disable</td> <td>Disable</td> <td>Disable</td> <td>Enable</td> <td>Disable</td> <td>1500</td> <td>1</td> <td>1800</td> <td>0</td> </tr> <tr> <td>1/0/5</td> <td>Disable</td> <td>Disable</td> <td>Disable</td> <td>Disable</td> <td>Enable</td> <td>Disable</td> <td>1500</td> <td>1</td> <td>1800</td> <td>0</td> </tr> <tr> <td>1/0/6</td> <td>Disable</td> <td>Disable</td> <td>Disable</td> <td>Disable</td> <td>Enable</td> <td>Disable</td> <td>1500</td> <td>1</td> <td>1800</td> <td>0</td> </tr> <tr> <td>1/0/7</td> <td>Disable</td> <td>Disable</td> <td>Disable</td> <td>Disable</td> <td>Enable</td> <td>Disable</td> <td>1500</td> <td>1</td> <td>1800</td> <td>0</td> </tr> <tr> <td>1/0/8</td> <td>Disable</td> <td>Disable</td> <td>Disable</td> <td>Disable</td> <td>Enable</td> <td>Disable</td> <td>1500</td> <td>1</td> <td>1800</td> <td>0</td> </tr> <tr> <td>1/0/9</td> <td>Disable</td> <td>Disable</td> <td>Disable</td> <td>Disable</td> <td>Enable</td> <td>Disable</td> <td>1500</td> <td>1</td> <td>1800</td> <td>0</td> </tr> <tr> <td>1/0/10</td> <td>Disable</td> <td>Disable</td> <td>Disable</td> <td>Disable</td> <td>Enable</td> <td>Disable</td> <td>1500</td> <td>1</td> <td>1800</td> <td>0</td> </tr> </tbody> </table> </div> |           |                    |                                   |              |            |                  |        |                                       |                    |                 |                | Interface | IPv6 Mode | DHCPv6 Client Mode | Stateless Address AutoConfig Mode | Routing Mode | Admin Mode | Operational Mode | MTU | Duplicate Address Detection Transmits | Life Time Interval | Adi NS Interval | 1/0/1 | Enable | Disable | Disable | Enable | Enable | Disable | 1500 | 1 | 1800 | 0 | 1/0/2 | Disable | Disable | Disable | Disable | Enable | Disable | 1500 | 1 | 1800 | 0 | 1/0/3 | Disable | Disable | Disable | Disable | Enable | Disable | 1500 | 1 | 1800 | 0 | 1/0/4 | Disable | Disable | Disable | Disable | Enable | Disable | 1500 | 1 | 1800 | 0 | 1/0/5 | Disable | Disable | Disable | Disable | Enable | Disable | 1500 | 1 | 1800 | 0 | 1/0/6 | Disable | Disable | Disable | Disable | Enable | Disable | 1500 | 1 | 1800 | 0 | 1/0/7 | Disable | Disable | Disable | Disable | Enable | Disable | 1500 | 1 | 1800 | 0 | 1/0/8 | Disable | Disable | Disable | Disable | Enable | Disable | 1500 | 1 | 1800 | 0 | 1/0/9 | Disable | Disable | Disable | Disable | Enable | Disable | 1500 | 1 | 1800 | 0 | 1/0/10 | Disable | Disable | Disable | Disable | Enable | Disable | 1500 | 1 | 1800 | 0 |
| Interface   | IPv6 Mode | DHCPv6 Client Mode | Stateless Address AutoConfig Mode | Routing Mode | Admin Mode | Operational Mode | MTU    | Duplicate Address Detection Transmits | Life Time Interval | Adi NS Interval |                |           |           |                    |                                   |              |            |                  |     |                                       |                    |                 |       |        |         |         |        |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |        |         |         |         |         |        |         |      |   |      |   |
| 1/0/1   | Enable    | Disable            | Disable                           | Enable       | Enable     | Disable          | 1500   | 1                                     | 1800               | 0               |                |           |           |                    |                                   |              |            |                  |     |                                       |                    |                 |       |        |         |         |        |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |        |         |         |         |         |        |         |      |   |      |   |
| 1/0/2   | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500   | 1                                     | 1800               | 0               |                |           |           |                    |                                   |              |            |                  |     |                                       |                    |                 |       |        |         |         |        |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |        |         |         |         |         |        |         |      |   |      |   |
| 1/0/3   | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500   | 1                                     | 1800               | 0               |                |           |           |                    |                                   |              |            |                  |     |                                       |                    |                 |       |        |         |         |        |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |        |         |         |         |         |        |         |      |   |      |   |
| 1/0/4   | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500   | 1                                     | 1800               | 0               |                |           |           |                    |                                   |              |            |                  |     |                                       |                    |                 |       |        |         |         |        |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |        |         |         |         |         |        |         |      |   |      |   |
| 1/0/5   | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500   | 1                                     | 1800               | 0               |                |           |           |                    |                                   |              |            |                  |     |                                       |                    |                 |       |        |         |         |        |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |        |         |         |         |         |        |         |      |   |      |   |
| 1/0/6   | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500   | 1                                     | 1800               | 0               |                |           |           |                    |                                   |              |            |                  |     |                                       |                    |                 |       |        |         |         |        |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |        |         |         |         |         |        |         |      |   |      |   |
| 1/0/7   | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500   | 1                                     | 1800               | 0               |                |           |           |                    |                                   |              |            |                  |     |                                       |                    |                 |       |        |         |         |        |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |        |         |         |         |         |        |         |      |   |      |   |
| 1/0/8   | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500   | 1                                     | 1800               | 0               |                |           |           |                    |                                   |              |            |                  |     |                                       |                    |                 |       |        |         |         |        |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |        |         |         |         |         |        |         |      |   |      |   |
| 1/0/9   | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500   | 1                                     | 1800               | 0               |                |           |           |                    |                                   |              |            |                  |     |                                       |                    |                 |       |        |         |         |        |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |        |         |         |         |         |        |         |      |   |      |   |
| 1/0/10  | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500   | 1                                     | 1800               | 0               |                |           |           |                    |                                   |              |            |                  |     |                                       |                    |                 |       |        |         |         |        |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |       |         |         |         |         |        |         |      |   |      |   |        |         |         |         |         |        |         |      |   |      |   |

- b. Scroll down and select the Interface **1/0/1** and **1/0/13** check boxes.
  - c. Enter the following information:
    - In the **IPv6 Mode** field, select **Enable**.
    - In the **Routing Mode** field, select **Enable**.
    - In the **Admin Mode** field, select **Enable**.
  - d. Click **Apply** to save the settings.
4. Assign an IPv6 address to 1/0/1.
- a. Select **Routing > IPv6 > Advanced > Prefix Configuration**.

A screen similar to the following displays.

| IPv6 Prefix               | Prefix Length | EUI64   | Valid Life Time | Preferred Life Time | Onlink Flag | Autonomous Flag | Command State |
|---------------------------|---------------|---------|-----------------|---------------------|-------------|-----------------|---------------|
| 2001:1::1                 | 64            | Disable | 2592000         | 604800              | Enable      | Enable          | [TENT]        |
| fe80::220c:c8ff:fe4d:9575 | 64            | Disable |                 |                     |             |                 | [TENT]        |

- b. In the Interface field, select **1/0/1**.
  - c. Enter the following information:
    - In the **IPv6 Prefix** field, enter **2001:1::1**.
    - In the **Prefix Length** field, enter **64**.
    - In the **EUI64** field, select **Disable**.
  - d. Click **Add** to save the settings.
5. Assign an IPv6 address to 1/0/13.
- a. Select **Routing > IPv6 > Advanced > Prefix Configuration**.

A screen similar to the following displays.

| IPv6 Prefix               | Prefix Length | EUI64   | Valid Life Time | Preferred Life Time |
|---------------------------|---------------|---------|-----------------|---------------------|
| 2001:2::1                 | 64            | Disable | 2592000         | 604800              |
| fe80::220c:c8ff:fe4d:9575 | 64            | Disable |                 |                     |

- b. Select Interface **1/0/13**.

- c. Enter the following information:
  - In the **IPv6 Prefix** field, enter **2001:2::1**.
  - In the **Prefix Length** field, enter **64**.
  - In the **EUI64** field, select **Disable**.
- d. Click **Add** to save the settings.
6. Configure the router ID of OSPFv3.
  - a. Select **Routing > OSPFv3 > Basic > OSPFv3 Configuration**.

A screen similar to the following displays.

| System   | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|--|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table  | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |
| <div>OSPFv3</div> <div>OSPFv3 Configuration</div> <div>           • Basic           <div>Admin Mode <input type="radio"/> Disable <input checked="" type="radio"/> Enable</div> </div> <div>           • OSPFv3 Configuration           <div>Router ID <input type="text" value="1.1.1.1"/></div> </div> <div>• Advanced</div> |           |         |      |          |            |             |        |                  |      |           |                |

- b. In the **Router ID** field, enter **1.1.1.1**.
- c. For Admin Mode, select the **Enable** radio button.
- d. Click **Apply**.
7. Enable OSPFv3 on interfaces 1/0/1 and 1/0/13.
  - a. Select **Routing > OSPFv3 > Advanced > Interface Configuration**.

A screen similar to the following displays.

| System   | Switching    | Routing | QoS        | Security        | Monitoring          | Maintenance    | Help          | Index            |      |           |                |           |              |         |            |                 |                     |                |               |                  |       |  |         |        |   |   |    |    |   |   |  |         |        |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |
|--|--------------|---------|------------|-----------------|---------------------|----------------|---------------|------------------|------|-----------|----------------|-----------|--------------|---------|------------|-----------------|---------------------|----------------|---------------|------------------|-------|--|---------|--------|---|---|----|----|---|---|--|---------|--------|---|---|----|----|---|--------------------------------|--|---------|---------|---|---|----|----|---|--------------------------------|--|---------|---------|---|---|----|----|---|--------------------------------|--|---------|---------|---|---|----|----|---|--------------------------------|--|---------|---------|---|---|----|----|---|--------------------------------|--|---------|---------|---|---|----|----|---|--------------------------------|--|---------|---------|---|---|----|----|---|
| Routing Table  | IP           | IPv6    | VLAN       | ARP             | RIP                 | OSPF           | OSPFv3        | Router Discovery | VRRP | Multicast | IPv6 Multicast |           |              |         |            |                 |                     |                |               |                  |       |  |         |        |   |   |    |    |   |   |  |         |        |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |
| <div>OSPFv3</div> <div>OSPFv3 Interface Configuration</div> <div>           • Basic           <div>1 2 3 VLANs All</div> </div> <div>           • Advanced           <div> <table border="1"> <thead> <tr> <th>Interface</th> <th>IPv6 Address</th> <th>Area ID</th> <th>Admin Mode</th> <th>Router Priority</th> <th>Retransmit Interval</th> <th>Hello Interval</th> <th>Dead Interval</th> <th>LSA Ack Interval</th> </tr> </thead> <tbody> <tr> <td>1/0/1</td> <td></td> <td>0.0.0.0</td> <td>Enable</td> <td>1</td> <td>5</td> <td>10</td> <td>40</td> <td>1</td> </tr> <tr> <td><input checked="" type="checkbox"/> 1/0/1</td> <td></td> <td>0.0.0.0</td> <td>Enable</td> <td>1</td> <td>5</td> <td>10</td> <td>40</td> <td>1</td> </tr> <tr> <td><input type="checkbox"/> 1/0/2</td> <td></td> <td>0.0.0.0</td> <td>Disable</td> <td>1</td> <td>5</td> <td>10</td> <td>40</td> <td>1</td> </tr> <tr> <td><input type="checkbox"/> 1/0/3</td> <td></td> <td>0.0.0.0</td> <td>Disable</td> <td>1</td> <td>5</td> <td>10</td> <td>40</td> <td>1</td> </tr> <tr> <td><input type="checkbox"/> 1/0/4</td> <td></td> <td>0.0.0.0</td> <td>Disable</td> <td>1</td> <td>5</td> <td>10</td> <td>40</td> <td>1</td> </tr> <tr> <td><input type="checkbox"/> 1/0/5</td> <td></td> <td>0.0.0.0</td> <td>Disable</td> <td>1</td> <td>5</td> <td>10</td> <td>40</td> <td>1</td> </tr> <tr> <td><input type="checkbox"/> 1/0/6</td> <td></td> <td>0.0.0.0</td> <td>Disable</td> <td>1</td> <td>5</td> <td>10</td> <td>40</td> <td>1</td> </tr> <tr> <td><input type="checkbox"/> 1/0/7</td> <td></td> <td>0.0.0.0</td> <td>Disable</td> <td>1</td> <td>5</td> <td>10</td> <td>40</td> <td>1</td> </tr> </tbody> </table> </div> </div> |              |         |            |                 |                     |                |               |                  |      |           |                | Interface | IPv6 Address | Area ID | Admin Mode | Router Priority | Retransmit Interval | Hello Interval | Dead Interval | LSA Ack Interval | 1/0/1 |  | 0.0.0.0 | Enable | 1 | 5 | 10 | 40 | 1 | <input checked="" type="checkbox"/> 1/0/1 |  | 0.0.0.0 | Enable | 1 | 5 | 10 | 40 | 1 | <input type="checkbox"/> 1/0/2 |  | 0.0.0.0 | Disable | 1 | 5 | 10 | 40 | 1 | <input type="checkbox"/> 1/0/3 |  | 0.0.0.0 | Disable | 1 | 5 | 10 | 40 | 1 | <input type="checkbox"/> 1/0/4 |  | 0.0.0.0 | Disable | 1 | 5 | 10 | 40 | 1 | <input type="checkbox"/> 1/0/5 |  | 0.0.0.0 | Disable | 1 | 5 | 10 | 40 | 1 | <input type="checkbox"/> 1/0/6 |  | 0.0.0.0 | Disable | 1 | 5 | 10 | 40 | 1 | <input type="checkbox"/> 1/0/7 |  | 0.0.0.0 | Disable | 1 | 5 | 10 | 40 | 1 |
| Interface  | IPv6 Address | Area ID | Admin Mode | Router Priority | Retransmit Interval | Hello Interval | Dead Interval | LSA Ack Interval |      |           |                |           |              |         |            |                 |                     |                |               |                  |       |  |         |        |   |   |    |    |   |   |  |         |        |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |
| 1/0/1  |              | 0.0.0.0 | Enable     | 1               | 5                   | 10             | 40            | 1                |      |           |                |           |              |         |            |                 |                     |                |               |                  |       |  |         |        |   |   |    |    |   |   |  |         |        |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |
| <input checked="" type="checkbox"/> 1/0/1  |              | 0.0.0.0 | Enable     | 1               | 5                   | 10             | 40            | 1                |      |           |                |           |              |         |            |                 |                     |                |               |                  |       |  |         |        |   |   |    |    |   |   |  |         |        |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |
| <input type="checkbox"/> 1/0/2   |              | 0.0.0.0 | Disable    | 1               | 5                   | 10             | 40            | 1                |      |           |                |           |              |         |            |                 |                     |                |               |                  |       |  |         |        |   |   |    |    |   |   |  |         |        |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |
| <input type="checkbox"/> 1/0/3   |              | 0.0.0.0 | Disable    | 1               | 5                   | 10             | 40            | 1                |      |           |                |           |              |         |            |                 |                     |                |               |                  |       |  |         |        |   |   |    |    |   |   |  |         |        |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |
| <input type="checkbox"/> 1/0/4   |              | 0.0.0.0 | Disable    | 1               | 5                   | 10             | 40            | 1                |      |           |                |           |              |         |            |                 |                     |                |               |                  |       |  |         |        |   |   |    |    |   |   |  |         |        |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |
| <input type="checkbox"/> 1/0/5   |              | 0.0.0.0 | Disable    | 1               | 5                   | 10             | 40            | 1                |      |           |                |           |              |         |            |                 |                     |                |               |                  |       |  |         |        |   |   |    |    |   |   |  |         |        |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |
| <input type="checkbox"/> 1/0/6   |              | 0.0.0.0 | Disable    | 1               | 5                   | 10             | 40            | 1                |      |           |                |           |              |         |            |                 |                     |                |               |                  |       |  |         |        |   |   |    |    |   |   |  |         |        |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |
| <input type="checkbox"/> 1/0/7   |              | 0.0.0.0 | Disable    | 1               | 5                   | 10             | 40            | 1                |      |           |                |           |              |         |            |                 |                     |                |               |                  |       |  |         |        |   |   |    |    |   |   |  |         |        |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |

- b. Scroll down and select the Interface **1/0/1** and **1/0/13** check boxes.
- c. In the **Admin Mode** field, select **Enable**.
- d. Click **Apply** to save the settings.
8. Enable multicast globally.
  - a. Select **Routing > Multicast > Global Configuration**.

A screen similar to the following displays.

| System  | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table   | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |
| <div> <div>Multicast</div> <div>Global Configuration</div> </div>   |           |         |      |          |            |             |        |                  |      |           |                |
| <div> <div> • Mroute Table • Global Configuration • Interface Configuration • DVMRP • IGMP • PIM • Static Routes Configuration • Admin Boundary Configuration </div> <div> Admin Mode Protocol State Table Maximum Entry Count Protocol Table Entry Count </div> <div> <input type="radio"/> Disable <input checked="" type="radio"/> Enable Non-Operational 2048 No Protocol Enabled 0 </div> </div> |           |         |      |          |            |             |        |                  |      |           |                |

b. For Admin Mode, select the **Enable** radio button.

c. Click **Apply**.

9. Enable PIM-DM globally.

a. Select **Routing > IPv6 Multicast > IPv6 PIM > Global Configuration**.

A screen similar to the following displays.

| System   | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|--|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table  | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |
| <div> <div>IPv6 Multicast</div> <div>PIM Global Configuration</div> </div>   |           |         |      |          |            |             |        |                  |      |           |                |
| <div> <div> • Mroute Table • IPv6 PIM • Global Configuration • SSM Configuration • Interface Configuration • PIM Neighbor • Candidate RP Configuration • BSR Candidate Configuration • Static RP Configuration • MLD • Static Routes Configuration </div> <div> Admin Mode </div> <div> <input type="radio"/> Disable <input checked="" type="radio"/> PIM-SM <input type="radio"/> PIM-DM </div> </div> |           |         |      |          |            |             |        |                  |      |           |                |

b. For Admin Mode, select the **Enable** radio button.

c. Click **Apply**.

10. Enable PIM-DM on interfaces 1/0/1 and 1/0/13.

a. Select **Routing > IPv6 Multicast > IPv6 PIM > Interface Configuration**.



A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

| IPv6 Multicast   |           | PIM Interface Configuration   |                 |                    |                |                     |            |             |                   |  |
|--|-----------|---|-----------------|--------------------|----------------|---------------------|------------|-------------|-------------------|--|
| <ul style="list-style-type: none"> <li>Route Table</li> <li>IPv6 PIM               <ul style="list-style-type: none"> <li>Global Configuration</li> <li>SSM Configuration</li> <li><b>Interface Configuration</b></li> <li>PIM Neighbor Configuration</li> <li>Candidate RP Configuration</li> <li>BSR Candidate Configuration</li> <li>Static RP Configuration</li> <li>MLD                   <ul style="list-style-type: none"> <li>Static Routes Configuration</li> </ul> </li> </ul> </li> </ul> |           | 1 2 3 VLANs All <span style="float: right;">Go To Interface <input type="text"/></span> |                 |                    |                |                     |            |             |                   |  |
|  | Interface | Admin Mode  | Protocol State  | IPv6 Prefix/Length | Hello Interval | Join/Prune Interval | BSR Border | DR Priority | Designated Router |  |
| <input checked="" type="checkbox"/>  | 1/0/1     | Enable  | Non-Operational |                    | 30             | 60                  | Disable    | 1           |                   |  |
| <input type="checkbox"/>   | 1/0/2     | Disable   | Non-Operational |                    | 30             | 60                  | Disable    | 1           |                   |  |
| <input type="checkbox"/>   | 1/0/3     | Disable   | Non-Operational |                    | 30             | 60                  | Disable    | 1           |                   |  |
| <input type="checkbox"/>   | 1/0/4     | Disable   | Non-Operational |                    | 30             | 60                  | Disable    | 1           |                   |  |
| <input type="checkbox"/>   | 1/0/5     | Disable   | Non-Operational |                    | 30             | 60                  | Disable    | 1           |                   |  |
| <input type="checkbox"/>   | 1/0/6     | Disable   | Non-Operational |                    | 30             | 60                  | Disable    | 1           |                   |  |
| <input type="checkbox"/>   | 1/0/7     | Disable   | Non-Operational |                    | 30             | 60                  | Disable    | 1           |                   |  |
| <input type="checkbox"/>   | 1/0/8     | Disable   | Non-Operational |                    | 30             | 60                  | Disable    | 1           |                   |  |
| <input type="checkbox"/>   | 1/0/9     | Disable   | Non-Operational |                    | 30             | 60                  | Disable    | 1           |                   |  |
| <input type="checkbox"/>   | 1/0/10    | Disable   | Non-Operational |                    | 30             | 60                  | Disable    | 1           |                   |  |
| <input type="checkbox"/>   | 1/0/11    | Disable   | Non-Operational |                    | 30             | 60                  | Disable    | 1           |                   |  |

- b. Scroll down and select the Interface **1/0/1** and **1/0/13** check boxes.
- c. In the **Admin Mode** field, select **Enable**.
- d. Click **Apply** to save the settings.

## MLD on Switch B

1. Enable IP routing on the switch.
  - a. Select **Routing > IP > Basic > IP Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

| IP   |  | IP Configuration           |   |
|--|--|----------------------------|---|
| <ul style="list-style-type: none"> <li>Basic</li> <li><b>IP Configuration</b></li> <li>Statistics</li> <li>Advanced</li> </ul> |  | Default Time to Live       | 64  |
|  |  | Routing Mode               | <input checked="" type="radio"/> Enable <input type="radio"/> Disable |
|  |  | ICMP Echo Replies          | <input checked="" type="radio"/> Enable <input type="radio"/> Disable |
|  |  | ICMP Redirects             | <input type="radio"/> Enable <input checked="" type="radio"/> Disable |
|  |  | ICMP Rate Limit Interval   | <input type="text" value="1000"/> (0 to 2147483647 ms)                |
|  |  | ICMP Rate Limit Burst Size | <input type="text" value="100"/> (1 to 200)                           |
|  |  | Maximum Next Hops          | 4   |

- b. For Routing Mode, select the **Enable** radio button.
- c. Click **Apply**.
2. Enable IPv6 unicast routing on the switch.
  - a. Select **Routing > IPv6 > Basic > Global Configuration**.



A screen similar to the following displays.

| System  | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table   | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |
| <div>IPv6</div> <div>IPv6 Global Configuration</div> <div> <div>Basic</div> <div>Global Configuration</div> <div>Route Table</div> <div>Advanced</div> </div> <div> <div>IPv6 Unicast Routing</div> <div> <div>Disable</div> <div>Enable</div> </div> <div> <div>Hop Limit</div> <div>64</div> <div>(1 to 255)</div> </div> <div> <div>ICMPv6 Rate Limit Error Interval</div> <div>1000</div> <div>(0 to 2147483647 msec)</div> </div> <div> <div>ICMPv6 Rate Limit Burst Size</div> <div>100</div> <div>(1 to 200)</div> </div> </div> |           |         |      |          |            |             |        |                  |      |           |                |

- b. For IPv6 Unicast Routing, select the **Enable** radio button.
  - c. Click **Apply**.
3. Configure 1/0/21 and 1/0/24 as IPv6 routing ports.
  - a. Select **Routing > IPv6 > Advanced > Interface Configuration**.

A screen similar to the following displays.

| System  | Switching | Routing            | QoS                               | Security     | Monitoring | Maintenance      | Help   | Index                                 |                    |           |                |           |           |                    |                                   |              |            |                  |     |                                       |                    |  |        |        |        |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |
|---|-----------|--------------------|-----------------------------------|--------------|------------|------------------|--------|---------------------------------------|--------------------|-----------|----------------|-----------|-----------|--------------------|-----------------------------------|--------------|------------|------------------|-----|---------------------------------------|--------------------|--|--------|--------|--------|---------|--------|---------|------|---|------|--------------------------------|---------|---------|---------|---------|--------|---------|------|---|------|--------------------------------|---------|---------|---------|---------|--------|---------|------|---|------|--------------------------------|---------|---------|---------|---------|--------|---------|------|---|------|--------------------------------|---------|---------|---------|---------|--------|---------|------|---|------|--------------------------------|---------|---------|---------|---------|--------|---------|------|---|------|--------------------------------|---------|---------|---------|---------|--------|---------|------|---|------|--------------------------------|---------|---------|---------|---------|--------|---------|------|---|------|--------------------------------|---------|---------|---------|---------|--------|---------|------|---|------|--------------------------------|---------|---------|---------|---------|--------|---------|------|---|------|
| Routing Table   | IP        | IPv6               | VLAN                              | ARP          | RIP        | OSPF             | OSPFv3 | Router Discovery                      | VRRP               | Multicast | IPv6 Multicast |           |           |                    |                                   |              |            |                  |     |                                       |                    |  |        |        |        |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |
| <div>IPv6</div> <div>IPv6 Interface Configuration</div> <div> <div>Basic</div> <div>Advanced</div> <div>Global Configuration</div> <div>Interface Configuration</div> <div>Statistics</div> <div>Neighbour Table</div> <div>Static Route Configuration</div> <div>Route Table</div> <div>Route Preference</div> <div>Tunnel Configuration</div> </div> <div> <div>1 2 3 VLANs All</div> <table border="1"> <thead> <tr> <th>Interface</th> <th>IPv6 Mode</th> <th>DHCPv6 Client Mode</th> <th>Stateless Address AutoConfig Mode</th> <th>Routing Mode</th> <th>Admin Mode</th> <th>Operational Mode</th> <th>MTU</th> <th>Duplicate Address Detection Transmits</th> <th>Life Time Interval</th> </tr> </thead> <tbody> <tr> <td><input checked="" type="checkbox"/> 1/0/21</td> <td>Enable</td> <td>Enable</td> <td>Enable</td> <td>Disable</td> <td>Enable</td> <td>Disable</td> <td>1500</td> <td>1</td> <td>1800</td> </tr> <tr> <td><input type="checkbox"/> 1/0/1</td> <td>Disable</td> <td>Disable</td> <td>Disable</td> <td>Disable</td> <td>Enable</td> <td>Disable</td> <td>1500</td> <td>1</td> <td>1800</td> </tr> <tr> <td><input type="checkbox"/> 1/0/2</td> <td>Disable</td> <td>Disable</td> <td>Disable</td> <td>Disable</td> <td>Enable</td> <td>Disable</td> <td>1500</td> <td>1</td> <td>1800</td> </tr> <tr> <td><input type="checkbox"/> 1/0/3</td> <td>Disable</td> <td>Disable</td> <td>Disable</td> <td>Disable</td> <td>Enable</td> <td>Disable</td> <td>1500</td> <td>1</td> <td>1800</td> </tr> <tr> <td><input type="checkbox"/> 1/0/4</td> <td>Disable</td> <td>Disable</td> <td>Disable</td> <td>Disable</td> <td>Enable</td> <td>Disable</td> <td>1500</td> <td>1</td> <td>1800</td> </tr> <tr> <td><input type="checkbox"/> 1/0/5</td> <td>Disable</td> <td>Disable</td> <td>Disable</td> <td>Disable</td> <td>Enable</td> <td>Disable</td> <td>1500</td> <td>1</td> <td>1800</td> </tr> <tr> <td><input type="checkbox"/> 1/0/6</td> <td>Disable</td> <td>Disable</td> <td>Disable</td> <td>Disable</td> <td>Enable</td> <td>Disable</td> <td>1500</td> <td>1</td> <td>1800</td> </tr> <tr> <td><input type="checkbox"/> 1/0/7</td> <td>Disable</td> <td>Disable</td> <td>Disable</td> <td>Disable</td> <td>Enable</td> <td>Disable</td> <td>1500</td> <td>1</td> <td>1800</td> </tr> <tr> <td><input type="checkbox"/> 1/0/8</td> <td>Disable</td> <td>Disable</td> <td>Disable</td> <td>Disable</td> <td>Enable</td> <td>Disable</td> <td>1500</td> <td>1</td> <td>1800</td> </tr> <tr> <td><input type="checkbox"/> 1/0/9</td> <td>Disable</td> <td>Disable</td> <td>Disable</td> <td>Disable</td> <td>Enable</td> <td>Disable</td> <td>1500</td> <td>1</td> <td>1800</td> </tr> </tbody> </table> </div> |           |                    |                                   |              |            |                  |        |                                       |                    |           |                | Interface | IPv6 Mode | DHCPv6 Client Mode | Stateless Address AutoConfig Mode | Routing Mode | Admin Mode | Operational Mode | MTU | Duplicate Address Detection Transmits | Life Time Interval | <input checked="" type="checkbox"/> 1/0/21 | Enable | Enable | Enable | Disable | Enable | Disable | 1500 | 1 | 1800 | <input type="checkbox"/> 1/0/1 | Disable | Disable | Disable | Disable | Enable | Disable | 1500 | 1 | 1800 | <input type="checkbox"/> 1/0/2 | Disable | Disable | Disable | Disable | Enable | Disable | 1500 | 1 | 1800 | <input type="checkbox"/> 1/0/3 | Disable | Disable | Disable | Disable | Enable | Disable | 1500 | 1 | 1800 | <input type="checkbox"/> 1/0/4 | Disable | Disable | Disable | Disable | Enable | Disable | 1500 | 1 | 1800 | <input type="checkbox"/> 1/0/5 | Disable | Disable | Disable | Disable | Enable | Disable | 1500 | 1 | 1800 | <input type="checkbox"/> 1/0/6 | Disable | Disable | Disable | Disable | Enable | Disable | 1500 | 1 | 1800 | <input type="checkbox"/> 1/0/7 | Disable | Disable | Disable | Disable | Enable | Disable | 1500 | 1 | 1800 | <input type="checkbox"/> 1/0/8 | Disable | Disable | Disable | Disable | Enable | Disable | 1500 | 1 | 1800 | <input type="checkbox"/> 1/0/9 | Disable | Disable | Disable | Disable | Enable | Disable | 1500 | 1 | 1800 |
| Interface   | IPv6 Mode | DHCPv6 Client Mode | Stateless Address AutoConfig Mode | Routing Mode | Admin Mode | Operational Mode | MTU    | Duplicate Address Detection Transmits | Life Time Interval |           |                |           |           |                    |                                   |              |            |                  |     |                                       |                    |  |        |        |        |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |
| <input checked="" type="checkbox"/> 1/0/21  | Enable    | Enable             | Enable                            | Disable      | Enable     | Disable          | 1500   | 1                                     | 1800               |           |                |           |           |                    |                                   |              |            |                  |     |                                       |                    |  |        |        |        |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |
| <input type="checkbox"/> 1/0/1  | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500   | 1                                     | 1800               |           |                |           |           |                    |                                   |              |            |                  |     |                                       |                    |  |        |        |        |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |
| <input type="checkbox"/> 1/0/2  | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500   | 1                                     | 1800               |           |                |           |           |                    |                                   |              |            |                  |     |                                       |                    |  |        |        |        |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |
| <input type="checkbox"/> 1/0/3  | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500   | 1                                     | 1800               |           |                |           |           |                    |                                   |              |            |                  |     |                                       |                    |  |        |        |        |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |
| <input type="checkbox"/> 1/0/4  | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500   | 1                                     | 1800               |           |                |           |           |                    |                                   |              |            |                  |     |                                       |                    |  |        |        |        |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |
| <input type="checkbox"/> 1/0/5  | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500   | 1                                     | 1800               |           |                |           |           |                    |                                   |              |            |                  |     |                                       |                    |  |        |        |        |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |
| <input type="checkbox"/> 1/0/6  | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500   | 1                                     | 1800               |           |                |           |           |                    |                                   |              |            |                  |     |                                       |                    |  |        |        |        |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |
| <input type="checkbox"/> 1/0/7  | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500   | 1                                     | 1800               |           |                |           |           |                    |                                   |              |            |                  |     |                                       |                    |  |        |        |        |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |
| <input type="checkbox"/> 1/0/8  | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500   | 1                                     | 1800               |           |                |           |           |                    |                                   |              |            |                  |     |                                       |                    |  |        |        |        |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |
| <input type="checkbox"/> 1/0/9  | Disable   | Disable            | Disable                           | Disable      | Enable     | Disable          | 1500   | 1                                     | 1800               |           |                |           |           |                    |                                   |              |            |                  |     |                                       |                    |  |        |        |        |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |                                |         |         |         |         |        |         |      |   |      |

- b. Scroll down and select the Interface **1/0/21** and **1/0/24** check boxes.
  - c. Enter the following information:
    - In the **IPv6 Mode** field, select **Enable**.
    - In the **Routing Mode** field, select **Enable**.
    - In the **Admin Mode** field, select **Enable**.
  - d. Click **Apply** to save the settings.
4. Assign an IPv6 address to 1/0/21.
  - a. Select **Routing > IPv6 > Advanced > Prefix Configuration**.

A screen similar to the following displays.

| System   | Switching     | Routing | QoS             | Security            | Monitoring | Maintenance | Help   | Index            |      |           |                |             |               |       |                 |                     |           |    |  |  |  |
|--|---------------|---------|-----------------|---------------------|------------|-------------|--------|------------------|------|-----------|----------------|-------------|---------------|-------|-----------------|---------------------|-----------|----|--|--|--|
| Routing Table  | IP            | IPv6    | VLAN            | ARP                 | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |             |               |       |                 |                     |           |    |  |  |  |
| <div>IPv6</div> <div>IPv6 Interface Selection</div> <div>Interface: 1/0/21</div> <div>IPv6 Interface Configuration</div> <table border="1"> <thead> <tr> <th>IPv6 Prefix</th> <th>Prefix Length</th> <th>EUI64</th> <th>Valid Life Time</th> <th>Preferred Life Time</th> </tr> </thead> <tbody> <tr> <td>2000:1::2</td> <td>64</td> <td></td> <td></td> <td></td> </tr> </tbody> </table> |               |         |                 |                     |            |             |        |                  |      |           |                | IPv6 Prefix | Prefix Length | EUI64 | Valid Life Time | Preferred Life Time | 2000:1::2 | 64 |  |  |  |
| IPv6 Prefix  | Prefix Length | EUI64   | Valid Life Time | Preferred Life Time |            |             |        |                  |      |           |                |             |               |       |                 |                     |           |    |  |  |  |
| 2000:1::2  | 64            |         |                 |                     |            |             |        |                  |      |           |                |             |               |       |                 |                     |           |    |  |  |  |

- b. In the Interface field, select **1/0/21**.
  - c. Enter the following information:
    - In the **IPv6 Prefix** field, enter **2001:1::2**.
    - In the **Prefix Length** field, enter **64**.
    - In the **EUI64** field, select **Disable**.
  - d. Click **Add** to save the settings.
5. Assign an IPv6 address to 1/0/24.
- a. Select **Routing > IPv6 > Advanced > Prefix Configuration**.

A screen similar to the following displays.

| System   | Switching     | Routing | QoS             | Security            | Monitoring | Maintenance | Help   | Index            |      |           |                |             |               |       |                 |                     |           |    |  |  |  |
|--|---------------|---------|-----------------|---------------------|------------|-------------|--------|------------------|------|-----------|----------------|-------------|---------------|-------|-----------------|---------------------|-----------|----|--|--|--|
| Routing Table  | IP            | IPv6    | VLAN            | ARP                 | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |             |               |       |                 |                     |           |    |  |  |  |
| <div>IPv6</div> <div>IPv6 Interface Selection</div> <div>Interface: 1/0/24</div> <div>IPv6 Interface Configuration</div> <table border="1"> <thead> <tr> <th>IPv6 Prefix</th> <th>Prefix Length</th> <th>EUI64</th> <th>Valid Life Time</th> <th>Preferred Life Time</th> </tr> </thead> <tbody> <tr> <td>2000:5::1</td> <td>64</td> <td></td> <td></td> <td></td> </tr> </tbody> </table> |               |         |                 |                     |            |             |        |                  |      |           |                | IPv6 Prefix | Prefix Length | EUI64 | Valid Life Time | Preferred Life Time | 2000:5::1 | 64 |  |  |  |
| IPv6 Prefix  | Prefix Length | EUI64   | Valid Life Time | Preferred Life Time |            |             |        |                  |      |           |                |             |               |       |                 |                     |           |    |  |  |  |
| 2000:5::1  | 64            |         |                 |                     |            |             |        |                  |      |           |                |             |               |       |                 |                     |           |    |  |  |  |

- b. Under IPv6 Interface Selection, in the **Interface** field, select **1/0/24**.
  - c. Enter the following information:
    - In the **IPv6 Prefix** field, enter **2001:3::1**.
    - In the **Prefix Length** field, enter **64**.
    - In the **EUI64** field, select **Disable**.
  - d. Click **Add** to save the settings.
6. Configure the router ID of OSPFv3.
- a. Select **Routing > OSPFv3 > Basic > OSPFv3 Configuration**.

A screen similar to the following displays.

| System  | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table   | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |
| <div> <div>OSPFv3</div> <div>OSPFv3 Configuration</div> </div> <div> <div>*Basic</div> <div>*OSPFv3 Configuration</div> <div>*Advanced</div> </div> <div> <div>Admin Mode</div> <div>Router ID</div> </div> <div> <div><input type="radio"/> Disable</div> <div><input checked="" type="radio"/> Enable</div> <div>2.2.2.2</div> </div> |           |         |      |          |            |             |        |                  |      |           |                |

- b. In the **Router ID** field, enter **2.2.2.2**.
  - c. For Admin Mode, select the **Enable** radio button.
  - d. Click **Apply**.
7. Enable OSPFv3 on interfaces 1/0/21 and 1/0/24.
- a. Select **Routing > OSPFv3 > Advanced > Interface Configuration**.

A screen similar to the following displays.

| System  | Switching    | Routing | QoS        | Security        | Monitoring          | Maintenance    | Help          | Index            |      |           |                |           |              |         |            |                 |                     |                |               |                  |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |
|---|--------------|---------|------------|-----------------|---------------------|----------------|---------------|------------------|------|-----------|----------------|-----------|--------------|---------|------------|-----------------|---------------------|----------------|---------------|------------------|--------------------------------|--|---------|---------|---|---|----|----|---|--------------------------------|--|---------|---------|---|---|----|----|---|--------------------------------|--|---------|---------|---|---|----|----|---|--------------------------------|--|---------|---------|---|---|----|----|---|--------------------------------|--|---------|---------|---|---|----|----|---|--------------------------------|--|---------|---------|---|---|----|----|---|--------------------------------|--|---------|---------|---|---|----|----|---|--------------------------------|--|---------|---------|---|---|----|----|---|
| Routing Table   | IP           | IPv6    | VLAN       | ARP             | RIP                 | OSPF           | OSPFv3        | Router Discovery | VRRP | Multicast | IPv6 Multicast |           |              |         |            |                 |                     |                |               |                  |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |
| <div> <div>OSPFv3</div> <div>OSPFv3 Interface Configuration</div> </div> <div> <div>*Basic</div> <div>*Advanced</div> </div> <div> <div>OSPFv3 Configuration</div> <div>Common Area Configuration</div> <div>Stub Area Configuration</div> <div>NSSA Area Configuration</div> <div>Area Range Configuration</div> <div>Interface Configuration</div> </div> <div> <div>1 2 3 VLANs All</div> <table border="1"> <thead> <tr> <th>Interface</th> <th>IPv6 Address</th> <th>Area ID</th> <th>Admin Mode</th> <th>Router Priority</th> <th>Retransmit Interval</th> <th>Hello Interval</th> <th>Dead Interval</th> <th>LSA Ack Interval</th> </tr> </thead> <tbody> <tr> <td><input type="checkbox"/> 1/0/1</td> <td></td> <td>0.0.0.0</td> <td>Disable</td> <td>1</td> <td>5</td> <td>10</td> <td>40</td> <td>1</td> </tr> <tr> <td><input type="checkbox"/> 1/0/2</td> <td></td> <td>0.0.0.0</td> <td>Disable</td> <td>1</td> <td>5</td> <td>10</td> <td>40</td> <td>1</td> </tr> <tr> <td><input type="checkbox"/> 1/0/3</td> <td></td> <td>0.0.0.0</td> <td>Disable</td> <td>1</td> <td>5</td> <td>10</td> <td>40</td> <td>1</td> </tr> <tr> <td><input type="checkbox"/> 1/0/4</td> <td></td> <td>0.0.0.0</td> <td>Disable</td> <td>1</td> <td>5</td> <td>10</td> <td>40</td> <td>1</td> </tr> <tr> <td><input type="checkbox"/> 1/0/5</td> <td></td> <td>0.0.0.0</td> <td>Disable</td> <td>1</td> <td>5</td> <td>10</td> <td>40</td> <td>1</td> </tr> <tr> <td><input type="checkbox"/> 1/0/6</td> <td></td> <td>0.0.0.0</td> <td>Disable</td> <td>1</td> <td>5</td> <td>10</td> <td>40</td> <td>1</td> </tr> <tr> <td><input type="checkbox"/> 1/0/7</td> <td></td> <td>0.0.0.0</td> <td>Disable</td> <td>1</td> <td>5</td> <td>10</td> <td>40</td> <td>1</td> </tr> <tr> <td><input type="checkbox"/> 1/0/8</td> <td></td> <td>0.0.0.0</td> <td>Disable</td> <td>1</td> <td>5</td> <td>10</td> <td>40</td> <td>1</td> </tr> </tbody> </table> </div> |              |         |            |                 |                     |                |               |                  |      |           |                | Interface | IPv6 Address | Area ID | Admin Mode | Router Priority | Retransmit Interval | Hello Interval | Dead Interval | LSA Ack Interval | <input type="checkbox"/> 1/0/1 |  | 0.0.0.0 | Disable | 1 | 5 | 10 | 40 | 1 | <input type="checkbox"/> 1/0/2 |  | 0.0.0.0 | Disable | 1 | 5 | 10 | 40 | 1 | <input type="checkbox"/> 1/0/3 |  | 0.0.0.0 | Disable | 1 | 5 | 10 | 40 | 1 | <input type="checkbox"/> 1/0/4 |  | 0.0.0.0 | Disable | 1 | 5 | 10 | 40 | 1 | <input type="checkbox"/> 1/0/5 |  | 0.0.0.0 | Disable | 1 | 5 | 10 | 40 | 1 | <input type="checkbox"/> 1/0/6 |  | 0.0.0.0 | Disable | 1 | 5 | 10 | 40 | 1 | <input type="checkbox"/> 1/0/7 |  | 0.0.0.0 | Disable | 1 | 5 | 10 | 40 | 1 | <input type="checkbox"/> 1/0/8 |  | 0.0.0.0 | Disable | 1 | 5 | 10 | 40 | 1 |
| Interface   | IPv6 Address | Area ID | Admin Mode | Router Priority | Retransmit Interval | Hello Interval | Dead Interval | LSA Ack Interval |      |           |                |           |              |         |            |                 |                     |                |               |                  |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |
| <input type="checkbox"/> 1/0/1  |              | 0.0.0.0 | Disable    | 1               | 5                   | 10             | 40            | 1                |      |           |                |           |              |         |            |                 |                     |                |               |                  |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |
| <input type="checkbox"/> 1/0/2  |              | 0.0.0.0 | Disable    | 1               | 5                   | 10             | 40            | 1                |      |           |                |           |              |         |            |                 |                     |                |               |                  |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |
| <input type="checkbox"/> 1/0/3  |              | 0.0.0.0 | Disable    | 1               | 5                   | 10             | 40            | 1                |      |           |                |           |              |         |            |                 |                     |                |               |                  |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |
| <input type="checkbox"/> 1/0/4  |              | 0.0.0.0 | Disable    | 1               | 5                   | 10             | 40            | 1                |      |           |                |           |              |         |            |                 |                     |                |               |                  |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |
| <input type="checkbox"/> 1/0/5  |              | 0.0.0.0 | Disable    | 1               | 5                   | 10             | 40            | 1                |      |           |                |           |              |         |            |                 |                     |                |               |                  |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |
| <input type="checkbox"/> 1/0/6  |              | 0.0.0.0 | Disable    | 1               | 5                   | 10             | 40            | 1                |      |           |                |           |              |         |            |                 |                     |                |               |                  |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |
| <input type="checkbox"/> 1/0/7  |              | 0.0.0.0 | Disable    | 1               | 5                   | 10             | 40            | 1                |      |           |                |           |              |         |            |                 |                     |                |               |                  |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |
| <input type="checkbox"/> 1/0/8  |              | 0.0.0.0 | Disable    | 1               | 5                   | 10             | 40            | 1                |      |           |                |           |              |         |            |                 |                     |                |               |                  |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |                                |  |         |         |   |   |    |    |   |

- b. Under OSPFv3 Interface Configuration, scroll down and select the Interface **1/0/21** and **1/0/24** check boxes.
  - c. In the OSPFv3 Interface Configuration, in the **Admin Mode** field, select **Enable**.
  - d. Click **Apply** to save the settings.
8. Enable multicast globally.
- a. Select **Routing > Multicast > Global Configuration**.

A screen similar to the following displays.

| System  | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table   | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |
| <div> <div>Multicast</div> <div>Global Configuration</div> </div> <div> <div>*Route Table</div> <div>*Global Configuration</div> <div>*Interface Configuration</div> <div>*DVMRP</div> <div>*IGMP</div> </div> <div> <div>Admin Mode</div> <div>Protocol State</div> <div>Table Maximum Entry Count</div> <div>Protocol</div> <div>Table Entry Count</div> </div> <div> <div><input checked="" type="radio"/> Disable</div> <div><input type="radio"/> Enable</div> <div>Non-Operational</div> <div>2048</div> <div>No Protocol Enabled</div> <div>0</div> </div> |           |         |      |          |            |             |        |                  |      |           |                |

- b. For Admin Mode, select the **Enable** radio button.
- c. Click **Apply**.

9. Enable PIM-DM globally.

- a. Select **Routing > IPv6 Multicast > IPv6PIM > Global Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

IPv6 Multicast

- Route Table
- IPv6 PIM
  - Global Configuration
  - SSM Configuration

PIM Global Configuration

Admin Mode

☐ Disable
 ☒ PIM-SM
 ☐ PIM-DM

- b. For Admin Mode, select the **Enable** radio button.

- c. Click **Apply**.

10. Enable PIM-DM on interfaces 1/0/21 and 1/0/24.

- a. Select **Routing > IPv6 Multicast > IPv6 PIM > Interface Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

IPv6 Multicast

- Route Table
- IPv6 PIM
  - Global Configuration
  - SSM Configuration
  - Interface Configuration
  - PIM Neighbor
  - Candidate RP Configuration

PIM Interface Configuration

1 2 3 VLANs All

Go To Interface

| Interface                      | Admin Mode | Protocol State  | IPv6 Prefix/Length | Hello Interval | Join/Prune Interval | BSR Border | DR Priority | Designated Router |
|--------------------------------|------------|-----------------|--------------------|----------------|---------------------|------------|-------------|-------------------|
| <input type="checkbox"/> 1/0/1 | Disable    | Non-Operational |                    | 30             | 60                  | Disable    | 1           |                   |
| <input type="checkbox"/> 1/0/2 | Disable    | Non-Operational |                    | 30             | 60                  | Disable    | 1           |                   |
| <input type="checkbox"/> 1/0/3 | Disable    | Non-Operational |                    | 30             | 60                  | Disable    | 1           |                   |
| <input type="checkbox"/> 1/0/4 | Disable    | Non-Operational |                    | 30             | 60                  | Disable    | 1           |                   |
| <input type="checkbox"/> 1/0/5 | Disable    | Non-Operational |                    | 30             | 60                  | Disable    | 1           |                   |

- b. Under PIM Interface Configuration, scroll down select the Interface **1/0/21** and **1/0/24** check boxes.

- c. In the **Admin Mode** field, select **Enable**.

- d. Click **Apply** to save the settings.

11. Enable MLD on the switch.

- a. Select **Routing > IPv6 Multicast > MLD > Global Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

| IPv6 Multicast  | MLD Global Configuration   |
|---|--|
| <ul style="list-style-type: none"> <li>• Route Table</li> <li>• IPv6 PIM</li> <li>• MLD</li> <li>• <b>Global Configuration</b></li> <li>• Routing Interface Configuration</li> <li>• Routing Interface Statistics</li> <li>• MLD Groups</li> <li>• MLD Traffic</li> <li>• Proxy Interface Configuration</li> <li>• Proxy Interface Statistics</li> <li>• Proxy Membership</li> <li>• Static Routes Configuration</li> </ul> | Admin Mode <input type="radio"/> Disable <input checked="" type="radio"/> Enable |

b. For Admin Mode, select the **Enable** radio button.

c. Click **Apply**.

12. Enable MLD on interface 1/0/24.

a. Select **Routing > IPv6 Multicast > MLD > Routing Interface Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

| IPv6 Multicast   | MLD Routing Interface Configuration  |                  |            |                  |                |                         |                        |                         |                        |  |        |                |    |   |     |       |    |                                |         |                |    |   |     |       |    |                                |         |                |    |   |     |       |    |                                |         |                |    |   |     |       |    |                                |         |                |    |   |     |       |    |
|--|--|------------------|------------|------------------|----------------|-------------------------|------------------------|-------------------------|------------------------|--|--------|----------------|----|---|-----|-------|----|--------------------------------|---------|----------------|----|---|-----|-------|----|--------------------------------|---------|----------------|----|---|-----|-------|----|--------------------------------|---------|----------------|----|---|-----|-------|----|--------------------------------|---------|----------------|----|---|-----|-------|----|
| <ul style="list-style-type: none"> <li>• Route Table</li> <li>• IPv6 PIM</li> <li>• MLD</li> <li>• Global Configuration</li> <li>• <b>Routing Interface Configuration</b></li> <li>• Routing Interface Statistics</li> </ul> | 1 2 3 VLANs All<br><table border="1"> <thead> <tr> <th>Interface</th> <th>Admin Mode</th> <th>Operational Mode</th> <th>Version</th> <th>Robustness</th> <th>Query Interval</th> <th>Query Max Response Time</th> <th>Startup Query Interval</th> </tr> </thead> <tbody> <tr> <td><input checked="" type="checkbox"/> 1/0/24</td> <td>Enable</td> <td>Not In Service</td> <td>V2</td> <td>2</td> <td>125</td> <td>10000</td> <td>31</td> </tr> <tr> <td><input type="checkbox"/> 1/0/1</td> <td>Disable</td> <td>Not In Service</td> <td>V2</td> <td>2</td> <td>125</td> <td>10000</td> <td>31</td> </tr> <tr> <td><input type="checkbox"/> 1/0/2</td> <td>Disable</td> <td>Not In Service</td> <td>V2</td> <td>2</td> <td>125</td> <td>10000</td> <td>31</td> </tr> <tr> <td><input type="checkbox"/> 1/0/3</td> <td>Disable</td> <td>Not In Service</td> <td>V2</td> <td>2</td> <td>125</td> <td>10000</td> <td>31</td> </tr> <tr> <td><input type="checkbox"/> 1/0/4</td> <td>Disable</td> <td>Not In Service</td> <td>V2</td> <td>2</td> <td>125</td> <td>10000</td> <td>31</td> </tr> </tbody> </table> | Interface        | Admin Mode | Operational Mode | Version        | Robustness              | Query Interval         | Query Max Response Time | Startup Query Interval | <input checked="" type="checkbox"/> 1/0/24 | Enable | Not In Service | V2 | 2 | 125 | 10000 | 31 | <input type="checkbox"/> 1/0/1 | Disable | Not In Service | V2 | 2 | 125 | 10000 | 31 | <input type="checkbox"/> 1/0/2 | Disable | Not In Service | V2 | 2 | 125 | 10000 | 31 | <input type="checkbox"/> 1/0/3 | Disable | Not In Service | V2 | 2 | 125 | 10000 | 31 | <input type="checkbox"/> 1/0/4 | Disable | Not In Service | V2 | 2 | 125 | 10000 | 31 |
| Interface  | Admin Mode   | Operational Mode | Version    | Robustness       | Query Interval | Query Max Response Time | Startup Query Interval |                         |                        |  |        |                |    |   |     |       |    |                                |         |                |    |   |     |       |    |                                |         |                |    |   |     |       |    |                                |         |                |    |   |     |       |    |                                |         |                |    |   |     |       |    |
| <input checked="" type="checkbox"/> 1/0/24   | Enable   | Not In Service   | V2         | 2                | 125            | 10000                   | 31                     |                         |                        |  |        |                |    |   |     |       |    |                                |         |                |    |   |     |       |    |                                |         |                |    |   |     |       |    |                                |         |                |    |   |     |       |    |                                |         |                |    |   |     |       |    |
| <input type="checkbox"/> 1/0/1   | Disable  | Not In Service   | V2         | 2                | 125            | 10000                   | 31                     |                         |                        |  |        |                |    |   |     |       |    |                                |         |                |    |   |     |       |    |                                |         |                |    |   |     |       |    |                                |         |                |    |   |     |       |    |                                |         |                |    |   |     |       |    |
| <input type="checkbox"/> 1/0/2   | Disable  | Not In Service   | V2         | 2                | 125            | 10000                   | 31                     |                         |                        |  |        |                |    |   |     |       |    |                                |         |                |    |   |     |       |    |                                |         |                |    |   |     |       |    |                                |         |                |    |   |     |       |    |                                |         |                |    |   |     |       |    |
| <input type="checkbox"/> 1/0/3   | Disable  | Not In Service   | V2         | 2                | 125            | 10000                   | 31                     |                         |                        |  |        |                |    |   |     |       |    |                                |         |                |    |   |     |       |    |                                |         |                |    |   |     |       |    |                                |         |                |    |   |     |       |    |                                |         |                |    |   |     |       |    |
| <input type="checkbox"/> 1/0/4   | Disable  | Not In Service   | V2         | 2                | 125            | 10000                   | 31                     |                         |                        |  |        |                |    |   |     |       |    |                                |         |                |    |   |     |       |    |                                |         |                |    |   |     |       |    |                                |         |                |    |   |     |       |    |                                |         |                |    |   |     |       |    |

b. Under MLD Routing Interface Configuration, scroll down and select the **1/0/24** check box.

Now 1/0/24 appears in the Interface field at the top.

c. In the **Admin Mode** field, select **Enable**.

d. Click **Apply**.



# MLD Snooping

In IPv4, Layer 2 switches can use IGMP snooping to limit the flooding of multicast traffic by dynamically configuring Layer 2 interfaces so that multicast traffic is forwarded to only those interfaces associated with IP multicast address. In IPv6, MLD snooping performs a similar function. With MLD snooping, IPv6 multicast data is selectively forwarded to a list of ports that want to receive the data, instead of being flooded to all ports in a VLAN. This list is constructed by snooping IPv6 multicast control packets.

MLD is a protocol used by IPv6 multicast routers to discover the presence of multicast listeners (nodes configured to receive IPv6 multicast packets) on its directly attached links and to discover which multicast packets are of interest to neighboring nodes. MLD is derived from IGMP; MLD version 1 (MLDv1) is equivalent to IGMPv2, and MLD version 2 (MLDv2) is equivalent to IGMPv3. MLD is a subprotocol of Internet Control Message Protocol version 6 (ICMPv6), and MLD messages are a subset of ICMPv6 messages, identified in IPv6 packets by a preceding Next Header value of 58.

The switch can snoop on both MLDv1 and MLDv2 protocol packets and bridge IPv6 multicast data based on destination IPv6 multicast MAC addresses. The switch can be configured to perform MLD snooping and IGMP snooping simultaneously.

## CLI: Configure MLD Snooping

1. Enter the following commands.

```
(Netgear Switch) #vlan da
(Netgear Switch) (Vlan)#vlan 300
(Netgear Switch) (Vlan)#exit
(Netgear Switch) #config
(Netgear Switch) (Config)#interface 1/0/1
(Netgear Switch) (Interface 1/0/1)#vlan participation include 300
(Netgear Switch) (Interface 1/0/1)#vlan pvid 300
(Netgear Switch) (Interface 1/0/1)#exit
(Netgear Switch) (Config)#interface 1/0/24
(Netgear Switch) (Interface 1/0/24)#vlan participation include 300
(Netgear Switch) (Interface 1/0/24)#vlan pvid 300
(Netgear Switch) (Interface 1/0/24)#exit
(Netgear Switch) (Config)#exit
(Netgear Switch) (Config)#set mld
(Netgear Switch) (Config)#exit
(Netgear Switch) #vlan database
(Netgear Switch) (Vlan)#set mld 300
(Netgear Switch) (Vlan)#exit
```

## 2. Enable MLD snooping on VLAN 300.

```
(Netgear Switch) #show mldsnooping
Admin Mode..... Enable
Multicast Control Frame Count..... 0
Interfaces Enabled for MLD Snooping..... None
VLANs enabled for MLD snooping..... 300
(Netgear Switch) #
```

## Local Browser Interface: Configure MLD Snooping

### 1. Create VLAN 300.

#### a. Select **Switching > VLAN > Basic > VLAN Configuration**.

A screen similar to the following displays.

| VLAN ID | VLAN Name | VLAN Type | Make Static |
|---------|-----------|-----------|-------------|
| 300     | default   | Default   | Disable     |

#### b. In the **VLAN ID** field, enter **300**.

#### c. Click **Add**.

### 2. Assign all of the ports to VLAN 300.

#### a. Select **Switching > VLAN > Advanced > VLAN Membership**.

A screen similar to the following displays.

| Unit 1 | Ports   |
|--------|---|
| 1      | 1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47  |
| 2      | 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 |

#### b. In the **VLAN ID** list, select **300**.



- 659

- Software Administration Manual

MLD

659

- Software Administration Manual

MLD

659

- Software Administration Manual

A screen similar to the following displays.

| System | Switching | Routing | QoS | Security  | Monitoring | Maintenance   | Help  | Index |
|--------|-----------|---------|-----|-----------|------------|---------------|-------|-------|
| VLAN   | Auto-VoIP | iSCSI   | STP | Multicast | MVR        | Address Table | Ports | LAG   |
| MLAG   |           |         |     |           |            |               |       |       |

| Multicast                 |   | MLD VLAN Configuration |  |  |  |  |
|---------------------------|---|------------------------|--|--|--|--|
| • MFDB                    | ▼ |                        |  |  |  |  |
| • IGMP Snooping           | ▼ |                        |  |  |  |  |
| • MLD Snooping            | ^ |                        |  |  |  |  |
| • Configuration           |   |                        |  |  |  |  |
| • Interface Configuration |   |                        |  |  |  |  |
| • MLD VLAN Configuration  |   |                        |  |  |  |  |

| VLAN ID | Fast Leave | Membership Interval | Maximum Response Time | Multicast Router Expiry Time | Proxy Querier Mode |
|---------|------------|---------------------|-----------------------|------------------------------|--------------------|
| 300     | ▼          |                     |                       |                              | ▼                  |

b. Enter the following information:

- In the **VLAN ID** field, enter **300**.
- In the **Admin Mode** field, select **Enable**.

6. Click **Add**.

# 33

## 33 DVMRP

---

### Distance Vector Multicast Routing Protocol

This chapter includes the following sections:

- [Distance Vector Multicast Routing Protocol Concepts](#)
- [CLI: Configure DVMRP](#)
- [Local Browser Interface: Configure DVMRP](#)

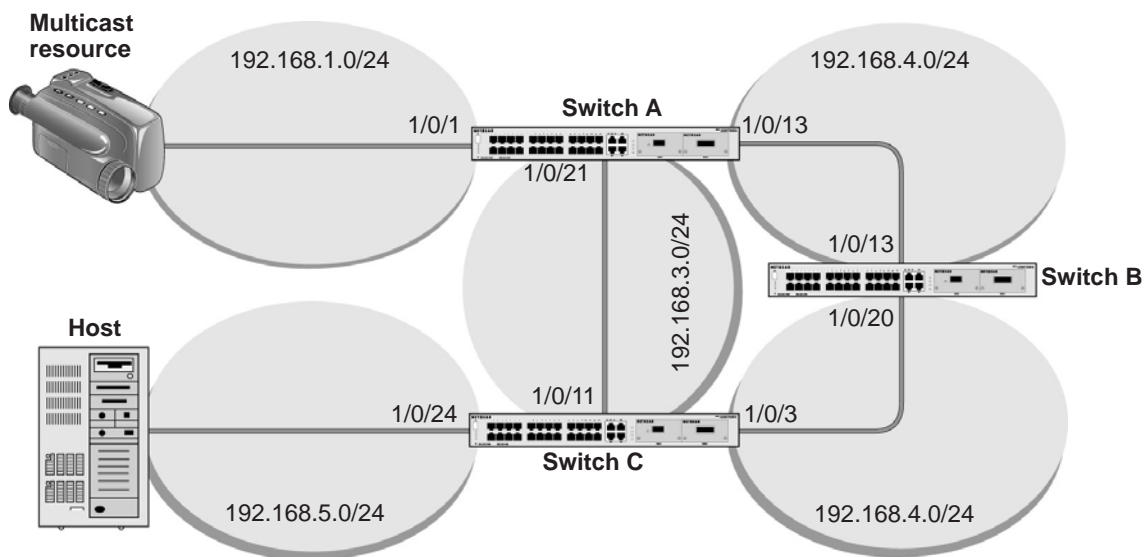
# Distance Vector Multicast Routing Protocol Concepts

The Distance Vector Multicast Routing Protocol (DVMRP) is used for multicasting over IP networks without routing protocols to support multicast. The DVMRP is based on the RIP protocol but more complicated than RIP. DVMRP maintains a link-state database to keep track of the return paths to the source of multicast packages.

The DVMRP operates as follows:

- The first message for any source-group pair is forwarded to the entire multicast network, with respect to the time-to-live (TTL) of the packet.
- TTL restricts the area to be flooded by the message.
- All the leaf routers that do not have members on directly attached subnetworks send back prune messages to the upstream router.
- The branch that transmitted a prune message is deleted from the delivery tree.
- The delivery tree, which is spanning to all the members in the multicast group, is constructed.

In this example, DVMRP is running on switches A, B, and C. IGMP is also running on Switch C, which is connected to the host directly. After the host sends an IGMP report to switch C, multicast streams are sent from the multicast resource to the host along the path built by DVMRP.



**Figure 64. DVMRP**

# CLI: Configure DVMRP

## DVMRP on Switch A

1. Create routing interfaces 1/0/1, 1/0/13, and 1/0/21.

```
(Netgear Switch) #config
(Netgear Switch) (Config)#ip routing
(Netgear Switch) (Config)#interface 1/0/1
(Netgear Switch) (Interface 1/0/1)#routing
(Netgear Switch) (Interface 1/0/1)#ip address 192.168.1.1 255.255.255.0
(Netgear Switch) (Interface 1/0/1)#exit
(Netgear Switch) (Config)#interface 1/0/13
(Netgear Switch) (Interface 1/0/13)#routing
(Netgear Switch) (Interface 1/0/13)#ip address 192.168.2.1 255.255.255.0
(Netgear Switch) (Interface 1/0/13)#exit
(Netgear Switch) (Config)#interface 1/0/21
(Netgear Switch) (Interface 1/0/21)#routing
(Netgear Switch) (Interface 1/0/21)#ip address 192.168.3.2 255.255.255.0
(Netgear Switch) (Interface 1/0/21)#exit
```

2. Enable IP multicast forwarding on the switch.

```
(Netgear Switch) (Config)#ip multicast
```

3. Enable DVMRP protocol on the switch.

```
(Netgear Switch) (Config)#ip dvmrp
```

**4. Enable DVMRP mode on the interfaces 1/0/1, 1/0/13, and 1/0/21.**

```

(Netgear Switch) (Config)#interface 1/0/1
(Netgear Switch) (Interface 1/0/1)#ip dvmrp
(Netgear Switch) (Interface 1/0/1)#exit
(Netgear Switch) (Config)#interface 1/0/13
(Netgear Switch) (Interface 1/0/13)#ip dvmrp
(Netgear Switch) (Interface 1/0/13)#exit
(Netgear Switch) (Config)#interface 1/0/21
(Netgear Switch) (Interface 1/0/21)#ip dvmrp
(Netgear Switch) (Interface 1/0/21)#exit
(Netgear Switch) #show ip dvmrp neighbor
Interface ..... 1/0/13
Neighbor IP Address ..... 192.168.2.2
State ..... Active
Up Time (hh:mm:ss) ..... 00:02:40
Expiry Time (hh:mm:ss) ..... 00:00:25
Generation ID ..... 1116347719
Major Version ..... 3
Minor Version ..... 255
Capabilities ..... Prune GenID Missing 11441
Received Routes ..... 0
Received Bad Packets ..... 0
Received Bad Routes ..... 0
Interface ..... 1/0/21
Neighbor IP Address ..... 192.168.3.1
State ..... Active
Up Time (hh:mm:ss) ..... 00:01:44
Expiry Time (hh:mm:ss) ..... 00:00:28
Generation ID ..... 1116595047
Major Version ..... 3
Minor Version ..... 255
More Entries or quit(q)
Capabilities ..... Prune GenID Missing 11441
Received Routes ..... 0
Received Bad Packets ..... 0
Received Bad Routes ..... 0

```

```
(Netgear Switch) #show ip mcast mroute summary
```

| Multicast Route Table Summary |           |          |                    |                         |
|-------------------------------|-----------|----------|--------------------|-------------------------|
| Source IP                     | Group IP  | Protocol | Incoming Interface | Outgoing Interface List |
| -----                         | -----     | -----    | -----              | -----                   |
| 192.168.1.2                   | 225.0.0.1 | DVMRP    | 1/0/1              | 1/0/21                  |

## DVMRP on Switch B

### 1. Create routing ports 1/0/13 and 1/0/20.

```
(Netgear Switch) #config
(Netgear Switch) (Config)#ip routing
(Netgear Switch) (Config)#interface 1/0/13
(Netgear Switch) (Interface 1/0/13)#routing
(Netgear Switch) (Interface 1/0/13)#ip address 192.168.2.2 255.255.255.0
(Netgear Switch) (Interface 1/0/13)#exit
(Netgear Switch) (Config)#interface 1/0/20
(Netgear Switch) (Interface 1/0/20)#routing
(Netgear Switch) (Interface 1/0/20)#ip address 192.1.168.4.1 255.255.255.0
(Netgear Switch) (Interface 1/0/20)#exit
(Netgear Switch) (Config)#exit
```

### 2. Enable IP multicast forwarding on the switch.

```
(Netgear Switch) (Config)#ip multicast
```

### 3. Enable DVMRP protocol on the switch.

```
(Netgear Switch) (Config)#ip dvmrp
```

### 4. Enable DVMRP mode on interfaceS 1/0/13 and 1/0/20.

```
(Netgear Switch) (Config)#interface 1/0/13
(Netgear Switch) (Interface 1/0/13)#ip dvmrp
(Netgear Switch) (Interface 1/0/13)#ex
(Netgear Switch) (Config)#interface 1/0/20
(Netgear Switch) (Interface 1/0/20)#ip dvmrp
(Netgear Switch) (Interface 1/0/20)#exit
(Netgear Switch) (Config)#exit
```



```
(Netgear Switch) #show ip dvmrp neighbor
Interface ..... 1/0/13
Neighbor IP Address ..... 192.168.2.1
State ..... Active
Up Time (hh:mm:ss) ..... 00:02:26
Expiry Time (hh:mm:ss) ..... 00:00:20
Generation ID ..... 88091
Major Version ..... 3
Minor Version ..... 255
Capabilities ..... Prune GenID Missing 11441
Received Routes ..... 0
Received Bad Packets ..... 0
Received Bad Routes ..... 0
Interface ..... 1/0/20
Neighbor IP Address ..... 192.168.4.2
State ..... Active
Up Time (hh:mm:ss) ..... 00:01:44
Expiry Time (hh:mm:ss) ..... 00:00:29
Generation ID ..... 1116595033
Major Version ..... 3
Minor Version ..... 255
Capabilities ..... Prune GenID Missing 11441
Received Routes ..... 0
Received Bad Packets ..... 0
Received Bad Routes ..... 0
```

```
(Netgear Switch) #show ip mcast mroute detail summary
```

```

                Multicast Route Table Summary
                Incoming      Outgoing
Source IP      Group IP      Protocol  Interface  Interface List
-----
192.168.1.2    225.0.0.1    DVMRP     1/0/13

```

## DVRMP on Switch C:

**1. Create routing interfaceS 1/0/11, 1/0/3, and 1/0/24.**

```
(Netgear Switch) #config
(Netgear Switch) (Config)#ip routing
(Netgear Switch) (Config)#ip interface 1/0/11
(Netgear Switch) (Interface 1/0/11)#ip routing
(Netgear Switch) (Interface 1/0/11)#ip address 192.168.3.1 255.255.255.0
(Netgear Switch) (Interface 1/0/11)#exit
(Netgear Switch) (Config)#interface 1/0/3
(Netgear Switch) (Interface 1/0/3)#routing
(Netgear Switch) (Interface 1/0/3)#ip address 192.168.4.2 255.255.255.0
(Netgear Switch) (Interface 1/0/3)#exit
(Netgear Switch) (Config)#interface 1/0/24
(Netgear Switch) (Interface 1/0/24)#routing
(Netgear Switch) (Interface 1/0/24)#ip address 192.168.5.1 255.255.255.0
(Netgear Switch) (Interface 1/0/24)#exit
```

**2. Enable IP multicast forwarding on the switch.**

```
(Netgear Switch) (Config)#ip multicast
```

**3. Enable IP DVMRP protocol on the switch.**

```
(Netgear Switch) (Config) #ip dvmrp
```

**4. Enable DVMRP mode on interfaces 1/0/3, 1/0/11, and 1/0/24.**

```
(Netgear Switch) (Config)#interface 1/0/3
(Netgear Switch) (Interface 1/0/3)#ip dvmrp
(Netgear Switch) (Interface 1/0/3)#exit
(Netgear Switch) (Config)#interface 1/0/11
(Netgear Switch) (Interface 1/0/11)#ip dvmrp
(Netgear Switch) (Interface 1/0/11)#exit
(Netgear Switch) (Config)#interface 1/0/24
(Netgear Switch) (Interface 1/0/24)#ip dvmrp
(Netgear Switch) (Interface 1/0/24)#exit
```

**5. Enable IGMP protocol on the switch.**

```
(Netgear Switch) (Config)# ip igmp
```

**6. Enable IGMP mode on the interface 1/0/24.**

```
(Netgear Switch) (Config)#interface 1/0/24
(Netgear Switch) (Interface 1/0/24)#ip igmp
(Netgear Switch) (Interface 1/0/24)#exit
```

```
(Netgear Switch) #show ip dvmrp neighbor
Interface ..... 1/0/11
Neighbor IP Address ..... 192.168.3.2
State ..... Active
Up Time (hh:mm:ss) ..... 00:01:03
Expiry Time (hh:mm:ss) ..... 00:00:24
Generation ID ..... 88099
Major Version ..... 3
Minor Version ..... 255
Capabilities ..... Prune GenID Missing 11441
Received Routes ..... 0
Received Bad Packets ..... 0
Received Bad Routes ..... 0
Interface ..... 1/0/3
Neighbor IP Address ..... 192.168.4.1
State ..... Active
Up Time (hh:mm:ss) ..... 00:01:17
Expiry Time (hh:mm:ss) ..... 00:00:23
Generation ID ..... 1116347728
Major Version ..... 3
Minor Version ..... 255

More Entries or quit(q)
Capabilities ..... Prune GenID Missing 11441
Received Routes ..... 0
Received Bad Packets ..... 0
Received Bad Routes ..... 0
(Netgear Switch) #show ip mcast mroute detail summary
```

```

                Multicast Route Table Summary
Source IP      Group IP      Protocol      Incoming      Outgoing
-----      -
192.168.1.2    225.0.0.1    DVMRP         1/0/11        1/0/24

```

# Local Browser Interface: Configure DVMRP

## DVMRP on Switch A

1. Enable IP routing on the switch.

- a. Select **Routing > IP > Basic > IP Configuration**.

A screen similar to the following displays.

| System             | Switching | Routing   | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|--------------------|-----------|---|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table      | IP        | IPv6  | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |
| IP                 |           | IP Configuration  |      |          |            |             |        |                  |      |           |                |
| • Basic            |           | Default Time to Live 64   |      |          |            |             |        |                  |      |           |                |
| • IP Configuration |           | Routing Mode <input checked="" type="radio"/> Enable <input type="radio"/> Disable      |      |          |            |             |        |                  |      |           |                |
| • Statistics       |           | ICMP Echo Replies <input checked="" type="radio"/> Enable <input type="radio"/> Disable |      |          |            |             |        |                  |      |           |                |
| • Advanced         |           | ICMP Redirects <input checked="" type="radio"/> Enable <input type="radio"/> Disable    |      |          |            |             |        |                  |      |           |                |
|                    |           | ICMP Rate Limit Interval 1000 (0 to 2147483647 ms)                                      |      |          |            |             |        |                  |      |           |                |
|                    |           | ICMP Rate Limit Burst Size 100 (1 to 200)   |      |          |            |             |        |                  |      |           |                |
|                    |           | Maximum Next Hops 4   |      |          |            |             |        |                  |      |           |                |

- b. For Routing Mode, select the **Enable** radio button.

- c. Click **Apply**.

2. Configure 1/0/1 as a routing port and assign an IP address to it.

- a. Select **Routing > IP > Advanced > IP Interface Configuration**.

A screen similar to the following displays.

| System                       | Switching | Routing                                   | QoS         | Security | Monitoring                      | Maintenance | Help          | Index            |      |           |                |
|------------------------------|-----------|---|-------------|----------|---------------------------------|-------------|---------------|------------------|------|-----------|----------------|
| Routing Table                | IP        | IPv6                                      | VLAN        | ARP      | RIP                             | OSPF        | OSPFv3        | Router Discovery | VRRP | Multicast | IPv6 Multicast |
| IP                           |           | IP Interface Configuration                |             |          |                                 |             |               |                  |      |           |                |
| • Basic                      |           | 1 2 3 VLANs All                           |             |          |                                 |             |               |                  |      |           |                |
| • Advanced                   |           |   |             |          |                                 |             |               |                  |      |           |                |
| • IP Configuration           |           |   |             |          |                                 |             |               |                  |      |           |                |
| • Statistics                 |           |   |             |          |                                 |             |               |                  |      |           |                |
| • IP Interface Configuration |           |   |             |          |                                 |             |               |                  |      |           |                |
|                              |           | Port                                      | Description | VLAN ID  | IP Address Configuration Method | IP Address  | Subnet Mask   | Routing Mode     |      |           |                |
|                              |           | 1/0/1                                     |             |          | Manual                          | 192.168.1.1 | 255.255.255.0 | Enable           |      |           |                |
|                              |           | <input checked="" type="checkbox"/> 1/0/1 |             |          | Manual                          | 192.168.1.1 | 255.255.255.0 | Enable           |      |           |                |

- b. Scroll down and select the Port **1/0/1** check box.

Now 1/0/1 appears in the Port field at the top.

- c. Enter the following information:

- In the **IP Address** field, enter **192.168.1.1**.
- In the **Subnet Mask** field, enter **255.255.255.0**.
- In the **Routing Mode** field, select **Enable**.

- d. Click **Apply** to save the settings.

3. Configure 1/0/13 as a routing port and assign an IP address to it.

- a. Select **Routing > IP > Advanced > IP Interface Configuration**.

A screen similar to the following displays.

| System  | Switching   | Routing | QoS                             | Security    | Monitoring    | Maintenance  | Help   | Index            |      |           |                |      |             |         |                                 |            |             |              |        |  |  |        |             |               |        |       |  |  |        |             |               |        |
|---|-------------|---------|---------------------------------|-------------|---------------|--------------|--------|------------------|------|-----------|----------------|------|-------------|---------|---------------------------------|------------|-------------|--------------|--------|--|--|--------|-------------|---------------|--------|-------|--|--|--------|-------------|---------------|--------|
| Routing Table   | IP          | IPv6    | VLAN                            | ARP         | RIP           | OSPF         | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |      |             |         |                                 |            |             |              |        |  |  |        |             |               |        |       |  |  |        |             |               |        |
| <div> <div>IP</div> <div>IP Interface Configuration</div> </div>  |             |         |                                 |             |               |              |        |                  |      |           |                |      |             |         |                                 |            |             |              |        |  |  |        |             |               |        |       |  |  |        |             |               |        |
| <div> <div>Basic</div> <div>Advanced</div> <div>IP Configuration</div> <div>Statistics</div> <div>IP Interface</div> </div>   |             |         |                                 |             |               |              |        |                  |      |           |                |      |             |         |                                 |            |             |              |        |  |  |        |             |               |        |       |  |  |        |             |               |        |
| <div> <div>1 2 3 VLANs All</div> <table border="1"> <thead> <tr> <th>Port</th> <th>Description</th> <th>VLAN ID</th> <th>IP Address Configuration Method</th> <th>IP Address</th> <th>Subnet Mask</th> <th>Routing Mode</th> </tr> </thead> <tbody> <tr> <td>1/0/13</td> <td></td> <td></td> <td>Manual</td> <td>192.168.2.1</td> <td>255.255.255.0</td> <td>Enable</td> </tr> <tr> <td>1/0/1</td> <td></td> <td></td> <td>Manual</td> <td>192.168.1.1</td> <td>255.255.255.0</td> <td>Enable</td> </tr> </tbody> </table> </div> |             |         |                                 |             |               |              |        |                  |      |           |                | Port | Description | VLAN ID | IP Address Configuration Method | IP Address | Subnet Mask | Routing Mode | 1/0/13 |  |  | Manual | 192.168.2.1 | 255.255.255.0 | Enable | 1/0/1 |  |  | Manual | 192.168.1.1 | 255.255.255.0 | Enable |
| Port  | Description | VLAN ID | IP Address Configuration Method | IP Address  | Subnet Mask   | Routing Mode |        |                  |      |           |                |      |             |         |                                 |            |             |              |        |  |  |        |             |               |        |       |  |  |        |             |               |        |
| 1/0/13  |             |         | Manual                          | 192.168.2.1 | 255.255.255.0 | Enable       |        |                  |      |           |                |      |             |         |                                 |            |             |              |        |  |  |        |             |               |        |       |  |  |        |             |               |        |
| 1/0/1   |             |         | Manual                          | 192.168.1.1 | 255.255.255.0 | Enable       |        |                  |      |           |                |      |             |         |                                 |            |             |              |        |  |  |        |             |               |        |       |  |  |        |             |               |        |

- b. Scroll down and select the Port **1/0/13** check box.  
Now 1/0/13 appears in the Port field at the top.
  - c. Enter the following information:
    - In the **IP Address** field, enter **192.168.2.1**.
    - In the **Subnet Mask** field, enter **255.255.255.0**.
    - In the **Routing Mode** field, select **Enable**.
  - d. Click **Apply** to save the settings.
4. Configure 1/0/21 as a routing port and assign an IP address to it.
  - a. Select **Routing > IP > Advanced > IP Interface Configuration**.

A screen similar to the following displays.

| System  | Switching   | Routing | QoS                             | Security    | Monitoring    | Maintenance  | Help   | Index            |      |           |                |      |             |         |                                 |            |             |              |        |  |  |        |             |               |        |       |  |  |        |             |               |        |
|---|-------------|---------|---------------------------------|-------------|---------------|--------------|--------|------------------|------|-----------|----------------|------|-------------|---------|---------------------------------|------------|-------------|--------------|--------|--|--|--------|-------------|---------------|--------|-------|--|--|--------|-------------|---------------|--------|
| Routing Table   | IP          | IPv6    | VLAN                            | ARP         | RIP           | OSPF         | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |      |             |         |                                 |            |             |              |        |  |  |        |             |               |        |       |  |  |        |             |               |        |
| <div> <div>IP</div> <div>IP Interface Configuration</div> </div>  |             |         |                                 |             |               |              |        |                  |      |           |                |      |             |         |                                 |            |             |              |        |  |  |        |             |               |        |       |  |  |        |             |               |        |
| <div> <div>Basic</div> <div>Advanced</div> <div>IP Configuration</div> <div>Statistics</div> <div>IP Interface</div> </div>   |             |         |                                 |             |               |              |        |                  |      |           |                |      |             |         |                                 |            |             |              |        |  |  |        |             |               |        |       |  |  |        |             |               |        |
| <div> <div>1 2 3 VLANs All</div> <table border="1"> <thead> <tr> <th>Port</th> <th>Description</th> <th>VLAN ID</th> <th>IP Address Configuration Method</th> <th>IP Address</th> <th>Subnet Mask</th> <th>Routing Mode</th> </tr> </thead> <tbody> <tr> <td>1/0/21</td> <td></td> <td></td> <td>Manual</td> <td>192.168.3.2</td> <td>255.255.255.0</td> <td>Enable</td> </tr> <tr> <td>1/0/1</td> <td></td> <td></td> <td>Manual</td> <td>192.168.1.1</td> <td>255.255.255.0</td> <td>Enable</td> </tr> </tbody> </table> </div> |             |         |                                 |             |               |              |        |                  |      |           |                | Port | Description | VLAN ID | IP Address Configuration Method | IP Address | Subnet Mask | Routing Mode | 1/0/21 |  |  | Manual | 192.168.3.2 | 255.255.255.0 | Enable | 1/0/1 |  |  | Manual | 192.168.1.1 | 255.255.255.0 | Enable |
| Port  | Description | VLAN ID | IP Address Configuration Method | IP Address  | Subnet Mask   | Routing Mode |        |                  |      |           |                |      |             |         |                                 |            |             |              |        |  |  |        |             |               |        |       |  |  |        |             |               |        |
| 1/0/21  |             |         | Manual                          | 192.168.3.2 | 255.255.255.0 | Enable       |        |                  |      |           |                |      |             |         |                                 |            |             |              |        |  |  |        |             |               |        |       |  |  |        |             |               |        |
| 1/0/1   |             |         | Manual                          | 192.168.1.1 | 255.255.255.0 | Enable       |        |                  |      |           |                |      |             |         |                                 |            |             |              |        |  |  |        |             |               |        |       |  |  |        |             |               |        |

- b. Scroll down and select the Port **1/0/13** check box.  
Now 1/0/13 appears in the Port field at the top.
  - c. Enter the following information:
    - In the **IP Address** field, enter **192.168.3.2**.
    - In the **Subnet Mask** field, enter **255.255.255.0**.
    - In the **Routing Mode** field, select **Enable**.
  - d. Click **Apply** to save the settings.
5. Enable IP multicast on the switch.
  - a. Select **Routing > Multicast > Global Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

| Multicast                      | Global Configuration   |
|--------------------------------|--|
| • Mroute Table                 | Admin Mode <input type="radio"/> Disable <input checked="" type="radio"/> Enable |
| • Global Configuration         | Protocol State Non-Operational   |
| • Interface Configuration      | Table Maximum Entry Count 2048   |
| • DVMRP                        | Protocol No Protocol Enabled   |
| • IGMP                         | Table Entry Count 0  |
| • PIM                          |  |
| • Static Routes Configuration  |  |
| • Admin Boundary Configuration |  |

b. For Admin Mode, select the **Enable** radio button.

c. Click **Apply**.

6. Enable DVMRP on the switch.

a. Select **Routing > Multicast > DVMRP > Global Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

| Multicast                 | DVMRP Global Configuration   |
|---------------------------|--|
| • Mroute Table            | Admin Mode <input type="radio"/> Disable <input checked="" type="radio"/> Enable |
| • Global Configuration    | Version 3  |
| • Interface Configuration | Total Number of Routes 0   |
| • DVMRP                   | Reachable Routes 0   |
| • Global Configuration    |  |
| • Interface Configuration |  |
| • DVMRP Neighbor          |  |
| • DVMRP Next Hop          |  |
| • DVMRP Prune             |  |
| • DVMRP Route             |  |
| • IGMP                    |  |

b. For Admin Mode, select the **Enable** radio button.

c. Click **Apply**.

7. Enable DVMRP on the interface.

a. Select **Routing > Multicast > DVMRP > Interface Configuration**.

A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

| Multicast                 | DVMRP Interface Configuration   |                |                |                  |               |                      |                     |                      |                     |             |       |        |                |             |   |   |   |   |   |       |        |                |             |   |   |   |   |   |
|---------------------------|---|----------------|----------------|------------------|---------------|----------------------|---------------------|----------------------|---------------------|-------------|-------|--------|----------------|-------------|---|---|---|---|---|-------|--------|----------------|-------------|---|---|---|---|---|
| • Mroute Table            | 1 2 3 VLANs All   |                |                |                  |               |                      |                     |                      |                     |             |       |        |                |             |   |   |   |   |   |       |        |                |             |   |   |   |   |   |
| • Global Configuration    | Go To Interface <input type="text"/> <input type="button" value="Go"/>  |                |                |                  |               |                      |                     |                      |                     |             |       |        |                |             |   |   |   |   |   |       |        |                |             |   |   |   |   |   |
| • Interface Configuration | <table border="1"> <thead> <tr> <th>Interface</th> <th>Interface Mode</th> <th>Protocol State</th> <th>Local Address</th> <th>Interface Metric</th> <th>Generation ID</th> <th>Received Bad Packets</th> <th>Received Bad Routes</th> <th>Sent Routes</th> </tr> </thead> <tbody> <tr> <td>1/0/1</td> <td>Enable</td> <td>Not in Service</td> <td>192.168.1.1</td> <td>1</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td> </tr> <tr> <td>1/0/1</td> <td>Enable</td> <td>Not in Service</td> <td>192.168.1.1</td> <td>1</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td> </tr> </tbody> </table> | Interface      | Interface Mode | Protocol State   | Local Address | Interface Metric     | Generation ID       | Received Bad Packets | Received Bad Routes | Sent Routes | 1/0/1 | Enable | Not in Service | 192.168.1.1 | 1 | 0 | 0 | 0 | 0 | 1/0/1 | Enable | Not in Service | 192.168.1.1 | 1 | 0 | 0 | 0 | 0 |
| Interface                 | Interface Mode  | Protocol State | Local Address  | Interface Metric | Generation ID | Received Bad Packets | Received Bad Routes | Sent Routes          |                     |             |       |        |                |             |   |   |   |   |   |       |        |                |             |   |   |   |   |   |
| 1/0/1                     | Enable  | Not in Service | 192.168.1.1    | 1                | 0             | 0                    | 0                   | 0                    |                     |             |       |        |                |             |   |   |   |   |   |       |        |                |             |   |   |   |   |   |
| 1/0/1                     | Enable  | Not in Service | 192.168.1.1    | 1                | 0             | 0                    | 0                   | 0                    |                     |             |       |        |                |             |   |   |   |   |   |       |        |                |             |   |   |   |   |   |
| • DVMRP                   |   |                |                |                  |               |                      |                     |                      |                     |             |       |        |                |             |   |   |   |   |   |       |        |                |             |   |   |   |   |   |
| • Global Configuration    |   |                |                |                  |               |                      |                     |                      |                     |             |       |        |                |             |   |   |   |   |   |       |        |                |             |   |   |   |   |   |
| • Interface Configuration |   |                |                |                  |               |                      |                     |                      |                     |             |       |        |                |             |   |   |   |   |   |       |        |                |             |   |   |   |   |   |

b. Scroll down select the Interface **1/0/1**, **1/0/13**, and **1/0/21** check boxes.

c. In the **Interface Mode** field, select **300**.

- d. Click **Apply** to save the settings.

## DVMRP on Switch B

1. Enable IP routing on the switch.

- a. Select **Routing > IP > Basic > IP Configuration**.

A screen similar to the following displays.

| System   | Switching | Routing                    | QoS  | Security  | Monitoring | Maintenance | Help   | Index            |      |           |                |
|--|-----------|----------------------------|------|---|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table  | IP        | IPv6                       | VLAN | ARP   | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |
| <div> <div>IP</div> <div>IP Configuration</div> </div> |           |                            |      |   |            |             |        |                  |      |           |                |
| • Basic  |           | Default Time to Live       |      | 64  |            |             |        |                  |      |           |                |
| • Advanced   |           | Routing Mode               |      | <input checked="" type="radio"/> Enable <input type="radio"/> Disable |            |             |        |                  |      |           |                |
| • IP Configuration                                     |           | ICMP Echo Replies          |      | <input checked="" type="radio"/> Enable <input type="radio"/> Disable |            |             |        |                  |      |           |                |
| • Statistics   |           | ICMP Redirects             |      | <input type="radio"/> Enable <input checked="" type="radio"/> Disable |            |             |        |                  |      |           |                |
| • IP Interface Configuration                           |           | ICMP Rate Limit Interval   |      | <input type="text" value="1000"/> (0 to 2147483647 ms)                |            |             |        |                  |      |           |                |
| • Secondary IP   |           | ICMP Rate Limit Burst Size |      | <input type="text" value="100"/> (1 to 200)                           |            |             |        |                  |      |           |                |
|  |           | Maximum Next Hops          |      | 4   |            |             |        |                  |      |           |                |

- b. For Routing Mode, select the **Enable** radio button.

- c. Click **Apply**.

2. Configure 1/0/13 as a routing port and assign an IP address to it.

- a. Select **Routing > IP > Advanced > IP Interface Configuration**.

A screen similar to the following displays.

| System   | Switching                           | Routing         | QoS  | Security | Monitoring | Maintenance | Help          | Index            |        |           |                |
|--|-------------------------------------|-----------------|------|----------|------------|-------------|---------------|------------------|--------|-----------|----------------|
| Routing Table  | IP                                  | IPv6            | VLAN | ARP      | RIP        | OSPF        | OSPFv3        | Router Discovery | VRRP   | Multicast | IPv6 Multicast |
| <div> <div>IP</div> <div>IP Interface Configuration</div> </div> |                                     |                 |      |          |            |             |               |                  |        |           |                |
| • Basic  |                                     | 1 2 3 VLANs All |      |          |            |             |               |                  |        |           |                |
| • Advanced   |                                     |                 |      |          |            |             |               |                  |        |           |                |
| • IP Configuration   |                                     |                 |      |          |            |             |               |                  |        |           |                |
| • Statistics   |                                     |                 |      |          |            |             |               |                  |        |           |                |
| • IP Interface Configuration                                     |                                     |                 |      |          |            |             |               |                  |        |           |                |
|  | <input checked="" type="checkbox"/> | 1/0/13          |      |          | Manual     | 192.168.2.2 | 255.255.255.0 | Enable           | Enable |           |                |
|  | <input type="checkbox"/>            | 1/0/1           |      |          | Manual     | 192.168.1.1 | 255.255.255.0 | Enable           | Enable |           |                |
|  | <input type="checkbox"/>            | 1/0/2           |      |          | None       | 0.0.0.0     | 0.0.0.0       | Disable          | Enable |           |                |

- b. Scroll down and select the Port **1/0/13** check box.

Now 1/0/13 appears in the Port field at the top.

- c. Enter the following information in the IP Interface Configuration.

- In the **IP Address** field, enter **192.168.2.2**.
- In the **Subnet Mask** field, enter **255.255.255.0**.
- In the **Routing Mode** field, select **Enable**.

- d. Click **Apply** to save the settings.

3. Configure 1/0/20 as a routing port and assign an IP address to it.

- a. Select **Routing > IP > Advanced > IP Interface Configuration**.



A screen similar to the following displays.

| System   | Switching   | Routing | QoS                             | Security    | Monitoring    | Maintenance  | Help                | Index            |      |           |                |      |             |         |                                 |            |             |              |                     |        |  |  |        |             |               |        |        |                                |  |  |        |             |               |        |        |
|--|-------------|---------|---------------------------------|-------------|---------------|--------------|---------------------|------------------|------|-----------|----------------|------|-------------|---------|---------------------------------|------------|-------------|--------------|---------------------|--------|--|--|--------|-------------|---------------|--------|--------|--------------------------------|--|--|--------|-------------|---------------|--------|--------|
| Routing Table  | IP          | IPv6    | VLAN                            | ARP         | RIP           | OSPF         | OSPFv3              | Router Discovery | VRRP | Multicast | IPv6 Multicast |      |             |         |                                 |            |             |              |                     |        |  |  |        |             |               |        |        |                                |  |  |        |             |               |        |        |
| <div> <div>IP</div> <div>IP Interface Configuration</div> </div>   |             |         |                                 |             |               |              |                     |                  |      |           |                |      |             |         |                                 |            |             |              |                     |        |  |  |        |             |               |        |        |                                |  |  |        |             |               |        |        |
| <div> <div> <ul style="list-style-type: none"> <li>Basic</li> <li>Advanced</li> <li>IP Configuration</li> <li>Statistics</li> <li><b>IP Interface Configuration</b></li> </ul> </div> <div> <div>1 2 3 VLANs All</div> <table border="1"> <thead> <tr> <th>Port</th> <th>Description</th> <th>VLAN ID</th> <th>IP Address Configuration Method</th> <th>IP Address</th> <th>Subnet Mask</th> <th>Routing Mode</th> <th>Administrative Mode</th> </tr> </thead> <tbody> <tr> <td>1/0/20</td> <td></td> <td></td> <td>Manual</td> <td>192.168.4.1</td> <td>255.255.255.0</td> <td>Enable</td> <td>Enable</td> </tr> <tr> <td><input type="checkbox"/> 1/0/1</td> <td></td> <td></td> <td>Manual</td> <td>192.168.1.1</td> <td>255.255.255.0</td> <td>Enable</td> <td>Enable</td> </tr> </tbody> </table> </div> </div> |             |         |                                 |             |               |              |                     |                  |      |           |                | Port | Description | VLAN ID | IP Address Configuration Method | IP Address | Subnet Mask | Routing Mode | Administrative Mode | 1/0/20 |  |  | Manual | 192.168.4.1 | 255.255.255.0 | Enable | Enable | <input type="checkbox"/> 1/0/1 |  |  | Manual | 192.168.1.1 | 255.255.255.0 | Enable | Enable |
| Port   | Description | VLAN ID | IP Address Configuration Method | IP Address  | Subnet Mask   | Routing Mode | Administrative Mode |                  |      |           |                |      |             |         |                                 |            |             |              |                     |        |  |  |        |             |               |        |        |                                |  |  |        |             |               |        |        |
| 1/0/20   |             |         | Manual                          | 192.168.4.1 | 255.255.255.0 | Enable       | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |        |  |  |        |             |               |        |        |                                |  |  |        |             |               |        |        |
| <input type="checkbox"/> 1/0/1   |             |         | Manual                          | 192.168.1.1 | 255.255.255.0 | Enable       | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |        |  |  |        |             |               |        |        |                                |  |  |        |             |               |        |        |

- b. Scroll and select the Port **1/0/20** check box.

Now 1/0/20 appears in the Interface field at the top.

- c. Enter the following information:

- In the **IP Address** field, enter **192.168.4.1**.
- In the **Subnet Mask** field, enter **255.255.255.0**.
- In the **Routing Mode** field, select **Enable**.

- d. Click **Apply** to save the settings.

4. Enable IP multicast on the switch.

- a. Select **Routing > Multicast > Global Configuration**.

A screen similar to the following displays.

| System  | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table   | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |
| <div> <div>Multicast</div> <div>Global Configuration</div> </div>   |           |         |      |          |            |             |        |                  |      |           |                |
| <div> <div> <ul style="list-style-type: none"> <li>Route Table</li> <li><b>Global Configuration</b></li> <li>Interface Configuration</li> <li>DVMRP</li> <li>IGMP</li> <li>PIM</li> <li>Static Routes Configuration</li> <li>Admin Boundary Configuration</li> </ul> </div> <div> <div>Admin Mode</div> <div> <input checked="" type="radio"/> Disable           <input type="radio"/> Enable         </div> <div>Protocol State</div> <div>Non-Operational</div> <div>Table Maximum Entry Count</div> <div>2048</div> <div>Protocol</div> <div>No Protocol Enabled</div> <div>Table Entry Count</div> <div>0</div> </div> </div> |           |         |      |          |            |             |        |                  |      |           |                |

- b. For Admin Mode, select the **Enable** radio button.

- c. Click **Apply**.

5. Enable DVMRP on the switch.

- a. Select **Routing > Multicast > DVMRP > Global Configuration**.

A screen similar to the following displays.

| System  | Switching | Routing  | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---|-----------|--|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table   | IP        | IPv6   | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |
| <div> <div>Multicast</div> <div>DVMRP Global Configuration</div> </div> |           |  |      |          |            |             |        |                  |      |           |                |
| • Multicast   |           | Admin Mode <input type="radio"/> Disable <input checked="" type="radio"/> Enable |      |          |            |             |        |                  |      |           |                |
| • Global Configuration  |           | Version 3  |      |          |            |             |        |                  |      |           |                |
| • Interface Configuration   |           | Total Number of Routes 0   |      |          |            |             |        |                  |      |           |                |
| • DVMRP   |           | Reachable Routes 0   |      |          |            |             |        |                  |      |           |                |
| • Global Configuration  |           |  |      |          |            |             |        |                  |      |           |                |
| • Interface Configuration   |           |  |      |          |            |             |        |                  |      |           |                |
| • DVMRP Neighbor  |           |  |      |          |            |             |        |                  |      |           |                |
| • DVMRP Next Hop  |           |  |      |          |            |             |        |                  |      |           |                |
| • DVMRP Prune   |           |  |      |          |            |             |        |                  |      |           |                |
| • DVMRP Route   |           |  |      |          |            |             |        |                  |      |           |                |

b. For Admin Mode, select the **Enable** radio button.

c. Click **Apply**.

6. Enable DVMRP on the interface.

a. Select **Routing > Multicast > DVMRP > Interface Configuration**.

A screen similar to the following displays.

| System   | Switching      | Routing   | QoS           | Security         | Monitoring    | Maintenance          | Help                | Index            |      |           |                |           |                |                |               |                  |               |                      |                     |             |       |        |                |             |   |   |   |   |   |
|--|----------------|---|---------------|------------------|---------------|----------------------|---------------------|------------------|------|-----------|----------------|-----------|----------------|----------------|---------------|------------------|---------------|----------------------|---------------------|-------------|-------|--------|----------------|-------------|---|---|---|---|---|
| Routing Table  | IP             | IPv6  | VLAN          | ARP              | RIP           | OSPF                 | OSPFv3              | Router Discovery | VRRP | Multicast | IPv6 Multicast |           |                |                |               |                  |               |                      |                     |             |       |        |                |             |   |   |   |   |   |
| <div> <div>Multicast</div> <div>DVMRP Interface Configuration</div> </div> |                |   |               |                  |               |                      |                     |                  |      |           |                |           |                |                |               |                  |               |                      |                     |             |       |        |                |             |   |   |   |   |   |
| • Multicast  |                | 1 2 3 VLANs All   |               |                  |               |                      |                     |                  |      |           |                |           |                |                |               |                  |               |                      |                     |             |       |        |                |             |   |   |   |   |   |
| • Global Configuration   |                | Go To Interface <input type="text"/> <b>Go</b>  |               |                  |               |                      |                     |                  |      |           |                |           |                |                |               |                  |               |                      |                     |             |       |        |                |             |   |   |   |   |   |
| • Interface Configuration  |                | <table border="1"> <thead> <tr> <th>Interface</th> <th>Interface Mode</th> <th>Protocol State</th> <th>Local Address</th> <th>Interface Metric</th> <th>Generation ID</th> <th>Received Bad Packets</th> <th>Received Bad Routes</th> <th>Swit Routes</th> </tr> </thead> <tbody> <tr> <td>1/0/1</td> <td>Enable</td> <td>Not In Service</td> <td>192.168.1.1</td> <td>1</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td> </tr> </tbody> </table> |               |                  |               |                      |                     |                  |      |           |                | Interface | Interface Mode | Protocol State | Local Address | Interface Metric | Generation ID | Received Bad Packets | Received Bad Routes | Swit Routes | 1/0/1 | Enable | Not In Service | 192.168.1.1 | 1 | 0 | 0 | 0 | 0 |
| Interface  | Interface Mode | Protocol State  | Local Address | Interface Metric | Generation ID | Received Bad Packets | Received Bad Routes | Swit Routes      |      |           |                |           |                |                |               |                  |               |                      |                     |             |       |        |                |             |   |   |   |   |   |
| 1/0/1  | Enable         | Not In Service  | 192.168.1.1   | 1                | 0             | 0                    | 0                   | 0                |      |           |                |           |                |                |               |                  |               |                      |                     |             |       |        |                |             |   |   |   |   |   |
| • DVMRP  |                |   |               |                  |               |                      |                     |                  |      |           |                |           |                |                |               |                  |               |                      |                     |             |       |        |                |             |   |   |   |   |   |
| • Global Configuration   |                |   |               |                  |               |                      |                     |                  |      |           |                |           |                |                |               |                  |               |                      |                     |             |       |        |                |             |   |   |   |   |   |
| • Interface Configuration  |                |   |               |                  |               |                      |                     |                  |      |           |                |           |                |                |               |                  |               |                      |                     |             |       |        |                |             |   |   |   |   |   |

b. Scroll down and select the Interface **1/0/13** and **1/0/20** check boxes.

c. In the **Interface Mode** field, select **Enable**.

d. Click **Apply** to save the settings.

## DVMRP on Switch C

1. Enable IP routing on the switch.

a. Select **Routing > IP > Basic > IP Configuration**.

A screen similar to the following displays.

| System   | Switching | Routing   | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|--|-----------|---|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table  | IP        | IPv6  | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |
| <div> <div>IP</div> <div>IP Configuration</div> </div> |           |   |      |          |            |             |        |                  |      |           |                |
| • Basic  |           | Default Time to Live 64   |      |          |            |             |        |                  |      |           |                |
| • IP Configuration                                     |           | Routing Mode <input type="radio"/> Enable <input checked="" type="radio"/> Disable      |      |          |            |             |        |                  |      |           |                |
| • Statistics   |           | ICMP Echo Replies <input type="radio"/> Enable <input checked="" type="radio"/> Disable |      |          |            |             |        |                  |      |           |                |
| • Advanced   |           | ICMP Redirects <input type="radio"/> Enable <input checked="" type="radio"/> Disable    |      |          |            |             |        |                  |      |           |                |
|  |           | ICMP Rate Limit Interval 1000 (0 to 2147483647 ms)                                      |      |          |            |             |        |                  |      |           |                |
|  |           | ICMP Rate Limit Burst Size 100 (1 to 200)   |      |          |            |             |        |                  |      |           |                |
|  |           | Maximum Next Hops 4   |      |          |            |             |        |                  |      |           |                |

b. For Routing Mode, select the **Enable** radio button.

c. Click **Apply**.

2. Configure 1/0/11 as a routing port and assign an IP address to it.
  - a. Select **Routing > IP > Advanced > IP Interface Configuration**.

A screen similar to the following displays.

| System  | Switching   | Routing | QoS                             | Security    | Monitoring    | Maintenance  | Help                | Index            |      |           |                |      |             |         |                                 |            |             |              |                     |        |  |  |        |             |               |        |        |       |  |  |      |         |         |        |        |
|---|-------------|---------|---------------------------------|-------------|---------------|--------------|---------------------|------------------|------|-----------|----------------|------|-------------|---------|---------------------------------|------------|-------------|--------------|---------------------|--------|--|--|--------|-------------|---------------|--------|--------|-------|--|--|------|---------|---------|--------|--------|
| Routing Table   | IP          | IPv6    | VLAN                            | ARP         | RIP           | OSPF         | OSPFv3              | Router Discovery | VRRP | Multicast | IPv6 Multicast |      |             |         |                                 |            |             |              |                     |        |  |  |        |             |               |        |        |       |  |  |      |         |         |        |        |
| <div> <div>IP</div> <div>IP Interface Configuration</div> </div>  |             |         |                                 |             |               |              |                     |                  |      |           |                |      |             |         |                                 |            |             |              |                     |        |  |  |        |             |               |        |        |       |  |  |      |         |         |        |        |
| <div> <div> <div>Basic</div> <div>Advanced</div> <div>IP Configuration</div> <div>Statistics</div> <div>IP Interface Configuration</div> </div> <div> <div>1 2 3 VLANs All</div> <table border="1"> <thead> <tr> <th>Port</th> <th>Description</th> <th>VLAN ID</th> <th>IP Address Configuration Method</th> <th>IP Address</th> <th>Subnet Mask</th> <th>Routing Mode</th> <th>Administrative Mode</th> </tr> </thead> <tbody> <tr> <td>1/0/11</td> <td></td> <td></td> <td>Manual</td> <td>192.168.3.1</td> <td>255.255.255.0</td> <td>Enable</td> <td>Enable</td> </tr> <tr> <td>1/0/1</td> <td></td> <td></td> <td>None</td> <td>0.0.0.0</td> <td>0.0.0.0</td> <td>Enable</td> <td>Enable</td> </tr> </tbody> </table> </div> </div> |             |         |                                 |             |               |              |                     |                  |      |           |                | Port | Description | VLAN ID | IP Address Configuration Method | IP Address | Subnet Mask | Routing Mode | Administrative Mode | 1/0/11 |  |  | Manual | 192.168.3.1 | 255.255.255.0 | Enable | Enable | 1/0/1 |  |  | None | 0.0.0.0 | 0.0.0.0 | Enable | Enable |
| Port  | Description | VLAN ID | IP Address Configuration Method | IP Address  | Subnet Mask   | Routing Mode | Administrative Mode |                  |      |           |                |      |             |         |                                 |            |             |              |                     |        |  |  |        |             |               |        |        |       |  |  |      |         |         |        |        |
| 1/0/11  |             |         | Manual                          | 192.168.3.1 | 255.255.255.0 | Enable       | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |        |  |  |        |             |               |        |        |       |  |  |      |         |         |        |        |
| 1/0/1   |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Enable       | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |        |  |  |        |             |               |        |        |       |  |  |      |         |         |        |        |

- b. Scroll down and select the Port **1/0/11** check box.  
Now 1/0/11 appears in the Port field at the top.
    - c. Enter the following information:
      - In the **IP Address** field, enter **192.168.3.1**.
      - In the **Subnet Mask** field, enter **255.255.255.0**.
      - In the **Routing Mode** field, select **Enable**.
    - d. Click **Apply** to save the settings.
3. Configure 1/0/3 as a routing port and assign an IP address to it.
  - a. Select **Routing > IP > Advanced > IP Interface Configuration**.

A screen similar to the following displays.

| System  | Switching   | Routing | QoS                             | Security    | Monitoring    | Maintenance  | Help                | Index            |      |           |                |      |             |         |                                 |            |             |              |                     |       |  |  |        |             |               |        |        |       |  |  |      |         |         |        |        |       |  |  |      |         |         |         |        |   |  |  |        |             |               |        |        |
|---|-------------|---------|---------------------------------|-------------|---------------|--------------|---------------------|------------------|------|-----------|----------------|------|-------------|---------|---------------------------------|------------|-------------|--------------|---------------------|-------|--|--|--------|-------------|---------------|--------|--------|-------|--|--|------|---------|---------|--------|--------|-------|--|--|------|---------|---------|---------|--------|---|--|--|--------|-------------|---------------|--------|--------|
| Routing Table   | IP          | IPv6    | VLAN                            | ARP         | RIP           | OSPF         | OSPFv3              | Router Discovery | VRRP | Multicast | IPv6 Multicast |      |             |         |                                 |            |             |              |                     |       |  |  |        |             |               |        |        |       |  |  |      |         |         |        |        |       |  |  |      |         |         |         |        |   |  |  |        |             |               |        |        |
| <div> <div>IP</div> <div>IP Interface Configuration</div> </div>  |             |         |                                 |             |               |              |                     |                  |      |           |                |      |             |         |                                 |            |             |              |                     |       |  |  |        |             |               |        |        |       |  |  |      |         |         |        |        |       |  |  |      |         |         |         |        |   |  |  |        |             |               |        |        |
| <div> <div> <div>Basic</div> <div>Advanced</div> <div>IP Configuration</div> <div>Statistics</div> <div>IP Interface Configuration</div> <div>Secondary IP</div> </div> <div> <div>1 2 3 VLANs All</div> <table border="1"> <thead> <tr> <th>Port</th> <th>Description</th> <th>VLAN ID</th> <th>IP Address Configuration Method</th> <th>IP Address</th> <th>Subnet Mask</th> <th>Routing Mode</th> <th>Administrative Mode</th> </tr> </thead> <tbody> <tr> <td>1/0/3</td> <td></td> <td></td> <td>Manual</td> <td>192.168.4.2</td> <td>255.255.255.0</td> <td>Enable</td> <td>Enable</td> </tr> <tr> <td>1/0/1</td> <td></td> <td></td> <td>None</td> <td>0.0.0.0</td> <td>0.0.0.0</td> <td>Enable</td> <td>Enable</td> </tr> <tr> <td>1/0/2</td> <td></td> <td></td> <td>None</td> <td>0.0.0.0</td> <td>0.0.0.0</td> <td>Disable</td> <td>Enable</td> </tr> <tr> <td><input checked="" type="checkbox"/> 1/0/3</td> <td></td> <td></td> <td>Manual</td> <td>192.168.4.2</td> <td>255.255.255.0</td> <td>Enable</td> <td>Enable</td> </tr> </tbody> </table> </div> </div> |             |         |                                 |             |               |              |                     |                  |      |           |                | Port | Description | VLAN ID | IP Address Configuration Method | IP Address | Subnet Mask | Routing Mode | Administrative Mode | 1/0/3 |  |  | Manual | 192.168.4.2 | 255.255.255.0 | Enable | Enable | 1/0/1 |  |  | None | 0.0.0.0 | 0.0.0.0 | Enable | Enable | 1/0/2 |  |  | None | 0.0.0.0 | 0.0.0.0 | Disable | Enable | <input checked="" type="checkbox"/> 1/0/3 |  |  | Manual | 192.168.4.2 | 255.255.255.0 | Enable | Enable |
| Port  | Description | VLAN ID | IP Address Configuration Method | IP Address  | Subnet Mask   | Routing Mode | Administrative Mode |                  |      |           |                |      |             |         |                                 |            |             |              |                     |       |  |  |        |             |               |        |        |       |  |  |      |         |         |        |        |       |  |  |      |         |         |         |        |   |  |  |        |             |               |        |        |
| 1/0/3   |             |         | Manual                          | 192.168.4.2 | 255.255.255.0 | Enable       | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |       |  |  |        |             |               |        |        |       |  |  |      |         |         |        |        |       |  |  |      |         |         |         |        |   |  |  |        |             |               |        |        |
| 1/0/1   |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Enable       | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |       |  |  |        |             |               |        |        |       |  |  |      |         |         |        |        |       |  |  |      |         |         |         |        |   |  |  |        |             |               |        |        |
| 1/0/2   |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |       |  |  |        |             |               |        |        |       |  |  |      |         |         |        |        |       |  |  |      |         |         |         |        |   |  |  |        |             |               |        |        |
| <input checked="" type="checkbox"/> 1/0/3   |             |         | Manual                          | 192.168.4.2 | 255.255.255.0 | Enable       | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |       |  |  |        |             |               |        |        |       |  |  |      |         |         |        |        |       |  |  |      |         |         |         |        |   |  |  |        |             |               |        |        |

- b. Scroll down and select the Port **1/0/3** check box.  
Now 1/0/3 appears in the Port field at the top.
    - c. Enter the following information:
      - In the **IP Address** field, enter **192.168.4.2**.
      - In the **Subnet Mask** field, enter **255.255.255.0**.
      - In the **Routing Mode** field, select **Enable**.
    - d. Click **Apply** to save the settings.
4. Configure 1/0/24 as a routing port and assign an IP address to it.
  - a. Select **Routing > IP > Advanced > IP Interface Configuration**.

A screen similar to the following displays.

| System  | Switching   | Routing | QoS                             | Security    | Monitoring    | Maintenance  | Help                | Index            |      |           |                |      |             |         |                                 |            |             |              |                     |  |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
|---|-------------|---------|---------------------------------|-------------|---------------|--------------|---------------------|------------------|------|-----------|----------------|------|-------------|---------|---------------------------------|------------|-------------|--------------|---------------------|--|--|--|--------|-------------|---------------|--------|--------|--------------------------------|--|--|------|---------|---------|---------|--------|--------------------------------|--|--|------|---------|---------|---------|--------|--------------------------------|--|--|------|---------|---------|---------|--------|
| Routing Table   | IP          | IPv6    | VLAN                            | ARP         | RIP           | OSPF         | OSPFv3              | Router Discovery | VRRP | Multicast | IPv6 Multicast |      |             |         |                                 |            |             |              |                     |  |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <div>IP</div> <div>IP Interface Configuration</div> <div>1 2 3 VLANs All</div> <div> <div>Basic</div> <div>Advanced</div> <div>IP Configuration</div> <div>Statistics</div> <div>IP Interface Configuration</div> <div>Secondary IP</div> </div> <table border="1"> <thead> <tr> <th>Port</th> <th>Description</th> <th>VLAN ID</th> <th>IP Address Configuration Method</th> <th>IP Address</th> <th>Subnet Mask</th> <th>Routing Mode</th> <th>Administrative Mode</th> </tr> </thead> <tbody> <tr> <td><input checked="" type="checkbox"/> 1/0/24</td> <td></td> <td></td> <td>Manual</td> <td>192.168.5.1</td> <td>255.255.255.0</td> <td>Enable</td> <td>Enable</td> </tr> <tr> <td><input type="checkbox"/> 1/0/1</td> <td></td> <td></td> <td>None</td> <td>0.0.0.0</td> <td>0.0.0.0</td> <td>Disable</td> <td>Enable</td> </tr> <tr> <td><input type="checkbox"/> 1/0/2</td> <td></td> <td></td> <td>None</td> <td>0.0.0.0</td> <td>0.0.0.0</td> <td>Disable</td> <td>Enable</td> </tr> <tr> <td><input type="checkbox"/> 1/0/3</td> <td></td> <td></td> <td>None</td> <td>0.0.0.0</td> <td>0.0.0.0</td> <td>Disable</td> <td>Enable</td> </tr> </tbody> </table> |             |         |                                 |             |               |              |                     |                  |      |           |                | Port | Description | VLAN ID | IP Address Configuration Method | IP Address | Subnet Mask | Routing Mode | Administrative Mode | <input checked="" type="checkbox"/> 1/0/24 |  |  | Manual | 192.168.5.1 | 255.255.255.0 | Enable | Enable | <input type="checkbox"/> 1/0/1 |  |  | None | 0.0.0.0 | 0.0.0.0 | Disable | Enable | <input type="checkbox"/> 1/0/2 |  |  | None | 0.0.0.0 | 0.0.0.0 | Disable | Enable | <input type="checkbox"/> 1/0/3 |  |  | None | 0.0.0.0 | 0.0.0.0 | Disable | Enable |
| Port  | Description | VLAN ID | IP Address Configuration Method | IP Address  | Subnet Mask   | Routing Mode | Administrative Mode |                  |      |           |                |      |             |         |                                 |            |             |              |                     |  |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input checked="" type="checkbox"/> 1/0/24  |             |         | Manual                          | 192.168.5.1 | 255.255.255.0 | Enable       | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |  |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input type="checkbox"/> 1/0/1  |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |  |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input type="checkbox"/> 1/0/2  |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |  |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |
| <input type="checkbox"/> 1/0/3  |             |         | None                            | 0.0.0.0     | 0.0.0.0       | Disable      | Enable              |                  |      |           |                |      |             |         |                                 |            |             |              |                     |  |  |  |        |             |               |        |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |                                |  |  |      |         |         |         |        |

- b. Scroll down and select the Port **1/0/24** check box.

Now 1/0/24 appears in the Port field at the top.

- c. Enter the following information:

- In the **IP Address** field, enter **192.168.5.1**.
- In the **Subnet Mask** field, enter **255.255.255.0**.
- In the **Routing Mode** field, select **Enable**.

- d. Click **Apply** to save the settings.

5. Enable IP multicast on the switch.

- a. Select **Routing > Multicast > Global Configuration**.

A screen similar to the following displays.

| System  | Switching  | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |            |  |                |                 |                           |      |          |                     |                   |   |
|---|--|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|------------|--|----------------|-----------------|---------------------------|------|----------|---------------------|-------------------|---|
| Routing Table   | IP   | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |            |  |                |                 |                           |      |          |                     |                   |   |
| <div>Multicast</div> <div>Global Configuration</div> <div> <div>Route Table</div> <div>Global Configuration</div> <div>Interface Configuration</div> <div>DVMRP</div> <div>IGMP</div> <div>PIM</div> <div>Static Routes Configuration</div> <div>Admin Boundary Configuration</div> </div> <table border="1"> <tbody> <tr> <td>Admin Mode</td> <td><input checked="" type="radio"/> Disable <input checked="" type="radio"/> Enable</td> </tr> <tr> <td>Protocol State</td> <td>Non-Operational</td> </tr> <tr> <td>Table Maximum Entry Count</td> <td>2048</td> </tr> <tr> <td>Protocol</td> <td>No Protocol Enabled</td> </tr> <tr> <td>Table Entry Count</td> <td>0</td> </tr> </tbody> </table> |  |         |      |          |            |             |        |                  |      |           |                | Admin Mode | <input checked="" type="radio"/> Disable <input checked="" type="radio"/> Enable | Protocol State | Non-Operational | Table Maximum Entry Count | 2048 | Protocol | No Protocol Enabled | Table Entry Count | 0 |
| Admin Mode  | <input checked="" type="radio"/> Disable <input checked="" type="radio"/> Enable |         |      |          |            |             |        |                  |      |           |                |            |  |                |                 |                           |      |          |                     |                   |   |
| Protocol State  | Non-Operational  |         |      |          |            |             |        |                  |      |           |                |            |  |                |                 |                           |      |          |                     |                   |   |
| Table Maximum Entry Count   | 2048   |         |      |          |            |             |        |                  |      |           |                |            |  |                |                 |                           |      |          |                     |                   |   |
| Protocol  | No Protocol Enabled  |         |      |          |            |             |        |                  |      |           |                |            |  |                |                 |                           |      |          |                     |                   |   |
| Table Entry Count   | 0  |         |      |          |            |             |        |                  |      |           |                |            |  |                |                 |                           |      |          |                     |                   |   |

- b. For Admin Mode, select the **Enable** radio button.

- c. Click **Apply**.

6. Enable DVMRP on the switch.

- a. Select **Routing > Multicast > DVMRP > Global Configuration**.

A screen similar to the following displays.

| System  | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table   | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |
| <div>Multicast</div> <div>DVMRP Global Configuration</div> <div> <div>• Mroute Table</div> <div>• Global Configuration</div> <div>• Interface Configuration</div> <div>• DVMRP</div> <div>• Global Configuration</div> <div>• Interface Configuration</div> <div>• DVMRP Neighbor</div> <div>• DVMRP Next Hop</div> <div>• DVMRP Prune</div> <div>• DVMRP Route</div> </div> <div> <div>Admin Mode</div> <div>Version</div> <div>Total Number of Routes</div> <div>Reachable Routes</div> </div> <div> <div><input type="radio"/> Disable <input checked="" type="radio"/> Enable</div> <div>3</div> <div>0</div> <div>0</div> </div> |           |         |      |          |            |             |        |                  |      |           |                |

b. For Admin Mode, select the **Enable** radio button.

c. Click **Apply**.

7. Enable DVMRP on the interface.

a. Select **Routing > Multicast > DVMRP > Interface Configuration**.

A screen similar to the following displays.

| System  | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table   | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |
| <div>Multicast</div> <div>DVMRP Interface Configuration</div> <div> <div>1 2 3 VLANs All</div> <div>Go To Interface</div> <div>Go</div> </div> <div> <div>Interface</div> <div>Interface Mode</div> <div>Protocol State</div> <div>Local Address</div> <div>Interface Metric</div> <div>Generation ID</div> <div>Received Bad Packets</div> <div>Received Bad Routes</div> <div>Sent Routes</div> </div> <div> <div>1/0/1</div> <div>Enable</div> <div>Not In Service</div> <div>0.0.0.0</div> <div>1</div> <div>0</div> <div>0</div> <div>0</div> </div> <div> <div>1/0/2</div> <div>Disable</div> <div>Not In Service</div> <div>0.0.0.0</div> <div>1</div> <div>0</div> <div>0</div> <div>0</div> </div> <div> <div>1/0/3</div> <div>Disable</div> <div>Not In Service</div> <div>192.168.4.2</div> <div>1</div> <div>0</div> <div>0</div> <div>0</div> </div> |           |         |      |          |            |             |        |                  |      |           |                |

b. Scroll down and select the Interface **1/0/3**, **1/0/11**, and **1/0/24** check boxes.

c. Select **Enable** in the **Interface Mode** field.

d. Click **Apply** to save the settings.

8. Enable IGMP on the switch.

a. Select **Routing > Multicast > IGMP > Global Configuration**.

A screen similar to the following displays.

| System  | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table   | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |
| <div>Multicast</div> <div>IGMP Global Configuration</div> <div> <div>• Mroute Table</div> <div>• Global Configuration</div> <div>• Interface Configuration</div> <div>• DVMRP</div> <div>• IGMP</div> <div>• Global Configuration</div> </div> <div> <div>Admin Mode</div> </div> <div> <div><input type="radio"/> Disable <input checked="" type="radio"/> Enable</div> </div> |           |         |      |          |            |             |        |                  |      |           |                |

b. For Admin Mode, select the **Enable** radio button.

c. Click **Apply**.

9. Enable IGMP on the interface.

a. Select **Routing > Multicast > IGMP > Routing Interface Configuration**.



A screen similar to the following displays.

| System        | Switching | Routing | QoS  | Security | Monitoring | Maintenance | Help   | Index            |      |           |                |
|---------------|-----------|---------|------|----------|------------|-------------|--------|------------------|------|-----------|----------------|
| Routing Table | IP        | IPv6    | VLAN | ARP      | RIP        | OSPF        | OSPFv3 | Router Discovery | VRRP | Multicast | IPv6 Multicast |

| Multicast   |           | IGMP Routing Interface Configuration  |         |            |                |                         |                        |                     |                            |                         |  |
|---|-----------|---|---------|------------|----------------|-------------------------|------------------------|---------------------|----------------------------|-------------------------|--|
| • Route Table<br>• Global Configuration<br>• Interface Configuration<br>• DVMRP<br>• IGMP<br>• Global Configuration<br>• <b>Routing Interface Configuration</b> |           | 1 2 3 VLANs All <span style="float: right;">Go To Interface <input type="text"/> <b>Go</b></span> |         |            |                |                         |                        |                     |                            |                         |  |
|   | Interface | Admin Mode  | Version | Robustness | Query Interval | Query Max Response Time | Startup Query Interval | Startup Query Count | Last Member Query Interval | Last Member Query Count |  |
| <input checked="" type="checkbox"/>   | 1/0/24    | Enable  | V3      | 2          | 125            | 100                     | 31                     | 2                   | 10                         | 2                       |  |
| <input type="checkbox"/>  | 1/0/1     | Disable   | V3      | 2          | 125            | 100                     | 31                     | 2                   | 10                         | 2                       |  |
| <input type="checkbox"/>  | 1/0/2     | Disable   | V3      | 2          | 125            | 100                     | 31                     | 2                   | 10                         | 2                       |  |
| <input type="checkbox"/>  | 1/0/3     | Disable   | V3      | 2          | 125            | 100                     | 31                     | 2                   | 10                         | 2                       |  |
| <input type="checkbox"/>  | 1/0/4     | Disable   | V3      | 2          | 125            | 100                     | 31                     | 2                   | 10                         | 2                       |  |

**b.** Scroll down and select the Interface **1/0/24** check box.

Now 1/0/24 appears in the Interface field at the top.

**c.** In the **Admin Mode** field, select **Enable**.

**d.** Click **Apply** to save the settings.

# 34

## 34 PTP End-to-End Transparent Clock

---

### Manage Precision Time Protocol

This chapter includes the following sections:

- [PTP Concepts](#)
- [PTP Time Stamp Operation](#)
- [PTP Transparent Clocks](#)
- [Manage the PTP End-to-End Transparent Clock](#)



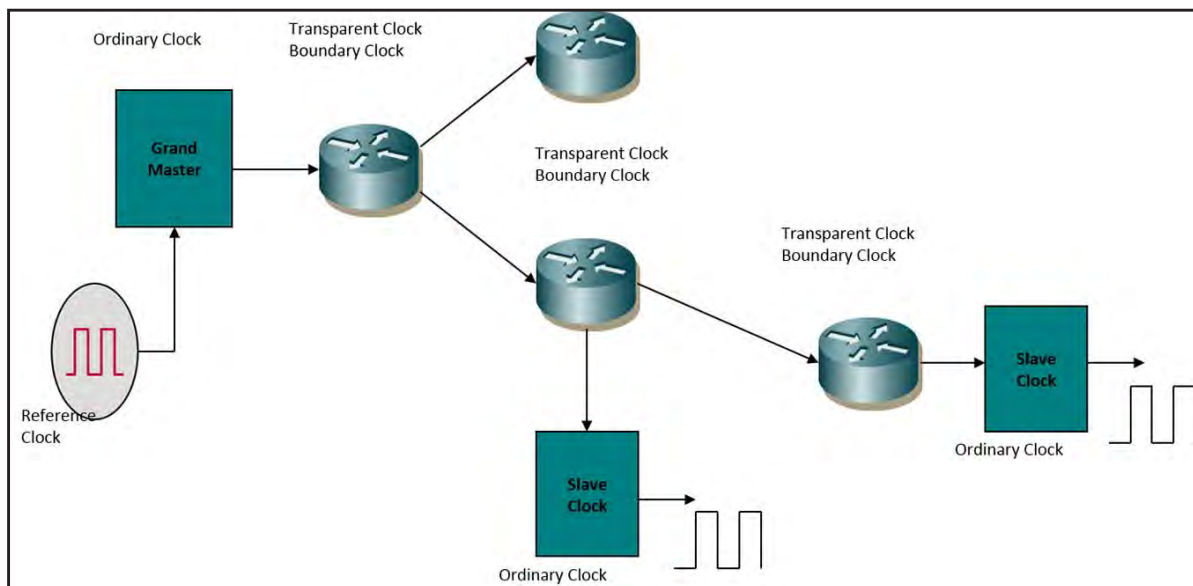
# PTP Concepts

Precision Time Protocol (PTP, IEEE 1588) is a protocol that enables precise synchronization of clocks with a sub-microsecond accuracy across a packet-based network. PTP lets network devices of different precision and resolution synchronize to a grandmaster clock through an exchange of packets across the network. The switch supports PTP end-to-end transparent clock, which is enabled by default, both globally and at the port level.

---

**Note:** The switch itself is not affected by PTP.

---



**Figure 65. PTP topology**

## PTP Time Stamp Operation

The IEEE 1588 protocol (PTP) requires protocol PTP packets to be time-stamped when they pass through the network.

Two types of time stamp operation exist:

- **Time stamp recording.** The switch records the time that a PTP event packet is received or transmitted. The record is available to the local CPU.
- **Time stamp correction.** The PTP packets are modified as they pass through a network device. The PTP packets include a correction field that can carry clock corrections for residence times of a transparent clock, path delay for peer-to-peer transparent clocks, and so on. The timestamp value is deducted from the correction field when the PTP

packet comes in to the device and is added to the correction field when the packet leaves the device. The result is that the correction field is updated with the period that the packet spends in the device.

Two types of *hardware* time stamp operation exist, one of which is supported by the M4300 switches:

- **1-step hardware time stamp.** The hardware supports corrections, allowing the PTP packets to be modified as they pass through the device. The M4300 series switches support 1-step hardware time stamps only:

The switch supports PTPv2 packets with a destination MAC address that is set to 01:1B:19:00:00:00. The switch does not support PTPv1 packets and drops those packets. The time stamp counter is 32 bits in length.

- **2-step hardware time stamp.** The hardware supports recording of time stamps of the PTP event packets. This time stamp is then retrieved by the local CPU on a device that supports the PTP firmware and is sent in a separate message. The M4300 series switches do not support 2-step hardware time stamps.

## PTP Transparent Clocks

A transparent clock is a PTP device that does not process PTP packets, but modifies them to account for the residence time correction. That is, the device measures the period that the PTP packets require to pass through the device, and then adds that time span to the PTP packets.

A transparent clock measures the variable delay as the PTP packets pass through a device. The measured delay is calculated by adding the residence time into the correction field of the PTP packet.

A transparent clock can be an end-to-end (E2E) clock or a peer-to-peer (P2P) clock. An E2E transparent clock updates the correction field of the PTP packet only with the residence time. A P2P clock can update the correction field with the residence time of packet and the path delay.

All M4300 series models support a PTP E2E transparent clock, with the exception of models M4300-24X24F, M4300-48X, and M4300-48XF.

The following limitations apply to a PTP E2E transparent clock on an M4300 series switch:

- You cannot configure a PTP E2E transparent clock at VLAN level. However, the feature functions well for VLAN-tagged packets.
- The PTP E2E transparent clock is intended for a standalone switch only. In a switch stack, a PTP E2E transparent clock is enabled by default only on the master unit. You cannot enable the feature on member ports.
- The PTP E2E transparent clock supports only the following three types of PTP event packets: Sync, Delay\_Req, and Delay\_Resp.

Of these three PTP event type packets, the switch can update the PTP packet correction field only for Sync and Delay\_Req. A Delay\_Resp PTP packet passes through the switch without modification.

- The switch does not detect and modify other PTP event packets, such as Announce, pDelay\_Req, pDelay\_Resp, and FollowUp.
- The switch supports PTP version 2 (PTPv2) only. PTP version 1 (PTPv1) is not supported.

## Manage the PTP End-to-End Transparent Clock

By default, the PTP E2E transparent clock is globally enabled on the switch, that is, on all physical ports. If you configure a LAG, the PTP E2E transparent clock is also enabled on the LAG because the feature is already enabled on all physical ports.

### CLI: Globally Disable PTP End-to-End Transparent Clock

```
(Netgear Switch) #configure
(Netgear Switch) (Config)#no ptp clock e2e-transparent
```

### CLI: Disable PTP End-to-End Transparent Clock for an Interface

```
(Netgear Switch) #configure
(Netgear Switch) (Config)#interface 1/1/1
(Netgear Switch) (Interface 1/1/1)#no ptp clock e2e-transparent
```

### CLI: Globally Reenable PTP End-to-End Transparent Clock

```
(Netgear Switch) #configure
(Netgear Switch) (Config)#ptp clock e2e-transparent
```

## CLI: Reenable PTP End-to-End Transparent Clock for an Interface

```
(Netgear Switch) #configure
(Netgear Switch) (Config)#interface 1/1/1
(Netgear Switch) (Interface 1/1/1)#ptp clock e2e-transparent
```

## CLI: Display the PTP End-to-End Transparent Clock Status

```
(Netgear Switch) #show ptp clock e2e-transparent

PTP TC mode..... Enabled

Interface      Configured Mode Operational Mode
-----
1/1/1          Enabled        Disabled
1/1/2          Enabled        Disabled
1/1/3          Enabled        Disabled
1/1/4          Enabled        Disabled
1/1/5          Enabled        Disabled
1/1/6          Enabled        Disabled
1/1/7          Enabled        Disabled
1/1/8          Enabled        Disabled
1/2/1          Enabled        Disabled
1/2/2          Enabled        Disabled
1/2/3          Enabled        Disabled
1/2/4          Enabled        Disabled
1/2/5          Enabled        Disabled
1/2/6          Enabled        Disabled
1/2/7          Enabled        Disabled
1/2/8          Enabled        Disabled
```

# 35

## 35 Link Dependency

---

### Configure Link State Groups

This chapter includes the following sections:

- [Link Dependency Concepts](#)
- [CLI: Create a Link State Group](#)
- [Local Browser Interface: Create a Link State Group](#)

# Link Dependency Concepts

Link dependency enables or disables ports in a group based on the link state of other ports in the same group. That is, the link state of some ports depends on the link state of other ports.

For example, if port A depends on port B and the switch detects link loss on B, the switch automatically brings down the link on port A. When the link is restored to port B, the switch automatically restores the link to port A. You can specify whether link A is brought up or brought down, depending on the state of link B. The ports that are participating in link dependency can be among different members of a stack.

To establish link dependency, you must define a link state group. A link state group is identified by a group number and consists of an upstream interface list, a downstream interface list, and an action (up or down) that is associated with the group. One or more link aggregation group (LAG) interfaces, one or more physical interfaces, or a combination of both LAG interfaces and physical interfaces can be members of the upstream and downstream interface list. If all the members of a link state group's upstream interface list go down, all the downstream interfaces in the link state group are either brought down or brought up, depending on the action that is associated with the group.

Note the following characteristics and limitations of link dependency:

- If you add an interface to the downstream list of a link state group, the interface remains down until you add an upstream interface to the list. The link status of the downstream interface is then determined by the link state of the upstream interface, as defined by the action that is associated with the link state group. To prevent downstream interfaces from remaining down in a link state group, configure upstream interfaces in the group before you configure downstream interfaces in the group.
- If the configured action for a link group is up and if any configured upstream interface is down, then upon configuring the downstream interfaces, all downstream interfaces are immediately brought down.
- When a physical interface is configured as an upstream or downstream interface for a link state group and you make the physical interface a member of a LAG interface, the physical interface continues to be an upstream or downstream interface for the link state group.
- An interface that is defined as an upstream interface in a link state group cannot be defined as a downstream interface in the same link state group.
- Link dependencies cannot be circular. That is, an interface that is defined as an upstream interface in one link state group cannot be defined as a downstream interface in another link state group if such a configuration causes circular dependencies between groups.

# CLI: Create a Link State Group

1. Create a link state group with group number 1.

```
(Netgear Switch) (Config)#link state group 1 action down
```

2. Configure port 1/0/1 as an upstream link.

```
(Netgear Switch) (Config)#interface 1/0/1
(Netgear Switch) (Interface 1/0/1)#link state group 1 upstream
```

3. Configure port 1/0/5 as a downstream link.

```
(Netgear Switch) (Interface 1/0/1)#interface 1/0/5
(Netgear Switch) (Interface 1/0/5)#link state group 1 downstream
(Netgear Switch) (Interface 1/0/5)#exit
```

4. Display the status of the link state group with group number 1.

```
(Netgear Switch) #show link state group 1
```

| GroupId | Downstream Interfaces | Upstream Interfaces | Link Action | Group State |
|---------|-----------------------|---------------------|-------------|-------------|
| 1       | 1/0/5                 | 1/0/1               | Link Down   | Up          |



# Local Browser Interface: Create a Link State Group

1. Configure the action for link state group with group number 1.
  - a. Select **System > Link Dependency > Link Dependency Group Configuration**.

A screen similar to the following displays.

| Group ID | Link Action |
|----------|-------------|
| 1        | Link Down   |
| 2        | Link Up     |
| 3        | Link Down   |
| 4        | Link Down   |
| 5        | Link Down   |
| 6        | Link Down   |
| 7        | Link Down   |
| 8        | Link Down   |
| 9        | Link Down   |
| 10       | Link Down   |
| 11       | Link Down   |
| 12       | Link Down   |
| 13       | Link Down   |

- b. Select the check box for Group ID 1.
  - 1 displays in the Group ID field of the table heading.
  - c. From the **Link Action** menu, select **Link Down**.
  - d. Click the **Apply** button.

Your settings are saved.

2. Configure port 1/0/1 as an upstream port.
  - a. Select **System > Link Dependency > Link Dependency Interface Configuration**.

A screen similar to the following displays.

| Interface | Link Status | Downstream Interface | Upstream Interface |
|-----------|-------------|----------------------|--------------------|
| 1/0/1     | Link Up     | FALSE                | TRUE               |
| 1/0/2     | Link Down   | FALSE                | FALSE              |
| 1/0/3     | Link Down   | FALSE                | FALSE              |
| 1/0/4     | Link Down   | FALSE                | FALSE              |
| 1/0/5     | Link Up     | FALSE                | FALSE              |
| 1/0/6     | Link Down   | FALSE                | FALSE              |
| 1/0/7     | Link Down   | FALSE                | FALSE              |
| 1/0/8     | Link Down   | FALSE                | FALSE              |
| 1/0/9     | Link Down   | FALSE                | FALSE              |
| 1/0/10    | Link Down   | FALSE                | FALSE              |
| 1/0/11    | Link Down   | FALSE                | FALSE              |
| 1/0/12    | Link Down   | FALSE                | FALSE              |
| 1/0/13    | Link Down   | FALSE                | FALSE              |
| 1/0/14    | Link Down   | FALSE                | FALSE              |
| 1/0/15    | Link Down   | FALSE                | FALSE              |

- b. Select the check box to the left of interface 1/0/1.  
1/0/1 displays in the Interface field of the table heading.

c. From the **Upstream Interface** menu, select **True**.

- d. Click the **Apply** button.

Your settings are saved.

3. Configure port 1/0/1 as an upstream port.

- a. Select **System > Link Dependency > Link Dependency Interface Configuration**.

A screen similar to the following displays.

System

Switching

Routing

QoS

Security

Monitoring

Maintenance

Help

Index

Management

Device View

Services

Stacking

PoE

SNMP

LLDP

Link Dependency

ISDP

Timer Schedule

Link Dependency

• Link Dependency

• Link Dependency Group Configuration

• Link Dependency Interface Configuration

| Interface                                 | Link Status | Downstream Interface | Upstream Interface |
|---|-------------|----------------------|--------------------|
| <input type="checkbox"/> 1/0/5            | Link Up     | TRUE                 | FALSE              |
| <input type="checkbox"/> 1/0/1            | Link Up     | FALSE                | TRUE               |
| <input type="checkbox"/> 1/0/2            | Link Down   | FALSE                | FALSE              |
| <input type="checkbox"/> 1/0/3            | Link Down   | FALSE                | FALSE              |
| <input type="checkbox"/> 1/0/4            | Link Down   | FALSE                | FALSE              |
| <input checked="" type="checkbox"/> 1/0/5 | Link Up     | FALSE                | FALSE              |
| <input type="checkbox"/> 1/0/6            | Link Down   | FALSE                | FALSE              |
| <input type="checkbox"/> 1/0/7            | Link Down   | FALSE                | FALSE              |
| <input type="checkbox"/> 1/0/8            | Link Down   | FALSE                | FALSE              |
| <input type="checkbox"/> 1/0/9            | Link Down   | FALSE                | FALSE              |
| <input type="checkbox"/> 1/0/10           | Link Down   | FALSE                | FALSE              |
| <input type="checkbox"/> 1/0/11           | Link Down   | FALSE                | FALSE              |
| <input type="checkbox"/> 1/0/12           | Link Down   | FALSE                | FALSE              |
| <input type="checkbox"/> 1/0/13           | Link Down   | FALSE                | FALSE              |
| <input type="checkbox"/> 1/0/14           | Link Down   | FALSE                | FALSE              |

- b. Select the check box to the left of interface 1/0/5.  
1/0/5 displays in the Interface field of the table heading.

c. From the **Downstream Interface** menu, select **True**.

- d. Click the **Apply** button.

Your settings are saved.

# 36

## Captive Portals

---

### Captive portals and client authentication

This chapter includes the following sections:

- [Captive Portal Concepts](#)
- [Captive Portal Configuration Concepts](#)
- [Enable a Captive Portal](#)
- [Client Access, Authentication, and Control](#)
- [Block a Captive Portal Instance](#)
- [Local Authorization, Create Users and Groups](#)
- [Remote Authorization \(RADIUS\) User Configuration](#)
- [SSL Certificates](#)

# Captive Portal Concepts

The captive portal feature is a software implementation that blocks clients from accessing the network until user verification has been established. You can set up verification to allow access for both guests and authenticated users. Authenticated users must be validated against a database of authorized captive portal users before access is granted.

The authentication server supports both HTTP and HTTPS web connections. In addition, you can configure a captive portal to use an optional HTTP port (in support of HTTP proxy networks). If configured, this additional port is then used exclusively by the captive portal. This optional port is in addition to the standard HTTP port 80, which is being used for all other web traffic.

The captive portal for wired interfaces allows the clients directly connected to the switch to be authenticated using a captive portal mechanism before the client is given access to the network. When you enable the captive portal feature on a wired physical port, the port is set in captive-portal- enabled state such that all the traffic coming to the port from the unauthenticated clients is dropped except for the ARP, DHCP, DNS, and NETBIOS packets. The switch forwards these packets so that unauthenticated clients can get an IP address and resolve the hostname or domain names. Data traffic from authenticated clients goes through, and the rules do not apply to these packets.

All the HTTP/HTTPS packets from unauthenticated clients are directed to the CPU on the switch for all the ports for which you enabled the captive portal feature. When an unauthenticated client opens a web browser and tries to connect to network, the captive portal redirects all the HTTP/HTTPS traffic from unauthenticated clients to the authenticating server on the switch. A captive portal web page is sent back to the unauthenticated client. The client can authenticate. If the client successfully authenticates, the client is given access to port.

You can enable the captive portal feature on all the physical ports on the switch. It is not supported for VLAN interfaces, loopback interfaces, or logical interfaces. The captive portal feature uses MAC-address based authentication and not port-based authentication. This means that all the clients connected to the captive portal interface must be authenticated before they can get access to the network.

Clients connecting to the captive portal interface have three states; unknown, unauthenticated, and authenticated.

- **Unknown.** In the unknown state, the captive portal does not redirect HTTP/S traffic to the switch, but instead asks the switch whether the client is authenticated or unauthenticated.
- **Unauthenticated.** The captive portal directs the HTTP/S traffic to the switch so that the client can authenticate with the switch.
- **Authenticated.** After successful authentication, the client is placed in authenticated state. In this state, all the traffic emerging from the client is forwarded through the switch.

# Captive Portal Configuration Concepts

This chapter introduces the objects that make up the captive portal and describes the interaction between the captive portal and the network administrator. It explains what configurations are visible to the network administrator and enumerates the events.

All the configurations included in this section are managed using the CLI, the local browser interface, and SNMP, with one exception; to customize the captive portal web page, you must use the local browser interface.

The captive portal configuration provides the network administrator control over verification and authentication, assignment to interfaces, client sessions, and web page customization.

You can create multiple captive portal configuration instances. Each captive portal configuration contains various flags and definitions used to control client access and content to customize the user verification web page. A captive portal configuration can be applied to one or more interfaces. An interface can only be a physical port on the switch. Software release 8.0 and newer versions can contain up to 10 captive portal configurations.

## Enable a Captive Portal

### CLI: Enable a Captive Portal

1. Enable captive portal on the switch.

```
(Netgear Switch) (config)#captive-portal  
(Netgear Switch) (Config-CP)#enable
```

2. Enable captive portal instance 1.

```
(Netgear Switch) (Config-CP)#configuration 1  
(Netgear Switch) (Config-CP 1)#enable
```

3. Enable captive portal instance 1 on port 1/0/1.

```
(Netgear Switch) (Config-CP 1)#interface 1/0/1
```

## Local Browser Interface: Enable a Captive Portal

1. Enable captive portal on the switch.
  - a. Select **Security > Control > Captive Portal > CP Global Configuration**.

A screen similar to the following displays.

| System   | Switching | Routing | QoS | Security | Monitoring | Maintenance | Help | Index |
|--|-----------|---------|-----|----------|------------|-------------|------|-------|
| Management Security Access Port Authentication Traffic Control Control ACL   |           |         |     |          |            |             |      |       |
| <div> <div>           • DHCP Snooping<br/>           • IP Source Guard<br/>           • Dynamic ARP Inspection<br/>           • Captive Portal<br/> <b>• CP Global Configuration</b><br/>           • CP Configuration<br/>           • CP Binding Configuration<br/>           • CP Binding Table<br/>           • CP Group Configuration<br/>           • CP User Configuration<br/>           • CP Trap Flags<br/>           • CP Client         </div> <div> <b>Captive Portal Global Configuration</b><br/>           Admin Mode <input type="radio"/> Disable <input checked="" type="radio"/> Enable<br/>           Operational Status Disabled<br/>           Disabled Reason Administrator Disabled<br/>           CP IP Address 0.0.0.0<br/>           Additional HTTP Port <input type="text" value="0"/> (0 to 65535)<br/>           Additional HTTP Secure Port <input type="text" value="0"/> (0 to 65535)<br/>           Authentication Timeout <input type="text" value="300"/> (60 to 600)<br/>           Supported Captive Portals 10<br/>           Configured Captive Portals 1<br/>           Active Captive Portals 0<br/>           System Supported Users 1024<br/>           Local Supported Users 128<br/>           Configured Local Users 0<br/>           Authenticated Users 0         </div> </div> |           |         |     |          |            |             |      |       |

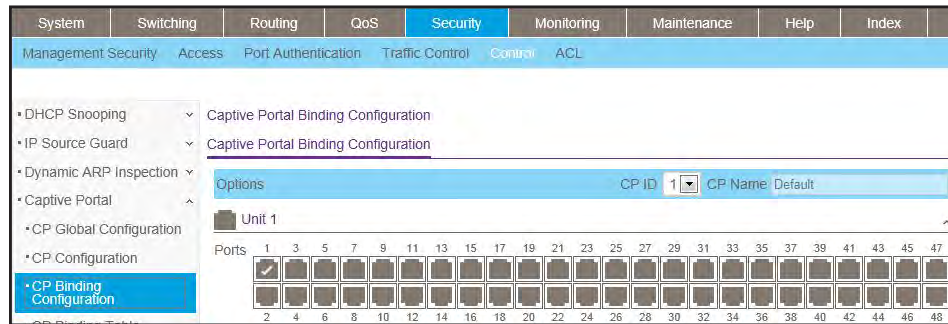
- b. For Admin Mode, Select the **Enable** radio button.
  - c. Click **Apply**.
2. Enable captive portal instance 1 on the switch.
  - a. Select **Security > Control > Captive Portal > CP Configuration**.

A screen similar to the following displays.

| System   | Switching | Routing    | QoS      | Security     | Monitoring | Maintenance | Help | Index |       |         |            |          |              |       |       |   |         |         |      |       |         |  |                                       |         |         |      |       |         |   |
|--|-----------|------------|----------|--------------|------------|-------------|------|-------|-------|---------|------------|----------|--------------|-------|-------|---|---------|---------|------|-------|---------|--|---------------------------------------|---------|---------|------|-------|---------|---|
| Management Security Access Port Authentication Traffic Control Control ACL   |           |            |          |              |            |             |      |       |       |         |            |          |              |       |       |   |         |         |      |       |         |  |                                       |         |         |      |       |         |   |
| <div> <div>           • DHCP Snooping<br/>           • IP Source Guard<br/>           • Dynamic ARP Inspection<br/>           • Captive Portal<br/>           • CP Global Configuration<br/> <b>• CP Configuration</b> </div> <div> <b>Captive Portal Configuration</b><br/> <table border="1"> <thead> <tr> <th>CP ID</th> <th>CP Name</th> <th>Admin Mode</th> <th>Protocol</th> <th>Verification</th> <th>Block</th> <th>Group</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>Default</td> <td>Disable</td> <td>http</td> <td>Guest</td> <td>Disable</td> <td></td> </tr> <tr> <td><input checked="" type="checkbox"/> 1</td> <td>Default</td> <td>Disable</td> <td>http</td> <td>Guest</td> <td>Disable</td> <td>0</td> </tr> </tbody> </table> </div> </div> |           |            |          |              |            |             |      |       | CP ID | CP Name | Admin Mode | Protocol | Verification | Block | Group | 1 | Default | Disable | http | Guest | Disable |  | <input checked="" type="checkbox"/> 1 | Default | Disable | http | Guest | Disable | 0 |
| CP ID  | CP Name   | Admin Mode | Protocol | Verification | Block      | Group       |      |       |       |         |            |          |              |       |       |   |         |         |      |       |         |  |                                       |         |         |      |       |         |   |
| 1  | Default   | Disable    | http     | Guest        | Disable    |             |      |       |       |         |            |          |              |       |       |   |         |         |      |       |         |  |                                       |         |         |      |       |         |   |
| <input checked="" type="checkbox"/> 1  | Default   | Disable    | http     | Guest        | Disable    | 0           |      |       |       |         |            |          |              |       |       |   |         |         |      |       |         |  |                                       |         |         |      |       |         |   |

- b. Scroll down and select the CP 1 check box.  
Now CP 1 appears in the CP ID field at the top.
  - c. In the **Admin Mode** field, select **Enable**.
  - d. Click **Apply** to save the settings.
3. Enable CP 1 on interface 1/0/1.
  - a. Select **Security > Controls > Captive Portal > CP Binding Configuration**.

A screen similar to the following displays.



- b. In the **CP ID** list, select **1**.
- c. Click **Unit 1**. The ports display.
- d. Click the gray box under port **1**.
- e. Click **Apply**.

## Client Access, Authentication, and Control

User verification can be configured to allow access for guest users—users who do not have assigned user names and passwords. User verification can also be configured to allow access for authenticated users. Authenticated users are required to enter a valid user name and password that must first be validated against the local database or a RADIUS server. Network access is granted once user verification has been confirmed. The administrator can block access to a captive portal configuration. When an instance is blocked, no client traffic is allowed through any interfaces associated with that captive portal configuration. Blocking a captive portal instance is a temporary command executed by the administrator and not saved in the configuration.

## Block a Captive Portal Instance

### CLI: Block a Captive Portal Instance

```
(Netgear Switch)(Config-CP 1)#block
```



## Local Browser Interface: Block a Captive Portal Instance

1. Select **Security > Control > Captive Portal > CP Configuration**.

A screen similar to the following displays.

| System                              | Switching         | Routing                  | QoS                 | Security                  | Monitoring         | Maintenance | Help | Index |
|-------------------------------------|-------------------|--------------------------|---------------------|---------------------------|--------------------|-------------|------|-------|
| Management                          | Security          | Access                   | Port Authentication | Traffic Control           | Control            | ACL         |      |       |
| • DHCP Snooping                     | • IP Source Guard | • Dynamic ARP Inspection | • Captive Portal    | • CP Global Configuration | • CP Configuration |             |      |       |
| Captive Portal Configuration        |                   |                          |                     |                           |                    |             |      |       |
| CP ID                               | CP Name           | Admin Mode               | Protocol            | Verification              | Block              | Group       |      |       |
| 1                                   | Default           | Enable                   | http                | Guest                     | Enable             |             |      |       |
| <input checked="" type="checkbox"/> | 1                 | Default                  | Enable              | http                      | Guest              | Blocked     |      | 0     |

2. Under Captive Portal Configuration, scroll down and select the CP 1 check box. Now CP 1 appears in the CP ID field at the top.
3. In the **Block** field, select **Enable**.
4. Click **Apply** to save the settings.

## Local Authorization, Create Users and Groups

When using local authentication, the administrator provides user identities for captive portal by adding unique user names and passwords to the local user database. This configuration is global to the captive portal component and can contain up to 128 user entries (a RADIUS server should be used if more users are required). A local user can belong to one or more groups. There is one group created by default with the group name *Default* to which all new users are assigned. All new captive portal instances are also assigned to the Default group. You can create new groups and modify the user/group association to allow only a subset of users access to a specific captive portal instance. Network access is granted upon successful user name, password, and group verification.

### CLI: Create Users and Groups

1. Create a group whose group ID is 2.

```
(Netgear Switch) #config
(Netgear Switch) (config)#captive-portal
(Netgear Switch)(Config-CP)# user group 2
```

2. Create a user whose name is user1.

```
(Netgear Switch) (Config-CP)#user 2 name user1
```

3. Configure the user's password.

```
(Netgear Switch) (Config-CP)#user 2 password
Enter password (8 to 64 characters): 12345678
Re-enter password: 12345678
```

4. Add the user to the group.

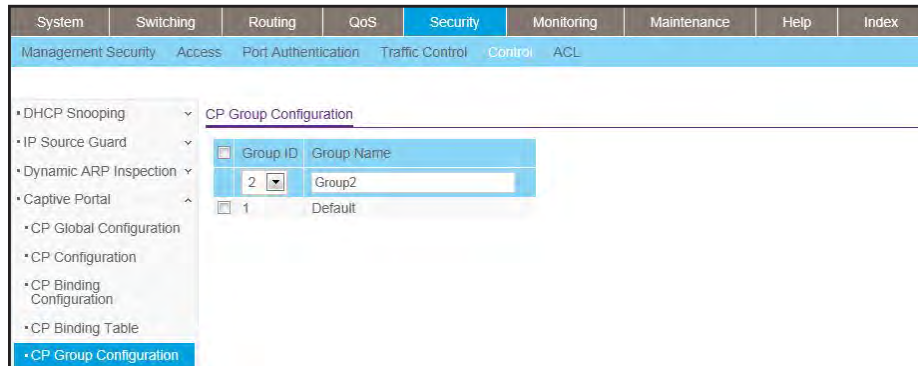
```
(Netgear Switch) (Config-CP)#user 2 group 2
```

## Local Browser Interface: Create Users and Groups

1. Create a group.

a. Select **Security > Control > Captive Portal > CP Group Configuration**.

A screen similar to the following displays.



b. Enter the following information:

- In the **Group ID** field, select **2**.
- In the **Group Name** field, enter **Group2**.

c. Click **Add**.

2. Create a user.

a. Select **Security > Control > Captive Portal > CP User Configuration**.

A screen similar to the following displays.

| User ID | User Name | Edit Password | Password | Confirm Password | Group | Session Timeout |
|---------|-----------|---------------|----------|------------------|-------|-----------------|
| 2       | user1     | Disable       | *****    | *****            | 1     |                 |

- b. Enter the following information:
- In the **User ID** Field, enter **2**.
  - In the **User Name** field, enter **user1**.
  - In the **Password** field, enter **12345678**.
  - In the **Confirm Password** field, enter **12345678**.
  - In the **Group** field, select **2**.
- c. Click **Add**.

## Remote Authorization (RADIUS) User Configuration

A remote RADIUS server can be used for client authentication. In software release 8.0 (or newer), the RADIUS authentication and accounting servers are configured separate from the captive portal configuration. In order to perform authentication and accounting using RADIUS, you configure one or more RADIUS servers and then references the servers using their names in the captive portal configuration. Each captive portal instance can be assigned one RADIUS authentication server and one RADIUS accounting server.

If RADIUS is enabled for a captive portal configuration and no RADIUS servers are assigned, the captive portal activation status will indicate that the instance is disabled with an appropriate reason code.

The following table indicates the RADIUS attributes that are used to configure captive portal users. The table indicates both RADIUS attributes and vendor specific attributes (VSA) that are used to configure captive portal. VSAs are denoted in the ID column and are comma delimited (vendor ID, attribute ID).

**Table 5. RADIUS Attributes for Configuring Captive Portal Users**

| <b>RADIUS Attribute</b>   | <b>No.</b> | <b>Description</b>  | <b>Range</b>      | <b>Usage</b> | <b>Default</b> |
|---------------------------|------------|---|-------------------|--------------|----------------|
| User-Name                 | 1          | User name to be authorized.   | 1–32 characters   | Required     | None           |
| User-Password             | 2          | User password.  | 8–64 characters   | Required     | None           |
| Session-Timeout           | 27         | Logout once session timeout is reached (seconds). If the attribute is 0 or not present, use the value configured for the captive portal.  | Integer (seconds) | Optional     | 0              |
| Idle-Timeout              | 28         | Log out once idle timeout is reached (seconds). If the attribute is 0 or not present, use the value configured for the captive portal.  | Integer (seconds) | Optional     | 0              |
| WISPr-Max-Band width-Up   | 14122, 7   | Maximum client transmit rate (b/s). Limits the bandwidth at which the client can send data into the network. If the attribute is 0 or not present, use the value configured for the captive portal.   | Integer           | Optional     | 0              |
| WISPr-Max-Band width-Down | 14122, 8   | Maximum client receive rate (b/s). Limits the bandwidth at which the client can receive data from the network. If the attribute is 0 or not present, use the value configured for the captive portal. | Integer           | Optional     | 0              |

## CLI: Configure RADIUS as the Verification Mode

```
(Netgear Switch) (Config-CP 1)#radius-auth-server Default-RADIUS-Server
(Netgear Switch) (Config-CP 1)#verification radius
```

## Local Browser Interface: Configure RADIUS as the Verification Mode

1. Select **Security > Control > Captive Portal > CP Configuration**.

A screen similar to the following displays.

| CP ID | CP Name | Admin Mode | Protocol | Verification | Block       | Group |
|-------|---------|------------|----------|--------------|-------------|-------|
| 1     | Default | Enable     | http     | RADIUS       | Not Blocked | 1     |

2. Scroll down and select the CP 1 check box. Now CP 1 appears in the CP ID field at the top.
3. Enter the following information:
  - In the **Verification** field, select **RADIUS**.
  - In the **Radius Auth Server** field, enter the RADIUS server name **Default-RADIUS-Server**.
4. Click **Apply**.

## SSL Certificates

A captive portal instance can be configured to use the HTTPS protocol during its user verification process. The connection method for HTTPS uses the Secure Sockets Layer (SSL) protocol, which requires a certificate to provide encryption. The certificate is presented to the user at connection time.

In software release 8.0 (or newer), the captive portal uses the same certificate that is used for secure HTTP connections. You can generate this certificate using a CLI command. If a captive portal instance is configured for the HTTPS protocol and there is not a valid certificate present on the system, the captive portal instance status will show Disabled with an appropriate reason code.

# 37

## 37 iSCSI

---

### Internal Small Computer System Interface

This chapter includes the following sections:

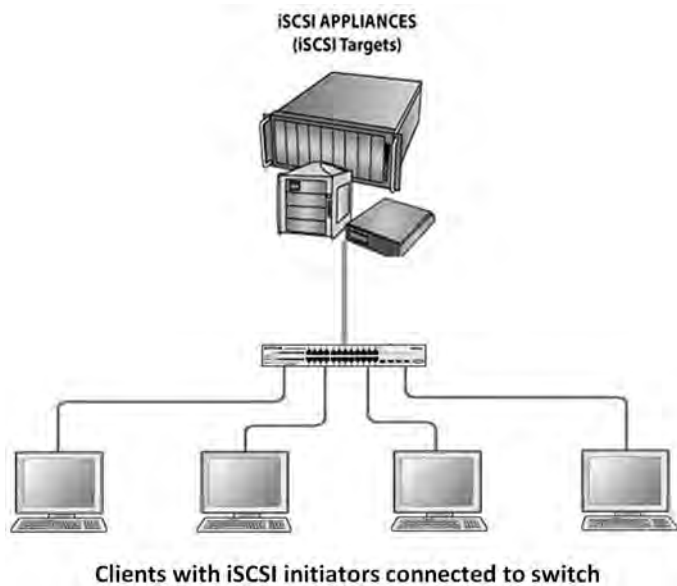
- [iSCSI Concepts](#)
- [Enable iSCSI Awareness with VLAN Priority Tag](#)
- [Enable iSCSI Awareness with DSCP](#)
- [Set the iSCSI Target Port](#)
- [Show iSCSI Sessions](#)

# iSCSI Concepts

The Internal Small Computer System Interface (iSCSI) feature is used in networks containing iSCSI initiators and targets where the administrator desires to protect the iSCSI traffic from interruption by giving the traffic preferential QoS treatment. The dynamically generated classifier rules are used to direct the iSCSI data traffic to queues that can be given the desired preference characteristics over other data transiting the switch. This can avoid session interruptions during times of congestion that would otherwise cause iSCSI packets to be dropped.

The administrator can select VLAN priority tag (VPT) or DSCP mapping for the QoS preferential treatment. iSCSI flows are assigned by default to the highest VPT/DSCP queue not used for chassis management or voice VLAN. The administrator should also take care of configuring the relevant Class of Service parameters for the queue chosen in order to complete the setting.

The following figure shows an example of iSCSI implementation.



**Figure 66. Sample iSCSI implementation**



# Enable iSCSI Awareness with VLAN Priority Tag

The example is shown as CLI commands and as local browser interface procedure.

## CLI: Enable iSCSI Awareness with VLAN Priority Tag

Use the following commands to enable iSCSI awareness, select VPT, and set VLAN number and aging time.

```
(Netgear Switch) #config
(Netgear Switch) (Config) #iscsi enable
(Netgear Switch) (Config) #iscsi cos vpt 5
(Netgear Switch) (Config) #iscsi aging time 10
(Netgear Switch) (Config) #exit
```

## Local Browser Interface: Enable iSCSI Awareness with VLAN Priority Tag

1. Enable iSCSI awareness, select VPT, and set VLAN number and aging time.
  - a. Select **Switching > iSCSI > Basic**.

A screen similar to the following displays.

- b. Enter the following information:
    - Next to iSCSI Status, select the **Enable** radio button.
    - Next to QoS Profile, select the **VLAN Priority Tag** radio button.
    - From the VLAN Priority Tag menu, select **5** (the default value).
    - Next to Remark, select the **Enable** radio button (the default value).
    - In the iSCSI Aging Time field, enter **10** (the default value).
  - c. Click **Apply** to save the settings.

# Enable iSCSI Awareness with DSCP

The example is shown as CLI commands and as local browser interface procedure.

## CLI: Enable iSCSI Awareness with DSCP

Use the following commands to enable iSCSI awareness, select DSCP, and set DSCP queue number and aging time.

```
(Netgear Switch) #config
(Netgear Switch) (Config) #iscsi enable
(Netgear Switch) (Config) #iscsi cos dscp 46
(Netgear Switch) (Config) #iscsi aging time 10
(Netgear Switch) (Config) #exit
```

## Local Browser Interface: Enable iSCSI Awareness with DSCP

1. Enable iSCSI awareness, select DSCP, and set the DSCP queue number and aging time.
  - a. Select **Switching > iSCSI > Basic**.

A screen similar to the following displays.

| System | Switching | Routing | QoS | Security  | Monitoring | Maintenance   | Help  | Index |      |
|--------|-----------|---------|-----|-----------|------------|---------------|-------|-------|------|
| VLAN   | Auto-VoIP | iSCSI   | STP | Multicast | MVR        | Address Table | Ports | LAG   | MLAG |

- Basic
  - iSCSI Global Configuration**
    - iSCSI Status: ☐ Disable ☒ Enable
    - QoS Profile: ☐ VLAN Priority Tag ☒ DSCP
    - VLAN Priority Tag: 5
    - DSCP: 46
    - Remark: ☐ Disable ☒ Enable
    - iSCSI Aging Time: 10 (1 to 43200 minutes)

- b. Enter the following information:
    - Next to iSCSI Status, select the **Enable** radio button.
    - Next to QoS Profile, select the **DSCP** radio button.
    - From the DSCP menu, select **46** (the default value).
    - Next to Remark, select the **Enable** radio button (the default value).
    - In the iSCSI Aging Time field, enter **10** (the default value).
2. Click **Apply** to save the settings.

# Set the iSCSI Target Port

When working with iSCSI that does not use the standard IANA assigned iSCSI ports (3260/860), NETGEAR recommends that you specify the target IP address. Then, the switch snoops frames only if the TCP destination port is one of the configured TCP ports and the destination IP address is the target IP address. This configuration improves the performance of the switch by preventing the CPU from processing non-iSCSI flows.

The example is shown as CLI commands and as local browser interface procedure.

## CLI: Set iSCSI Target Port

Use the following commands to set iSCSI target port to 49154 at IP address 172.16.1.20.

```
(Netgear Switch) #config
(Netgear Switch) (Config) #iscsi target port 49154 address 172.16.1.20
(Netgear Switch) (Config) #exit
```

## Local Browser Interface: Set iSCSI Target Port

1. Configure the iSCSI target port.
  - a. Select **Switching > iSCSI > Advanced > iSCSI Targets**.

A screen similar to the following displays.

| TCP Port                      | IP Address  | Target Name (0 to 223) |
|-------------------------------|-------------|------------------------|
| 49154                         | 172.16.1.20 |                        |
| <input type="checkbox"/> 860  | 0.0.0.0     |                        |
| <input type="checkbox"/> 3260 | 0.0.0.0     |                        |

- b. Enter the following information:
      - In the TCP Port field, enter **49154**.
      - In the IP Address field, enter **172.16.1.20**.
    - c. Click **Apply** to save the settings.

# Show iSCSI Sessions

The example is shown as CLI commands and as local browser interface procedure

## CLI: Show iSCSI Sessions

Use the following commands to show iSCSI sessions and session details:

```
(Netgear Switch) #show iscsi sessions

Session 0:
-----
Target: iqn.2012-08.com.example:storage.lun1
Initiator: iqn.1991-05.com.microsoft:netgear-think
ISID: 400001370000

(Netgear Switch) #show iscsi sessions detailed

Session 0:
-----

Target: iqn.2012-08.com.example:storage.lun1
Initiator: iqn.1991-05.com.microsoft:netgear-think
Up Time: 00:00:04:11 (DD:HH:MM:SS)
Time for aging out: 382 secs
ISID: 400001370000

Initiator          Initiator          Target             Target
IP Address         TCP Port           IP Address         TCP Port
-----
192.168.10.107     57965             192.168.10.116    3260

(Netgear Switch) #
```

The command shows that there is an active iSCSI session. The initiator is at IP address 192.168.10.107 and the Target is at IP address 192.168.10.116

## Local Browser Interface: Show iSCSI Sessions

1. Show iSCSI sessions.

- a. Select **Switching > iSCSI > Advanced > Sessions**.

A screen similar to the following displays.

| System | Switching | Routing | QoS | Security  | Monitoring | Maintenance   | Help  | Index |      |
|--------|-----------|---------|-----|-----------|------------|---------------|-------|-------|------|
| VLAN   | Auto-VoIP | iSCSI   | STP | Multicast | MVR        | Address Table | Ports | LAG   | MLAG |

iSCSI

• Basic

• Advanced

• Global Configuration

• iSCSI Targets

• Sessions

• Sessions Detailed

iSCSI Sessions

|                                      |   |                             |
|--------------------------------------|---|-----------------------------|
| Target Name                          | Initiator Name                                    | ISID (Initiator Session ID) |
| iqn.2012-12.local.mynet.storage.lun1 | iqn.1991-05.com.microsoft.jitran-t430.netgear.com | 400001370000                |

# 38

## 38 Override Factory Defaults

---

Use another factory default configuration file

This chapter includes one section:

- [Override the Factory Default Configuration File](#)

# Override the Factory Default Configuration File

NETGEAR managed switches support a single set of default configurations and scaling parameters, which are hard-coded in the factory default configuration file. To enable you to use a different set of default configurations and scaling parameters, you can override the factory default configuration file and specify that another file in the file system must be regarded as the factory defaults. After you issue the `clear config` privileged EXEC command, the switch uses the new factory defaults.

## CLI: Install Another Factory Defaults Configuration File

1. Create a new factory default configuration file.

The file format must be the same as the format of the startup configuration file.

2. Disable STP and LLDP MED on all interfaces.

If the switch is not configured for STP and LLDP MED, you can skip this step.

```
(Netgear Switch) #configure
(Netgear Switch) (Config)#no spanning-tree
(Netgear Switch) (Config)#no lldp med all
```

3. Save the new factory default configuration file as a text file named `factory_default.txt`.

4. Download the `factory_default.txt` file to the switch.

```
(Netgear Switch) #copy tftp://172.26.2.100/factory_default.txt nvram:factory-defaults

Mode..... TFTP
Set Server IP..... 172.26.2.100
Path..... ./
Filename..... factory_default.txt
Data Type..... Text Configuration
Download configuration file. Configuration will be applied upon next reboot.
Management access will be blocked for the duration of the transfer
Are you sure you want to start? (y/n) y
File transfer in progress. Management access will be blocked for the duration of the
transfer. please wait...
File transfer successful..
```



## CLI: Erase the Old Factory Default Configuration File

1. Erase the old factory default configuration file from the switch.

```
(Netgear Switch) #erase factory-default
```

2. Reload the switch.

The new factory default configuration file (that is, the factory\_default.txt. file) takes effect.

# 39

## 39 NETGEAR SFP

---

### Small form-factor pluggables

This chapter includes one section:

- [Connect with a NETGEAR AGM731F SFP](#)

# Connect with a NETGEAR AGM731F SFP

Cisco provides a way to support third-party small form-factor pluggables (SFPs). For example, a NETGEAR AGM731F SFP can function between a Cisco switch and a NETGEAR switch.

1. Before connecting the NETGEAR switch to the Cisco switch, configure the following command on the Cisco switch.

```
service unsupported-transceiver
no errdisable detect cause gbic-invalid
```

2. Make sure that the autonegotiation mode is the same on both sides.

The following supported autonegotiation mode can be configured on the NETGEAR switch and the Cisco switch.

| NETGEAR switch with AGM731F | Cisco switch with AGM731F | Result         |
|-----------------------------|---------------------------|----------------|
| Autonegotiation mode        | No speed nonegotiate mode | The link is up |
| No autonegotiation mode     | Speed nonegotiate mode    | The link is up |

# 40

## Expandable Ports Configuration

---

### APM402XL Port Card

This chapter includes one section:

- [Expand a 40G Port on an APM402XL Port Card to Four 10G Ports](#)

# Expand a 40G Port on an APM402XL Port Card to Four 10G Ports

The APM402XL port card provides two 40G port in which you can install QSFP+ interface modules. You can expand each single 40G port to four 10G ports. The total number of supported ports on the APM402XL port card is eight. Expanding ports does not change this total number.

The APM402XL port card follows a fixed port-numbering scheme for the 40G ports and the expanded 10G ports:

- Ports 1 and 5 are designated as 40G ports. If you use the **hardware profile portmode** command, port 1 (`<unit>/<slot>/1`) and port 5 (`<unit>/<slot>/5`) are designated as 40G ports.

By default, when you insert an APM402XL port card, ports 1 and 5 are enabled at 40G speed.

All other ports (that is, ports 2,3,4 and ports 6,7,8) remain detached or disabled.

- Ports 1, 2, 3, and 4 become enabled and operate at 10G speed if you expand port 1.
- Ports 5, 6, 7, and 8 become enabled and operate at 10G speed if you expand port 5.
- All ports, that is, ports 1 through 8, become enabled and operate at 10G speed if you expand both ports 1 and 5.

After you expanded one or both ports to four 10G ports, you can also use the **hardware profile portmode** command or the local browser interface to return the ports to 40G.

## CLI: Expand a 40G Port to Four 10G Ports

```
(Netgear Switch) #config
(Netgear Switch) (Config)#interface 1/7/1
(Netgear Switch) (Interface 1/7/1)#hardware profile portmode 4x10G
```

## Local Browser Interface: Expand a 40G Port to Four 10G Ports

1. Select **Switching > Ports > Expandable Port Configuration**.

| System | Switching | Routing | QoS | Security  | Monitoring | Maintenance   | Help  | Index |     |     |                    |
|--------|-----------|---------|-----|-----------|------------|---------------|-------|-------|-----|-----|--------------------|
| VLAN   | Auto-VoIP | iSCSI   | STP | Multicast | MVR        | Address Table | Ports | LAG   | PFC | MRP | L2 Loop Protection |

| Ports  | Expandable Port Configuration  |                     |                 |                     |       |       |       |   |       |       |                                |       |       |
|--|--|---------------------|-----------------|---------------------|-------|-------|-------|---|-------|-------|--------------------------------|-------|-------|
| <ul style="list-style-type: none"> <li>• Port Configuration</li> <li>• Port Description</li> <li>• Port Transceiver</li> <li>• <b>Expandable Port Configuration</b></li> </ul> | <div> 1 All Go To Interface <input type="text"/> Go </div> <table border="1"> <thead> <tr> <th>40G Interface</th> <th>Configured Mode</th> <th>Operational Port(s)</th> </tr> </thead> <tbody> <tr> <td>1/7/1</td> <td>4x10G</td> <td>1/7/1</td> </tr> <tr> <td><input checked="" type="checkbox"/> 1/7/1</td> <td>1x40G</td> <td>1/7/1</td> </tr> <tr> <td><input type="checkbox"/> 1/7/5</td> <td>1x40G</td> <td>1/7/5</td> </tr> </tbody> </table> <div> 1 All Go To Interface <input type="text"/> Go </div> | 40G Interface       | Configured Mode | Operational Port(s) | 1/7/1 | 4x10G | 1/7/1 | <input checked="" type="checkbox"/> 1/7/1 | 1x40G | 1/7/1 | <input type="checkbox"/> 1/7/5 | 1x40G | 1/7/5 |
| 40G Interface  | Configured Mode  | Operational Port(s) |                 |                     |       |       |       |   |       |       |                                |       |       |
| 1/7/1  | 4x10G  | 1/7/1               |                 |                     |       |       |       |   |       |       |                                |       |       |
| <input checked="" type="checkbox"/> 1/7/1  | 1x40G  | 1/7/1               |                 |                     |       |       |       |   |       |       |                                |       |       |
| <input type="checkbox"/> 1/7/5   | 1x40G  | 1/7/5               |                 |                     |       |       |       |   |       |       |                                |       |       |

2. Select port **1/7/1**.

Port 1/7/1 displays in the 40G Interface field of the table heading.

3. From the **Configured Mode** menu, select **4x10G**.
4. Click the **Apply** button.

# Index

## Numerics

- 40G port 712
- 6in4 tunnels 537
- 6to4 tunnels 543
- 802.1d (classic STP) 522
- 802.1s (MSTP) 525
- 802.1w (RSTP) 523
- 802.1x (port security) 327

## A

- access ports 70
- accounting for commands 378
- ACL mirroring 207
- ACL redirection 213
- ACLs (access control lists) 172
- active directory (AD), MAB 405
- APM402XL port card 712
- ARP (Address Resolution Protocol)
  - dynamic inspection 345
  - proxy feature 161
- authentication manager 380
- authentication, captive portal 693
- authorization, privileged EXEC commands 373
- auto VoIP 266
- Automatic error recovery 433

## B

- backup router, VRRP 168
- banner, pre-login 421
- bindings, static 359
- bootstrap router (BSR) 599
- border routers, OSPF 115
- BSR (bootstrap router) 599
- buffered logs, syslog 443

## C

- captive portals 690
- Change of authorization (CoA), RADIUS 384
- class, DiffServ 242

- classic STP 522
- client access, captive portal 693
- color conform policies, DiffServ 280
- command accounting 378
- compatibility, switch stack firmware 464
- compatible mode, MVR 303
- configuration files, switch stacks 464
- configuration scripting 418
- CoS (Class of Service) queuing 232

## D

- DAI (Dynamic ARP inspection) 345
- default configuration file, overriding 707
- default routes, port routing 83
- dense mode, PIM 575
- DHCP L2 relay 625
- DHCP L3 relay 630
- DHCP messages, maximum rate 360
- DHCP reservation, configuring 488
- DHCP servers
  - configuring 485
  - rogue, finding 356
- DHCP snooping 352
- DHCPv6 relay 507
- DHCPv6 routing interface 570
- DHCPv6 servers 492
- Differentiated Services Code Point (DSCP)
  - CoS queuing 232
  - DiffServ 242
  - iSCSI 700
- DiffServ (Differentiated Services) 242
- Distance Vector Multicast Routing Protocol (DVMRP) 662
- DNS (domain name system) 481
- double VLANs (DVLANS) 511
- DSCP (Differentiated Services Code Point)
  - CoS queuing 232
  - DiffServ 242
  - iSCSI 700
- dual images 426
- DVLANS (double VLANs) 511



DVMRP (Distance Vector Multicast Routing Protocol)  
662

Dynamic ARP inspection (DAI) 345

dynamic mode

DHCP server 485

MVR 309

dynamic port locking 317

## E

edge device, DiffServ 242

email alerting, syslog 448

end-to-end, PTP transparent clock 681

Error disablement 433

EXEC command authorization 373

expanding 40G ports 712

Explicit Congestion Notification (ECN) 287

## F

factory defaults, overriding 707

firmware and firmware mismatch, switch stacks 455

## G

GARP (Generic Attribute Registration Protocol) 56

groups

captive portal 694

link state 684

guest VLANs 333

GVRP (GARP VLAN Registration Protocol) 56

## H

host name, DNS 482

hosts, logging 445

## I

IGMP (Internet Group Management Protocol) snooping  
and querying 291

installing, switch stacks 453

inter-area routers

IPv4 108

IPv6 494

interior node, DiffServ 242

IP ACLs 173

IP source guard 361

IPv6

ACLs 222

configuring interfaces 562

DHCPv6 servers 492

DiffServ 273

inter-area routers 494

tunnels 537

IPv6 stateless RA guard 386

iSCSI initiators and targets 700

isolated ports 61, 324

isolated VLANs 61, 193

## L

LAGs (link aggregation groups) 21

levels of severity, syslog 448

limits, dynamic and static MAC addresses 318

link dependency 684

locking ports 317

Loop protection 435

## M

MAB (MAC Authentication Bypass) 391

MAC ACLs 172

MAC addresses, static 321

MAC Authentication Bypass (MAB) 391

MAC-based VLANs 33

management ACLs 221

managing, switch stacks 461

mapping

CoS queues 232

static 350

master router, VRRP 166

master switch and member switches, switch stacks 451

migrating configuration, switch stacks 456

mirroring

ACLs 207

ports 422

MLD (multicast listener discovery) 644

monitoring, sFlow 475

moving, stack master 468

MSTP (multiple STP) 525

multicast routers 294

multicast VLAN registration (MVR) 302

MVR (multicast VLAN registration) 302

## N

network policy server, MAB 397

Nondisruptive configuration management 437

NSSA areas, OSPF 131

## O

- organizationally unique identifier (OUI) 267
- OSPF (Open Shortest Path First) 108
- OUI-based auto VoIP 267
- outbound Telnet 429

## P

- Per VLAN (Rapid) Spanning Tree Protocol (PV(R)STP) 527
- PIM (Protocol Independent Multicast) 575
- policy based routing (PBR) 155
- policy server, MAB 397
- policy, DiffServ 242
- port analyzer 423
- port mirroring 422
- port routing 78
- port security 317
- Precision Time Protocol (PTP) 680
- preconfiguring, switch stack members 465
- primary VLANs 61
- priority values, switch stack members 453
- private VLAN groups 515
- private VLANs 61
- promiscuous ports 61
- protected ports 321
- Protocol Independent Multicast (PIM) 575
- protocol-based auto VoIP 266
- protocol-based VLANs 37
- PTP (Precision Time Protocol) 680
- PV(R)STP (Per VLAN (Rapid) Spanning Tree Protocol) 527

## Q

- queriers, IGMP 296
- queues, CoS 233

## R

- RADIUS
  - accounting server 379
  - assigning VLANs 338
  - captive portal authorization 696
- RADIUS change of authorization (CoA) 384
- redirection, ACLs 213
- relay, DHCPv6 507
- relays, DHCP L2 and DHCP L3 624
- remote switched port analyzer (RSPAN) 423
- renumbering, switch stack members 466

- reverse path forwarding (RPF) 576
- RIP (Routing Information Protocol) 95
- rogue DHCP servers 356
- route-map statement 155
- routing interface, configuring for IPv6 563
- routing, VLANs 88
- RPF (reverse path forwarding) 576
- RSPAN (remote switched port analyzer) 423
- RSTP (rapid STP) 523
- rules, ACLs 172

## S

- sampling, sFlow 478
- SCCP (Skinny Call Control Protocol) 266
- scheduler mode, strict priority 236
- scripting, configuration 418
- security, ports 317
- service, DiffServ 242
- Session Initiation Protocol (SIP) 266
- session limit and time-out, Telnet 432
- severity levels, syslog 448
- sFlow monitoring 475
- shaping traffic, CoS 239
- Simple Network Time Protocol (SNTP) 409
- SIP (Session Initiation Protocol) 266
- Skinny Call Control Protocol (SCCP) 266
- small form-factor pluggable (SFP) 710
- SNMP (Simple Network Management Protocol) 470
- snooping
  - DHCP 352
  - IGMP 291
  - MLD 657
- SNTP (Simple Network Time Protocol) 409
- Spanning Tree Protocol (STP) 522
- sparse mode, PIM 598
- SSL certificates 698
- stacking switches 450
- stateful address assignment, IPv6 492
- stateless DHCPv6 server 498, 502
- stateless RA guard, IPv6 386
- static bindings 359
- static MAC addresses 321
- static mapping 350
- static port locking 317
- static routes, port routing 85
- STP (Spanning Tree Protocol) 522
- strict priority schedule mode, CoS 236
- stub areas, OSPF 121

- subnet-based VLANs 41
- switch port modes 70
- switch stacks 450
- system logging (syslog), logging, syslog 440

## T

- TACACS+ accounting server 378
- target port, iSCSI 703
- TCP flags, ACLs 178
- Telnet, outbound 429
- time zone, SNTP server 413
- traceroute 417, 418
- traffic shaping, CoS 239
- transparent clock, PTP 681
- traplogs, syslog 444
- traps, SNMP 472
- trunk ports 70
- trust mode
  - global, configuring 235
  - interface, configuring for 238
- trusted ports, CoS 232
- tunnels, IPv6 537

## U

- untrusted ports, CoS 233
- upgrading firmware, switch stacks 455
- users, captive portal 694

## V

- Virtual Router Redundancy Protocol (VRRP)
  - concepts and configuring 165
- virtual VLANs 41
- VLAN groups, private 515
- VLAN priority tag (VPT) 700
- VLAN routing
  - concepts and configuring 88
  - IPv6 566
  - OSPF 143
  - RIP 102
- VLANs
  - concepts and configuring 25
  - double VLANs 511
  - guest VLANs 333
  - voice 44
- voice VLANs 44
- VoIP (voice over IP)
  - auto 266
  - DiffServ 258

- VPTs (VLAN priority tag) 700
- VRRP (Virtual Router Redundancy Protocol)
  - concepts and configuring 165

## W

- WRED (weighted random early discard) 232
- WRED explicit congestion notification 287