Lab - Implement MP-BGP

Topology
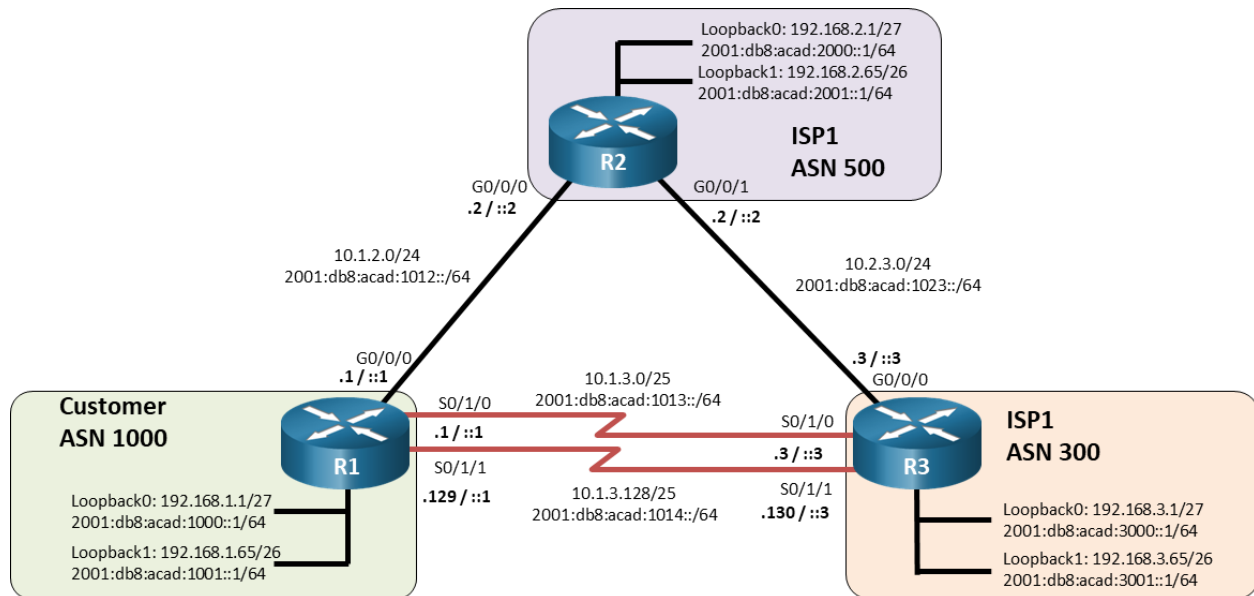
Addressing Table

Device	Interface	IPv4 Address	IPv6 Address	IPv6 Link-Local
R1	G0/0/0	10.1.2.1/24	2001:db8:acad:1012::1/64	fe80::1:1
	S0/1/0	10.1.3.1/25	2001:db8:acad:1013::1/64	fe80::1:2
	S0/1/1	10.1.3.129/25	2001:db8:acad:1014::1/64	fe80::1:3
	Loopback0	192.168.1.1/27	2001:db8:acad:1000::1/64	fe80::1:4
	Loopback1	192.168.1.65/26	2001:db8:acad:1001::1/64	fe80::1:5
R2	G0/0/0	10.1.2.2/24	2001:db8:acad:1012::2/64	fe80::2:1
	G0/0/1	10.2.3.2/24	2001:db8:acad:1023::2/64	fe80::2:2
	Loopback0	192.168.2.1/27	2001:db8:acad:2000::1/64	fe80::2:3
	Loopback1	192.168.2.65/26	2001:db8:acad:2001::1/64	fe80::2:4
R3	G0/0/0	10.2.3.3/24	2001:db8:acad:1023::3/64	fe80::3:1
	S0/1/0	10.1.3.3/25	2001:db8:acad:1013::3/64	fe80::3:2
	S0/1/1	10.1.3.130/25	2001:db8:acad:1014::3/64	fe80::3:3
	Loopback0	192.168.3.1/27	2001:db8:acad:3000::1/64	fe80::3:4
	Loopback1	192.168.3.65/26	2001:db8:acad:3001::1/64	fe80::3:5

Objectives

Part 1: Build the Network and Configure Basic Device Settings and Interface Addressing

Part 2: Configure MP-BGP on all Routers

Part 3: Verify MP-BGP

Part 4: Configure and Verify IPv6 Summarization

Background / Scenario

In this lab, you will configure MP-BGP, BGP for IPv4 and IPv6 using address families.

Note: This lab is an exercise in developing, deploying, and verifying various path manipulation tools for BGP, and does not reflect networking best practices.

Note: The routers used with CCNP hands-on labs are Cisco 4221 with Cisco IOS XE Release 16.9.4 (universalk9 image). Other routers and Cisco IOS versions can be used. Depending on the model and Cisco IOS version, the commands available and the output produced might vary from what is shown in the labs.

Note: Make sure that the routers and switches have been erased and have no startup configurations. If you are unsure contact your instructor.

Required Resources

- 3 Routers (Cisco 4221 with Cisco IOS XE Release 16.9.4 universal image or comparable)
- 1 PC (Choice of operating system with a terminal emulation program installed)
- Console cables to configure the Cisco IOS devices via the console ports
- Ethernet and serial cables as shown in the topology

Instructions

Part 1: Build the Network and Configure Basic Device Settings and Interface Addressing

In Part 1, you will set up the network topology and configure basic settings and interface addressing on routers.

Step 1: Cable the network as shown in the topology.

Attach the devices as shown in the topology diagram, and cable as necessary.

Step 2: Configure basic settings for each router.

a. Console into each router, enter global configuration mode, and apply the basic settings and interface addressing. A command list for each router is listed below to perform initial configuration.

Router R1

```
hostname R1
no ip domain lookup
line con 0
 logging sync
 exec-time 0 0
 exit
interface Loopback0
```

```
  ip address 192.168.1.1 255.255.255.224
  ipv6 address FE80::1:4 link-local
  ipv6 address 2001:DB8:ACAD:1000::1/64
  no shut
interface Loopback1
  ip address 192.168.1.65 255.255.255.192
  ipv6 address FE80::1:5 link-local
  ipv6 address 2001:DB8:ACAD:1001::1/64
  no shut
interface GigabitEthernet0/0/0
  ip address 10.1.2.1 255.255.255.0
  ipv6 address FE80::1:1 link-local
  ipv6 address 2001:DB8:ACAD:1012::1/64
  no shut
interface Serial0/1/0
  ip address 10.1.3.1 255.255.255.128
  ipv6 address FE80::1:2 link-local
  ipv6 address 2001:DB8:ACAD:1013::1/64
  no shut
interface Serial0/1/1
  ip address 10.1.3.129 255.255.255.128
  ipv6 address FE80::1:3 link-local
  ipv6 address 2001:DB8:ACAD:1014::1/64
  no shut
```

Router R2

```
hostname R2
no ip domain lookup
line con 0
  logging sync
  exec-time 0 0
  exit
interface Loopback0
  ip address 192.168.2.1 255.255.255.224
  ipv6 address FE80::2:3 link-local
  ipv6 address 2001:DB8:ACAD:2000::1/64
  no shut
interface Loopback1
  ip address 192.168.2.65 255.255.255.192
  ipv6 address FE80::2:4 link-local
  ipv6 address 2001:DB8:ACAD:2001::1/64
  no shut
interface GigabitEthernet0/0/0
  ip address 10.1.2.2 255.255.255.0
  ipv6 address FE80::2:1 link-local
  ipv6 address 2001:DB8:ACAD:1012::2/64
```

```
  no shut
 interface GigabitEthernet0/0/1
  ip address 10.2.3.2 255.255.255.0
  ipv6 address FE80::2:2 link-local
  ipv6 address 2001:DB8:ACAD:1023::2/64
  no shut
```

Router R3

```
hostname R3
no ip domain lookup
line con 0
 logging sync
 exec-time 0 0
 exit
interface Loopback0
 ip address 192.168.3.1 255.255.255.224
 ipv6 address FE80::3:4 link-local
 ipv6 address 2001:DB8:ACAD:3000::1/64
 no shut
interface Loopback1
 ip address 192.168.3.65 255.255.255.192
 ipv6 address FE80::3:5 link-local
 ipv6 address 2001:DB8:ACAD:3001::1/64
 no shut
interface GigabitEthernet0/0/0
 ip address 10.2.3.3 255.255.255.0
 negotiation auto
 ipv6 address FE80::3:1 link-local
 ipv6 address 2001:DB8:ACAD:1023::3/64
 no shut
interface Serial0/1/0
 ip address 10.1.3.3 255.255.255.128
 ipv6 address FE80::3:2 link-local
 ipv6 address 2001:DB8:ACAD:1013::3/64
 no shut
interface Serial0/1/1
 ip address 10.1.3.130 255.255.255.128
 ipv6 address FE80::3:3 link-local
 ipv6 address 2001:DB8:ACAD:1014::3/64
 no shut
```

b. Save the running configuration to startup-config.

Part 2: Configure MP-BGP on all Routers

Step 1: Implement eBGP and neighbor relationships on R1 for IPv4 and IPv6.

a. Enable IPv6 routing.

```
R1(config)# ipv6 unicast-routing
```

b. Enter BGP configuration mode from global configuration mode, specifying AS 1000 and configure the router ID.

```
R1(config)# router bgp 1000
R1(config-router)# bgp router-id 1.1.1.1
```

c. Based on the topology diagram, configure all the designated IPv4 neighbors for R1.

```
R1(config-router)# neighbor 10.1.2.2 remote-as 500
R1(config-router)# neighbor 10.1.3.3 remote-as 300
R1(config-router)# neighbor 10.1.3.130 remote-as 300
```

d. Based on the topology diagram, configure all the designated IPv6 neighbors for R1.

```
R1(config-router)# neighbor 2001:db8:acad:1012::2 remote-as 500
R1(config-router)# neighbor 2001:db8:acad:1013::3 remote-as 300
R1(config-router)# neighbor 2001:db8:acad:1014::3 remote-as 300
```

e. Enter address family configuration mode for IPv4 and activate each of the IPv4 neighbors.

```
R1(config-router)# address-family ipv4 unicast
R1(config-router-af)# neighbor 10.1.2.2 activate
R1(config-router-af)# neighbor 10.1.3.3 activate
R1(config-router-af)# neighbor 10.1.3.130 activate
R1(config-router-af)# exit
```

f. Enter address family configuration mode for IPv6 and activate each of the IPv6 neighbors.

```
R1(config-router)# address-family ipv6 unicast
R1(config-router-af)# neighbor 2001:db8:acad:1012::2 activate
R1(config-router-af)# neighbor 2001:db8:acad:1013::3 activate
R1(config-router-af)# neighbor 2001:db8:acad:1014::3 activate
R1(config-router-af)# exit
```

Step 2: Implement eBGP and neighbor relationships on R2 for IPv4 and IPv6.

a. Enable IPv6 routing.

```
R2(config)# ipv6 unicast-routing
```

b. Enter BGP configuration mode from global configuration mode, specifying AS 500 and configure the router ID.

```
R2(config)# router bgp 500
R2(config-router)# bgp router-id 2.2.2.2
```

c. Based on the topology diagram, configure all the designated IPv4 neighbors for R1.

```
R2(config-router)# neighbor 10.1.2.1 remote-as 1000
R2(config-router)# neighbor 10.2.3.3 remote-as 300
```

d. Based on the topology diagram, configure all the designated IPv6 neighbors for R1.

```
R2(config-router)# neighbor 2001:db8:acad:1012::1 remote-as 1000
R2(config-router)# neighbor 2001:db8:acad:1023::3 remote-as 300
```

e. Enter address family configuration mode for IPv4 and activate each of the IPv4 neighbors.

```
R2(config-router)# address-family ipv4 unicast
R2(config-router-af)# neighbor 10.1.2.1 activate
```

```
R2(config-router-af)# neighbor 10.2.3.3 activate
R2(config-router-af)# exit
```

f. Enter address family configuration mode for IPv6 and activate each of the IPv6 neighbors.

```
R2(config-router)# address-family ipv6 unicast
R2(config-router-af)# neighbor 2001:db8:acad:1012::1 activate
R2(config-router-af)# neighbor 2001:db8:acad:1023::3 activate
R2(config-router-af)# exit
```

Step 3: Implement eBGP and neighbor relationships on R3 for IPv4 and IPv6.

a. Enable IPv6 routing.

```
R3(config)# ipv6 unicast-routing
```

b. Enter BGP configuration mode from global configuration mode, specifying AS 300 and configure the router ID.

```
R3(config)# router bgp 300
R3(config-router)# bgp router-id 3.3.3.3
```

c. Based on the topology diagram, configure all the designated IPv4 neighbors for R1.

```
R3(config-router)# neighbor 10.2.3.2 remote-as 500
R3(config-router)# neighbor 10.1.3.1 remote-as 1000
R3(config-router)# neighbor 10.1.3.129 remote-as 1000
```

d. Based on the topology diagram, configure all the designated IPv6 neighbors for R1.

```
R3(config-router)# neighbor 2001:db8:acad:1023::2 remote-as 500
R3(config-router)# neighbor 2001:db8:acad:1013::1 remote-as 1000
R3(config-router)# neighbor 2001:db8:acad:1014::1 remote-as 1000
```

e. Enter address family configuration mode for IPv4 and activate each of the IPv4 neighbors.

```
R3(config-router)# address-family ipv4 unicast
R3(config-router-af)# neighbor 10.1.3.1 activate
R3(config-router-af)# neighbor 10.1.3.129 activate
R3(config-router-af)# neighbor 10.2.3.2 activate
R3(config-router-af)# exit
```

f. Enter address family configuration mode for IPv6 and activate each of the IPv6 neighbors.

```
R3(config-router)# address-family ipv6 unicast
R3(config-router-af)# neighbor 2001:db8:acad:1023::2 activate
R3(config-router-af)# neighbor 2001:db8:acad:1013::1 activate
R3(config-router-af)# neighbor 2001:db8:acad:1014::1 activate
R3(config-router-af)# exit
```

Step 4: Advertise IPv4 and IPv6 prefixes on R1.

a. Enter address family configuration mode for IPv4 and advertise the IPv4 prefixes.

```
R1(config-router)# address-family ipv4 unicast
R1(config-router-af)# network 192.168.1.0 mask 255.255.255.224
R1(config-router-af)# network 192.168.1.64 mask 255.255.255.192
R1(config-router-af)# exit
```

b. Enter address family configuration mode for IPv6 and advertise the IPv6 prefixes.

```
R1(config-router)# address-family ipv6 unicast
R1(config-router-af)# network 2001:db8:acad:1000::/64
R1(config-router-af)# network 2001:db8:acad:1001::/64
R1(config-router-af)# exit
```

Step 5: Advertise IPv4 and IPv6 prefixes on R2.

a. Enter address family configuration mode for IPv4 and advertise the IPv4 prefixes.

```
R2(config-router)# address-family ipv4 unicast
R2(config-router-af)# network 192.168.2.0 mask 255.255.255.224
R2(config-router-af)# network 192.168.2.64 mask 255.255.255.192
R2(config-router-af)# exit
```

b. Enter address family configuration mode for IPv6 and advertise the IPv6 prefixes.

```
R2(config-router)# address-family ipv6 unicast
R2(config-router-af)# network 2001:db8:acad:2000::/64
R2(config-router-af)# network 2001:db8:acad:2001::/64
R2(config-router-af)# exit
```

Step 6: Advertise IPv4 and IPv6 prefixes on R3.

a. Enter address family configuration mode for IPv4 and advertise the IPv4 prefixes.

```
R3(config-router)# address-family ipv4 unicast
R3(config-router-af)# network 192.168.3.0 mask 255.255.255.224
R3(config-router-af)# network 192.168.3.64 mask 255.255.255.192
R3(config-router-af)# exit
```

b. Enter address family configuration mode for IPv6 and advertise the IPv6 prefixes.

```
R3(config-router)# address-family ipv6 unicast
R3(config-router-af)# network 2001:db8:acad:3000::/64
R3(config-router-af)# network 2001:db8:acad:3001::/64
R3(config-router-af)# exit
```

Note: Notice that the networks between the routers are not being advertised in eBGP. Typically, only the prefixes of the AS need to be advertised in eBGP. eBGP neighbors are typically directly connected and therefore will be able to form an adjacency. There is typically no need to advertise and inject the directly connected prefixes into the BGP routing table.

Part 3: Verify MP-BGP

Step 1: Display detailed neighbor adjacency information.

Use the **show bgp all neighbors** command on R2 to display detailed information about BGP connections to neighbors for all (IPv4 and IPv6) address families. Each neighbor shows that it is in the "Established" state. This indicates that the router can send and receive BGP messages. R2 has two neighbor addresses, R1 and R3, for each address family, IPv4 and IPv6.

```
R2# show bgp all neighbors
For address family: IPv4 Unicast
BGP neighbor is 10.1.2.1,  remote AS 1000, external link
  BGP version 4, remote router ID 1.1.1.1
  BGP state = Established, up for 01:56:25
```

```
    Last read 00:00:48, last write 00:00:50, hold time is 180, keepalive interval is 60
  seconds
  <output omitted>


  BGP neighbor is 10.2.3.3,   remote AS 300, external link
    BGP version 4, remote router ID 3.3.3.3
    BGP state = Established, up for 01:55:47
    Last read 00:00:04, last write 00:00:41, hold time is 180, keepalive interval is 60
  seconds
  <output omitted>


  For address family: IPv6 Unicast
  BGP neighbor is 2001:DB8:ACAD:1012::1,   remote AS 1000, external link
    BGP version 4, remote router ID 1.1.1.1
    BGP state = Established, up for 01:56:39
    Last read 00:00:07, last write 00:00:04, hold time is 180, keepalive interval is 60
  seconds
  <output omitted>


  BGP neighbor is 2001:DB8:ACAD:1023::3,   remote AS 300, external link
    BGP version 4, remote router ID 3.3.3.3
    BGP state = Established, up for 01:56:09
    Last read 00:00:32, last write 00:00:48, hold time is 180, keepalive interval is 60
  seconds
  <output omitted>
```

Note: Most information displayed using **show bgp all neighbors** command has been omitted for brevity. The command **show bgp neighbors** is used to display only BGP for IPv4 adjacencies. To display the same information for only IPv6 neighbors, use the command **show bgp ipv6 neighbors**.

What is the BGP state for each neighbor adjacency?

How often are BGP keepalives sent?

How many seconds will a BGP session remain open if no further keepalive messages are received?

Step 2: Display summary neighbor adjacency information.

Use the **show bgp ipv4 unicast summary** and **show bgp ipv6 unicast summary** commands on R2 to display a summary of IPv4/IPv6 peering information with R1 and R3. The information displayed using the **show bgp ipv4 unicast summary** is a subset of **show ip all bgp** command.

```
  R2# show bgp ipv4 unicast summary
  BGP router identifier 2.2.2.2, local AS number 500
  BGP table version is 11, main routing table version 11
  6 network entries using 1488 bytes of memory
  10 path entries using 1360 bytes of memory
  5/3 BGP path/bestpath attribute entries using 1400 bytes of memory
  4 BGP AS-PATH entries using 128 bytes of memory
  0 BGP route-map cache entries using 0 bytes of memory
  0 BGP filter-list cache entries using 0 bytes of memory
  BGP using 4376 total bytes of memory
  BGP activity 12/0 prefixes, 20/0 paths, scan interval 60 secs
```

```
Neighbor        V          AS MsgRcvd MsgSent  TblVer  InQ OutQ Up/Down  State/PfxRcd
10.1.2.1        4        1000     152     151      11    0    0 02:12:36  4
10.2.3.3        4         300     150     150      11    0    0 02:11:51  4
```

R2# **show bgp ipv6 unicast summary**
```
BGP router identifier 2.2.2.2, local AS number 500
BGP table version is 9, main routing table version 9
6 network entries using 1632 bytes of memory
10 path entries using 1520 bytes of memory
5/3 BGP path/bestpath attribute entries using 1400 bytes of memory
4 BGP AS-PATH entries using 128 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 4680 total bytes of memory
BGP activity 12/0 prefixes, 20/0 paths, scan interval 60 secs


Neighbor        V          AS MsgRcvd MsgSent  TblVer  InQ OutQ Up/Down  State/PfxRcd
2001:DB8:ACAD:1012::1
                4        1000     150     150       9    0    0 02:12:39  4
2001:DB8:ACAD:1023::3
                4         300     151     150       9    0    0 02:11:54  4
```

What is the difference between the "local AS number" and the "AS" number displayed in the list of BGP neighbors?

Step 3: Verify BGP tables for IPv4 and IPv6.

a. Use the **show bgp ipv4 unicast** command on R2 to display its IPv4 BGP table. This command is equivalent to the **show ip bgp** command and either command can be used. Notice that R1 shows six IPv4 networks in its IPv4 BGP table. Each network is valid "*" and has one path which is the best path ">". Amongst other information, the next hop IPv4 address and the AS path are included.

R2# **show bgp ipv4 unicast**
```
BGP table version is 11, local router ID is 2.2.2.2
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
              t secondary path, L long-lived-stale,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found


     Network          Next Hop            Metric LocPrf Weight Path
 *   192.168.1.0/27   10.2.3.3                               0 300 1000 i
 *>                   10.1.2.1                 0             0 1000 i
 *   192.168.1.64/26  10.2.3.3                               0 300 1000 i
 *>                   10.1.2.1                 0             0 1000 i
 *>  192.168.2.0/27   0.0.0.0                  0         32768 i
 *>  192.168.2.64/26  0.0.0.0                  0         32768 i
 *   192.168.3.0/27   10.1.2.1                               0 1000 300 i
 *>                   10.2.3.3                 0             0 300 i
```

```
 *      192.168.3.64/26  10.1.2.1                                 0 1000 300 i
 *>                       10.2.3.3                  0              0 300 i
```

b. Use the **show bgp ipv6 unicast** command on R2 to display similar information for its IPv6 BGP table.

```
R2# show bgp ipv6 unicast
BGP table version is 9, local router ID is 2.2.2.2
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
              t secondary path, L long-lived-stale,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *   2001:DB8:ACAD:1000::/64
                      2001:DB8:ACAD:1023::3
                                                        0 300 1000 i
 *>                   2001:DB8:ACAD:1012::1
                                          0              0 1000 i
 *   2001:DB8:ACAD:1001::/64
                      2001:DB8:ACAD:1023::3
                                                        0 300 1000 i
 *>                   2001:DB8:ACAD:1012::1
                                          0              0 1000 i
 *>  2001:DB8:ACAD:2000::/64
                      ::                  0          32768 i
 *>  2001:DB8:ACAD:2001::/64
                      ::                  0          32768 i
 *   2001:DB8:ACAD:3000::/64
                      2001:DB8:ACAD:1012::1
                                                        0 1000 300 i
 *>                   2001:DB8:ACAD:1023::3
                                          0              0 300 i
 *   2001:DB8:ACAD:3001::/64
                      2001:DB8:ACAD:1012::1
                                                       0 1000 300 i
 *>                   2001:DB8:ACAD:1023::3
                                          0              0 300 i
```

In the first output **show bgp ipv4 unicast**, why is 10.1.2.1 the preferred next hop address for 192.168.1.0 instead of 10.2.3.3?

Why do some entries in the **show bgp ipv6 unicast** output include a next hop address of "::"?

Step 4: Viewing explicit routes and path attributes.

a. Use the **show bgp ipv4 unicast** *ipv4-prefix subnet-mask* command on R2 to display all the paths for a specific route and BGP path attributes for that route.

```
R2# show bgp ipv4 unicast 192.168.1.0 255.255.255.224
BGP routing table entry for 192.168.1.0/27, version 2
Paths: (2 available, best #2, table default)
```

```
Advertised to update-groups:
   1
Refresh Epoch 1
300 1000
  10.2.3.3 from 10.2.3.3 (3.3.3.3)
    Origin IGP, localpref 100, valid, external
    rx pathid: 0, tx pathid: 0
Refresh Epoch 1
1000
  10.1.2.1 from 10.1.2.1 (1.1.1.1)
    Origin IGP, metric 0, localpref 100, valid, external, best
    rx pathid: 0, tx pathid: 0x0
```

The **show bgp ipv6 unicast** *ipv6-prefix prefix-length* command displays similar information for IPv6 prefixes.

```
R2# show bgp ipv6 unicast 2001:db8:acad:1000::/64
BGP routing table entry for 2001:DB8:ACAD:1000::/64, version 2
Paths: (2 available, best #2, table default)
  Flag: 0x100
  Advertised to update-groups:
     1
  Refresh Epoch 1
  300 1000
    2001:DB8:ACAD:1023::3 (FE80::3:1) from 2001:DB8:ACAD:1023::3 (3.3.3.3)
      Origin IGP, localpref 100, valid, external
      rx pathid: 0, tx pathid: 0
  Refresh Epoch 1
  1000
    2001:DB8:ACAD:1012::1 (FE80::1:1) from 2001:DB8:ACAD:1012::1 (1.1.1.1)
      Origin IGP, metric 0, localpref 100, valid, external, best
      rx pathid: 0, tx pathid: 0x0
```

Why does the output for the **show bgp ipv6 unicast** command include the link-local address following the global unicast address?

_____

b. Use the **show bgp ipv4 unicast neighbors** *ipv4-prefix* **advertised-routes** command on R2 to display IPv4 routes advertised to a specific neighbor.

```
R2# show bgp ipv4 unicast neighbors 10.1.2.1 advertised-routes
BGP table version is 11, local router ID is 2.2.2.2
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
              t secondary path, L long-lived-stale,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop         Metric LocPrf Weight Path
 *>  192.168.1.0/27   10.1.2.1              0             0 1000 i
 *>  192.168.1.64/26  10.1.2.1              0             0 1000 i
 *>  192.168.2.0/27   0.0.0.0              0         32768 i
 *>  192.168.2.64/26  0.0.0.0              0         32768 i
```

```
 *>   192.168.3.0/27   10.2.3.3                   0              0 300 i
 *>   192.168.3.64/26  10.2.3.3                   0              0 300 i


Total number of prefixes 6
```

c. Use the **show bgp ipv6 unicast** *ipv5-prefix prefix-length* command to display similar information for IPv6 advertised routes.

```
R2# show bgp ipv6 unicast neighbors 2001:db8:acad:1012::1 advertised-routes
BGP table version is 9, local router ID is 2.2.2.2
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
              t secondary path, L long-lived-stale,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop         Metric LocPrf Weight Path
 *>   2001:DB8:ACAD:1000::/64
                   2001:DB8:ACAD:1012::1
                                          0              0 1000 i
 *>   2001:DB8:ACAD:1001::/64
                   2001:DB8:ACAD:1012::1
                                          0              0 1000 i
 *>   2001:DB8:ACAD:2000::/64
                   ::                     0          32768 i
 *>   2001:DB8:ACAD:2001::/64
                   ::                     0          32768 i
 *>   2001:DB8:ACAD:3000::/64
                   2001:DB8:ACAD:1023::3
                                          0              0 300 i
 *>   2001:DB8:ACAD:3001::/64
                   2001:DB8:ACAD:1023::3
                                          0              0 300 i


Total number of prefixes 6
```

Why do some entries in the **show bgp ipv4 unicast neighbors** output include a next hop address of 0.0.0.0 and the **show bgp ipv6 unicast neighbors** output includes a next hop address of "::"?

Step 5: Verifying the IP routing tables for IPv4 and IPv6.

a. By examining the IPv4 and IPv6 routing tables on R2, you can verify that BGP is receiving the IPv4 and IPv6 prefixes from R1 and R3.

```
R2# show ip route bgp | begin Gateway
Gateway of last resort is not set

      192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks
B        192.168.1.0/27 [20/0] via 10.1.2.1, 04:29:03
B        192.168.1.64/26 [20/0] via 10.1.2.1, 04:28:32
      192.168.3.0/24 is variably subnetted, 2 subnets, 2 masks
```

```
B          192.168.3.0/27 [20/0] via 10.2.3.3, 04:17:14
B          192.168.3.64/26 [20/0] via 10.2.3.3, 04:16:44


R2# show ipv6 route bgp | section 2001
B    2001:DB8:ACAD:1000::/64 [20/0]
      via FE80::1:1, GigabitEthernet0/0/0
B    2001:DB8:ACAD:1001::/64 [20/0]
      via FE80::1:1, GigabitEthernet0/0/0
B    2001:DB8:ACAD:3000::/64 [20/0]
      via FE80::3:1, GigabitEthernet0/0/1
B    2001:DB8:ACAD:3001::/64 [20/0]
       via FE80::3:1, GigabitEthernet0/0/1
```

Part 4: Configure and Verify IPv6 Route Summarization

Summarizing prefixes conserves router resources and accelerates best-path calculation by reducing the size of the table. Summarization can be configured either for prefixes originated by the AS or prefixes received from downstream providers. Summarization also provides the benefits of stability by hiding flapping routes or having to install new prefixes when they are contained within a summary.

a. Verify R2 and R3 are receiving 2001:db8:acad:1000::/64 and 2001:db8:acad:1001::/64 from R1.

```
R2# show ipv6 route bgp | section 2001
B    2001:DB8:ACAD:1000::/64 [20/0]
      via FE80::1:1, GigabitEthernet0/0/0
B    2001:DB8:ACAD:1001::/64 [20/0]
      via FE80::1:1, GigabitEthernet0/0/0
B    2001:DB8:ACAD:3000::/64 [20/0]
      via FE80::3:1, GigabitEthernet0/0/1
B    2001:DB8:ACAD:3001::/64 [20/0]
      via FE80::3:1, GigabitEthernet0/0/1


R3# show ipv6 route bgp | section 2001
B    2001:DB8:ACAD:1000::/64 [20/0]
      via FE80::1:2, Serial0/1/0
B    2001:DB8:ACAD:1001::/64 [20/0]
      via FE80::1:2, Serial0/1/0
B    2001:DB8:ACAD:2000::/64 [20/0]
      via FE80::2:2, GigabitEthernet0/0/0
B    2001:DB8:ACAD:2001::/64 [20/0]
      via FE80::2:2, GigabitEthernet0/0/0
```

b. Although AS 1000 only has two IPv6 prefixes - 2001:db8:acad:1000::/64 and 2001:db8:acad:1001::/64, this customer has been allocated the entire 2001:db8:acad:1000::/52 prefix (2001:db8:acad:1xxx).

R1 is configured using the **aggregate-address** command in IPv6 AF mode to summarize its IPv6 prefixes. This is known as a summary route or aggregate route. The **summary-only** option suppresses the more specific prefixes from also being advertised.

```
R1(config)# router bgp 1000
R1(config-router)# address-family ipv6 unicast
R1(config-router-af)# aggregate-address 2001:db8:acad:1000::/52 summary-only
```

c. Verify that R2 and R3 are now receiving the aggregate route and installing it in the IPv6 BGP table.

```
R2# show bgp ipv6 unicast | begin Network
    Network           Next Hop          Metric LocPrf Weight Path
 *  2001:DB8:ACAD:1000::/52
                      2001:DB8:ACAD:1023::3
                                                     0 300 1000 i
 *>                   2001:DB8:ACAD:1012::1
                                        0            0 1000 i
<output omitted>
```

```
R3# show bgp ipv6 unicast | begin Network
    Network           Next Hop          Metric LocPrf Weight Path
 *  2001:DB8:ACAD:1000::/52
                      2001:DB8:ACAD:1023::2
                                                     0 500 1000 i
 *                    2001:DB8:ACAD:1014::1
                                        0            0 1000 i
<output omitted>
```

d. Verify that R2 and R3 are now receiving the aggregate route and it is installed in the IPv6 routing table.

```
R2# show ipv6 route bgp | section 2001
B   2001:DB8:ACAD:1000::/52 [20/0]
     via FE80::1:1, GigabitEthernet0/0/0
B   2001:DB8:ACAD:3000::/64 [20/0]
     via FE80::3:1, GigabitEthernet0/0/1
B   2001:DB8:ACAD:3001::/64 [20/0]
     via FE80::3:1, GigabitEthernet0/0/1
```

```
R3# show ipv6 route bgp | section 2001
B   2001:DB8:ACAD:1000::/52 [20/0]
     via FE80::1:2, Serial0/1/0
B   2001:DB8:ACAD:2000::/64 [20/0]
     via FE80::2:2, GigabitEthernet0/0/0
B   2001:DB8:ACAD:2001::/64 [20/0]
     via FE80::2:2, GigabitEthernet0/0/0
```

If R1's 2001:db8:acad:1000::/64 network went down, what would be the effect, if any, on the routing tables of R2 and R3? Explain.

Router Interface Summary Table

Router Model	Ethernet Interface #1	Ethernet Interface #2	Serial Interface #1	Serial Interface #2
1800	Fast Ethernet 0/0 (F0/0)	Fast Ethernet 0/1 (F0/1)	Serial 0/0/0 (S0/0/0)	Serial 0/0/1 (S0/0/1)
1900	Gigabit Ethernet 0/0 (G0/0)	Gigabit Ethernet 0/1 (G0/1)	Serial 0/0/0 (S0/0/0)	Serial 0/0/1 (S0/0/1)
2801	Fast Ethernet 0/0 (F0/0)	Fast Ethernet 0/1 (F0/1)	Serial 0/1/0 (S0/1/0)	Serial 0/1/1 (S0/1/1)

Router Model	Ethernet Interface #1	Ethernet Interface #2	Serial Interface #1	Serial Interface #2
2811	Fast Ethernet 0/0 (F0/0)	Fast Ethernet 0/1 (F0/1)	Serial 0/0/0 (S0/0/0)	Serial 0/0/1 (S0/0/1)
2900	Gigabit Ethernet 0/0 (G0/0)	Gigabit Ethernet 0/1 (G0/1)	Serial 0/0/0 (S0/0/0)	Serial 0/0/1 (S0/0/1)
4221	Gigabit Ethernet 0/0/0 (G0/0/0)	Gigabit Ethernet 0/0/1 (G0/0/1)	Serial 0/1/0 (S0/1/0)	Serial 0/1/1 (S0/1/1)
4300	Gigabit Ethernet 0/0/0 (G0/0/0)	Gigabit Ethernet 0/0/1 (G0/0/1)	Serial 0/1/0 (S0/1/0)	Serial 0/1/1 (S0/1/1)

Note: To find out how the router is configured, look at the interfaces to identify the type of router and how many interfaces the router has. There is no way to effectively list all the combinations of configurations for each router class. This table includes identifiers for the possible combinations of Ethernet and Serial interfaces in the device. The table does not include any other type of interface, even though a specific router may contain one. An example of this might be an ISDN BRI interface. The string in parenthesis is the legal abbreviation that can be used in Cisco IOS commands to represent the interface.