SDN Practical 7: Implementing BGP Communities

Aim: Implement BGP Communities

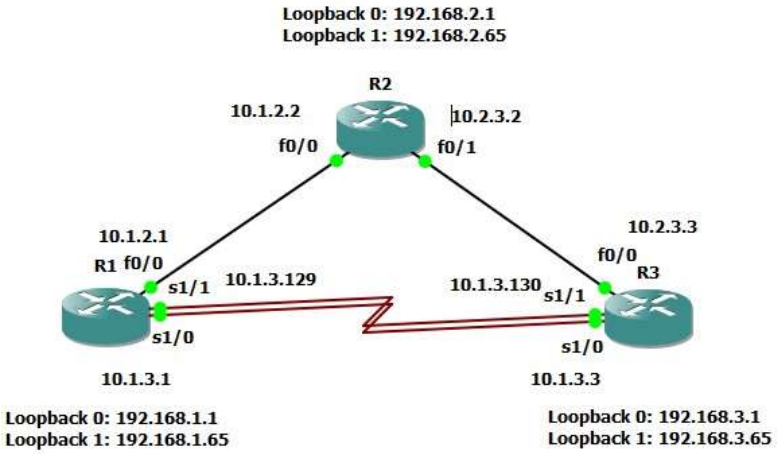
1. Implement eBGP for Ipv4.
2. Implement MP (Multi protocol) -BGP
3. Implement BGP path Manipulation

1. Implement eBGP for Ipv4.

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

Addressing

Step 1:Design the Topology



Step 2: Configure all 3 Routers.

Router R1

```
R1#
R1#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#no ip domain lookup
R1(config)#line con 0
R1(config-line)#logginf syn
R1(config-line)#logging sync
R1(config-line)#logging synchronous
R1(config-line)#exev - ti
R1(config-line)#exec - ti
R1(config-line)#exec-ti
R1(config-line)#exec-timeout 0 0
R1(config-line)#exit
R1(config)#Int
R1(config)#Interface Loopback0
R1(config-if)#
*Mar  1 00:01:47.967: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
R1(config-if)#ip address 192.168.1.1 255.255.255.224
R1(config-if)#no shut
R1(config-if)#no shutdown
R1(config-if)#exit
R1(config)#Int
R1(config)#Interface Loopback1
R1(config-if)#
*Mar  1 00:02:33.975: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback1, changed state to up
R1(config-if)#ip address 192.168.1.65 255.255.255.192
R1(config-if)#no sh
R1(config-if)#exit
R1(config)#interface
R1(config)#interface fastEthernet 0/0
R1(config-if)#ip address 10.1.2.1 255.255.255.0
R1(config-if)#no shut
R1(config-if)#exit
R1(config)#
*Mar  1 00:04:16.863: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Mar  1 00:04:17.863: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R1(config)#
R1(config)#
```

```
R1(config)#
R1(config)#
R1(config)#interface Serial 1/0
R1(config-if)#ip address 10.1.3.1 255.255.255.128
R1(config-if)#no shut
R1(config-if)#
*Mar  1 00:05:19.847: %LINK-3-UPDOWN: Interface Serial1/0, changed state to up
*Mar  1 00:05:20.847: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/0, changed state to up
R1(config-if)#exit
R1(config)#
R1(config)#interface Ser
*Mar  1 00:05:42.107: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/0, changed state to down
R1(config)#interface Serial 1/1
R1(config-if)#ip address 10.1.3.129 255.255.255.128
R1(config-if)#no shut
R1(config-if)#exit
R1(config)#
*Mar  1 00:06:31.131: %LINK-3-UPDOWN: Interface Serial1/1, changed state to up
*Mar  1 00:06:32.131: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/1, changed state to up
R1(config)#
*Mar  1 00:07:02.107: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/1, changed state to down
R1(config)#
```

Router R2

```
R2#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R2(config)#no ip domain lookup
R2(config)#line con 0
R2(config-line)#logging syn
R2(config-line)#logging synchronous
R2(config-line)#exec-t
R2(config-line)#exec-timeout 0 0
R2(config-line)#exit
R2(config)#
R2(config)#interface Loopback0
R2(config-if)#
*Mar  1 00:10:46.943: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
R2(config-if)#ip address 192.168.2.1 255.255.255.224
R2(config-if)#no shut
R2(config-if)#exit
R2(config)#interface Loopback1
R2(config-if)#ip address
*Mar  1 00:11:17.755: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback1, changed state to up
R2(config-if)#ip address 192.168.2.65 255.255.255.192
R2(config-if)#o shut
               ^
% Invalid input detected at '^' marker.

R2(config-if)#no shut
R2(config-if)#exit
R2(config)#
R2(config)#interface fastEthernet 0/0
R2(config-if)#ip address 10.1.2.2 255.255.255.0
R2(config-if)#no shut
R2(config-if)#exit
R2(config)#
*Mar  1 00:13:15.887: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Mar  1 00:13:16.887: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R2(config)#
R2(config)#interface fastEthernet 0/1
R2(config-if)#ip address 10.1.2.2 255.255.255.0
% 10.1.2.0 overlaps with FastEthernet0/0
R2(config-if)#no shut
% 10.1.2.0 overlaps with FastEthernet0/0
FastEthernet0/1: incorrect IP address assignment
R2(config-if)#ip address 10.2.3.2 255.255.255.0
R2(config-if)#no shut
R2(config-if)#exit
*Mar  1 00:14:53.883: %LINK-3-UPDOWN: Interface FastEthernet0/1, changed state to up
*Mar  1 00:14:54.883: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
R2(config-if)#exit
R2(config)#
```

Router R3:

```
R3#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R3(config)#no ip domain lookup
R3(config)#line con 0\
               ^
% Invalid input detected at '^' marker.

R3(config)#line con 0
R3(config-line)#logging sy
R3(config-line)#logging synchronous
R3(config-line)#exec-time
R3(config-line)#exec-timeout 0 0
R3(config-line)#exit
R3(config)#interface Loopback0
R3(config-if)#
*Mar  1 00:16:25.411: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
R3(config-if)#ip address 192.168.3.1 255.255.255.224
R3(config-if)#no shut
R3(config-if)#exit
R3(config)#interface Loopback1
R3(config-if)#
*Mar  1 00:17:26.627: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback1, changed state to up
R3(config-if)#ip address 192.168.3.65 255.255.255.192
R3(config-if)#no shut
R3(config-if)#exit
R3(config)#interface fastEthernet 0/0
R3(config-if)#ip address 10.2.3.3 255.255.255.0
R3(config-if)#no shut
R3(config-if)#exit
R3(config)#
*Mar  1 00:18:53.691: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Mar  1 00:18:54.691: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R3(config)#
R3(config)#
R3(config)#
R3(config)#interface Serial 1/0
R3(config-if)#ip address 10.1.3.1 255.255.255.128
R3(config-if)#no shut
R3(config-if)#exit
*Mar  1 00:19:35.923: %LINK-3-UPDOWN: Interface Serial1/0, changed state to up
*Mar  1 00:19:36.923: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/0, changed state to up
R3(config-if)#exit
R3(config)#interface Serial 1/1
R3(config-if)#ip address 10.1.3.130 255.255.255.128
R3(config-if)#no shut
R3(config-if)#exit
R3(config)#
*Mar  1 00:20:14.035: %LINK-3-UPDOWN: Interface Serial1/1, changed state to up
*Mar  1 00:20:15.035: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/1, changed state to up
R3(config)#
```

Part 2: Configure and Verify eBGP for IPv4 on all Routers Step 1: Implement BGP and neighbor relationships on R1.

```
R1(config)#
R1(config)#router bgp 1000
R1(config-router)#bgp router-id 1.1.1.1
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
R1(config-router)#network 192.168.1.0 mask 255.255.255.224
R1(config-router)#network 192.168.1.64 mask 255.255.255.192
R1(config-router)#
```

Step 2: Implement BGP and neighbor relationships on R2.

```
R2(config)#
R2(config)#
R2(config)#router bgp 500
R2(config-router)#bgp router-id
*Mar  1 00:27:16.411: %BGP-3-NOTIFICATION: sent to neighbor 10.1.2.1 2/2 (peer in wrong AS) 2 bytes 03E8
R2(config-router)#bgp router-id  FFFF FFFF FFFF FFFF FFFF FFFF FFFF FFFF 002D 0104 03E8 00B4 0101 0101 1002
R2(config-router)#bgp router-id 2.2.2.2
R2(config-router)#neighbor 10.1.2.1 rem
*Mar  1 00:27:44.027: %BGP-3-NOTIFICATION: sent to neighbor 10.1.2.1 2/2 (peer in wrong AS) 2 bytes 03E8
R2(config-router)#neighbor 10.1.2.1 remote as FFFF FFFF FFFF FFFF FFFF FFFF FFFF FFFF 002D 0104 03E8 00B4 01
 00
R2(config-router)#neighbor 10.1.2.1 remote-as 1000
R2(config-router)#
*Mar  1 00:28:18.251: %BGP-5-ADJCHANGE: neighbor 10.1.2.1 Up
R2(config-router)#neighbor 10.2.3.3 remote-as 300
R2(config-router)#neighbor 192.168.2.0 mask 255.255.255.224
                                           ^
% Invalid input detected at '^' marker.

R2(config-router)#network 192.168.2.0 mask 255.255.255.224
R2(config-router)#network 192.168.2.64 mask 255.255.255.192
R2(config-router)#
```

Step 3: Implement BGP and neighbor relationships on R3.

```
R3(config)#router bgp 300
R3(config-router)#bgp router-id 3.3.3.3
R3(config-router)#no bgp default ipv4-unicast
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
R3(config-router)#
```

Step 4: Verifying BGP neighbor relationships.

```
R1#
R1#show ip route bgp
     192.168.2.0/24 is variably subnetted, 2 subnets, 2 masks
B       192.168.2.64/26 [20/0] via 10.1.2.2, 00:04:27
B       192.168.2.0/27 [20/0] via 10.1.2.2, 00:04:57
R1#
```

```
R2#
R2#show ip route bgp
     192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks
B       192.168.1.64/26 [20/0] via 10.1.2.1, 00:07:08
B       192.168.1.0/27 [20/0] via 10.1.2.1, 00:07:08
R2#
```

```
R2#show ip bgp neighbors
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 00:10:50
  Last read 00:00:49, last write 00:00:49, hold time is 180, keepalive interval is 60 seconds
  Neighbor capabilities:
    Route refresh: advertised and received(old & new)
    Address family IPv4 Unicast: advertised and received
  Message statistics:
    InQ depth is 0
    OutQ depth is 0
                         Sent       Rcvd
    Opens:                  7          7
    Notifications:          5          0
    Updates:                2          3
    Keepalives:            14         14
    Route Refresh:          0          0
    Total:                 28         27
  Default minimum time between advertisement runs is 30 seconds

 For address family: IPv4 Unicast
  BGP table version 5, neighbor version 5/0
 Output queue size : 0
  Index 1, Offset 0, Mask 0x2
  1 update-group member
                               Sent       Rcvd
  Prefix activity:             ----       ----
    Prefixes Current:             2          2 (Consumes 104 bytes)
    Prefixes Total:               2          2
    Implicit Withdraw:            0          0
    Explicit Withdraw:            0          0
    Used as bestpath:           n/a          2
    Used as multipath:          n/a          0

                                  Outbound    Inbound
  Local Policy Denied Prefixes:   --------    -------
    AS_PATH loop:                      n/a          2
    Bestpath from this peer:             2        n/a
    Total:                               2          2
  Number of NLRIs in the update sent: max 1, min 1

  Connections established 2; dropped 1
  Last reset 00:13:36, due to BGP Notification sent, peer in wrong AS
  Message received that caused BGP to send a Notification:
    FFFFFFFF FFFFFFFF FFFFFFFF FFFFFFFF
    002D0104 03E80054 01010101 10020601
    04000100 01020280 00020202 00
Connection state is ESTAB, I/O status: 1, unread input bytes: 0
Connection is ECN Disabled, Minimum incoming TTL 0, Outgoing TTL 1
Local host: 10.1.2.2, Local port: 179
Foreign host: 10.1.2.1, Foreign port: 21190
```

• The interfaces on R3 need to be activated in IPv4 AF configuration mode.

```
R3(config-router)#
R3(config-router)#address-family ipv4
R3(config-router-af)#neighbor 10.1.3.1 activate
R3(config-router-af)#neighbor 10.1.3.129 activate
*Mar  1 00:56:45.435: %BGP-5-ADJCHANGE: neighbor 10.1.3.1 Up
R3(config-router-af)#neighbor 10.1.3.129 activate
R3(config-router-af)#neighbor 10.2.3. activate
*Mar  1 00:57:16.187: %BGP-5-ADJCHANGE: neighbor 10.1.3.129 Up
R3(config-router-af)#neighbor 10.2.3.2 activate
R3(config-router-af)#network 192.168.3.0 mask 255.255.255.224
*Mar  1 00:58:01.019: %BGP-5-ADJCHANGE: neighbor 10.2.3.2 Up
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)#
```

Verify that the BGP state between R2 and R3 has now been established.

```
R2#
R2#show ip bgp neighbors | begin BGP neighbor is 10.2.3.3
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 00:05:23
  Last read 00:00:22, last write 00:00:22, hold time is 180, keepalive interval is 60 seconds
  Neighbor capabilities:
    Route refresh: advertised and received(old & new)
    Address family IPv4 Unicast: advertised and received
  Message statistics:
    InQ depth is 0
    OutQ depth is 0
                         Sent       Rcvd
    Opens:                  1          1
    Notifications:          0          0
    Updates:                3          4
    Keepalives:             8          8
    Route Refresh:          0          0
    Total:                 12         13
  Default minimum time between advertisement runs is 30 seconds

 For address family: IPv4 Unicast
  BGP table version 7, neighbor version 7/0
 Output queue size : 0
  Index 1, Offset 0, Mask 0x2
  1 update-group member
```

Step 5: Examining the running-configs.

```
R1#
R1#show running-config | section bgp
router bgp 1000
 no synchronization
 bgp router-id 1.1.1.1
 bgp log-neighbor-changes
 network 192.168.1.0 mask 255.255.255.224
 network 192.168.1.64 mask 255.255.255.192
 neighbor 10.1.2.2 remote-as 500
 neighbor 10.1.3.3 remote-as 300
 neighbor 10.1.3.130 remote-as 300
 no auto-summary
R1#
```

```
R2#show running-config | section bgp
router bgp 500
 no synchronization
 bgp router-id 2.2.2.2
 bgp log-neighbor-changes
 network 192.168.2.0 mask 255.255.255.224
 network 192.168.2.64 mask 255.255.255.192
 neighbor 10.1.2.1 remote-as 1000
 neighbor 10.2.3.3 remote-as 300
 no auto-summary
R2#
```

```
R3#show running-config | section bgp
router bgp 300
 bgp router-id 3.3.3.3
 no bgp default ipv4-unicast
 bgp log-neighbor-changes
 neighbor 10.1.3.1 remote-as 1000
 neighbor 10.1.3.129 remote-as 1000
 neighbor 10.2.3.2 remote-as 500
 !
 address-family ipv4
 neighbor 10.1.3.1 activate
 neighbor 10.1.3.129 activate
 neighbor 10.2.3.2 activate
 no auto-summary
 no synchronization
 network 192.168.3.0 mask 255.255.255.224
 network 192.168.3.64 mask 255.255.255.192
 exit-address-family
R3#
```

Step 6: Verifying BGP operations.

```
R2#sh ip bgp
BGP table version is 7, 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
Origin codes: i - IGP, e - EGP, ? - incomplete

   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
R2#
```

```
R2#
R2#sh ip bgp 192.168.1.0
BGP routing table entry for 192.168.1.0/27, version 3
Paths: (2 available, best #2, table Default-IP-Routing-Table)
  Advertised to update-groups:
     1
  300 1000
    10.2.3.3 from 10.2.3.3 (3.3.3.3)
      Origin IGP, localpref 100, valid, external
  1000
    10.1.2.1 from 10.1.2.1 (1.1.1.1)
      Origin IGP, metric 0, localpref 100, valid, external, best
R2#
```

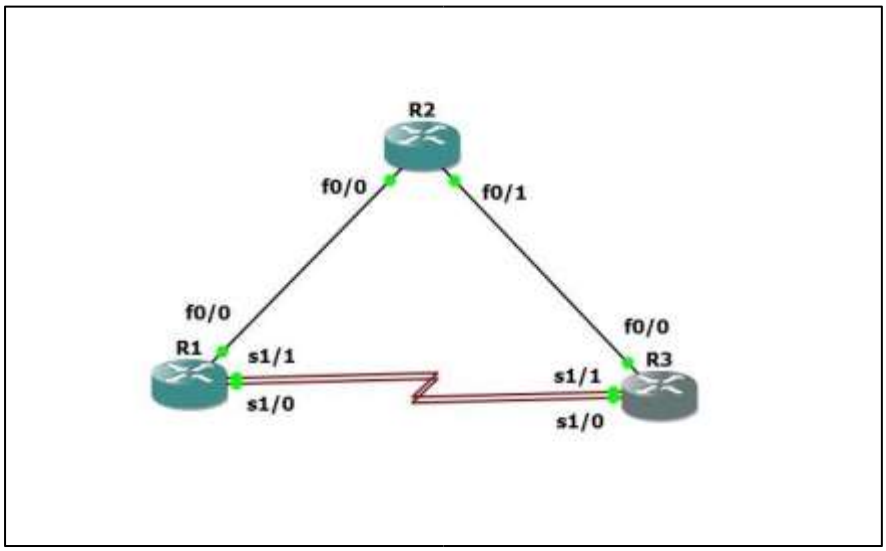
```
R2#show ip bgp neighbors
BGP neighbor is 10.1.2.1,  remote AS 1000, external link
  BGP version 4, remote router ID 1.1.1.1
  BGP state = Established, up for 00:51:07
  Last read 00:00:07, last write 00:00:07, hold time is 180, keepalive interval is 60 seconds
  Neighbor capabilities:
    Route refresh: advertised and received(old & new)
    Address family IPv4 Unicast: advertised and received
  Message statistics:
    InQ depth is 0
    OutQ depth is 0
                         Sent       Rcvd
    Opens:                  7          7
    Notifications:          5          0
    Updates:                3          4
    Keepalives:            55         55
    Route Refresh:          0          0
    Total:                 68         69
  Default minimum time between advertisement runs is 30 seconds

 For address family: IPv4 Unicast
  BGP table version 7, neighbor version 7/0
 Output queue size : 0
  Index 1, Offset 0, Mask 0x2
  1 update-group member
                                 Sent       Rcvd
  Prefix activity:               ----       ----
    Prefixes Current:               6          4 (Consumes 208 bytes)
    Prefixes Total:                 4          4
    Implicit Withdraw:              0          0
    Explicit Withdraw:              0          0
    Used as bestpath:             n/a          2
    Used as multipath:            n/a          0

                                   Outbound    Inbound
  Local Policy Denied Prefixes:    --------    -------
    AS_PATH loop:                       n/a          2
    Bestpath from this peer:              2        n/a
    Total:                                2          2
  Number of NLRIs in the update sent: max 2, min 1
```

```
Local host: 10.1.2.2, Local port: 179
Foreign host: 10.1.2.1, Foreign port: 21100

Enqueued packets for retransmit: 0, input: 0  mis-ordered: 0 (0 bytes)

Event Timers (current time is 0x48DE14):
Timer          Starts    Wakeups            Next
Retrans            57          0             0x0
TimeWait            0          0             0x0
AckHold            57         35             0x0
SendWnd             0          0             0x0
KeepAlive           0          0             0x0
GiveUp              0          0             0x0
PmtuAger            0          0             0x0
DeadWait            0          0             0x0

iss: 3893891963  snduna: 3893893194  sndnxt: 3893893194     sndwnd:  15154
irs: 1678904485  rcvnxt: 1678906744  rcvwnd:      15106  delrcvwnd:   1270

SRTT: 300 ms, RTTO: 303 ms, RTV: 3 ms, KRTT: 0 ms
minRTT: 12 ms, maxRTT: 300 ms, ACK hold: 200 ms
Flags: passive open, nagle, gen tcbs
IP Precedence value : 6

Datagrams (max data segment is 1460 bytes):
Rcvd: 93 (out of order: 0), with data: 58, total data bytes: 1278
Sent: 92 (retransmit: 0, fastretransmit: 0, partialack: 0, Second Congestion: 0), with data: 56, total data bytes: 1230

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 00:21:37
  Last read 00:00:36, last write 00:00:36, hold time is 180, keepalive interval is 60 seconds
  Neighbor capabilities:
    Route refresh: advertised and received(old & new)
    Address family IPv4 Unicast: advertised and received
  Message statistics:
    InQ depth is 0
    OutQ depth is 0
                         Sent       Rcvd
    Opens:                  1          1
    Notifications:          0          0
    Updates:                3          4
    Keepalives:            24         24
    Route Refresh:          0          0
    Total:                 28         29
  Default minimum time between advertisement runs is 30 seconds

 For address family: IPv4 Unicast
  BGP table version 7, neighbor version 7/0
 Output queue size : 0
  Index 1, Offset 0, Mask 0x2
  1 update-group member
                                 Sent       Rcvd
```

2. Implement MP(Multi protocol) -BGP

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

Step 1:Design the Topology



Step 2: Configure basic settings for each router.

• Router R1:

```
R1#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#no ip domain lookup
R1(config)#line con 0
R1(config-line)#exec-t
R1(config-line)#exec-timeout 0 0
R1(config-line)#logging syn
R1(config-line)#logging synchronous
R1(config-line)#exit
R1(config)#banner motd # This is R1, BGP Manipultion Lab #
R1(config)#ipv6 unicast-routing
R1(config)#interface f0/0
R1(config-if)#ip address 10.1.2.1 255.255.255.0
R1(config-if)#ipv6 address fe80::1:1 link-local
R1(config-if)#ipv6 address 2001:db8:acad:1012::1/64
R1(config-if)#no sh
R1(config-if)#exit
R1(config)#
*Mar  1 00:04:01.775: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Mar  1 00:04:02.775: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R1(config)#interface s1/0
R1(config-if)#ip address 10.1.3.1 255.255.255.128
R1(config-if)#ipv6 address fe80::1:2 link-local
R1(config-if)#ipv6 address 2001:db8:acad:1013::1/80
R1(config-if)#no sh
R1(config-if)#exit
*Mar  1 00:05:37.407: %LINK-3-UPDOWN: Interface Serial1/0, changed state to up
R1(config-if)#exit
*Mar  1 00:05:38.415: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/0, changed state to up
R1(config-if)#exit
*Mar  1 00:06:02.135: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/0, changed state to down
R1(config-if)#exit
R1(config)#
R1(config)#
R1(config)#interface s1/1
R1(config-if)#ip address 10.1.3.1 255.255.255.128
R1(config-if)#ipv6 address fe80::1:3 link-local
R1(config-if)#ipv6 address 2001:db8:acad:1014::1/80
R1(config-if)#no sh
R1(config-if)#exit
```

```
R1(config)#
*Mar  1 00:08:54.623: %LINK-3-UPDOWN: Interface Serial1/1, changed state to up
R1(config)#
*Mar  1 00:08:55.631: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/1, changed state to up
R1(config)#interface loopback 0
*Mar  1 00:09:22.139: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/1, changed state to down
R1(config)#interface loopback 0
R1(config-if)#ip addre
*Mar  1 00:09:27.983: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
R1(config-if)#ip address 192.168.1.1 255.255.255.224
R1(config-if)#ipv6 address fe80::1:4 link-local
R1(config-if)#ipv6 address 2001:db8:acad:1000::1/64
R1(config-if)#no sh
R1(config-if)#exit
R1(config)#interface loopback 1
R1(config-if)#ip address
*Mar  1 00:11:22.511: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback1, changed state to up
R1(config-if)#ip address 192.168.1.65 255.255.255.192
R1(config-if)#ipv6 address fe80::1:5 link-local
R1(config-if)#ipv6 address 2001:db8:acad:1001::1/64
R1(config-if)#no sh
R1(config-if)#exit
R1(config)#
```

- Router R2:

```
R2#
R2#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R2(config)#no ip domain lookup
R2(config)#line con 0
R2(config-line)#exec-timeout 0 0
R2(config-line)#logging syn
R2(config-line)#logging synchronous
R2(config-line)#exit
R2(config)#banner motd # This is R2, BGP Path Manipulation Lab #
R2(config)#ipv6 unicast-routing
R2(config)#interface f0/0
R2(config-if)#ip address 10.1.2.2 255.255.255.0
R2(config-if)#ipv6 address fe80::2:1 link-local
R2(config-if)#ipv6 address 2001:db8:acad:1021::2/64
R2(config-if)#no sh
R2(config-if)#exit
R2(config)#
*Mar  1 00:45:09.047: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Mar  1 00:45:10.047: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R2(config)#
R2(config)#interface f0/1
R2(config-if)#ip address 10.2.3.2 255.255.255.0
R2(config-if)#ipv6 address fe80::2:2 link-local
R2(config-if)#ipv6 address 2001:db8:acad:1023::2/64
R2(config-if)#no sh
R2(config-if)#exit
R2(config)#
*Mar  1 00:47:01.819: %LINK-3-UPDOWN: Interface FastEthernet0/1, changed state to up
*Mar  1 00:47:02.819: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
R2(config)#interface loopback 0
R2(config-if)#
*Mar  1 00:47:30.967: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
R2(config-if)#ip address 192.168.2.1 255.255.255.224
R2(config-if)#ipv6 address fe80::2:3 link-local
R2(config-if)#ipv6 address 2001:db8:acad:2000::2/64
R2(config-if)#no sh
R2(config-if)#exit
R2(config)#interface loopback 1
R2(config-if)#ip adde
*Mar  1 00:49:01.603: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback1, changed state to up
R2(config-if)#ip address 192.168.2.65 255.255.255.192
R2(config-if)#ipv6 address fe80::2:4 link-local
R2(config-if)#ipv6 address 2001:db8:acad:2001::2/64
R2(config-if)#no sh
R2(config-if)#exit
R2(config)#
```

- Router R3

```
R3#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R3(config)#no ip domain lookup
R3(config)#line con 0
R3(config-line)#exec-ti
R3(config-line)#exec-timeout 0 0
R3(config-line)#logging sync
R3(config-line)#logging synchronous
R3(config-line)#exit
R3(config)#banner motd # This is R3, BGP Path Manipulation Lab #
R3(config)#ipv6 unicast-routing
R3(config)#interface f0/0
R3(config-if)#ip address 10.2.3.3 255.255.255.0
R3(config-if)#ipv6 address fe80::3:1 link-local
R3(config-if)#ipv6 address 2001:db8:acad:1023::3/64
R3(config-if)#no sh
R3(config-if)#exit
R3(config)#
*Mar  1 00:55:46.539: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Mar  1 00:55:47.539: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R3(config)#interface s1/0
R3(config-if)#ip address 10.1.3.3 255.255.255.128
R3(config-if)#ipv6 address fe80::3:2 link-local
R3(config-if)#ipv6 address 2001:db8:acad:1013::3/80
R3(config-if)#no sh
R3(config-if)#exit
R3(config)#
*Mar  1 00:57:31.219: %LINK-3-UPDOWN: Interface Serial1/0, changed state to up
*Mar  1 00:57:32.219: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/0, changed state to up
R3(config)#interface s1/1
R3(config-if)#ip address 10.1.3.130 255.255.255.128
R3(config-if)#ipv6 address fe80::3:3 link-local
R3(config-if)#ipv6 address 2001:db8:acad:1014::3/80
R3(config-if)#no sh
R3(config-if)#exit
R3(config)#
*Mar  1 00:59:39.419: %LINK-3-UPDOWN: Interface Serial1/1, changed state to up
R3(config)#in
*Mar  1 00:59:40.427: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/1, changed state to up
```

```
R3(config)#interface loopback 0
R3(config-if)#ip address
*Mar  1 00:59:59.675: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
R3(config-if)#ip address 192.168.3.1 255.255.255.224
R3(config-if)#ipv6 address fe80::3:4 link-local
R3(config-if)#ipv6 address 2001:db8:acad:3000::1/64
R3(config-if)#no sh
R3(config-if)#exit
R3(config)#interface loopback 1
R3(config-if)#ip address
*Mar  1 01:02:36.075: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback1, changed state to up
R3(config-if)#ip address 192.168.3.65 255.255.255.192
R3(config-if)#ipv6 address fe80::3:5 link-local
R3(config-if)#ipv6 address 2001:db8:acad:3001::1/64
R3(config-if)#
```

Part 2: Configure and Verify Multi-Protocol BGP on all Routers

Step 1: On R1, create the core BGP configuration

```
R1(config)#router bgp 6500
R1(config-router)#bgp router-id 1.1.1.1
R1(config-router)#no bgp default ipv4-unicast
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
R1(config-router)#neighbor 2001:db8:acad:1013::3 remote 500
R1(config-router)#no neighbor 2001:db8:acad:1013::3 remote 500
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
```

Step 2: On R1, configure the IPv4 unicast address family.

```
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)#no neighbor 2001:db8:acad:1012::2 activate
R1(config-router-af)#no neighbor 2001:db8:acad:1013::3 activate
R1(config-router-af)#no neighbor 2001:db8:acad:1014::3 activate
R1(config-router-af)#neighbor activate 10.1.2.2 activate
                                       ^
% Invalid input detected at '^' marker.

R1(config-router-af)#neighbor activate 10.1.3.3 activate
                                       ^
% Invalid input detected at '^' marker.

R1(config-router-af)#exit
R1(config-router)#neighbor activate 10.1.2.2 activate
                                    ^
% Invalid input detected at '^' marker.

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)#
R1(config-router-af)#
```

Step 3: On R1, configure the IPv6 unicast address family.

```
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)#network 2001:db8:acad:1012::2 activate
                                                   ^
% Invalid input detected at '^' marker.

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)#
```

Step 4: Verify that MP-BGP is operational.

```
R1#show bgp ipv4 unicast summary
BGP router identifier 1.1.1.1, local AS number 6500
BGP table version is 3, main routing table version 3
2 network entries using 234 bytes of memory
2 path entries using 104 bytes of memory
2/1 BGP path/bestpath attribute entries using 248 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 586 total bytes of memory
BGP activity 4/0 prefixes, 4/0 paths, scan interval 60 secs

Neighbor        V    AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
10.1.2.2        4   500       0       0        0    0    0 never    Active
10.1.3.3        4   300       0       0        0    0    0 never    Active
10.1.3.130      4   300       0       0        0    0    0 never    Active
```

```
R1#show bgp ipv6 unicast summary
BGP router identifier 1.1.1.1, local AS number 6500
BGP table version is 3, main routing table version 3
2 network entries using 298 bytes of memory
2 path entries using 152 bytes of memory
2/1 BGP path/bestpath attribute entries using 248 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 698 total bytes of memory
BGP activity 4/0 prefixes, 4/0 paths, scan interval 60 secs

Neighbor        V    AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
2001:DB8:ACAD:1012::2
                4   500       0       0        0    0    0 never    Active
2001:DB8:ACAD:1013::3
                4   300       0       0        0    0    0 never    Active
2001:DB8:ACAD:1014::3
                4   300       0       0        0    0    0 never    Active
R1#
```

- Use the show bgp ipv4 unicast and show bgp ipv6 unicast commands to view the specified BGP tables.

```
R1#show bgp ipv4 unicast
BGP table version is 3, local router ID is 1.1.1.1
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
*> 192.168.1.0/27   0.0.0.0                  0         32768 i
*> 192.168.1.64/26  0.0.0.0                  0         32768 i
R1#
```

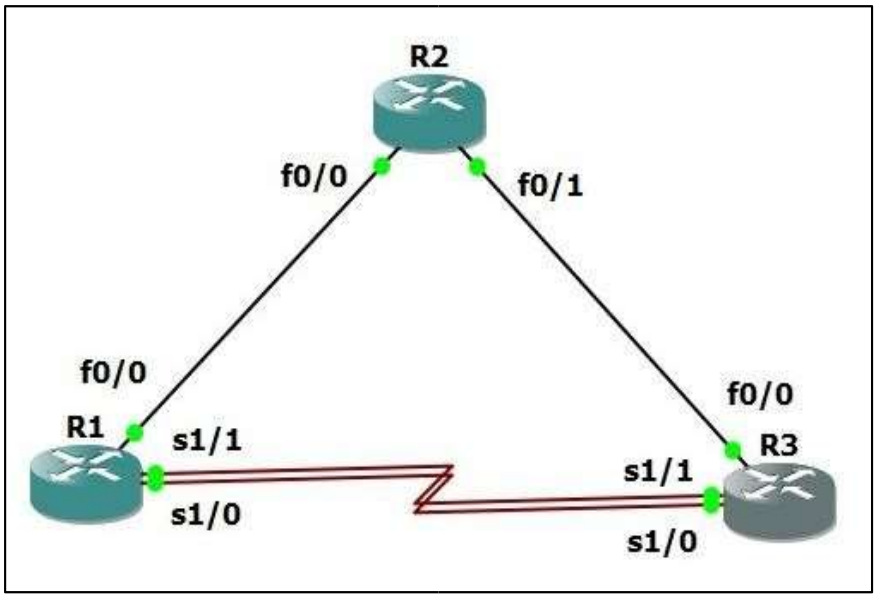
```
R1#show bgp ipv6 unicast
BGP table version is 3, local router ID is 1.1.1.1
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
*> 2001:DB8:ACAD:1000::/64
                    ::                       0         32768 i
*> 2001:DB8:ACAD:1001::/64
                    ::                       0         32768 i
% NOTE: This command is deprecated. Please use 'show bgp ipv6 unicast'
R1#
```

- Viewing Routing tables.

```
R1#show ipv6 route bgp
IPv6 Routing Table - 12 entries
Codes: C - Connected, L - Local, S - Static, R - RIP, B - BGP
       U - Per-user Static route
       I1 - ISIS L1, I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary
       O - OSPF intra, OI - OSPF inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
       ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
R1#
```

3. Implement BGP path Manipulation

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



Step 2: Configure basic settings for each router.

- Router R1

```
R1#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#line con 0
R1(config-line)#exec timeout 0 0
                   ^
% Invalid input detected at '^' marker.

R1(config-line)#exec-timeout 0 0
R1(config-line)#logging sy
R1(config-line)#logging synchronous
R1(config-line)#banner motd # This is R1, BGP Path Manipultaion Lab #
R1(config)#ipv6 unicast-routing
R1(config)#interface f0/0
R1(config-if)#ip address 10.1.2.1 255.255.255.0
R1(config-if)#ipv6 address fe80::1:1 link-local
R1(config-if)#ipv6 address 2001:db8:acad:1012::1/64
R1(config-if)#no sh
R1(config-if)#esit
              ^
% Invalid input detected at '^' marker.

R1(config-if)#esit
*Mar  1 00:03:55.915: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Mar  1 00:03:56.915: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R1(config-if)#exit
R1(config)#interface s1/0
R1(config-if)#ip address 10.1.3.1 255.255.255.128
R1(config-if)#ipv6 address fe80::1:2 link-local
R1(config-if)#ipv6 address 2001:db8:acad:1013::1/64
R1(config-if)#no sh
R1(config-if)#exit
R1(config)#
*Mar  1 00:05:27.015: %LINK-3-UPDOWN: Interface Serial1/0, changed state to up
R1(config)#
*Mar  1 00:05:28.023: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/0, changed state to up
R1(config)#interface s1/1
R1(config-if)#ip address 10.1.3.1
*Mar  1 00:05:53.719: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/0, changed state to down
R1(config-if)#ip address 10.1.3.129 255.255.255.128
R1(config-if)#ipv6 address fe80::1:3 link-local
R1(config-if)#ipv6 address 2001:db8:acad:1014::1/64
R1(config-if)#no sh
R1(config-if)#exit
R1(config)#
```

```
R1(config)#interface loopback 0
R1(config-if)#ip address
*Mar  1 00:08:06.447: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
R1(config-if)#ip address 192.168.1.1 255.255.255.224
R1(config-if)#ipv6 address fe80::1:4 link-local
R1(config-if)#ipv6 address 2001:db8:acad:1000::1/64
R1(config-if)#no sh
R1(config-if)#exit
R1(config)#interface loopback 1
R1(config-if)#ip addres
*Mar  1 00:09:45.139: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback1, changed state to up
R1(config-if)#ip address 192.168.1.65 255.255.255.192
R1(config-if)#ipv6 address fe80::1:5 link-local
R1(config-if)#ipv6 address 2001:db8:acad:1001::1/64
R1(config-if)#no sh
R1(config-if)#exit
R1(config)#
```

- Router R2

```
R2#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R2(config)#no ip domain lookup
R2(config)#line con 0
R2(config-line)#exec-timeout 0 0
R2(config-line)#logging syn
R2(config-line)#logging synchronous
R2(config-line)#banner motd # This is R2, BGP Path Manipulation Lab #
R2(config)#ipv6 unicast-routing
R2(config)#inteface f0/0
             ^
% Invalid input detected at '^' marker.

R2(config)#interface f0/0
R2(config-if)#ip address 10.1.2.2 255.255.255.0
R2(config-if)#ipv6 address fe80::2:1 link-local
R2(config-if)#ipv6 address 2001:db8:acad:1012::2/64
R2(config-if)#no sh
R2(config-if)#exit
R2(config)#
*Mar  1 00:15:56.991: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Mar  1 00:15:57.991: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R2(config)#interface f0/1
R2(config-if)#ip address 10.2.3.2 255.255.255.0
R2(config-if)#ipv6 address fe80::2:2 link-local
R2(config-if)#ipv6 address 2001:db8:acad:1023::2/64
R2(config-if)#no sh
R2(config-if)#exit
R2(config)#
*Mar  1 00:17:11.147: %LINK-3-UPDOWN: Interface FastEthernet0/1, changed state to up
*Mar  1 00:17:12.147: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
R2(config)#interface loopback 0
R2(config-if)#ip a
*Mar  1 00:17:46.455: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
R2(config-if)#ip address 192.168.2.1 255.255.255.224
R2(config-if)#ipv6 address fe80::2:3 link-local
R2(config-if)#ipv6 address 2001:db8:acad:2000::2/64
R2(config-if)#no sh
R2(config-if)#exit
R2(config)#interface loopback 0
R2(config-if)#no ipv6 address 2001:db8:acad:2000::2/64
R2(config-if)#ipv6 address 2001:db8:acad:2000::1/64
R2(config-if)#no shut
R2(config-if)#exit
R2(config)#interface loopback 1
R2(config-if)#
*Mar  1 00:20:07.227: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback1, changed state to up
R2(config-if)#ip address 192.168.2.65 255.255.255.192
R2(config-if)#ipv6 address fe80::2:4 link-local
R2(config-if)#ipv6 address 2001:db8:acad:2001::1/64
R2(config-if)#no shut exit
                   ^
% Invalid input detected at '^' marker.

R2(config-if)#no shut
R2(config-if)#exit
R2(config)#
```

- Router R3

```
R3#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R3(config)#no ip domain lookup
R3(config)#line con 0
R3(config-line)#exec-timeout 0 0
R3(config-line)#logging syn
R3(config-line)#logging synchronous
R3(config-line)#banner motd # This is R3,BGP Path Manipulation Lab #
R3(config)#ipv6 uncast-routing
                ^
% Invalid input detected at '^' marker.

R3(config)#ipv6 unicast-routing
R3(config)#interface f0/0
R3(config-if)#ip address 10.2.3.3 255.255.255.0
R3(config-if)#ipv6 address fe80::3:1 link-local
R3(config-if)#ipv6 address 2001:db8:acad:1023::3/64
R3(config-if)#no sh
R3(config-if)#exit
R3(config)#
*Mar  1 00:24:27.647: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Mar  1 00:24:28.647: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R3(config)#interface s1/0
R3(config-if)#ip address 10.1.3.3 255.255.255.128
R3(config-if)#ipv6 address fe80::3:2 link-local
R3(config-if)#ipv6 address 2001:db8:acad:1013::3/64
R3(config-if)#no sh
R3(config-if)#exit
R3(config)#
*Mar  1 00:25:54.775: %LINK-3-UPDOWN: Interface Serial1/0, changed state to up
R3(config)#
*Mar  1 00:25:55.783: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/0, changed state to up
R3(config)#interface s1/1
R3(config-if)#ip address 10.1.3.130 255.255.255.128
R3(config-if)#ipv6 address fe80::3:3 link-local
R3(config-if)#ipv6 address 2001:db8:acad:1014::3/64
R3(config-if)#no sh
R3(config-if)#exit
R3(config)#
*Mar  1 00:26:39.783: %LINK-3-UPDOWN: Interface Serial1/1, changed state to up
R3(config)#
*Mar  1 00:26:40.791: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/1, changed state to up
R3(config)#interface loopback 0
R3(config-if)#
*Mar  1 00:26:53.915: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
R3(config-if)#ip address 192.168.3.1 255.255.255.224
R3(config-if)#ipv6 address fe80::3:4 link-local
R3(config-if)#ipv6 address 2001:db8:acad:3000::1/64
R3(config-if)#no sh
R3(config-if)#exit
R3(config)#interface loopback 1
R3(config-if)#
*Mar  1 00:28:05.039: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback1, changed state to up
R3(config-if)#ip address 192.168.3.65 255.255.255.192
R3(config-if)#ipv6 address fe80::3:5 link-local
R3(config-if)#ipv6 address 2001:db8:acad:3001::1/64
R3(config-if)#no sh
R3(config-if)#exit
R3(config)#
```

Part 2: Configure and Verify Multi-Protocol BGP on all Routers Step 1:
On R1, create the core BGP configuration.

```
R1(config)#router bgp 6500
R1(config-router)#bgp router-id 1.1.1.1
R1(config-router)#no bgp default ipv4-unicast
R1(config-router)#neighbor
% Incomplete command.

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
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
R1(config-router)#
```

Step 2: On R1, configure the IPv4 unicast address family.

```
R1(config-router)#
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)#no neighbor 2001:db8:acad:1012::2 activate
R1(config-router-af)#no neighbor 2001:db8:acad:1013::3 activate
R1(config-router-af)#no neighbor 2001:db8:acad:1014::3 activate
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
```

Step 3: On R1, configure the IPv6 unicast address family.

```
R1(config-router-af)#
R1(config-router-af)#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)#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)#
```

Step 4: Configure MP-BGP on R2 and R3 as you did in the previous step.

```
R2(config)#router bgp 500
R2(config-router)#bgp router-id 2.2.2.2
R2(config-router)#no bgp default ipv4-unicast
R2(config-router)#neighbor 10.1.2.1 remote-as 6500
R2(config-router)#neighbor 10.2.3.3 remote-as 300
R2(config-router)#neighbor 2001:db8:acad:1012::1 remote-as 6500
R2(config-router)#neighbor 2001:db8:acad:1023::3 remote-as 300
R2(config-router)#address-family ipv4
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)#neighbor 10.1.2.1 activate
R2(config-router-af)#neighbor 10.2.3.3 activate
R2(config-router-af)#
*Mar  1 00:44:52.351: %BGP-5-ADJCHANGE: neighbor 10.1.2.1 Up
R2(config-router-af)#no neighbor 2001:db8:acad:1012::1 activate
R2(config-router-af)#no neighbor 2001:db8:acad:1023::3 activate
R2(config-router-af)#exit-address-family
R2(config-router)#
R2(config-router)#
R2(config-router)#address-family ipv6
R2(config-router-af)#network 2001:db8:acad:2000::/64
R2(config-router-af)#network 2001:db8:acad:2001::/64
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)#
*Mar  1 00:48:22.739: %BGP-5-ADJCHANGE: neighbor 2001:DB8:ACAD:1012::1 Up
R2(config-router-af)#exit-address-family
R2(config-router)#
```

```
R3(config)#
R3(config)#router bgp 300
R3(config-router)#bgp router-id 3.3.3.3
R3(config-router)#no bgp default ipv4-unicast
R3(config-router)#neighbor 10.1.3.1 remote-as 6500
R3(config-router)#neighbor 10.1.3.129 remote-as 6500
R3(config-router)#neighbor 10.2.3.2 remote-as 500
R3(config-router)#neighbor 2001:db8:acad:1013::1 remote-as 6500
R3(config-router)#neighbor 2001:db8:acad:1014::1 remote-as 6500
R3(config-router)#neighbor 2001:db8:acad:1023::2 remote-as 500
R3(config-router)#address-family ipv4
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)#neighbor 10.1.3.1 activate
R3(config-router-af)#neighbor 10.1.3.129 activate
R3(config-router-af)#
*Mar  1 00:54:20.131: %BGP-5-ADJCHANGE: neighbor 10.1.3.1 Up
R3(config-router-af)#neighbor 10.1.3.129 activate
*Mar  1 00:54:45.479: %BGP-5-ADJCHANGE: neighbor 10.1.3.129 Up
R3(config-router-af)#no neighbor 2001:db8:acad:1013::1 activate
R3(config-router-af)#no neighbor 2001:db8:acad:1014::1 activate
R3(config-router-af)#no neighbor 2001:db8:acad:1023::2 activate
R3(config-router-af)#exit-address-family
R3(config-router)#address-family ipv6
R3(config-router-af)#network 2001:db8:acad:3000::/64
R3(config-router-af)#network 2001:db8:acad:3001::/64
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)#neighbor 2001:db8:acad:1014:: activate
*Mar  1 00:57:27.243: %BGP-5-ADJCHANGE: neighbor 2001:DB8:ACAD:1014::1 Up 2 activate
R3(config-router-af)#neighbor 2001:db8:acad:1023::2 activate
R3(config-router-af)#
*Mar  1 00:57:46.247: %BGP-5-ADJCHANGE: neighbor 2001:DB8:ACAD:1023::2 Up
R3(config-router-af)#
*Mar  1 00:57:49.523: %BGP-5-ADJCHANGE: neighbor 2001:DB8:ACAD:1013::1 Up
R3(config-router-af)#exit-address-family
R3(config-router)#
```

Step 5: Verify that MP-BGP is operational.

```
R1#show bgp ipv4 unicast summary
BGP router identifier 1.1.1.1, local AS number 6500
BGP table version is 7, main routing table version 7
6 network entries using 702 bytes of memory
8 path entries using 416 bytes of memory
6/3 BGP path/bestpath attribute entries using 744 bytes of memory
4 BGP AS-PATH entries using 96 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 1958 total bytes of memory
BGP activity 12/0 prefixes, 22/0 paths, scan interval 60 secs

Neighbor        V    AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
10.1.2.2        4   500      21      21        7    0    0 00:14:16        2
10.1.3.3        4   300       9      11        7    0    0 00:04:48        2
10.1.3.130      4   300      11      11        7    0    0 00:04:22        2
R1#
```

```
R1#show bgp ipv6 unicast summary
BGP router identifier 1.1.1.1, local AS number 6500
BGP table version is 9, main routing table version 9
6 network entries using 894 bytes of memory
14 path entries using 1064 bytes of memory
6/3 BGP path/bestpath attribute entries using 744 bytes of memory
4 BGP AS-PATH entries using 96 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 2798 total bytes of memory
BGP activity 12/0 prefixes, 22/0 paths, scan interval 60 secs

Neighbor        V    AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
2001:DB8:ACAD:1012::2
                4   500      20      20        9    0    0 00:12:35        4
2001:DB8:ACAD:1013::3
                4   300      12      10        9    0    0 00:03:09        4
2001:DB8:ACAD:1014::3
                4   300      12      11        9    0    0 00:03:31        4
% NOTE: This command is deprecated. Please use 'show bgp ipv6 unicast'
R1#
```

```
R1#show bgp ipv4 unicast | begin Network
   Network          Next Hop            Metric LocPrf Weight Path
*> 192.168.1.0/27   0.0.0.0                  0         32768 i
*> 192.168.1.64/26  0.0.0.0                  0         32768 i
*> 192.168.2.0/27   10.1.2.2                 0             0 500 i
*> 192.168.2.64/26  10.1.2.2                 0             0 500 i
*  192.168.3.0/27   10.1.3.130               0             0 300 i
*>                  10.1.3.3                 0             0 300 i
*  192.168.3.64/26  10.1.3.130               0             0 300 i
*>                  10.1.3.3                 0             0 300 i
R1#
```

```
R1#show bgp ipv6 unicast | begin Network
   Network          Next Hop            Metric LocPrf Weight Path
*> 2001:DB8:ACAD:1000::/64
                    ::                       0         32768 i
*> 2001:DB8:ACAD:1001::/64
                    ::                       0         32768 i
*  2001:DB8:ACAD:2000::/64
                    2001:DB8:ACAD:1014::3
                                                           0 300 500 i
*                   2001:DB8:ACAD:1013::3
                                                           0 300 500 i
*>                  2001:DB8:ACAD:1012::2
                                             0             0 500 i
*  2001:DB8:ACAD:2001::/64
                    2001:DB8:ACAD:1014::3
                                                           0 300 500 i
*                   2001:DB8:ACAD:1013::3
                                                           0 300 500 i
*>                  2001:DB8:ACAD:1012::2
                                             0             0 500 i
*  2001:DB8:ACAD:3000::/64
                    2001:DB8:ACAD:1012::2
                                                           0 500 300 i
*>                  2001:DB8:ACAD:1013::3
                                             0             0 300 i
*                   2001:DB8:ACAD:1014::3
                                             0             0 300 i
*  2001:DB8:ACAD:3001::/64
                    2001:DB8:ACAD:1012::2
                                                           0 500 300 i
*>                  2001:DB8:ACAD:1013::3
                                             0             0 300 i
*                   2001:DB8:ACAD:1014::3
                                             0             0 300 i
R1#
```

• View Routing Tables:

```
R1#show ipv6 route bgp
IPv6 Routing Table - 16 entries
Codes: C - Connected, L - Local, S - Static, R - RIP, B - BGP
       U - Per-user Static route
       I1 - ISIS L1, I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary
       O - OSPF intra, OI - OSPF inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
       ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
B   2001:DB8:ACAD:2000::/64 [20/0]
     via FE80::2:1, FastEthernet0/0
B   2001:DB8:ACAD:2001::/64 [20/0]
     via FE80::2:1, FastEthernet0/0
B   2001:DB8:ACAD:3000::/64 [20/0]
     via FE80::3:2, Serial1/0
B   2001:DB8:ACAD:3001::/64 [20/0]
     via FE80::3:2, Serial1/0
R1#
```

Part 3: Configure and Verify BGP Path Manipulation Settings on all Routers Step 1:
Configure ACL-based route filtering.

• On R1, issue the command show bgp ipv4 unicast | i 300 to see what prefixes ASN300 is sharing via BGP. Take note of those prefixes that do not originate in ASN300.

```
R1#
R1#show bgp ipv4 unicast | i 300
*  192.168.3.0/27   10.1.3.130              0             0 300 i
*>                  10.1.3.3                0             0 300 i
*  192.168.3.64/26  10.1.3.130              0             0 300 i
*>                  10.1.3.3                0             0 300 i
R1#show bgp ipv4 unicast | i 300
*  192.168.3.0/27   10.1.3.130              0             0 300 i
*>                  10.1.3.3                0             0 300 i
*  192.168.3.64/26  10.1.3.130              0             0 300 i
*>                  10.1.3.3                0             0 300 i
R1#show bgp ipv4 unicast | begin 192.168.3
*  192.168.3.0/27   10.1.3.130              0             0 300 i
*>                  10.1.3.3                0             0 300 i
*  192.168.3.64/26  10.1.3.130              0             0 300 i
*>                  10.1.3.3                0             0 300 i
R1#
```

- On R3, configure an access list designed to match the source address and mask of the networks belonging to ASN300:

```
R3(config)#ip access-list extended ALLOWED_TO_R!
R3(config-ext-nacl)#permit ip 192.168.3.0 0.0.0.0 255.255.255.224 0.0.0.0
R3(config-ext-nacl)#permit ip 192.168.3.64 0.0.0.0 255.255.255.192 0.0.0.0
R3(config-ext-nacl)#exit
R3(config)#
```

- On R3, apply the ALLOWED_TO_R1 ACL as a distribute list to the IPv4 neighbor adjacencies with R1.

```
R3(config)#router bgp 300
R3(config-router)#address-family ipv4 unicast
R3(config-router-af)#neighbor 10.1.3.1 distribute-list ALLOWED_TO_R1 out
R3(config-router-af)#neighbor 10.1.3.129 distribute-list ALLOWED_TO_R1 out
R3(config-router-af)#end
R3#
*Mar  1 01:47:41.011: %SYS-5-CONFIG_I: Configured from console by console
R3#
```

- Perform a reset of the IPv4 adjacency with R1 for the outbound traffic without tearing down the session.

```
R3#clear bgp ipv4 unicast 6500 out
R3#
```

- On R1, issue the command show bgp ipv4 unicast | i 300 to see what prefixes routes ASN300 is now sharing via BGP. All of the prefixes should now originate in ASN300:

```
R1#show bgp ipv4 unicast | i 300
*  192.168.3.0/27   10.1.3.130              0             0 300 i
*>                  10.1.3.3                0             0 300 i
*  192.168.3.64/26  10.1.3.130              0             0 300 i
*>                  10.1.3.3                0             0 300 i
R1#
```

Step 2: Configure prefix-list-based route filtering.

- On R1, issue the command show bgp ipv4 unicast | begin 192.168.3 to see what prefixes ASN500 is sharing via BGP. Take note of those prefixes that do not originate in ASN500.

```
R1#show bgp ipv4 unicast | begin 192.168.3
*  192.168.3.0/27   10.1.3.130              0             0 300 i
*>                  10.1.3.3                0             0 300 i
*  192.168.3.64/26  10.1.3.130              0             0 300 i
*>                  10.1.3.3                0             0 300 i
R1#
```

s

- On R1, configure a prefix list designed to match the source address and mask of networks belonging to ASN500.

```
R1(config)#ip prefix-list ALLOWED_FROM_R2 seq 5 permit 192.168.2.0/24 le 27
```

- Apply the ALLOWED_FROM_R2 prefix list to the IPv4 neighbor adjacencies for R2.

```
R1(config)#router bgp 6500
R1(config-router)#address-family ipv4 unicast
R1(config-router-af)#neighbor 10.1.2.2 prefix-list ALLOWED_FROM_R2 in
R1(config-router-af)#end
R1#
```

- Perform a reset of the IPv4 adjacency with R2 for the inbound traffic without tearing down the session

```
R1#clear bgp ipv4 unicast 500 in
```

- On R1, issue the command show bgp ipv4 unicast | i 500 to see what prefixes routes ASN500 is now sharing via BGP. All of the prefixes should now originate in ASN500.

```
R1#show bgp ipv4 unicast | i 500
*> 192.168.2.0/27   10.1.2.2              0             0 500 i
*> 192.168.2.64/26  10.1.2.2              0             0 500 i
R1#
```

Step 3: Configure an AS-PATH ACL to filter routes being advertised.

- On R2, issue the command show bgp ipv4 unicast | begin Network to see what prefixes ASN6500 is sharing via BGP.

```
R2#show bgp ipv4 unicast | begin Network
   Network          Next Hop            Metric LocPrf Weight Path
*> 192.168.1.0/27   10.1.2.1                 0             0 6500 i
*> 192.168.1.64/26  10.1.2.1                 0             0 6500 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 6500 300 i
*> 192.168.3.64/26  10.1.2.1                               0 6500 300 i
R2#
```

- On R1, configure AS-PATH ACL to match the routes from the local ASN.

```
R1#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#ip as-path access-list 1 permit ^$
R1(config)#
```

- On R1, apply the AS-PATH ACL as a filter-list on the adjacency configured with R2.

```
R1(config)#router bgp 6500
R1(config-router)#address-family ipv4 unicast
R1(config-router-af)#neighbor 10.1.2.2 filter-list 1 out
R1(config-router-af)#end
```

- On R1, perform a reset of the IPv4 adjacency with R2 for the outbound traffic without tearing down the session

```
R1#clear bgp ipv4 unicast 500 out
```

- On R2, issue the command show bgp ipv4 unicast | i 6500 to see what prefixes routes ASN6500 is now sharing via BGP. All of the prefixes should now originate in ASN6500.

```
R2#show bgp ipv4 unicast | i 6500
*> 192.168.1.0/27   10.1.2.1              0             0 6500 i
*> 192.168.1.64/26  10.1.2.1              0             0 6500 i
R2#
```

Step 4: Configure IPv6 prefix-list-based route filtering.

- On R1, issue the command show bgp ipv6 unicast neighbors 2001:db8:acad:1012::2 routes to see what IPv6 prefixes ASN500 is sharing via BGP.

```
R1#show bgp ipv6 unicast neighbors 2001:db8:acad:1012::2 routes
BGP table version is 9, local router ID is 1.1.1.1
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
*> 2001:DB8:ACAD:2000::/64
                    2001:DB8:ACAD:1012::2
                                         0             0 500 i
*> 2001:DB8:ACAD:2001::/64
                    2001:DB8:ACAD:1012::2
                                         0             0 500 i
*  2001:DB8:ACAD:3000::/64
                    2001:DB8:ACAD:1012::2
                                                       0 500 300 i
*  2001:DB8:ACAD:3001::/64
                    2001:DB8:ACAD:1012::2
                                                       0 500 300 i

Total number of prefixes 4
```

- On R1, configure an IPv6 prefix list designed to match the source address and mask of networks belonging to ASN500.

```
R1(config)#ipv6 prefix-list IPV6_ALLOWED_FROM_R2 seq 5 permit 2001:db8:acad:20$
R1(config)#$-list IPV6_ALLOWED_FROM_R2 seq 10 permit 2001:db8:acad:2001::/64
R1(config)#
```

- Apply the IPV6_ALLOWED_FROM_R2 prefix list to the IPv6 neighbor adjacencies for R2

```
R1(config)#router bgp 6500
R1(config-router)#address-family ipv6 unicast
R1(config-router-af)#$01:db8:acad:1012::2 prefix-list IPV6_ALLOWED_FROM_R2 in
R1(config-router-af)#end
R1#
```

- Perform a reset of the IPv6 adjacency with R2 for the inbound traffic without tearing down the session.

```
R1#clear bgp ipv6 unicast 500 in
R1#
```

On R1, issue the command show bgp ipv6 unicast neighbors 2001:db8:acad:1012::2 routes to see what IPv6 prefixes routes ASN500 is now sharing via BGP. All of the IPv6 prefixes should now originate in ASN500.

```
R1#show bgp ipv6 unicast neighbors 2001:db8:acad:1012::2 routes
BGP table version is 9, local router ID is 1.1.1.1
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
*> 2001:DB8:ACAD:2000::/64
                    2001:DB8:ACAD:1012::2
                                         0             0 500 i
*> 2001:DB8:ACAD:2001::/64
                    2001:DB8:ACAD:1012::2
                                         0             0 500 i

Total number of prefixes 2
```

Step 5: Configure BGP path attribute manipulation to effect routing

```
R1#show bgp ipv4 unicast 192.168.3.0
BGP routing table entry for 192.168.3.0/27, version 7
Paths: (2 available, best #2, table Default-IP-Routing-Table)
  Advertised to update-groups:
     1
  300
    10.1.3.130 from 10.1.3.130 (3.3.3.3)
      Origin IGP, metric 0, localpref 100, valid, external
  300
    10.1.3.3 from 10.1.3.3 (3.3.3.3)
      Origin IGP, metric 0, localpref 100, valid, external, best
R1#
```

- On R1, configure a prefix list designed to match the source address and mask of networks belonging to ASN300.

```
R1#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#$ist PREFERRED_IPV4_PATH seq 5 permit 192.168.3.0/24 le 27
R1(config)#
```

- Create a route-map named USE_THIS_PATH_FOR_IPV4 that matches on the prefix list you just created and sets the local preference to 250.

```
R1(config)#route-map USE_THIS_PATH_FOR_IPV4 permit 10
R1(config-route-map)#match ip address prefix-list PREFERRED_IPV4_PATH
R1(config-route-map)#set local-preference 250
R1(config-route-map)#exit
```

- Next, apply this route map to the BGP neighbor 10.1.3.130.

```
R1(config)#router bgp 6500
R1(config-router)#address-family ipv4 unicast
R1(config-router-af)#neighbor 10.1.3.130 route-map USE_THIS_PATH_FOR_IPV4 in
R1(config-router-af)#end
```

- Perform a reset of the IPv4 adjacency with R3 for the inbound traffic without tearing down the session.

```
R1#clear bgp ipv4 unicast 300 in
```

- On R1, issue the command show ip route bgp and take note of the next hop addresses for the 192.168.3.0/27 and 192.168.3.64/26 networks; it should be 10.1.3.130 for both. Issue the command show bgp ipv4 unicast and you should see the local preference value in the appropriate column.

```
R1#show ip route bgp
     192.168.2.0/24 is variably subnetted, 2 subnets, 2 masks
B       192.168.2.64/26 [20/0] via 10.1.2.2, 02:00:47
B       192.168.2.0/27 [20/0] via 10.1.2.2, 02:00:47
     192.168.3.0/24 is variably subnetted, 2 subnets, 2 masks
B       192.168.3.64/26 [20/0] via 10.1.3.130, 00:00:10
B       192.168.3.0/27 [20/0] via 10.1.3.130, 00:00:10
```

```
R1#show bgp ipv4 unicast | begin Network
   Network          Next Hop            Metric LocPrf Weight Path
*> 192.168.1.0/27   0.0.0.0                  0         32768 i
*> 192.168.1.64/26  0.0.0.0                  0         32768 i
*> 192.168.2.0/27   10.1.2.2                 0             0 500 i
*> 192.168.2.64/26  10.1.2.2                 0             0 500 i
*> 192.168.3.0/27   10.1.3.130               0    250      0 300 i
*                   10.1.3.3                 0             0 300 i
*> 192.168.3.64/26  10.1.3.130               0    250      0 300 i
*                   10.1.3.3                 0             0 300 i
R1#
```