Practical 9

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:
What Does External Border Gateway Protocol (EBGP) Mean?
- External Border Gateway Protocol (EBGP) is a Border Gateway Protocol (BGP) extension that is used for communication between distinct autonomous systems (AS).
- EBGP enables network connections between autonomous systems and autonomous systems implemented with BGP.
- It serves as the primary protocol behind global Internet or AS connectivity.
- EBGP is generally used for the interconnection of networks for different organizations or the global Internet.
- These organizations may be Internet service providers (ISP), universities or large corporations that have a vast network infrastructure.
- For EBGP to work, each AS must implement BGP for internal communications.
- EBGP is used and implemented at the edge or border router that provides interconnectivity for two or more autonomous systems.
- It works in collaboration with Internal Border Gateway Protocol (IBGP) to transfer data from the external Internet/AS to the internal Internet/AS, and vice versa.

Step 1: Build the topology:
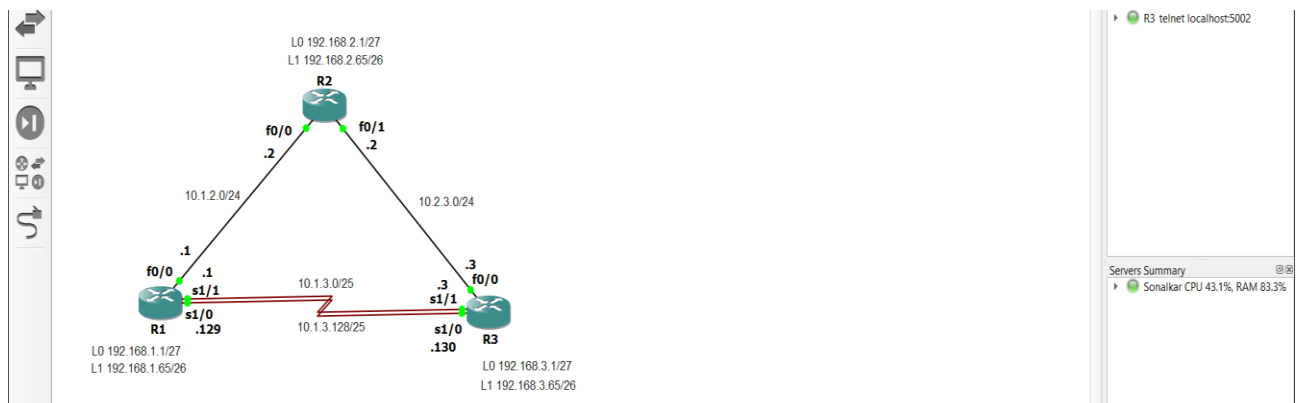
Step 2: Configure basic configuration in the routers

R1:

```
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)#logging sync
R1(config-line)#exec
R1(config-line)#exec-
R1(config-line)#exec-timeout 0 0
R1(config-line)#exit
R1(config)#int f0/0
R1(config-if)#ip add 10.1.2.1 255.255.255.0
R1(config-if)#no shut
R1(config-if)#ex
R1(config)#
*Mar  1 00:05:14.795: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Mar  1 00:05:15.795: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R1(config)#int s1/0
R1(config-if)#ip add 10.1.3.1 255.255.255.128
R1(config-if)#no shut
R1(config-if)#ex
R1(config)#
*Mar  1 00:05:44.311: %LINK-3-UPDOWN: Interface Serial1/0, changed state to up
*Mar  1 00:05:45.311: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/0, changed state to up
R1(config)#int s1/1
R1(config-if)#ip add 10.1.3.129 255.255.255.128
R1(config-if)#
*Mar  1 00:06:13.163: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/0, changed state to down
R1(config-if)#no shut
R1(config-if)#ex
R1(config)#
*Mar  1 00:06:22.523: %LINK-3-UPDOWN: Interface Serial1/1, changed state to up
*Mar  1 00:06:23.523: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/1, changed state to up
R1(config)#int L0
R1(config-if)#
*Mar  1 00:06:32.119: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
R1(config-if)#ip add 192.168.1.1 255.255.255.224
R1(config-if)#no shut
*Mar  1 00:06:53.175: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/1, changed state to down
R1(config-if)#no shut
R1(config-if)#ex
R1(config)#int L1
R1(config-if)#
*Mar  1 00:07:01.979: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback1, changed state to up
R1(config-if)#ip add 192.168.1.65 255.255.255.192
R1(config-if)#no shut
R1(config-if)#ex
R1(config)#end
R1#wr
Building configuration...

*Mar  1 00:07:32.487: %SYS-5-CONFIG_I: Configured from console by console[OK]
R1#
R1#
R1#
R1#
*Mar  1 00:14:33.155: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/0, changed state to up
R1#
*Mar  1 00:15:03.171: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/1, changed state to up
R1#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#
R1(config)#
```

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)#logging synch
R2(config-line)#logging synchronous
R2(config-line)#exec-timeout 0 0
R2(config-line)#ex
% Ambiguous command:  "ex"
R2(config-line)#exit
R2(config)#int f0/0
R2(config-if)#ip add 10.1.2.2 255.255.255.0
R2(config-if)#no shut
R2(config-if)#ex
R2(config)#
*Mar  1 00:10:10.811: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Mar  1 00:10:11.811: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R2(config)#int f0/1
R2(config-if)#ip add 10.2.3.2 255.255.255.0
R2(config-if)#no shut
R2(config-if)#ex
R2(config)#
*Mar  1 00:10:46.859: %LINK-3-UPDOWN: Interface FastEthernet0/1, changed state to up
*Mar  1 00:10:47.859: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
R2(config)#int L0
R2(config-if)#
*Mar  1 00:11:00.943: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
R2(config-if)#ip add 192.168.2.1 255.255.255.224
R2(config-if)#no shut
R2(config-if)#ex
R2(config)#int L1
R2(config-if)#ip ad
*Mar  1 00:11:34.879: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback1, changed state to up
R2(config-if)#ip add 192.168.2.65 255.255.255.192
R2(config-if)#no shut
R2(config-if)#ex
R2(config)#end
R2#wr
Building configuration...
[OK]
R2#
```

R3:

```
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)#logging synch
R3(config-line)#logging synchronous
R3(config-line)#exec-time
R3(config-line)#exec-timeout 0 0
R3(config-line)#exit
R3(config)#int f0/0
R3(config-if)#ip add 10.2.3.3 255.255.255.0
R3(config-if)#no shut
R3(config-if)#ex
R3(config)#int
*Mar  1 00:13:50.651: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Mar  1 00:13:51.651: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R3(config)#int s1/0
R3(config-if)#ip add 10.1.3.3 255.255.255.128
R3(config-if)#no shut
R3(config-if)#ex
R3(config)#
*Mar  1 00:14:20.635: %LINK-3-UPDOWN: Interface Serial1/0, changed state to up
*Mar  1 00:14:21.635: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/0, changed state to up
R3(config)#int s1/1
R3(config-if)#ip add 10.1.3.130 255.255.255.128
R3(config-if)#no shut
R3(config-if)#ex
R3(config)#
*Mar  1 00:14:47.539: %LINK-3-UPDOWN: Interface Serial1/1, changed state to up
*Mar  1 00:14:48.539: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/1, changed state to up
R3(config)#int L0
R3(config-if)#
*Mar  1 00:14:59.879: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
R3(config-if)#ip add 192.168.3.1 255.255.255.224
R3(config-if)#no shut
R3(config-if)#ex
R3(config)#int L1
R3(config-if)#
*Mar  1 00:15:31.055: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback1, changed state to up
R3(config-if)#ip add 192.168.3.65 255.255.255.192
R3(config-if)#no shut
R3(config-if)#ex
R3(config)#end
R3#wr
*Mar  1 00:16:15.667: %SYS-5-CONFIG_I: Configured from console by console
R3#wr
Building configuration...
[OK]
R3#
R3#
```

Step 3: Implement BGP and neighbor relationships on all the routers

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)#
```

R2:

```
R2#
R2#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R2(config)#router bgp 500
R2(config-router)#bgp router-id 2.2.2.2
R2(config-router)#neighbor 10.1.2.1 remote-as 1000
R2(config-router)#neighbor
*Mar  1 00:39:18.819: %BGP-5-ADJCHANGE: neighbor 10.1.2.1 Up
R2(config-router)#neighbor 10.2.3.3 remote-as 300
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)#
R2(config-router)#
```

R3:

```
R3#
R3#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
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 on R1 and R2:

R1:

```
R1#sh 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, 00:01:57
B       192.168.2.0/27 [20/0] via 10.1.2.2, 00:02:28
R1#
```

R2:

```
R2#sh 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, 00:02:46
B       192.168.1.0/27 [20/0] via 10.1.2.1, 00:02:46
R2#
```

Step 5: Using 'sh ip bgp neighbor' on R2 we can notice the BGP state between R2 and R1 is established, while the BGP state between R2 and R3 is idle

```
R2#
R2#
R2#sh 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 00:04:01
  Last read 00:00:00, last write 00:00:00, 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          3
    Keepalives:         6          6
    Route Refresh:      0          0
    Total:             10         10
  Default minimum time between advertisement runs is 30 seconds
```

Step 6: The interfaces on R3 need to be activated in IPv4 AF configuration mode.

The neighbor activate command in IPv4 AF configuration mode is required to enable the exchange of BGP information between neighbors. This will enable R3 to form an established neighbor adjacency with both R1 and R2.

Additionally, because bgp default ipv4-unicast is disabled, network commands must be configured 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
R3(config-router-af)#neighbor 10.1.3. activate
*Mar  1 00:45:16.195: %BGP-5-ADJCHANGE: neighbor 10.1.3.1 Up
R3(config-router-af)#neighbor 10.1.3.2 activate
*Mar  1 00:45:20.183: %BGP-5-ADJCHANGE: neighbor 10.1.3.129 Up
R3(config-router-af)#neighbor 10.1.3.2 activate
% Specify remote-as or peer-group commands first
R3(config-router-af)#neighbor 10.2.3.2 activate
R3(config-router-af)#network 192.168.3.0 mask 255.255.255.224
R3(config-router-af)#network 192.168.3.0 mask 255.255.255.224
*Mar  1 00:46:04.539: %BGP-5-ADJCHANGE: neighbor 10.2.3.2 Up
R3(config-router-af)#network 192.168.3.64 mask 255.255.255.224
R3(config-router-af)#network 192.168.3.64 mask 255.255.255.192
R3(config-router-af)#end
R3#
```

Step 7: Verify that the BGP state between R2 and R3 has now been established

```
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 00:03:56
  Last read 00:00:57, last write 00:00:57, 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:            4          4
    Keepalives:         7          7
    Route Refresh:      0          0
    Total:             12         12
  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 8: Examining the running-configs on all the routers

R1:

```
R1#
R1#
R1#sh 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:

```
R2#
R2#sh 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:

```
          - - -- -- - - - - - - - -- - - - -- - - - - - - - - -- - - - -
R3#sh 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
 network 192.168.3.64 mask 255.255.255.224
 exit-address-family
R3#
```

Step 9: Verifying BGP operations.

To verify the BGP operation on R2, issue the 'show ip bgp' command.

```
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#
```

Use the show ip bgp ip-address command to display all the paths for a specific route and the BGP path attributes for that route.

```
R2#
R2#sh ip bgp 192.168.1.0
BGP routing table entry for 192.168.1.0/27, version 2
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#
```

Examine the BGP neighbor relationships on R2 using the show ip bgp neighbors command.

```
 Number of NLRIs in the update sent: max 2, min 1

R2#sh 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 00:10:25
  Last read 00:00:24, last write 00:00:24, 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:                5          5
    Keepalives:            12         12
    Route Refresh:          0          0
    Total:                 18         18
  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:              6          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
    Total:                               0         2
  Number of NLRIs in the update sent: max 2, min 1

  Connections established 1; dropped 0
  Last reset never
Connection state is ESTAB, I/O status: 1, unread input bytes: 0
Connection is ECN Disabled, Mininum incoming TTL 0, Outgoing TTL 1
Local host: 10.1.2.2, Local port: 179
Foreign host: 10.1.2.1, Foreign port: 23664

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

Event Timers (current time is 0x2DBEB0):
Timer          Starts    Wakeups           Next
Retrans            17          0            0x0
TimeWait            0          0            0x0
AckHold            18         17            0x0
SendWnd             0          0            0x0
KeepAlive           0          0            0x0
GiveUp              0          0            0x0
PmtuAger            0          0            0x0
DeadWait            0          0            0x0

iss:   160596169  snduna:  160596698  sndnxt:  160596698     sndwnd:  15856
irs:    38816499  rcvnxt:   38817023  rcvwnd:      15861  delrcvwnd:    523

SRTT: 269 ms, RTTO: 516 ms, RTV: 247 ms, KRTT: 0 ms
minRTT: 24 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: 24 (out of order: 0), with data: 18, total data bytes: 523
Sent: 34 (retransmit: 0, fastretransmit: 0, partialack: 0, Second Congestion: 0), with data: 16, total data bytes: 528

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 00:03:56
  Last read 00:00:57, last write 00:00:57, 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:                4          4
    Keepalives:             7          7
    Route Refresh:          0          0
    Total:                 12         12
  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

R2#
```

We have successfully implemented the Ebgp Protocol for IPv4.

2. Implement MP(Multi-protocol) -BGP

The normal version of BGP (Border Gateway Protocol) only supported IPv4 unicast prefixes. Nowadays we use MP-BGP (Multiprotocol BGP) which supports different addresses.

Multiprotocol BGP supports IPv4 and IPv6 address families and their unicast and multicast variants.

Multiprotocol BGP (MP-BGP) is an extension to BGP that enables BGP to carry routing information for multiple network layers and address families. MP-BGP can carry the unicast routes used for multicast routing separately from the routes used for unicast IP forwarding.

Step 1: Build a network topology:
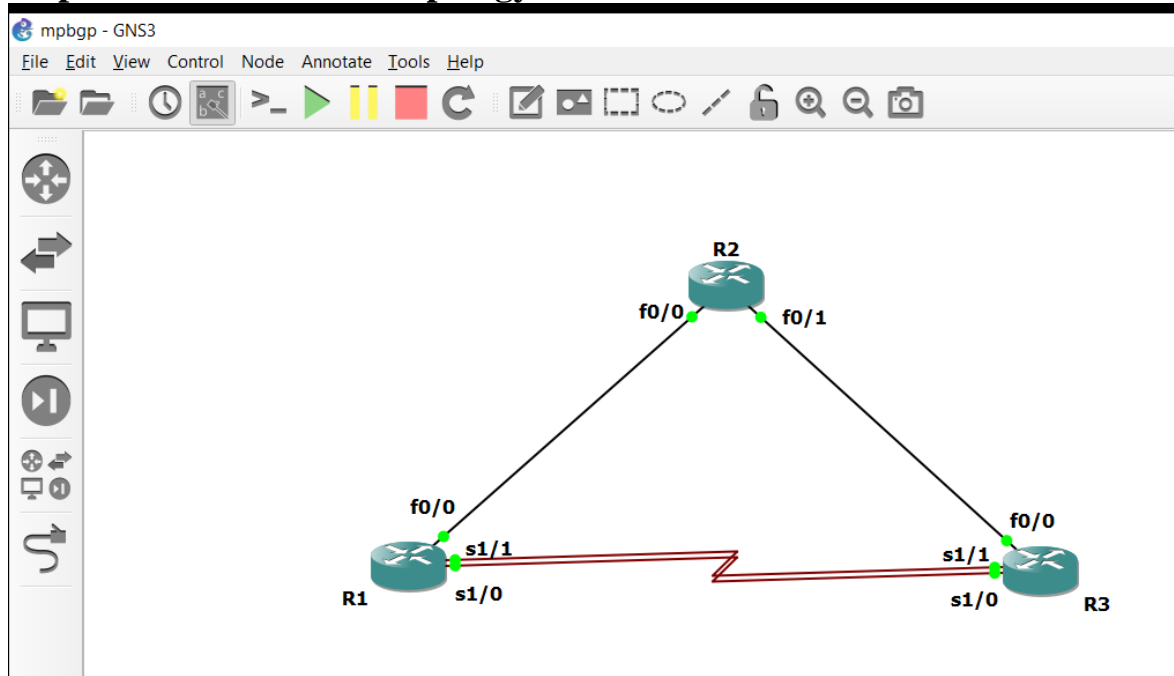
Step 2: Configure basic configuration in the routers:

R1:

```
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)#exec-time
R1(config-line)#exec-timeout 0 0
R1(config-line)#logging synch
R1(config-line)#logging synchronous
R1(config-line)#exit
R1(config)#ipv6 unicast-routing
R1(config)#ip add 10.1.2.1 255.255.255.0
                   ^
% Invalid input detected at '^' marker.

R1(config)#inf f0/0
              ^
% Invalid input detected at '^' marker.

R1(config)#int f0/0
R1(config-if)#ip add 10.1.2.1 255.255.255.0
R1(config-if)#ipv6 add fe80::1:1 link-local
R1(config-if)#ipv6 add 2001:db8:acad:1012::1/64
R1(config-if)#no shut
R1(config-if)#ex
R1(config)#
*Mar  1 00:03:57.555: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Mar  1 00:03:58.555: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R1(config)#int s1/0
R1(config-if)#ip add 10.1.3.1 255.255.255.128
R1(config-if)#ipv6 add fe80::1:2 link-local
R1(config-if)#ipv6 add 2001:db8:acad:1013::1/80
R1(config-if)#no shut
R1(config-if)#ex
R1(config)#
*Mar  1 00:05:19.619: %LINK-3-UPDOWN: Interface Serial1/0, changed state to up
R1(config)#
*Mar  1 00:05:20.627: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/0, changed state to up
R1(config)#int s1/1
R1(config-if)#ip add 10.1.
*Mar  1 00:05:42.855: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/0, changed state to down
R1(config-if)#ip add 10.1.3.1 255.255.255.128
R1(config-if)#ipv6 add fe80::1:3 link-local
R1(config-if)#ipv6 add 2001:db8:acad:1014::1/80
R1(config-if)#no shut
R1(config-if)#ex
R1(config)#
```

```
R1(config)#
*Mar  1 00:06:44.747: %LINK-3-UPDOWN: Interface Serial1/1, changed state to up
*Mar  1 00:06:45.747: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/1, changed state to up
R1(config)#int L0
R1(config-if)#
*Mar  1 00:07:12.859: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/1, changed state to down
R1(config-if)#
*Mar  1 00:07:14.971: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
R1(config-if)#ip add 192.168.1.1 255.255.255.224
R1(config-if)#ipv6 add fe80::1:4 link-local
R1(config-if)#ipv6 add 2001:db8:acad:1000::1/64
R1(config-if)#no shut
R1(config-if)#ex
R1(config)#int L1
R1(config-if)#ipv6 add 2001:db8:acad:1000::1/64
*Mar  1 00:08:36.983: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback1, changed state to up
R1(config-if)#ip add 192.168.1.65 255.255.255.192
R1(config-if)#ipv6 add fe80::1:4 link-local
R1(config-if)#no ipv6 add fe80::1:4 link-local
R1(config-if)#ipv6 add fe80::1:5 link-local
R1(config-if)#ipv6 add 2001:db8:acad:1001::1/64
R1(config-if)#no shut
R1(config-if)#ex
R1(config)#end
```

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 synch
R2(config-line)#logging synchronous
R2(config-line)#exit
R2(config)#ipv6 unicast-routing
R2(config)#int f0/0
R2(config-if)#ip add 10.1.2.2 255.255.255.0
R2(config-if)#ipv6 add fe80::2:1 link-local
R2(config-if)#ipv6 add 2001:db8:acad:1021::2/64
R2(config-if)#no shut
R2(config-if)#ex
R2(config)#int f
*Mar  1 00:11:23.963: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Mar  1 00:11:24.963: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R2(config)#int f0/1
R2(config-if)#ip add 10.2.3.2 255.255.255.0
R2(config-if)#ipv6 add fe80::2:2 link-local
R2(config-if)#ipv6 add 2001:db8:acad:1023::2/64
R2(config-if)#no shut
R2(config-if)#ex
R2(config)#
*Mar  1 00:12:14.227: %LINK-3-UPDOWN: Interface FastEthernet0/1, changed state to up
*Mar  1 00:12:15.227: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
R2(config)#int L0
R2(config-if)#i
*Mar  1 00:12:20.467: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
R2(config-if)#ip add 192.168.2.1 255.255.255.224
R2(config-if)#ipv6 add fe80::2:3 link-local
R2(config-if)#ipv6 add 2001:db8:acad:2000::2/64
R2(config-if)#no shut
R2(config-if)#ex
R2(config)#int L1
R2(config-if)#ip
*Mar  1 00:13:25.155: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback1, changed state to up
R2(config-if)#ip add 192.168.2.65 255.255.255.192
R2(config-if)#ipv6 add fe80::2:4 link-local
R2(config-if)#ipv6 add 2001:db8:acad:2001::2/64
R2(config-if)#no shut
R2(config-if)#ex
R2(config)#end
```

R3:

```
R3#
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-timout 0 0
                          ^
% Invalid input detected at '^' marker.

R3(config-line)#logging synch
R3(config-line)#exec-timeout 0 0
R3(config-line)#logging synch
R3(config-line)#logging synchronous
R3(config-line)#exit
R3(config)#ipv6 unicast-routing
R3(config)#int f0/0
R3(config-if)#ip add 10.2.3.3 255.255.255.0
R3(config-if)#ipv6 add fe80::3:1 link-local
R3(config-if)#ipv6 add 2001:db8:acad:1023::3/64
R3(config-if)#no shut
R3(config-if)#ex
R3(config)#
*Mar  1 00:29:19.087: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Mar  1 00:29:20.087: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R3(config)#int s1/0
R3(config-if)#ip add 10.1.3.3 255.255.255.128
R3(config-if)#ipv6 add fe80::3:2 link-local
R3(config-if)#ipv6 add 2001:db8:acad:1013::3/80
R3(config-if)#no shut
R3(config-if)#ex
R3(config)#
*Mar  1 00:30:12.527: %LINK-3-UPDOWN: Interface Serial1/0, changed state to up
R3(config)#
*Mar  1 00:30:13.535: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/0, changed state to up
R3(config)#int s1/1
R3(config-if)#ip add 10.1.3.130 255.255.255.128
R3(config-if)#ipv6 add fe80::3:3 link-local
R3(config-if)#ipv6 add 2001:db8:acad:1014::3/80
R3(config-if)#no shut
R3(config-if)#ex
R3(config)#
*Mar  1 00:31:11.143: %LINK-3-UPDOWN: Interface Serial1/1, changed state to up
R3(config)#
*Mar  1 00:31:12.151: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/1, changed state to up
R3(config)#int L0
R3(config-if)#
*Mar  1 00:31:19.047: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
R3(config-if)#ip add 192.168.3.1 255.255.255.224
R3(config-if)#ipv6 add fe80::3:4 link-local
R3(config-if)#ipv6 add 2001:db8:acad:3000::1/64
R3(config-if)#no shut
R3(config-if)#ex
R3(config)#int L1
R3(config-if)#ip
*Mar  1 00:32:15.407: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback1, changed state to up
R3(config-if)#ip add 192.168.3.65 255.255.255.192
R3(config-if)#ipv6 add fe80::3:5 link local
                                  ^
% Invalid input detected at '^' marker.

R3(config-if)#ipv6 add fe80::3:5 link-local
R3(config-if)#ipv6 add 2001:db8:acad:3001::1/64
R3(config-if)#no shut
R3(config-if)#ex
R3(config)#
```

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

We will configure and verify Multi-Protocol BGP on all routers to achieve full connectivity between the routers.

First, we will complete configuration for R1.

Create the core BGP configuration on R1:

```
R1#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#router bgp 6500
R1(config-router)#bgp router-id 1.1.1.1
R1(config-router)#no bgp defualt ipv4-unicast
                              ^
% Invalid input detected at '^' marker.

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: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 3: Configure the IPv4 unicast address family On R1.

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

Step 4: Configure the IPv6 unicast address family On R1.

```
R1(config-router)#
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)#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 5: Verify that MP-BGP is operational.

Use the 'show bgp ipv4 unicast summary' and 'show bgp ipv6 unicast summary' commands to verify that BGP has established adjacencies and received prefixes.

IPv4:

```
R1#sh 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    Idle
R1#
```

IPv6:

```
R1#sh 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
% NOTE: This command is deprecated. Please use 'show bgp ipv6 unicast'
R1#
```

Step 6: Use the 'show bgp ipv4 unicast' and 'show bgp ipv6 unicast' commands to view the specified BGP tables.

```
R1#sh 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#sh 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'
```

Step 7: Use the 'show ipv6 route bgp' commands to view the routing tables.

```
R1#sh 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:

BGP (Border Gateway Protocol) routers usually receive multiple paths to the same destination. Like how our IGPs (RIP, EIGRP, OSPF) work, we need to select the best path to each destination.

BGP however, selects the best path based on a list of attributes. On the Internet, it's more important that you have granular control over how you forward your traffic and to which autonomous systems instead of just going for the shortest path based on a metric.

Step 1: Build the network topology:
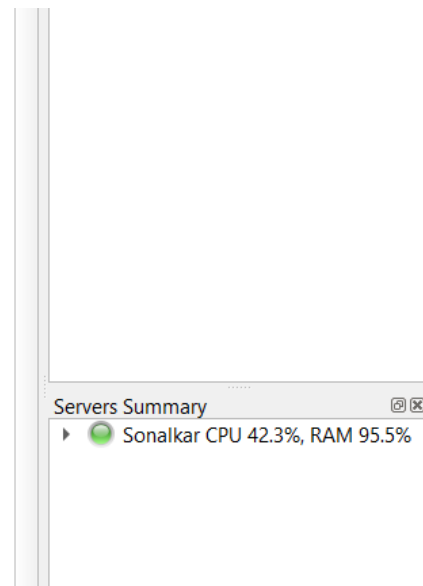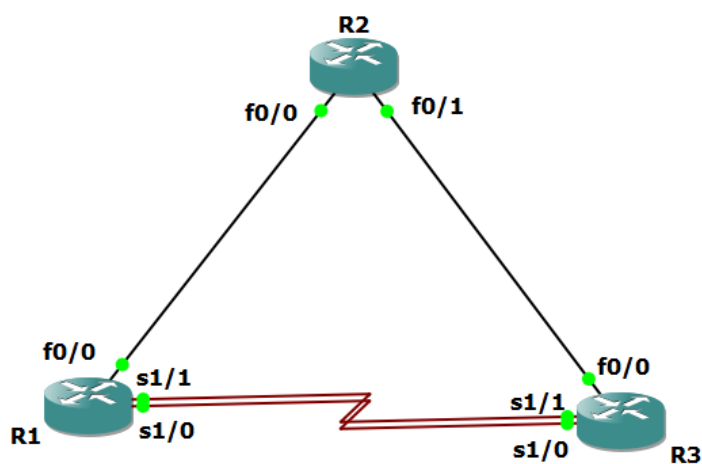
Step 2: Configure basic configure for all the router:

R1:

```
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
R1(config-line)#logging syn
R1(config-line)#logging synchronous
R1(config-line)#ipv6 unicast-routing
R1(config)#int f0/0
R1(config-if)#ip add 10.1.2.1 255.255.255.0
R1(config-if)#ipv6 add fe80::1:1 link-local
R1(config-if)#ipv6 add 2001:db8:acad:1012::1/64
R1(config-if)#no shut
R1(config-if)#ex
R1(config)#
*Mar  1 00:04:49.007: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Mar  1 00:04:50.007: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R1(config)#int s1/0
R1(config-if)#ip add 10.1.3.1 255.255.255.128
R1(config-if)#ipv6 add fe80::1:2 link-local
R1(config-if)#ipv6 add 2001:db8:acad:1013::1/64
R1(config-if)#no shut
R1(config-if)#ex
R1(config)#
*Mar  1 00:05:40.391: %LINK-3-UPDOWN: Interface Serial1/0, changed state to up
R1(config)#
*Mar  1 00:05:41.399: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/0, changed state to up
R1(config)#int
*Mar  1 00:06:02.703: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/0, changed state to down
R1(config)#int s1/1
R1(config-if)#ip add 10.1.3.129 255.255.255.128
R1(config-if)#ipv6 add fe80::1:3 link-local
R1(config-if)#ipv6 add 2001:db8:acad:1014::1/64
R1(config-if)#no shut
R1(config-if)#ex
R1(config)#
*Mar  1 00:07:02.707: %LINK-3-UPDOWN: Interface Serial1/1, changed state to up
R1(config)#in
*Mar  1 00:07:03.715: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/1, changed state to up
R1(config)#
R1(config)#
R1(config)#
R1(config)#int L0
R1(config-if)#
*Mar  1 00:07:16.667: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
R1(config-if)#ip add 192.168.1.1 255.255.255.224
R1(config-if)#
*Mar  1 00:07:32.703: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/1, changed state to down
R1(config-if)#ipv6 add fe80::1:4 link-local
R1(config-if)#ipv6 add 2001:db8:acad:1000::1/64
R1(config-if)#no shut
R1(config-if)#ex
R1(config)#int L1
R1(config-if)#
*Mar  1 00:08:18.807: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback1, changed state to up
R1(config-if)#ip add 192.168.1.65 255.255.255.192
R1(config-if)#ipv6 add fe80::1:5 link-local
R1(config-if)#ipv6 add 2001:db8:acad:1001::1/64
R1(config-if)#no shut
R1(config-if)#ex
R1(config)#end
R1#wr
Building configuration...
[OK]
```

R2:

```
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 sy
R2(config-line)#logging synchronous
R2(config-line)#ipv6 unicast-routing
R2(config)#int f0/0
R2(config-if)#ip add 10.1.2.2 255.255.255.0
R2(config-if)#ipv6 add fe80::2:1 link-local
R2(config-if)#ipv6 add 2001:db8:acad:1012::2/64
R2(config-if)#no shut
R2(config-if)#ex
R2(config)#
*Mar  1 00:11:20.923: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Mar  1 00:11:21.923: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R2(config)#int f0/1
R2(config-if)#ip add 10.2.3.2 255.255.255.0
R2(config-if)#ipv6 add fe80::2:2 link-local
R2(config-if)#ipv6 add 2001:db8:acad:1023::2/64
R2(config-if)#no shut
R2(config-if)#ex
R2(config)#
*Mar  1 00:13:05.899: %LINK-3-UPDOWN: Interface FastEthernet0/1, changed state to up
*Mar  1 00:13:06.899: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
R2(config)#int L0
R2(config-if)#
*Mar  1 00:13:45.987: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
R2(config-if)#ip add 192.168.2.1 255.255.255.224
R2(config-if)#ipv6 add fe80::2:3 link-local
R2(config-if)#ipv6 add 2001:db8:acad:2000::1/64
R2(config-if)#no shut
R2(config-if)#ex
R2(config)#int L1
R2(config-if)#
*Mar  1 00:16:35.403: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback1, changed state to up
R2(config-if)#ip add 192.168.2.65 255.255.255.192
R2(config-if)#ipv6 add fe80::2:4 link-local
R2(config-if)#ipv6 add 2001:db8:acad:2001::1/64
R2(config-if)#no shut
R2(config-if)#ex
R2(config)#end
R2#wr
Building configuration...

*Mar  1 00:17:28.623: %SYS-5-CONFIG_I: Configured from console by console[OK]
R2#
R2#
R2#
R2#
```

R3:

```
⋮        ● R1                    ● R2                    ● R3                    ×

R3#
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 sy
R3(config-line)#logging synchronous
R3(config-line)#ipv6 unicast-routing
R3(config)#int f0/0
R3(config-if)#ip add 10.2.3.3 255.255.255.0
R3(config-if)#ipv6 add fe80::3:1 link-local
R3(config-if)#ipv6 add 2001:db8:acad:1023::3/64
R3(config-if)#no shut
R3(config-if)#ex
R3(config)#
*Mar  1 00:19:52.999: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Mar  1 00:19:53.999: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R3(config)#int s1/0
R3(config-if)#ip add 10.1.3.3 255.255.255.128
R3(config-if)#ipv6 add fe80::3:2 link-local
R3(config-if)#ipv6 add 2001:db8:acad:1013::3/64
R3(config-if)#no shut
R3(config-if)#ex
R3(config)#
*Mar  1 00:21:01.651: %LINK-3-UPDOWN: Interface Serial1/0, changed state to up
R3(config)#
*Mar  1 00:21:02.659: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/0, changed state to up
R3(config)#int s1/1
R3(config-if)#ip add 10.1.3.130 255.255.255.128
R3(config-if)#ipv6 add fe80::3:3 link-local
R3(config-if)#ipv6 add 2001:db8:acad:1014::3/64
R3(config-if)#no shut
R3(config-if)#ex
R3(config)#
*Mar  1 00:21:48.879: %LINK-3-UPDOWN: Interface Serial1/1, changed state to up
R3(config)#
*Mar  1 00:21:49.887: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/1, changed state to up
R3(config)#int L0
R3(config-if)#
*Mar  1 00:21:57.635: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
R3(config-if)#ip add 192.168.3.1 255.255.255.224
R3(config-if)#ipv6 add fe80::3:4 link-local
R3(config-if)#ipv6 add 2001:db8:acad:3000::1/64
R3(config-if)#no shut
R3(config-if)#ex
R3(config)#int L1
R3(config-if)#
*Mar  1 00:22:55.927: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback1, changed state to up
R3(config-if)#ip add 192.168.3.65 255.255.255.192
R3(config-if)#ipv6 add fe80::3:5 link-local
R3(config-if)#ipv6 add 2001:db8:acad:3001::1/64
R3(config-if)#no shut
R3(config-if)#ex
R3(config)#end
R3#wr
*Mar  1 00:23:39.223: %SYS-5-CONFIG_I: Configured from console by console
R3#wr
Building configuration...
[OK]
R3#
```

Step 3: Configure and Verify Multi-Protocol BGP on all Routers:

On R1, create the core BGP configuration.

```
R1#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#router bgp 6500
R1(config-router)#bgp router-id 1.1.1.1
R1(config-router)#no bgp ipv4-unicast
                             ^
% Invalid input detected at '^' marker.

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: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)#
```

On R1, configure the IPv4 unicast address family.

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

On R1, configure the IPv6 unicast address family.

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

Step 4: Configure MP-BGP on R2 and R3 as we did for R1:

R2:

```
R2#
R2#
R2#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
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)#
R2(config-router)#
```

```
R2(config-router)#
R2(config-router)#add
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. activate
*Mar  1 00:43:40.807: %BGP-5-ADJCHANGE: neighbor 10.1.2.1 Up
R2(config-router-af)#neighbor 10.2.3.3 activate
R2(config-router-af)#exit-add
R2(config-router-af)#exit-address-family
R2(config-router)#
R2(config-router)#
R2(config-router)#
R2(config-router)#
R2(config-router)#add
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)#exi
R2(config-router-af)#exit-address-family
R2(config-router)#
```

R3:

```
R3#
R3#config
Configuring from terminal, memory, or network [terminal]? t
Enter configuration commands, one per line.  End with CNTL/Z.
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)#
R3(config-router)#add
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 acti
R3(config-router-af)#neighbor 10.1.3.1 activate
R3(config-router-af)#neighbor 10.1.3.129 activate
*Mar  1 00:52:20.555: %BGP-5-ADJCHANGE: neighbor 10.1.3.1 Up
R3(config-router-af)#neighbor 10.1.3.129 activate
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:1014:: activate
*Mar  1 00:52:51.839: %BGP-5-ADJCHANGE: neighbor 10.1.3.129 Up
R3(config-router-af)#no neighbor 2001:db8:acad:1023::2 activate
R3(config-router-af)#exit
R3(config-router-af)#exit-address-family
R3(config-router)#
R3(config-router)#end
R3#
```

```
Enter configuration commands, one per line.  End with CNTL/Z.
R3(config)#router bgp 300
R3(config-router)#add
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)#network 2001:db8:acad:1013::1 activate
                                                    ^
% Invalid input detected at '^' marker.

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:1023::2 activate
R3(config-router-af)#exit
R3(config-router-af)#exit-address-family
R3(config-router)#end
R3#
```

Step 5: Verify that MP-BGP is operational.

IPv4:

```
R1#
R1#
R1#sh bgp ipv4 unicast sum
R1#sh 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
4/3 BGP path/bestpath attribute entries using 496 bytes of memory
2 BGP AS-PATH entries using 48 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 1662 total bytes of memory
BGP activity 10/0 prefixes, 12/0 paths, scan interval 60 secs

Neighbor        V    AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
10.1.2.2        4   500      22      23        7    0    0 00:16:13        2
10.1.3.3        4   300      12      14        7    0    0 00:07:33        2
10.1.3.130      4   300      14      14        7    0    0 00:07:02        2
R1#
```

IPv6:

```
R1#
*Mar  1 01:13:34.275: %BGP-5-ADJCHANGE: neighbor 2001:DB8:ACAD:1013::3 Up
R1#sh bgp ipv6 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 894 bytes of memory
6 path entries using 456 bytes of memory
4/3 BGP path/bestpath attribute entries using 496 bytes of memory
2 BGP AS-PATH entries using 48 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 1894 total bytes of memory
BGP activity 12/0 prefixes, 14/0 paths, scan interval 60 secs

Neighbor        V    AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
2001:DB8:ACAD:1012::2
                4   500      32      32        7    0    0 00:25:04        2
2001:DB8:ACAD:1013::3
                4   300       2       2        0    0    0 00:00:13        0
2001:DB8:ACAD:1014::3
                4   300       7       7        7    0    0 00:00:17        2
```

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

IPv4:

```
R1#sh 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
```

IPv6:

```
R1#
R1#sh 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#
R1#
```

Use the ipv6 route bgp commands to view the routing tables.

```
R1#sh 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#
R1#
```

Configure and Verify BGP Path Manipulation Settings on all Routers:

Step 6*:* Configure ACL-based route filtering:

A. 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#
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#
R1#
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#
R1#
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#
```

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

```
R3#
R3#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R3(config)#ip access-list ex
R3(config)#ip access-list extended ALLOWED_TO_R1
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)#
```

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

```
R3(config)#
R3(config)#router bgp 300
R3(config-router)#add
R3(config-router)#address-family ipv4 uni
R3(config-router)#address-family ipv4 unicast
R3(config-router-af)#neighbor 10.1.3.1 dis
R3(config-router-af)#neighbor 10.1.3.1 dist
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)#
```

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

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

E. 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
```

Step 7: Configure prefix-list-based route filtering.

A. 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 | 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
```

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

```
  ⋮     ● R1                    ×    ● R2                      ● R

R1#
R1#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#ip prefix-list ALLOWED_FROM_R2 seq 5 permit 192.168.2.0/24 le 27
R1(config)#
```

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

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

D. 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
```

E. 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#
R1#sh 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 8: Configure an AS-PATH ACL to filter routes being advertised.

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

```
R2#sh 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#
R2#
```

B. 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)#
```

C. 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)#add
R1(config-router)#address-family ipv4 unicast
R1(config-router-af)#nrigh
R1(config-router-af)#nei
R1(config-router-af)#neighbor 10.1.2.2 fil
R1(config-router-af)#neighbor 10.1.2.2 filter-list 1 out
R1(config-router-af)#end
R1#
```

D. 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
```

E. 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#
R2#
R2#sh 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#
R2#
```

Step 9: Configure IPv6 prefix-list-based route filtering.

A. 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                        ×    ● R2                          ● R3

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

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

```
Total number of prefixes 4
R1#
R1#ipv6 prefix-list IPV6_ALLOWED_FROM_R2 seq 5 permit 2001:db8:acad:2000::/64
          ^
% Invalid input detected at '^' marker.

R1#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#$-list IPV6_ALLOWED_FROM_R2 seq 5 permit 2001:db8:acad:2000::/64
R1(config)#$-list IPV6_ALLOWED_FROM_R2 seq 10 permit 2001:db8:acad:2001::/64
R1(config)#
```

C. Apply the IPV6_ALLOWED_FROM_R2 prefix list to the IPv6 neighbor adjacencies for R2

```
R1(config)#
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#
R1#
```

D. 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
```

E. 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#
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
```

solarwinds   Solar-PuTTY *free tool*

Step 10: Configure BGP path attribute manipulation to effect routing

A. On R1, issue the command show ip route bgp and take note of the next hop addresses for the 192.168.3.0/27

```
                ⦂     ● R1                    ×      ● R2

R1#
R1#
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#
```

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

```
R1#
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)#
```

C. 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)#
R1(config)#
R1(config)#route-map USE_THIS_PATH_FOR_IPV4 permit 10
R1(config-route-map)#match ip address prefix-list PERFERRED_IPV4_PATH
R1(config-route-map)#set local-preference 250
R1(config-route-map)#exit
R1(config)#
```

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

```
R1(config)#
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
R1#
```

E. 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
```

F. 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

```
R1#
R1#sh 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, 00:48:36
B        192.168.2.0/27 [20/0] via 10.1.2.2, 00:48:36
      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#
R1#
R1#sh 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#
R1#
R1#
R1#sh run
```

solarwinds | Solar-PuTTY *free tool*

Step 11: Run sh run commands on all the router to see the whole output:

R1:

```
R1#
R1#
R1#
R1#sh run
Building configuration...

Current configuration : 3797 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R1
!
boot-start-marker
boot-end-marker
!
!
no aaa new-model
memory-size iomem 5
no ip icmp rate-limit unreachable
ip cef
ip tcp synwait-time 5
!
!
!
!
no ip domain lookup
!
ipv6 unicast-routing
!
!
!
interface Loopback0
 ip address 192.168.1.1 255.255.255.224
 ipv6 address 2001:DB8:ACAD:1000::1/64
 ipv6 address FE80::1:4 link-local
!
interface Loopback1
 ip address 192.168.1.65 255.255.255.192
 ipv6 address 2001:DB8:ACAD:1001::1/64
 ipv6 address FE80::1:5 link-local
!
interface FastEthernet0/0
```

```
interface FastEthernet0/0
 ip address 10.1.2.1 255.255.255.0
 duplex auto
 speed auto
 ipv6 address 2001:DB8:ACAD:1012::1/64
 ipv6 address FE80::1:1 link-local
!
```

```
interface Serial1/0
 ip address 10.1.3.1 255.255.255.128
 ipv6 address 2001:DB8:ACAD:1013::1/64
 ipv6 address FE80::1:2 link-local
 serial restart-delay 0
!
interface Serial1/1
 ip address 10.1.3.129 255.255.255.128
 ipv6 address 2001:DB8:ACAD:1014::1/64
 ipv6 address FE80::1:3 link-local
 serial restart-delay 0
!
```

```
 shutdown
 serial restart-delay 0
!
router bgp 6500
 bgp router-id 1.1.1.1
 no bgp default ipv4-unicast
 bgp log-neighbor-changes
 neighbor 10.1.2.2 remote-as 500
 neighbor 10.1.3.3 remote-as 300
 neighbor 10.1.3.130 remote-as 300
 neighbor 2001:DB8:ACAD:1012::2 remote-as 500
 neighbor 2001:DB8:ACAD:1013::3 remote-as 300
 neighbor 2001:DB8:ACAD:1014::3 remote-as 300
 !
 address-family ipv4
 neighbor 10.1.2.2 activate
 neighbor 10.1.2.2 prefix-list ALLOWED_FROM_R2 in
 neighbor 10.1.2.2 filter-list 1 out
 neighbor 10.1.3.3 activate
 neighbor 10.1.3.130 activate
 neighbor 10.1.3.130 route-map USE_THIS_PATH_FOR_IPV4 in
 no auto-summary
 no synchronization
 network 192.168.1.0 mask 255.255.255.224
 network 192.168.1.64 mask 255.255.255.192
 exit-address-family
 !
 address-family ipv6
 neighbor 2001:DB8:ACAD:1012::2 activate
 neighbor 2001:DB8:ACAD:1012::2 prefix-list IPV6_ALLOWED_FROM_R2 in
 neighbor 2001:DB8:ACAD:1013::3 activate
 neighbor 2001:DB8:ACAD:1014::3 activate
 network 2001:DB8:ACAD:1000::/64
 network 2001:DB8:ACAD:1001::/64
 exit-address-family
 !
!
ip as-path access-list 1 permit ^$
!
no ip http server
no ip http secure-server
!
!
ip prefix-list ALLOWED_FROM_R2 seq 5 permit 192.168.2.0/24 le 27
!
ip prefix-list PREFERRED_IPV4_PATH seq 5 permit 192.168.3.0/24 le 27
no cdp log mismatch duplex
!
!
ipv6 prefix-list IPV6_ALLOWED_FROM_R2 seq 5 permit 2001:DB8:ACAD:2000::/64
ipv6 prefix-list IPV6_ALLOWED_FROM_R2 seq 10 permit 2001:DB8:ACAD:2001::/64
route-map USE_THIS_PATH_FOR_IPV4 permit 10
 match ip address prefix-list PERFERRED_IPV4_PATH
 set local-preference 250
!
!
!
control-plane
!
!
!
!
```

```
!
line con 0
 exec-timeout 0 0
 privilege level 15
 logging synchronous
line aux 0
 exec-timeout 0 0
 privilege level 15
 logging synchronous
line vty 0 4
 login
!
!
end

R1#
R1#copy running-config startup-config
Destination filename [startup-config]?
Building configuration...
[OK]
R1#
```

R2:

```
R2#
R2#sh run
Building configuration...

Current configuration : 2897 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R2
!
boot-start-marker
boot-end-marker
!
!
no aaa new-model
memory-size iomem 5
no ip icmp rate-limit unreachable
ip cef
ip tcp synwait-time 5
!
!
!
!
no ip domain lookup
!
ipv6 unicast-routing
!
!
```

```
!
interface Loopback0
 ip address 192.168.2.1 255.255.255.224
 ipv6 address 2001:DB8:ACAD:2000::1/64
 ipv6 address FE80::2:3 link-local
!
interface Loopback1
 ip address 192.168.2.65 255.255.255.192
 ipv6 address 2001:DB8:ACAD:2001::1/64
 ipv6 address FE80::2:4 link-local
!
interface FastEthernet0/0
 ip address 10.1.2.2 255.255.255.0
 duplex auto
 speed auto
 ipv6 address 2001:DB8:ACAD:1012::2/64
 ipv6 address FE80::2:1 link-local
!
interface Serial0/0
 no ip address
 shutdown
 clock rate 2000000
!
interface FastEthernet0/1
 ip address 10.2.3.2 255.255.255.0
 duplex auto
 speed auto
 ipv6 address 2001:DB8:ACAD:1023::2/64
 ipv6 address FE80::2:2 link-local
!
```

```
 shutdown
 serial restart-delay 0
!
router bgp 500
 bgp router-id 2.2.2.2
 no bgp default ipv4-unicast
 bgp log-neighbor-changes
 neighbor 10.1.2.1 remote-as 6500
 neighbor 10.2.3.3 remote-as 300
 neighbor 2001:DB8:ACAD:1012::1 remote-as 6500
 neighbor 2001:DB8:ACAD:1023::3 remote-as 300
 !
 address-family ipv4
 neighbor 10.1.2.1 activate
 neighbor 10.2.3.3 activate
 no auto-summary
 no synchronization
 network 192.168.2.0 mask 255.255.255.224
 network 192.168.2.64 mask 255.255.255.192
 exit-address-family
 !
 address-family ipv6
 neighbor 2001:DB8:ACAD:1012::1 activate
 neighbor 2001:DB8:ACAD:1023::3 activate
 network 2001:DB8:ACAD:2000::/64
 network 2001:DB8:ACAD:2001::/64
 exit-address-family
!
!
!
no ip http server
no ip http secure-server
!
no cdp log mismatch duplex
!
!
!
!
control-plane
!
!
!
!
!
!
!
!
line con 0
 exec-timeout 0 0
 privilege level 15
 logging synchronous
line aux 0
 exec-timeout 0 0
 privilege level 15
 logging synchronous
line vty 0 4
 login
!
!
end

R2#copy running-config startup-config
```

R3:

```
R3#sh run
Building configuration...

Current configuration : 3360 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R3
!
boot-start-marker
boot-end-marker
!
!
no aaa new-model
memory-size iomem 5
no ip icmp rate-limit unreachable
ip cef
ip tcp synwait-time 5
!
!
!
!
no ip domain lookup
!
ipv6 unicast-routing
!
```

```
!
interface Loopback0
 ip address 192.168.3.1 255.255.255.224
 ipv6 address 2001:DB8:ACAD:3000::1/64
 ipv6 address FE80::3:4 link-local
!
interface Loopback1
 ip address 192.168.3.65 255.255.255.192
 ipv6 address 2001:DB8:ACAD:3001::1/64
 ipv6 address FE80::3:5 link-local
!
```

```
 ipv6 address FE80::3:5 link-local
!
interface FastEthernet0/0
 ip address 10.2.3.3 255.255.255.0
 duplex auto
 speed auto
 ipv6 address 2001:DB8:ACAD:1023::3/64
 ipv6 address FE80::3:1 link-local
!
interface Serial0/0
```

```
!
interface Serial1/0
 ip address 10.1.3.3 255.255.255.128
 ipv6 address 2001:DB8:ACAD:1013::3/64
 ipv6 address FE80::3:2 link-local
 serial restart-delay 0
!
interface Serial1/1
 ip address 10.1.3.130 255.255.255.128
 ipv6 address 2001:DB8:ACAD:1014::3/64
 ipv6 address FE80::3:3 link-local
 serial restart-delay 0
!
```

```
!
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 6500
 neighbor 10.1.3.129 remote-as 6500
 neighbor 10.2.3.2 remote-as 500
 neighbor 2001:DB8:ACAD:1013::1 remote-as 6500
 neighbor 2001:DB8:ACAD:1014::1 remote-as 6500
 neighbor 2001:DB8:ACAD:1023::2 remote-as 500
 !
 address-family ipv4
 neighbor 10.1.3.1 activate
 neighbor 10.1.3.1 distribute-list ALLOWED_TO_R1 out
 neighbor 10.1.3.129 activate
 neighbor 10.1.3.129 distribute-list ALLOWED_TO_R1 out
 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
 !
 address-family ipv6
 neighbor 2001:DB8:ACAD:1013::1 activate
 neighbor 2001:DB8:ACAD:1014::1 activate
 neighbor 2001:DB8:ACAD:1023::2 activate
 network 2001:DB8:ACAD:3000::/64
 network 2001:DB8:ACAD:3001::/64
 exit-address-family
!
!
!
no ip http server
no ip http secure-server
!
ip access-list extended ALLOWED_TO_R1
 permit ip host 192.168.3.0 host 255.255.255.224
 permit ip host 192.168.3.64 host 255.255.255.192
!
no cdp log mismatch duplex
!
!
!
!
control-plane
!
!
!
!
line con 0
 exec-timeout 0 0
 privilege level 15
 logging synchronous
line aux 0
 exec-timeout 0 0
 privilege level 15
 logging synchronous
line vty 0 4
 login
!
!
end

R3#
R3#copy running-config startup-config
Destination filename [startup-config]?
Building configuration...
[OK]
R3#
```

I have only pasted the sh run output which is useful to us.

We have successfully implemented BGP path Manipulation.