# BGP Routing Protocol Practice Labs

**Redouane MEDDANE**

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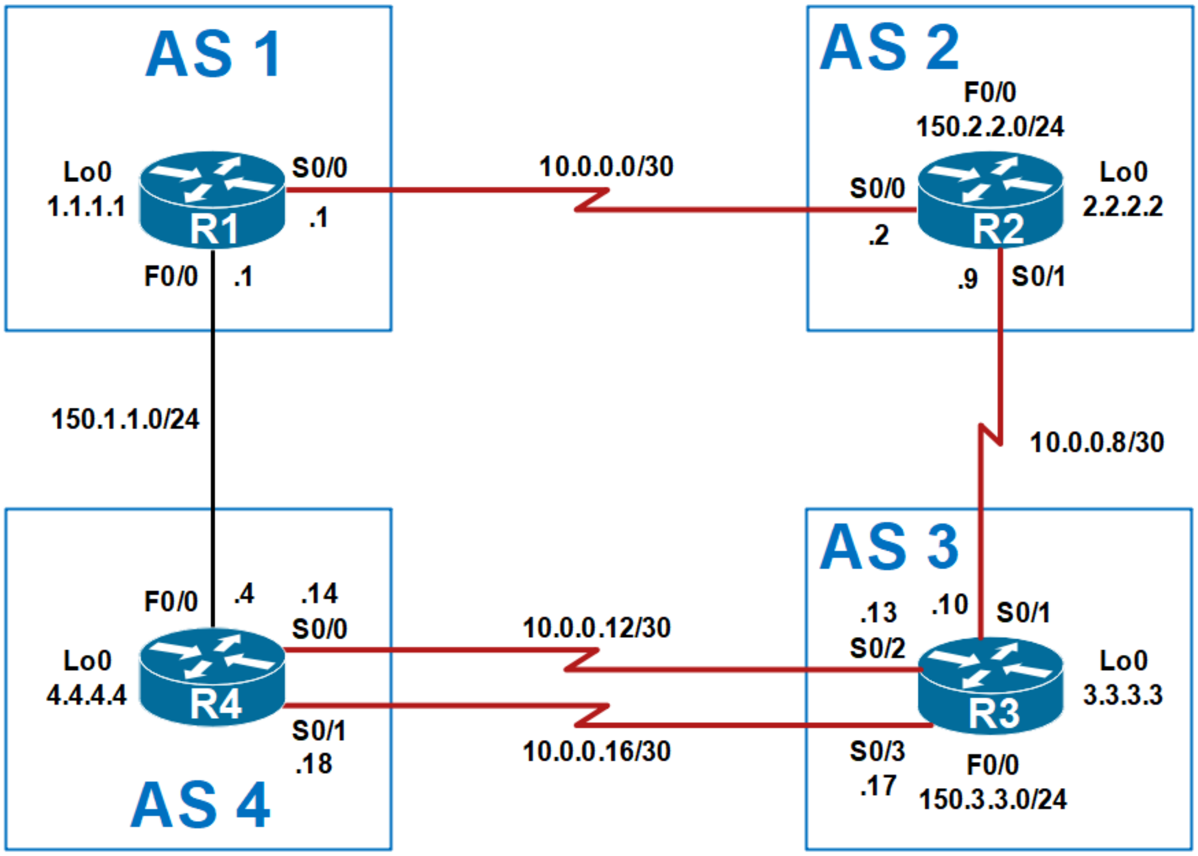
## Lab 1: MED and AS-Path Prepend




**Basic configuration**

**R1:**

```
interface Loopback0
 ip address 1.1.1.1 255.255.255.255
!
interface FastEthernet0/0
 ip address 150.1.1.1 255.255.255.0
 no shut
!
interface Serial0/0
 ip address 10.0.0.1 255.255.255.252
 no shut
```

**R2:**

```
interface Loopback0
 ip address 2.2.2.2 255.255.255.255
!
interface Loopback192
 ip address 192.1.1.1 255.255.255.0
!
interface Loopback193
 ip address 193.1.1.1 255.255.255.0
!
```

```
interface Loopback194
 ip address 194.1.1.1 255.255.255.0
!
interface Loopback195
 ip address 195.1.1.1 255.255.255.0
!
interface Serial0/0
 ip address 10.0.0.2 255.255.255.252
 no shut
!
interface Serial0/1
 ip address 10.0.0.9 255.255.255.252
 no shut
```

**R3:**

```
interface Loopback0
 ip address 3.3.3.3 255.255.255.255
!
interface FastEthernet0/0
 ip address 150.3.3.3 255.255.255.0
 no shut
!
interface Serial0/1
 ip address 10.0.0.10 255.255.255.252
 no shut
!
interface Serial0/2
 ip address 10.0.0.13 255.255.255.252
 no shut
!
interface Serial0/3
 ip address 10.0.0.17 255.255.255.252
 no shut
```

**R4:**

```
interface Loopback0
 ip address 4.4.4.4 255.255.255.255
!
interface FastEthernet0/0
 ip address 150.1.1.4 255.255.255.0
 no shut
!
interface Serial0/0
 ip address 10.0.0.14 255.255.255.252
 no shut
!
interface Serial0/1
 ip address 10.0.0.18 255.255.255.252
 no shut
```

**Configure BGP as illustrated in the topology. Use the Loopback 0 addresses for peering. Do NOT configure any IGPs. Instead, use static routes only. R1 should peer with R2 and R4. R2 should peer with R1 and R3. R3 should peer with R2 and R4. R4 should peer with R1 and R3.**

```
R1(config)#ip route 2.2.2.2 255.255.255.255 serial 0/0
R1(config)#ip route 4.4.4.4 255.255.255.255 fastethernet 0/0 150.1.1.4
R1(config)#router bgp 1
```

```
R1(config-router)#neighbor 2.2.2.2 remote-as 2
R1(config-router)#neighbor 2.2.2.2 update-source loopback 0
R1(config-router)#neighbor 2.2.2.2 ebgp-multihop 3
R1(config-router)#neighbor 4.4.4.4 remote-as 4
R1(config-router)#neighbor 4.4.4.4 update-source loopback 0
R1(config-router)#neighbor 4.4.4.4 ebgp-multihop 3
```

```
R2(config)#ip route 1.1.1.1 255.255.255.255 serial 0/0
R2(config)#ip route 3.3.3.3 255.255.255.255 serial 0/1
R2(config)#router bgp 2
R2(config-router)#neighbor 1.1.1.1 remote-as 1
R2(config-router)#neighbor 1.1.1.1 update-source loopback 0
R2(config-router)#neighbor 1.1.1.1 ebgp-multihop 3
R2(config-router)#neighbor 3.3.3.3 remote-as 3
R2(config-router)#neighbor 3.3.3.3 update-source loopback 0
R2(config-router)#neighbor 3.3.3.3 ebgp-multihop 3
```

```
R3(config)#ip route 2.2.2.2 255.255.255.255 serial 1/1
R3(config)#ip route 4.4.4.4 255.255.255.255 serial 1/2
R3(config)#ip route 4.4.4.4 255.255.255.255 serial 1/3
R3(config)#router bgp 3
R3(config-router)#neighbor 2.2.2.2 remote-as 2
R3(config-router)#neighbor 2.2.2.2 update-source loopback 0
R3(config-router)#neighbor 2.2.2.2 ebgp-multihop 3
R3(config-router)#neighbor 4.4.4.4 remote-as 4
R3(config-router)#neighbor 4.4.4.4 update-source loopback 0
R3(config-router)#neighbor 4.4.4.4 ebgp-multihop 3
```

```
R4(config)#ip route 1.1.1.1 255.255.255.255 fastethernet 0/0 150.1.1.1
R4(config)#ip route 3.3.3.3 255.255.255.255 serial 0/0
R4(config)#ip route 3.3.3.3 255.255.255.255 serial 0/1
R4(config)#router bgp 4
R4(config-router)#neighbor 1.1.1.1 remote-as 1
R4(config-router)#neighbor 1.1.1.1 update-source loopback 0
R4(config-router)#neighbor 1.1.1.1 ebgp-multihop 3
R4(config-router)#neighbor 3.3.3.3 remote-as 3
R4(config-router)#neighbor 3.3.3.3 update-source loopback 0
R4(config-router)#neighbor 3.3.3.3 ebgp-multihop 3
```

**In order to ensure that the ORIGIN code is INCOMPLETE, you need to redistribute the LAN subnets into BGP. However, you can also use the network statement in conjunction with a route map and set the ORIGIN code within the route map.**

```
R1(config)#route-map CONNECTED permit 10
R1(config-route-map)#match interface fastethernet 0/0
R1(config-route-map)#exit
R1(config)#route-map CONNECTED deny 20
R1(config-route-map)#exit
R1(config)#router bgp 1
R1(config-router)#redistribute connected route-map CONNECTED
R1(config-router)#exit
```

**You can verify the ORIGIN code by looking at the prefix entry in the BGP Tables. The ORIGIN code of INCOMPLETE is denoted by a question mark (?) in the output of the show ip bgp command. You can view additional detail on a per-prefix basis also when using this command.**

```
R1(config-router)#do show ip bgp
BGP table version is 4, 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
*  150.1.1.0/24     4.4.4.4                  0             0 4 ?
*>                  0.0.0.0                  0         32768 ?
*> 150.2.2.0/24     2.2.2.2                  0             0 2 ?
*  150.3.3.0/24     4.4.4.4                                0 4 3 ?
*>                  2.2.2.2                                0 2 3 ?
```

```
R2(config-if)#do show ip bgp
BGP table version is 4, local router ID is 195.1.1.1
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
*  150.1.1.0/24     3.3.3.3                                0 3 4 ?
*>                  1.1.1.1                  0             0 1 ?
*> 150.2.2.0/24     0.0.0.0                  0         32768 ?
*> 150.3.3.0/24     3.3.3.3                  0             0 3 ?
```

```
R3(config-router)#do show ip bgp
BGP table version is 5, local router ID is 3.3.3.3
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
*> 150.1.1.0/24     4.4.4.4                  0             0 4 ?
*                   2.2.2.2                                0 2 1 ?
*  150.2.2.0/24     4.4.4.4                                0 4 1 2 ?
*>                  2.2.2.2                  0             0 2 ?
*> 150.3.3.0/24     0.0.0.0                  0         32768 ?
```

```
R4(config-router)#do show ip bgp
BGP table version is 6, local router ID is 4.4.4.4
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
*> 150.1.1.0/24     0.0.0.0                  0         32768 ?
*                   1.1.1.1                  0             0 1 ?
*  150.2.2.0/24     3.3.3.3                                0 3 2 ?
*>                  1.1.1.1                                0 1 2 ?
*  150.3.3.0/24     1.1.1.1                                0 1 2 3 ?
*>                  3.3.3.3                  0             0 3 ?
```

**Configure BGP, so that R4 prefers the path via R3 to reach any subnet**
**In the output of the show ip bgp command on R4 we can see that the preferred route to reach 150.3.3.0 is via R3, however the preferred route to reach 150.2.2.0 is via R1 (the lowest router-id), also, to ensure that the subnet 150.1.1.0 will be reached via R3, configure BGP on R1 to advertise all prefixes with a longer AS-PATH to influence the path selection as follow:**

```
R1(config)#route-map PREP permit 10
R1(config-route-map)#set as-path prepend 1 1 1 1
R1(config-route-map)#exit
R1(config)#router bgp 1
R1(config-router)#neighbor 4.4.4.4 route-map PREP out
R1(config-router)#exit
```

**Notice now the preferred path to reach both prefixes 150.3.3.0 and 150.2.2.0 is via R3 with the next-hop 3.3.3.3 because the shortest AS-PATH length:**

```
R4(config)#do show ip bgp
BGP table version is 7, local router ID is 4.4.4.4
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
*  150.1.1.0/24     1.1.1.1                  0             0 1 1 1 1 1 ?
*>                  0.0.0.0                  0         32768 ?
*  150.2.2.0/24     1.1.1.1                                0 1 1 1 1 1 2 ?
*>                  3.3.3.3                                0 3 2 ?
*> 150.3.3.0/24     3.3.3.3                  0             0 3 ?
```

**Configure R4 so that it sends all updates to R3 with a MED of 4. Configure R2 so that it sends all updates to R3 with a MED of 2. Ensure that R3 prefers all routes with the better (lower) MED value.**

**Before configuring the MED let's verify the BGP RIBs on R3:**
**The preferred path to reach the prefix 150.1.1.0 is via R4, we should see all routes with the next-hop R2:**

```
R3(config)#do show ip bgp
BGP table version is 5, local router ID is 3.3.3.3
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
*  150.1.1.0/24     2.2.2.2                                0 2 1 ?
*>                  4.4.4.4                  0             0 4 ?
*> 150.2.2.0/24     2.2.2.2                  0             0 2 ?
*> 150.3.3.0/24     0.0.0.0                  0         32768 ?
```

**Let's configure MED on R3:**

```
R4(config)#route-map MED permit 10
R4(config-route-map)#set metric 4
R4(config-route-map)#exit
R4(config)#router bgp 4
R4(config-router)#neighbor 3.3.3.3 route-map MED out
R4(config-router)#exit
```

```
R2(config)#route-map MED permit 10
R2(config-route-map)#set metric 2
R2(config-route-map)#exit
R2(config)#router bgp 2
```

```
R2(config-router)#neighbor 3.3.3.3 route-map MED out
R2(config-router)#exit
```

**Let's verify the BGP RIBs of R3:**
**We have still the best path to reach 150.1.1.0 via R4 as shown by the show ip bgp command on R3 below, so the problem is not resolved even if R2 advertises the lowest MED comparing with R4.**
**The reason is: we met two issues in this case:**
**-the first issue is: by default, the MED is only compared for path received from the same AS ,in this case R3 receives two values of MED from two routers (R2 and R4) configured in different AS.**
**-The second issue: the MED is compared after the AS-PATH in the BGP decision process. In this case R3 will select the path via R4 as the best path to the 150.1.1.0/24 prefix because of the shorter AS-PATH length.**

```
R3(config)#do show ip bgp
BGP table version is 10, local router ID is 3.3.3.3
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
*> 150.1.1.0/24     4.4.4.4                  4             0 4 ?
*                   2.2.2.2                  2             0 2 1 ?
*> 150.2.2.0/24     2.2.2.2                  2             0 2 ?
*> 150.3.3.0/24     0.0.0.0                  0         32768 ?
R3(config)#
```

**To override the two issues, configure the bgp always-compare-med command to avoid the first issue so always compare the MED even if MED is received from Different AS. And bgp bestpath as-path ignore command to avoid the second issue so that R3 override the BGP decision process by ignoring the step of the AS-PATH in the BGP Decision Process:**
**Let's configure these two commands:**

```
R3(config)#router bgp 3
R3(config-router)#bgp bestpath as-path ignore
R3(config-router)#bgp always-compare-med
```

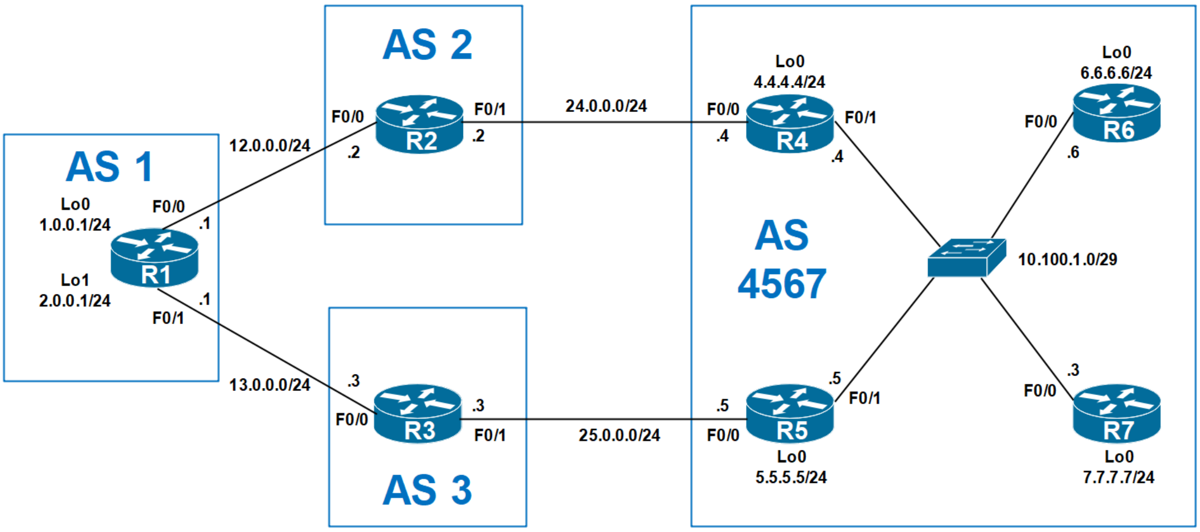
**We can see for the prefix 150.1.1.0 that the path with the longer AS-PATH length is preferred because the lowest MED even if the AS-PATH takes precedence over the MED in the order of the path selection in BGP:**

```
R3(config)#do show ip bgp 150.1.1.0 255.255.255.0
BGP routing table entry for 150.1.1.0/24, version 2
Paths: (2 available, best #2, table Default-IP-Routing-Table)
Flag: 0x820
  Advertised to update-groups:
        1
  4
    4.4.4.4 from 4.4.4.4 (4.4.4.4)
      Origin incomplete, metric 4, localpref 100, valid, external
  2 1
    2.2.2.2 from 2.2.2.2 (195.1.1.1)
      Origin incomplete, metric 2, localpref 100, valid, external, best
```

**Another way to verify all BGP RIBs with do show ip bgp, R3 prefers all routes from R2 because the lowest MED:**

```
R3(config-router)#do show ip bgp
BGP table version is 4, local router ID is 3.3.3.3
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
*  150.1.1.0/24     4.4.4.4                  4             0 4 ?
*>                  2.2.2.2                  2             0 2 1 ?
*  150.2.2.0/24     4.4.4.4                  4             0 4 1 1 1 1 1 2 ?
*>                  2.2.2.2                  2             0 2 ?
*> 150.3.3.0/24     0.0.0.0                  0         32768 ?
R3(config-router)#
```

## Lab 2: BGP Local Preference




**Basic configuration**

**R1:**

```
interface Loopback0
 ip address 1.0.0.1 255.0.0.0
!
interface Loopback1
 ip address 2.0.0.1 255.0.0.0
!
interface FastEthernet0/0
 ip address 12.0.0.1 255.255.255.0
 no shutdown
!
interface FastEthernet0/1
 ip address 13.0.0.1 255.255.255.0
 no shutdown
```

**R2:**

```
interface FastEthernet0/0
 ip address 12.0.0.2 255.255.255.0
 no shutdown
!
interface FastEthernet0/1
 ip address 24.0.0.2 255.255.255.0
 no shutdown
```

**R3:**

```
interface FastEthernet0/0
 ip address 13.0.0.3 255.255.255.0
 no shutdown
!
interface FastEthernet0/1
 ip address 35.0.0.3 255.255.255.0
 no shutdown
```

**R4:**

```
interface Loopback0
 ip address 4.4.4.4 255.255.255.255
!
interface FastEthernet0/0
 ip address 24.0.0.4 255.255.255.0
 no shutdown
!
interface FastEthernet0/1
 ip address 10.100.1.4 255.255.255.248
 no shutdown
```

**R5:**

```
interface Loopback0
 ip address 5.5.5.5 255.255.255.255
!
interface FastEthernet0/0
 ip address 35.0.0.5 255.255.255.0
 no shutdown
!
interface FastEthernet0/1
 ip address 10.100.1.5 255.255.255.248
 no shutdown
```

**R6:**

```
interface Loopback0
 ip address 6.6.6.6 255.255.255.255
!
interface FastEthernet0/0
 ip address 10.100.1.6 255.255.255.248
 no shutdown
```

**R7:**

```
interface Loopback0
 ip address 7.7.7.7 255.255.255.255
!
interface FastEthernet0/0
 ip address 10.100.1.3 255.255.255.248
 no shutdown
```

**Configure EIGRP AS 4567 on R4, R5, R6 and R7 and advertise the subnet 10.100.1.0/29 and the loopback 0 subnets:**

**R4:**

```
router eigrp 4567
 network 4.4.4.4 0.0.0.0
 network 10.100.1.0 0.0.0.7
```

**R5:**

```
router eigrp 4567
 network 5.5.5.5 0.0.0.0
 network 10.100.1.0 0.0.0.7
```

**R6:**

```
router eigrp 4567
 network 6.6.6.6 0.0.0.0
```

```
 network 10.100.1.0 0.0.0.7
```

**R7:**

```
router eigrp 4567
 network 7.7.7.7 0.0.0.0
 network 10.100.1.0 0.0.0.7
```

**Configure iBGP in AS 4567, use loopback 0 interface for peering and use peer group configuration.**

**Configure eBGP between AS 4567 and AS 2 and AS 3.**
**Configure eBGP between AS 2 and AS 1.**
**Configure eBGP between AS 3 and AS 1, advertise 1.0.0.0/8 and 2.0.0.0/8 subnets in BGP:**

**R4:**

```
router bgp 4567
 network 10.100.1.0 mask 255.255.255.248
 neighbor INTERNAL peer-group
 neighbor INTERNAL remote-as 4567
 neighbor INTERNAL update-source Loopback0
 neighbor INTERNAL next-hop-self
 neighbor 5.5.5.5 peer-group INTERNAL
 neighbor 6.6.6.6 peer-group INTERNAL
 neighbor 7.7.7.7 peer-group INTERNAL
 neighbor 24.0.0.2 remote-as 2
```

**R5:**

```
router bgp 4567
 network 10.100.1.0 mask 255.255.255.248
 neighbor INTERNAL peer-group
 neighbor INTERNAL remote-as 4567
 neighbor INTERNAL update-source Loopback0
 neighbor INTERNAL next-hop-self
 neighbor 4.4.4.4 peer-group INTERNAL
 neighbor 6.6.6.6 peer-group INTERNAL
 neighbor 7.7.7.7 peer-group INTERNAL
 neighbor 35.0.0.3 remote-as 3
```

**R6:**

```
router bgp 4567
 neighbor INTERNAL peer-group
 neighbor INTERNAL remote-as 4567
 neighbor INTERNAL update-source Loopback0
 neighbor 4.4.4.4 peer-group INTERNAL
 neighbor 5.5.5.5 peer-group INTERNAL
 neighbor 7.7.7.7 peer-group INTERNAL
```

**R7:**

```
router bgp 4567
 neighbor INTERNAL peer-group
 neighbor INTERNAL remote-as 4567
 neighbor INTERNAL update-source Loopback0
 neighbor 4.4.4.4 peer-group INTERNAL
 neighbor 5.5.5.5 peer-group INTERNAL
 neighbor 6.6.6.6 peer-group INTERNAL
```

**R1:**

```
router bgp 1
 network 1.0.0.0
 network 2.0.0.0
 neighbor 12.0.0.2 remote-as 2
 neighbor 13.0.0.3 remote-as 3
```

**R2:**

```
router bgp 2
 neighbor 12.0.0.1 remote-as 1
 neighbor 24.0.0.4 remote-as 4567
```

**R3:**

```
router bgp 3
 neighbor 13.0.0.1 remote-as 1
 neighbor 35.0.0.5 remote-as 4567
```

**Verify the peer-group and see the current members, the members on this group are: R5 5.5.5.5, R6 6.6.6.6 and R7 7.7.7.7:**

```
R4#sh ip bgp peer-group INTERNAL
BGP peer-group is INTERNAL,  remote AS 4567
  BGP version 4
  Default minimum time between advertisement runs is 0 seconds

 For address family: IPv4 Unicast
  BGP neighbor is INTERNAL, peer-group internal, members:
  5.5.5.5 6.6.6.6 7.7.7.7
  Index 0, Offset 0, Mask 0x0
  NEXT_HOP is always this router
  Update messages formatted 0, replicated 0
  Number of NLRIs in the update sent: max 0, min 0
```

**Peer groups is used for less processing power, let's verify the adjacencies:**

```
R1(config-router)#do show ip bgp sum
BGP router identifier 2.0.0.1, local AS number 1
BGP table version is 6, main routing table version 6
3 network entries using 351 bytes of memory
4 path entries using 208 bytes of memory
4/2 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 1103 total bytes of memory
BGP activity 3/0 prefixes, 4/0 paths, scan interval 60 secs

Neighbor        V    AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
12.0.0.2        4     2       6       6        6    0    0 00:01:33        1
13.0.0.3        4     3       6       6        6    0    0 00:00:34        1
R1(config-router)#
```

```
R4(config-router)#do show ip bgp sum
BGP router identifier 4.4.4.4, local AS number 4567
BGP table version is 5, main routing table version 5
3 network entries using 351 bytes of memory
```

```
6 path entries using 312 bytes of memory
5/2 BGP path/bestpath attribute entries using 620 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 1331 total bytes of memory
BGP activity 3/0 prefixes, 6/0 paths, scan interval 60 secs

Neighbor        V    AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
5.5.5.5         4  4567      11      11        5    0    0 00:06:58        3
6.6.6.6         4  4567      10      12        5    0    0 00:07:05        0
7.7.7.7         4  4567      10      12        5    0    0 00:06:27        0
24.0.0.2        4     2       7       6        5    0    0 00:01:55        2
```

```
R7(config-router)#do show ip bgp sum
BGP router identifier 7.7.7.7, local AS number 4567
BGP table version is 5, main routing table version 5
3 network entries using 351 bytes of memory
6 path entries using 312 bytes of memory
4/2 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 1207 total bytes of memory
BGP activity 3/0 prefixes, 6/0 paths, scan interval 60 secs

Neighbor        V    AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
4.4.4.4         4  4567      12      10        5    0    0 00:06:47        3
5.5.5.5         4  4567      12      10        5    0    0 00:07:08        3
6.6.6.6         4  4567       9       9        5    0    0 00:06:56        0
```

**Ensure AS 4567 will use the link between R3-R5 towards network 2.0.0.0/8. Use LOCAL_PREF only.**
**Before configuring the Local-Pref, let's use a traceroute on R6 and R7 toward 2.0.0.1. We can see that the packet goes through R4--R2:**

```
R6#traceroute 2.0.0.1
Type escape sequence to abort.
Tracing the route to 2.0.0.1
  1 10.100.1.4 72 msec 24 msec 24 msec
  2 24.0.0.2 60 msec 28 msec 80 msec
  3 12.0.0.1 96 msec *  96 msec
R6#
```

```
R7(config-router)#do traceroute 2.0.0.1
Type escape sequence to abort.
Tracing the route to 2.0.0.1
  1 10.100.1.4 56 msec 56 msec 12 msec
  2 24.0.0.2 52 msec 48 msec 32 msec
  3 12.0.0.1 84 msec *  108 msec
R7(config-router)
```

**Verify the RIB of R6 and R7:**
**Notice that the best route to reach 2.0.0.0/24 is via R4 (4.4.4.4) denoted by " *>i " on both R6 and R7:**

```
R6#show ip bgp
```

```
BGP table version is 5, local router ID is 6.6.6.6
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
* i1.0.0.0          5.5.5.5                  0    100      0 3 1 i
*>i                 4.4.4.4                  0    100      0 2 1 i
* i2.0.0.0          5.5.5.5                  0    100      0 3 1 i
*>i                 4.4.4.4                  0    100      0 2 1 i
r i10.100.1.0/29    5.5.5.5                  0    100      0 i
r>i                 4.4.4.4                  0    100      0 i
```

```
R7(config-router)#do show ip bgp
BGP table version is 5, local router ID is 7.7.7.7
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
* i1.0.0.0          5.5.5.5                  0    100      0 3 1 i
*>i                 4.4.4.4                  0    100      0 2 1 i
* i2.0.0.0          5.5.5.5                  0    100      0 3 1 i
*>i                 4.4.4.4                  0    100      0 2 1 i
r i10.100.1.0/29    5.5.5.5                  0    100      0 i
r>i                 4.4.4.4                  0    100      0 i
```

**To ensure that the traffic goes through R5--R3 you will tell to R5 to advertise into BGP AS 4567 the prefix 2.0.0.0/24 with a better (higher) local-preference than R4 as follow, by default the Local-Pref is equal to 100:**

```
router bgp 4567
 neighbor 35.0.0.3 route-map RM_LOC_PREF in
!
ip prefix-list NET-2 seq 5 permit 2.0.0.0/8
!
route-map RM_LOC_PREF permit 10
 match ip address prefix-list NET-2
 set local-preference 200
!
route-map RM_LOC_PREF permit 20
```

**Verify the RIB of R6 and R7.**
**The best route now toward 2.0.0.0/24 on both R6 and R7 is via R5 (5.5.5.5) because the better (higher) Local-Preference 200:**

```
R6#show ip bgp
BGP table version is 6, local router ID is 6.6.6.6
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
* i1.0.0.0          5.5.5.5                  0    100      0 3 1 i
*>i                 4.4.4.4                  0    100      0 2 1 i
*>i2.0.0.0          5.5.5.5                  0    200      0 3 1 i
r i10.100.1.0/29    5.5.5.5                  0    100      0 i
```

```
r>i                 4.4.4.4                  0    100      0 i
```

```
R7(config)#do show ip bgp
BGP table version is 6, local router ID is 7.7.7.7
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
* i1.0.0.0          5.5.5.5                  0    100      0 3 1 i
*>i                 4.4.4.4                  0    100      0 2 1 i
*>i2.0.0.0          5.5.5.5                  0    200      0 3 1 i
r i10.100.1.0/29    5.5.5.5                  0    100      0 i
r>i                 4.4.4.4                  0    100      0 i
```

**The traceroute shown that the packet goes through R5--R3 to reach 2.0.0.0/24:**

```
R6#traceroute 2.0.0.1
Type escape sequence to abort.
Tracing the route to 2.0.0.1
  1 10.100.1.5 76 msec 108 msec 20 msec
  2 35.0.0.3 100 msec 120 msec 32 msec
  3 13.0.0.1 148 msec *  176 msec
R6#
```

```
R7(config)#do traceroute 2.0.0.1
Type escape sequence to abort.
Tracing the route to 2.0.0.1
  1 10.100.1.5 68 msec 136 msec 28 msec
  2 35.0.0.3 112 msec 76 msec 36 msec
  3 13.0.0.1 180 msec *  204 msec
```

**Ensure AS 4567 will use the link between R2-R4 towards network 1.0.0.0/8. Use LOCAL_PREF only.**
**You will tell to R4 to advertise into BGP AS 4567 the prefix 1.0.0.0/24 with a better(higher) local-preference than R4 as follow,by default the Local-Pref is equal to 100:**

```
router bgp 4567
neighbor 24.0.0.2 route-map RM_LOC_PREF in
 no auto-summary
!
ip prefix-list NET-1 seq 5 permit 1.0.0.0/8
!
route-map RM_LOC_PREF permit 10
 match ip address prefix-list NET-1
 set local-preference 200
!
route-map RM_LOC_PREF permit 20
```

**Now the best path to reach 1.0.0.0/24 is via R4 on both R6 and R7 because the better(higher) Local-Preference 200 :**

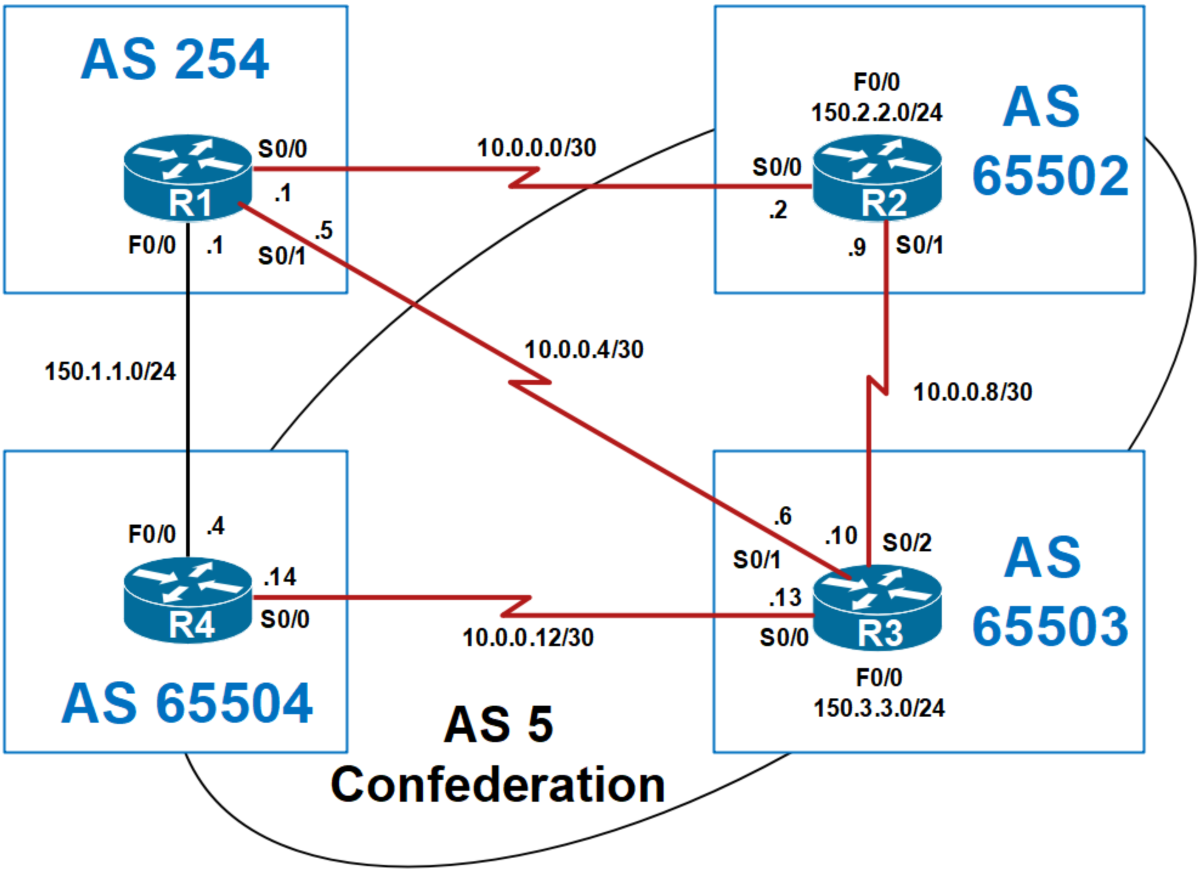
```
R6#show ip bgp
BGP table version is 10, local router ID is 6.6.6.6
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale
```

```
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
*>i1.0.0.0          4.4.4.4                  0    200      0 2 1 i
*>i2.0.0.0          5.5.5.5                  0    200      0 3 1 i
r>i10.100.1.0/29    4.4.4.4                  0    100      0 i
r i                 5.5.5.5                  0    100      0 i
```

```
R7(config)#do show ip bgp
BGP table version is 10, local router ID is 7.7.7.7
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
*>i1.0.0.0          4.4.4.4                  0    200      0 2 1 i
*>i2.0.0.0          5.5.5.5                  0    200      0 3 1 i
r>i10.100.1.0/29    4.4.4.4                  0    100      0 i
r i                 5.5.5.5                  0    100      0 i
```

**Note: you must enter the clear ip bgp * command to reset the bgp neighbors relationship when configuring the Local-Preference to take effect.**

## Lab 3: BGP path control




**Basic Configuration**

**R1:**

```
interface FastEthernet0/0
 ip address 150.1.1.1 255.255.255.0
 no shutd
!
interface Serial0/0
 ip address 10.0.0.1 255.255.255.252
 no shutd
!
interface Serial0/1
 ip address 10.0.0.5 255.255.255.252
 no shutd
```

**R2:**

```
interface FastEthernet0/0
 ip address 150.2.2.2 255.255.255.0
 no shutd
!
interface Serial0/0
 ip address 10.0.0.2 255.255.255.252
 no shutd
!
```

```
interface Serial0/1
 ip address 10.0.0.9 255.255.255.252
 no shutd
```

**R3:**

```
interface FastEthernet0/0
 ip address 150.3.3.3 255.255.255.0
 no shutd
!
interface Serial0/0
 ip address 10.0.0.13 255.255.255.252
 no shutd
!
interface Serial0/1
 ip address 10.0.0.6 255.255.255.252
 no shutd
!
interface Serial0/2
 ip address 10.0.0.10 255.255.255.252
 no shutd
```

**R4:**

```
interface FastEthernet0/0
 ip address 150.1.1.4 255.255.255.0
 no shutd
!
interface Serial0/0
 ip address 10.0.0.14 255.255.255.252
 no shutd
```

**Configure BGP as illustrated in the topology. R1 will peer to R2, R3, and R4 using directly connected IP addresses. From R1s perspective, all these routers reside in AS 5. R1 should advertise the 150.1.1.0/24 prefix via BGP.**
**Configure BGP on R2, R3, and R4 as illustrated in the topology. All routers will reside in AS 5 to the outside world. Internally, R2 will reside in AS 65502, R3 will reside in AS 65503, and R4 will reside in AS 65504. R2 will peer to R3, which in turn will peer to R4. R2 and R4 will not peer to each other. Ensure that R1, R2, and R3 routers peer with R1 is AS 254. Next, configure R2, R3, and R4 to advertise their respective 150.x.x.x/24 subnets. Ensure that all of the routers can ping the LAN IP address of every other router.**

**R1:**

```
router bgp 254
 bgp router-id 1.1.1.1
 neighbor 150.1.1.4 remote-as 5
 neighbor 10.0.0.2 remote-as 5
 neighbor 10.0.0.6 remote-as 5
 network 150.1.1.0 mask 255.255.255.0
```

**R2:**

```
router bgp 65502
 bgp router-id 2.2.2.2
 bgp confederation identifier 5
 bgp confederation peers 65503
 network 150.2.2.0 mask 255.255.255.0
 neighbor 10.0.0.1 remote-as 254
 neighbor 10.0.0.10 remote-as 65503
 neighbor 10.0.0.10 next-hop-self
```

**R3:**

```
router bgp 65503
 bgp router-id 3.3.3.3
 bgp confederation identifier 5
 bgp confederation peers 65502 65504
 network 150.3.3.0 mask 255.255.255.0
 neighbor 10.0.0.5 remote-as 254
 neighbor 10.0.0.9 remote-as 65502
 neighbor 10.0.0.9 next-hop-self
 neighbor 10.0.0.14 remote-as 65504
 neighbor 10.0.0.14 next-hop-self
```

**R4:**

```
router bgp 65504
 bgp router-id 4.4.4.4
 bgp confederation identifier 5
 bgp confederation peers 65503
 network 150.1.1.0 mask 255.255.255.0
 neighbor 10.0.0.13 remote-as 65503
 neighbor 10.0.0.13 next-hop-self
 neighbor 150.1.1.1 remote-as 254
```

**Configure AS 5 so that R2 and R3 prefer the path via R1 to reach the 150.1.1.0/24 prefix. Ensure that this is ONLY applicable to this single prefix.**

**The best path to reach 150.1.1.0 from R2 is via R3 through the AS 5 confederation as shown by the following output in the section confed-external, best:**

```
R2#show ip bgp 150.1.1.0 255.255.255.0
BGP routing table entry for 150.1.1.0/24, version 10
Paths: (2 available, best #1, table Default-IP-Routing-Table)
Advertised to update-groups:
2
(65503 65504)
10.0.0.10 from 10.0.0.10 (3.3.3.3)
Origin IGP, metric 0, localpref 100, valid, confed-external, best
254
10.0.0.1 from 10.0.0.1 (1.1.1.1)
Origin IGP, metric 0, localpref 100, valid, external
```

**The best path to reach 150.1.1.0 from R3 is via R4 as shown by the following output in the section confed-external, best:**

```
R3#show ip bgp 150.1.1.0 255.255.255.0
BGP routing table entry for 150.1.1.0/24, version 6
Paths: (2 available, best #1, table Default-IP-Routing-Table)
Advertised to update-groups:
1 2
(65504)
10.0.0.14 from 10.0.0.14 (4.4.4.4)
Origin IGP, metric 0, localpref 100, valid, confed-external, best
254
10.0.0.5 from 10.0.0.5 (1.1.1.1)
Origin IGP, metric 0, localpref 100, valid, external
```

**To complete this task, you need to modify either the WEIGHT or the LOCAL_PREF attributes for the 150.1.1.0/24 prefix received from R1 on routers R2 and R3.**

```
R2(config)#router bgp 65502
R2(config-router)#neighbor 10.0.0.1 route-map weight-R1 in
R2(config-router)#ip prefix-list NET-R1 seq 5 permit 150.1.1.0/24
R2(config)#route-map weight-R1 permit 10
R2(config-route-map)# match ip address prefix-list NET-R1
R2(config-route-map)# set weight 1000
R2(config-route-map)#route-map weight-R1 permit 20
```

```
R3(config)#router bgp 65503
R3(config-router)#neighbor 10.0.0.5 route-map weight-R1 in
R3(config-router)#ip prefix-list NET-R1 seq 5 permit 150.1.1.0/24
R3(config)#route-map weight-R1 permit 10
R3(config-route-map)# match ip address prefix-list NET-R1
R3(config-route-map)# set weight 1000
R3(config-route-map)#
R3(config-route-map)#route-map weight-R1 permit 20
```

**let's verify the result after clearing the bgp neighbors:**

```
R2(config-route-map)#do clear ip bgp *
R3(config-route-map)#do clear ip bgp *
```

**Both R2 and R3 prefer the path through R1 (10.0.0.1):**

```
R2(config-route-map)#do show ip bgp 150.1.1.0 255.255.255.0
BGP routing table entry for 150.1.1.0/24, version 2
Paths: (2 available, best #2, table Default-IP-Routing-Table)
Flag: 0x820
Advertised to update-groups:
1
(65503) 254
10.0.0.10 from 10.0.0.10 (3.3.3.3)
Origin IGP, metric 0, localpref 100, valid, confed-external
254
10.0.0.1 from 10.0.0.1 (1.1.1.1)
Origin IGP, metric 0, localpref 100, weight 1000, valid, external, best
```

```
R3(config-route-map)#do show ip bgp 150.1.1.0 255.255.255.0
BGP routing table entry for 150.1.1.0/24, version 2
Paths: (3 available, best #3, table Default-IP-Routing-Table)
Flag: 0x820
Advertised to update-groups:
1
(65502) 254
10.0.0.9 from 10.0.0.9 (2.2.2.2)
Origin IGP, metric 0, localpref 100, valid, confed-external
(65504)
10.0.0.14 from 10.0.0.14 (4.4.4.4)
Origin IGP, metric 0, localpref 100, valid, confed-external
254
10.0.0.5 from 10.0.0.5 (1.1.1.1)
Origin IGP, metric 0, localpref 100, weight 1000, valid, external, best
```

**let's look the path from R1 to reach 150.3.3.0/24 ,there are three valid routes but the path through R3(10.0.0.6) is the best, we can influence the path selection by manipulating the ORIGIN, IGP is preferred over EGP and EGP is preferred than incomplete, notice in the following output the origin of the three paths is IGP:**

```
R1#show ip bgp 150.3.3.0 255.255.255.0
BGP routing table entry for 150.3.3.0/24, version 17
Paths: (3 available, best #3, table Default-IP-Routing-Table)
Advertised to update-groups:
1
5
150.1.1.4 from 150.1.1.4 (4.4.4.4)
Origin IGP, localpref 100, valid, external
5
10.0.0.2 from 10.0.0.2 (2.2.2.2)
Origin IGP, localpref 100, valid, external
5
10.0.0.6 from 10.0.0.6 (3.3.3.3)
Origin IGP, metric 0, localpref 100, valid, external, best
```

**R1 has three paths to the 150.3.3.0/24 subnet advertised by R3. Configure your network so that R1 prefers the path via R2 first, the path via R4 second and then path via R3. You are not allowed to make any changes on R1. Additionally, you are NOT allowed to modify the AS_PATH or MED attributes or administrative distance.**

**There is another BGP attribute that can be used to influence path selection: ORIGIN. During the BGP best path selection process, if all paths have the same AS_PATH length, then prefer the path with the lowest ORIGIN. An ORIGIN of IGP (I) is more preferred (lower) than EGP (E) , which in turn in more preferred (lower) than Incomplete (?). In mathematical terms, IGP < EGP < Incomplete. Because all routers are advertising this prefix with an ORIGIN of IGP, because it was injected into BGP on R3 using the network command, you only need to modify this attribute on R2 and R3.**
**R3 will set the origin of 150.3.3.0 as incomplete and R4 advertises the prefix 150.3.3.0 as EGP, while R2 advertises this routes with the origin IGP which is preferred over incomplete and EGP origins:**

```
R3(config)#ip prefix-list NET-R3 seq 5 permit 150.3.3.0/24
R3(config)#route-map ORIGIN permit 10
R3(config-route-map)# match ip address prefix-list NET-R3
R3(config-route-map)# set origin incomplete
R3(config-route-map)#
R3(config-route-map)#route-map ORIGIN permit 20
R3(config-route-map)#router bgp 65503
R3(config-router)#neighbor 10.0.0.5 route-map ORIGIN out
```

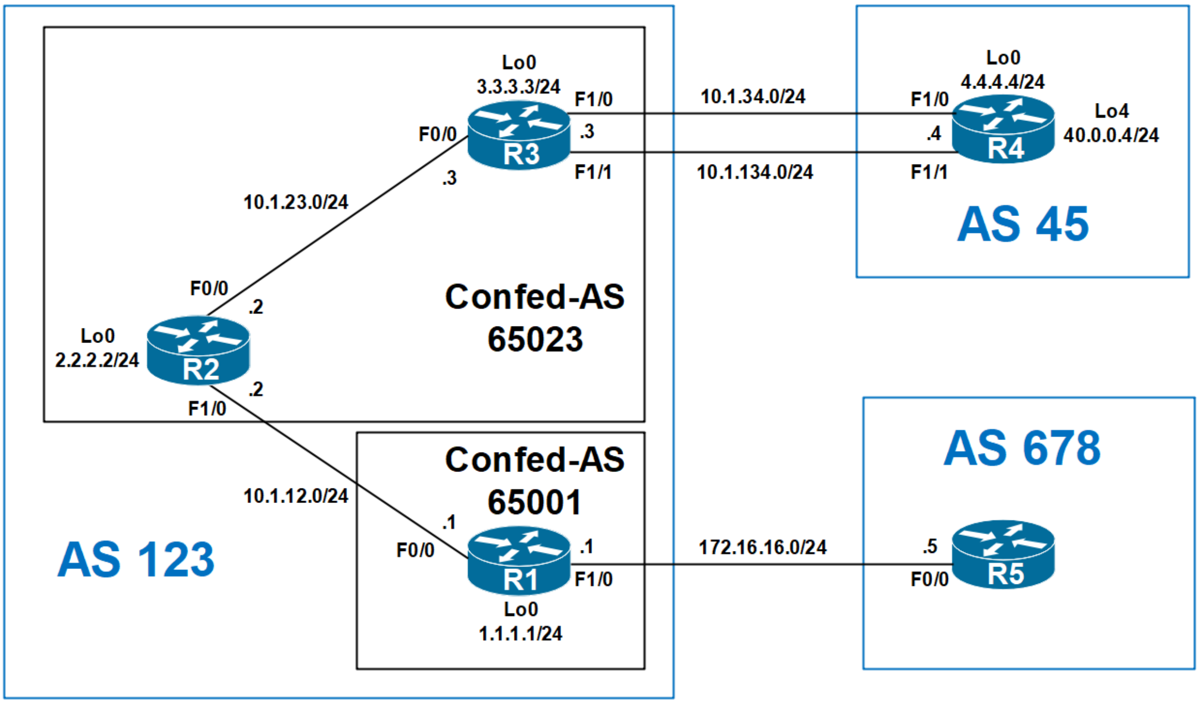
```
R4(config)#ip prefix-list NET-R4 seq 5 permit 150.3.3.0/24
R4(config)#route-map ORIGIN permit 10
R4(config-route-map)# match ip address prefix-list NET-R4
R4(config-route-map)# set origin egp 1
R4(config-route-map)#router bgp 65504
R4(config-router)#neighbor 150.1.1.1 route-map ORIGIN out
```

**The preferred route is via R2 (10.0.0.2) ,notice the origin is displayed for the prefix 150.3.3.0/24,R2 as IGP ,R4 as EGP and R3 as incomplete:**

```
R1#show ip bgp 150.3.3.0 255.255.255.0
BGP routing table entry for 150.3.3.0/24, version 23
```

```
Paths: (3 available, best #2, table Default-IP-Routing-Table)
Flag: 0x820
Advertised to update-groups:
1
5
150.1.1.4 from 150.1.1.4 (4.4.4.4)
Origin EGP, localpref 100, valid, external
5
10.0.0.2 from 10.0.0.2 (2.2.2.2)
Origin IGP, localpref 100, valid, external, best
5
10.0.0.6 from 10.0.0.6 (3.3.3.3)
Origin incomplete, metric 0, localpref 100, valid, external
```

## Lab 4: BGP Confederations




**Basic configuration**

**R1:**

```
interface Loopback0
 ip address 1.1.1.1 255.255.255.0
!
interface FastEthernet0/0
 ip address 10.1.12.1 255.255.255.0
 no shutdown
!
interface FastEthernet1/0
 ip address 172.16.16.1 255.255.255.0
 no shutdown
```

**R2:**

```
interface Loopback0
 ip address 2.2.2.2 255.255.255.0
!
interface FastEthernet0/0
 ip address 10.1.23.2 255.255.255.0
 no shutdown
!
interface FastEthernet1/0
 ip address 10.1.12.2 255.255.255.0
 no shutdown
```

**R3:**

```
interface Loopback0
 ip address 3.3.3.3 255.255.255.0
!
```

```
interface FastEthernet0/0
 ip address 10.1.23.3 255.255.255.0
 no shutdown
!
interface FastEthernet1/0
 ip address 10.1.34.3 255.255.255.0
 no shutdown
!
ip route 4.4.4.0 255.255.255.0 10.1.34.4
ip route 4.4.4.0 255.255.255.0 10.1.134.4
```

**R4:**

```
interface Loopback0
 ip address 4.4.4.4 255.255.255.0
!
interface Loopback4
 ip address 40.0.0.4 255.255.255.0
!
interface FastEthernet1/0
 ip address 10.1.34.4 255.255.255.0
 sno shutdown
!
interface FastEthernet1/1
 ip address 10.1.134.4 255.255.255.0
 no shutdown
!
ip route 3.3.3.0 255.255.255.0 10.1.34.3
ip route 3.3.3.0 255.255.255.0 10.1.134.3
```

**R5:**

```
interface FastEthernet0/0
 ip address 172.16.16.5 255.255.255.0
 no shutdown
```

**In this internetwork topology, R1 is in sub-AS 65001, with R2 and R3 in sub-AS 65023. In this case, R1 and R3 will not be neighbors. The following list outlines the sequence of events to propagate a prefix:**

**1. R3 will learn prefix 40.0.0.0/24 through eBGP from AS 45 (R4).**
**2. R3 will advertise the prefix through iBGP to R2.**
**3. R2 will advertise the prefix through confederation eBGP to R1.**

**R1 Configuration. Note the sub-AS in the router bgp command, and the true AS in the bgp confederation identifier command. Also note the neighbor ebgp-multihop command for confederation eBGP peer R2, as they are using loopbacks. Also, sync is not needed now that the confederation has been created.**

```
R1#show run | s router
router eigrp 100
 network 1.0.0.0
 network 10.0.0.0
router bgp 65001
 bgp log-neighbor-changes
 bgp confederation identifier 123
 bgp confederation peers 65023
 network 172.16.16.0 mask 255.255.255.0
 neighbor 2.2.2.2 remote-as 65023
```

```
 neighbor 2.2.2.2 ebgp-multihop 2
 neighbor 2.2.2.2 update-source Loopback0
 neighbor 172.16.16.5 remote-as 678
R1#
```

**R2 Configuration. Note the bgp confederation peers 65001 command. Without it,R2 would think that neighbor 1.1.1.1 was a true eBGP connection, and remove the confederation AS_PATH entries before advertising to R1.**

```
R2#show run | s router
router eigrp 100
 network 2.0.0.0
 network 10.0.0.0
router bgp 65023
 bgp log-neighbor-changes
 bgp confederation identifier 123
 bgp confederation peers 65001
 neighbor 1.1.1.1 remote-as 65001
 neighbor 1.1.1.1 ebgp-multihop 2
 neighbor 1.1.1.1 update-source Loopback0
 neighbor 3.3.3.3 remote-as 65023
 neighbor 3.3.3.3 update-source Loopback0
R2#
```

**R3 Configuration. Note that R3 does not need a bgp confederation peers command, as it does not have any confederation eBGP peers.**

```
R3#show run | s router
router eigrp 100
 network 3.0.0.0
 network 10.0.0.0
router bgp 65023
 bgp log-neighbor-changes
 bgp confederation identifier 123
 neighbor 2.2.2.2 remote-as 65023
 neighbor 2.2.2.2 update-source Loopback0
 neighbor 2.2.2.2 next-hop-self
 neighbor 4.4.4.4 remote-as 45
 neighbor 4.4.4.4 ebgp-multihop 2
 neighbor 4.4.4.4 update-source Loopback0
R3#
```

```
R4#show run | s router
router bgp 45
 bgp log-neighbor-changes
 network 40.0.0.0 mask 255.255.255.0
 neighbor 3.3.3.3 remote-as 123
 neighbor 3.3.3.3 ebgp-multihop 2
 neighbor 3.3.3.3 update-source Loopback0
R4#
```

```
R5#show run | s router
router bgp 678
 bgp log-neighbor-changes
 neighbor 172.16.16.1 remote-as 123
R5#
```

**R1 has received the 40.0.0.0/24 prefix, with sub-AS 65023 shown in parentheses, and true AS 45 shown outside the parentheses. R1 has also learned the same prefix via AS 678 and R5. The route through the sub-AS is best because it is the shortest AS_PATH; the shortest AS_PATH logic ignores the confederation sub-autonomous systems.**

```
R1#show ip bgp
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, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>  40.0.0.0/24      3.3.3.3                  0    100      0 (65023) 45 i
 *>  172.16.16.0/24   0.0.0.0                  0         32768 i
R1#
```

**R6 shows its received update from R1, showing the removed sub-AS, and the inclusion of the true AS, AS 123.**

```
R5#show ip bgp
BGP table version is 3, local router ID is 172.16.16.5
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>  40.0.0.0/24      172.16.16.1                            0 123 45 i
 r>  172.16.16.0/24   172.16.16.1              0             0 123 i
R5#
```

```
R5#show ip bgp neighbor 172.16.16.1 received-routes
BGP table version is 3, local router ID is 172.16.16.5
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>  40.0.0.0/24      172.16.16.1                            0 123 45 i
 r>  172.16.16.0/24   172.16.16.1              0             0 123 i

Total number of prefixes 2
R5#
```

```
R5#ping 40.0.0.4
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 40.0.0.4, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 184/195/212 ms
R5#
```

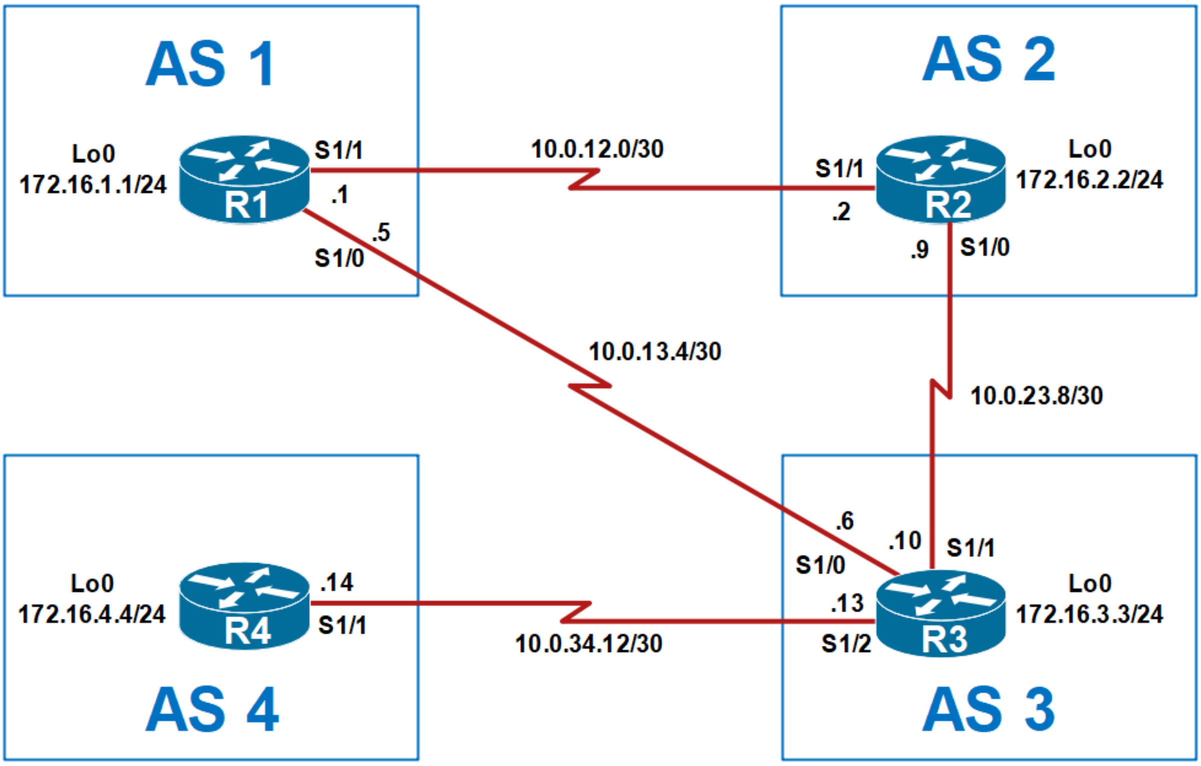
```
R2#show ip bgp
```

```
BGP table version is 3, local router ID is 2.2.2.2
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>i 40.0.0.0/24      3.3.3.3                  0    100      0 45 i
 *>  172.16.16.0/24   1.1.1.1                  0    100      0 (65001) i
R2#
```

```
R3#show ip bgp
BGP table version is 3, local router ID is 3.3.3.3
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>  40.0.0.0/24      4.4.4.4                  0             0 45 i
 *>i 172.16.16.0/24   1.1.1.1                  0    100      0 (65001) i
R3#
```

```
R4#show ip bgp
BGP table version is 3, local router ID is 4.4.4.4
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>  40.0.0.0/24      0.0.0.0                  0         32768 i
 *>  172.16.16.0/24   3.3.3.3                                0 123 i
R4#
```

## Lab 5: Bestpath as-path ignore and aggregate-address




**Basic configuration**

**R1:**

```
interface Loopback0
 ip address 172.16.1.1 255.255.255.0
!
interface Serial1/0
 ip address 10.0.13.5 255.255.255.252
 no shutd
!
interface Serial1/1
 ip address 10.0.12.1 255.255.255.252
 no shutd
```

**R2:**

```
interface Loopback0
 ip address 172.16.2.2 255.255.255.0
!
interface Serial1/0
 ip address 10.0.23.9 255.255.255.252
 no shutd
!
interface Serial1/1
 ip address 10.0.12.2 255.255.255.252
 no shutd
```

**R3:**

```
interface Loopback0
 ip address 172.16.3.3 255.255.255.0
!
interface Serial1/0
 ip address 10.0.13.6 255.255.255.252
 no shutd
!
interface Serial1/1
 ip address 10.0.23.10 255.255.255.252
 no shutd
!
interface Serial1/2
 ip address 10.0.34.13 255.255.255.252
 no shutd
```

**R4:**

```
interface Loopback0
 ip address 172.16.4.4 255.255.255.0
!
interface Serial1/1
 ip address 10.0.34.14 255.255.255.252
 no shutd
```

**R1 will peer with R2 and R3. R2 will peer with R1 and R3. R3 will peer with R1, R2 and R4. R4 will peer only with R3. The routers should all use their physical interface addresses for BGP peering.**

**R1**

```
router bgp 1
 bgp router-id 1.1.1.1
 neighbor 10.0.12.2 remote-as 2
 neighbor 10.0.13.6 remote-as 3
```

**R2**

```
router bgp 2
 bgp router-id 2.2.2.2
 neighbor 10.0.12.1 remote-as 1
 neighbor 10.0.23.10 remote-as 3
```

**R3**

```
router bgp 3
 bgp router-id 3.3.3.3
 no neighbor 10.0.13.5 remote-as 5
 neighbor 10.0.23.9 remote-as 2
 neighbor 10.0.34.14 remote-as 4
```

**R4**

```
router bgp 4
 bgp router-id 4.4.4.4
 neighbor 10.0.34.13 remote-as 3
```

**Check the status of all BGP connections with the do show ip bgp summary command:**

```
R1(config-router)#do show ip bgp summary
BGP router identifier 1.1.1.1, local AS number 1
BGP table version is 1, main routing table version 1
```

```
Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down
State/PfxRcd
10.0.12.2       4            2       5       5        1    0    0 00:02:14
0
10.0.13.6       4            3       2       2        1    0    0 00:00:21
0
```

```
R2(config-router)#do show ip bgp summary
BGP router identifier 2.2.2.2, local AS number 2
BGP table version is 1, main routing table version 1

Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down
State/PfxRcd
10.0.12.1       4            1       5       5        1    0    0 00:02:16
0
10.0.23.10      4            3       5       5        1    0    0 00:02:13
0
```

```
R3(config-router)#do show ip bgp summary
BGP router identifier 3.3.3.3, local AS number 3
BGP table version is 1, main routing table version 1

Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down
State/PfxRcd
10.0.13.5       4            1       3       3        1    0    0 00:01:18
0
10.0.23.9       4            2       6       6        1    0    0 00:03:07
0
10.0.34.14      4            4       2       2        1    0    0 00:00:10
0
R3(config-router)#
```

```
R4(config-if)#do show ip bgp summary
BGP router identifier 4.4.4.4, local AS number 4
BGP table version is 1, main routing table version 1

Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down
State/PfxRcd
10.0.34.13      4            3       2       2        1    0    0 00:00:13
0
R4(config-if)#
```

**Advertise the 172.16.x.0/24 LAN subnets on all routers via BGP. These should be injected using the network command on all routers. Verify that all routers' LAN subnets can ping every other routers LAN subnet.**

**R1**

```
router bgp 1
 network 172.16.1.0 mask 255.255.255.0
```

**R2**

```
router bgp 2
 network 172.16.2.0 mask 255.255.255.0
```

**R3**

```
router bgp 3
 network 172.16.3.0 mask 255.255.255.0
```

**R4**

```
router bgp 4
 network 172.16.4.0 mask 255.255.255.0
```

**Verify that all routers have the 172.16.x.0/24 subnets in their BGP Tables:**

```
R1(config)#do show ip bgp
BGP table version is 5, 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, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>  172.16.1.0/24    0.0.0.0                  0         32768 i
 *   172.16.2.0/24    10.0.13.6                              0 3 2 i
 *>                   10.0.12.2                0             0 2 i
 *   172.16.3.0/24    10.0.12.2                              0 2 3 i
 *>                   10.0.13.6                0             0 3 i
 *   172.16.4.0/24    10.0.12.2                              0 2 3 4 i
 *>                   10.0.13.6                              0 3 4 i
```

```
R2(config)#do show ip bgp
BGP table version is 5, local router ID is 2.2.2.2
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *   172.16.1.0/24    10.0.23.10                             0 3 1 i
 *>                   10.0.12.1                0             0 1 i
 *>  172.16.2.0/24    0.0.0.0                  0         32768 i
 *   172.16.3.0/24    10.0.12.1                              0 1 3 i
 *>                   10.0.23.10               0             0 3 i
 *   172.16.4.0/24    10.0.12.1                              0 1 3 4 i
 *>                   10.0.23.10                             0 3 4 i
```

```
R3(config-router)#do show ip bgp
BGP table version is 5, local router ID is 3.3.3.3
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *   172.16.1.0/24    10.0.23.9                              0 2 1 i
 *>                   10.0.13.5                0             0 1 i
 *   172.16.2.0/24    10.0.13.5                              0 1 2 i
 *>                   10.0.23.9                0             0 2 i
 *>  172.16.3.0/24    0.0.0.0                  0         32768 i
```

```
 *>  172.16.4.0/24    10.0.34.14               0             0 4 i
```

```
R4(config-router)#do show ip bgp
BGP table version is 5, local router ID is 4.4.4.4
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>  172.16.1.0/24    10.0.34.13                             0 3 1 i
 *>  172.16.2.0/24    10.0.34.13                             0 3 2 i
 *>  172.16.3.0/24    10.0.34.13               0             0 3 i
 *>  172.16.4.0/24    0.0.0.0                  0         32768 i
```

**Finally, verify that each router can ping every other routers' LAN interface from its own:**

```
R1#ping 172.16.2.2 source loopback0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.2.2, timeout is 2 seconds:
Packet sent with a source address of 172.16.1.1
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 8/97/236 ms
R1#
```

```
R1#ping 172.16.3.3 source loopback0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.3.3, timeout is 2 seconds:
Packet sent with a source address of 172.16.1.1
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 8/84/128 ms
R1#

R1#ping 172.16.4.4 source loopback0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.4.4, timeout is 2 seconds:
Packet sent with a source address of 172.16.1.1
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 68/103/140 ms
R1#
```

```
R2#ping 172.16.1.1 source loopback0
*Mar 26 01:37:51.095: %SYS-5-CONFIG_I: Configured from console by console
R2#ping 172.16.1.1 source loopback0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.1.1, timeout is 2 seconds:
Packet sent with a source address of 172.16.2.2
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 36/102/144 ms
R2#

R2#ping 172.16.3.3 source loopback0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.3.3, timeout is 2 seconds:
Packet sent with a source address of 172.16.2.2
!!!!!
```

```
Success rate is 100 percent (5/5), round-trip min/avg/max = 104/121/152 ms
R2#

R2#ping 172.16.4.4 source loopback0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.4.4, timeout is 2 seconds:
Packet sent with a source address of 172.16.2.2
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 120/140/148 ms
R2#
```

```
R3#ping 172.16.1.1 source loopback0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.1.1, timeout is 2 seconds:
Packet sent with a source address of 172.16.3.3
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 28/37/48 ms
R3#

R3#ping 172.16.2.2 source loopback0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.2.2, timeout is 2 seconds:
Packet sent with a source address of 172.16.3.3
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 28/34/40 ms
R3#

R3#ping 172.16.4.4 source loopback0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.4.4, timeout is 2 seconds:
Packet sent with a source address of 172.16.3.3
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 96/106/120 ms
R3#
```

```
R4#ping 172.16.1.1 source loopback0
*Mar 26 01:39:50.211: %SYS-5-CONFIG_I: Configured from console by console
R4#ping 172.16.1.1 source loopback0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.1.1, timeout is 2 seconds:
Packet sent with a source address of 172.16.4.4
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 116/129/152 ms
R4#

R4#ping 172.16.2.2 source loopback0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.2.2, timeout is 2 seconds:
Packet sent with a source address of 172.16.4.4
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 88/124/140 ms
R4#

R4#ping 172.16.3.3 source loopback0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.3.3, timeout is 2 seconds:
Packet sent with a source address of 172.16.4.4
```

```
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 80/104/128 ms
R4#
```

**Configure R1 with the following Loopback interfaces:**

**Loopback 1: IP Address 192.0.0.1/32**
**Loopback 0: IP Address 192.0.1.1/32**

**R1**

```
interface loopback 1
ip add 192.0.0.1 255.255.255.255
```

```
interface loopback 2
ip add 192.0.1.1 255.255.255.255
```

**These prefixes should be advertised only to R2. Next, configure R2 to advertise a single route for these prefixes to R3. Ensure that this aggregate route ONLY appears in the BGP Table of R4 but not in the BGP Table of R1. Follow the restrictions below:**

**You can NOT use an outbound route map on R1**
**You can NOT use any outbound filters or route maps on R2 or R3**
**You can NOT use any inbound filters or route maps on R1 or R3**
**You can NOT modify administrative distance values**

**To do the first part of the requirement, create a prefix-list named FILTER which matches the two prefixes with a deny action and a third sequence to allow other prefixes, then under router bgp we tell to R1 to apply this prefix-list toward the neighbor 10.0.13.6 which is R3:**

```
ip prefix-list FILTER seq 1 deny 192.0.0.1/32
ip prefix-list FILTER seq 2 deny 192.0.1.1/32
ip prefix-list FILTER seq 3 permit 0.0.0.0/0 le 32
!
router bgp 1
network 192.0.0.1 mask 255.255.255.255
network 192.0.1.1 mask 255.255.255.255
neighbor 10.0.13.6 prefix-list FILTER out
```

**The show ip bgp neighbors 10.0.12.2 advertised-routes command displays which prefixes or routes are being advertised to R2, notice the presence of the two prefixes 192.0.0.1/32 and 192.0.1.1/32:**

```
R1(config)#do show ip bgp neighbors 10.0.12.2 advertised-routes
BGP table version is 7, 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, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>  172.16.1.0/24    0.0.0.0                  0         32768 i
 *>  172.16.3.0/24    10.0.13.6                0             0 3 i
 *>  172.16.4.0/24    10.0.13.6                              0 3 4 i
 *>  192.0.0.1/32     0.0.0.0                  0         32768 i
 *>  192.0.1.1/32     0.0.0.0                  0         32768 i
```

```
Total number of prefixes 5
```

**The show ip bgp neighbors 10.0.13.6 advertised-routes command displays which prefixes or routes are being advertised to R3, notice now the absence of the two prefixes 192.0.0.1/32 and 192.0.1.1/32 because the filtering configured on R1:**

```
R1(config)#do show ip bgp neighbors 10.0.13.6 advertised-routes
BGP table version is 7, 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, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>  172.16.1.0/24    0.0.0.0                  0         32768 i
 *>  172.16.2.0/24    10.0.12.2                0             0 2 i

Total number of prefixes 2
```

**The second part requires that you summarize these prefixes and ensure that they are NOT advertised back to R1 by R3. Given the restrictions. When summarizing with BGP, if you use the aggregate-address command, the router that performs the aggregation removes, by default, any other AS_PATH information (AS_SET). The summarized route is therefore originated from the AS of the router that generated the summary. This means that if the routes that are summarized were received from another AS, as is our case, the aggregate can be re-advertised back to that AS, causing some issues (such as routing loop. For example, assume the following command was issued on R2:**

**On R2 we will use the aggregate-address command in order to advertise a single route for the prefixes 192.0.0.1/32 and 192.0.1.1/32 to R3.**
**Keep in mind that when summarizing with BGP, if we use the aggregate-address command, the router (R2 in our case) that performs the aggregation, by default it removes any other AS_PATH information (AS_SET). The summarized route is thus originated from the AS of the router that generated the summary (R2) not the router that generates the routes of the specific subnets (R1). This means that if the routes that are summarized were received from another AS, like with our case the aggregate can be re-advertised back to that AS (AS 1), causing some issues suche loop problems.**

**We can verify when summarizing on R2 as follow:**

**R2**

```
router bgp 2
 aggregate-address 192.0.0.0 255.255.254.0 summary-only
```

**From the BGP table of R3, R2 suppresses the specific 192.0.0.1/32 and 192.0.1.1/32 prefixes and advertises only a single route to R3. This route appears on R3 as follows:**
**Notice that the AS_PATH shows that this aggregate route is originated from AS 2, in other word the AS 1 is not listed in the BGP table of R3 for the summary route:**

```
R3#show ip bgp 192.0.0.0 255.255.254.0
BGP routing table entry for 192.0.0.0/23, version 50
Paths: (1 available, best #1, table default)
Flag: 0x820
  Not advertised to any peer
  Refresh Epoch 1
  2, (aggregated by 2 2.2.2.2)
```

```
    10.0.23.9 from 10.0.23.9 (2.2.2.2)
      Origin IGP, metric 0, localpref 100, valid, external, atomic-aggregate, best
      rx pathid: 0, tx pathid: 0x0
```

**Notice that the AS_PATH shows that this aggregate originates in AS 2, even though it is based on prefixes originated in AS 1. Given this, R1 will accept this same prefix from both R2 an R3:**

```
R1(config)#do show ip bgp 192.0.0.0 255.255.254.0
BGP routing table entry for 192.0.0.0/23, version 14
Paths: (2 available, best #2, table default)
  Advertised to update-groups:
     6
  Refresh Epoch 2
  3 2, (aggregated by 2 2.2.2.2)
    10.0.13.6 from 10.0.13.6 (3.3.3.3)
      Origin IGP, localpref 100, valid, external, atomic-aggregate
      rx pathid: 0, tx pathid: 0
  Refresh Epoch 1
  2, (aggregated by 2 2.2.2.2)
    10.0.12.2 from 10.0.12.2 (2.2.2.2)
      Origin IGP, metric 0, localpref 100, valid, external, atomic-aggregate, best
      rx pathid: 0, tx pathid: 0x0
```

**To avoid this issue, add the keyword as-set to the aggregate-address command. It includes all AS of the specific prefixes from which the aggregate is generated. This prevents the aggregate from being advertised back to this AS 1, in other word the routers receiving this UPDATE will see their own AS_PATH in the update and drop it, according to the BGP loop prevention mechanism rule:**

**R2**

```
router bgp 2
aggregate-add 192.0.0.0 255.255.254.0 summary-only as-set
```

**Following this change, the aggregate now reflects an origin of AS 1 when seen on R3:**

```
R3#show ip bgp 192.0.0.0 255.255.254.0
BGP routing table entry for 192.0.0.0/23, version 55
Paths: (1 available, best #1, table default)
  Advertised to update-groups:
     1
  Refresh Epoch 1
  2 1, (aggregated by 2 2.2.2.2)
    10.0.23.9 from 10.0.23.9 (2.2.2.2)
      Origin IGP, metric 0, localpref 100, valid, external, best
      rx pathid: 0, tx pathid: 0x0
```

**Because R1 sees its own AS_PATH in the list, it does NOT accept the aggregate:**

```
R1(config)#do show ip bgp 192.0.0.0 255.255.254.0
% Network not in table
R1(config)#
```

**R1, R2 and R3 can ping the 192.0.0.1/32 and 192.0.1.1/32 prefixes from the loopback interfaces as a sources:**

```
R2#ping 192.0.0.1 source lo0
Type escape sequence to abort.
```

```
Sending 5, 100-byte ICMP Echos to 192.0.0.1, timeout is 2 seconds:
Packet sent with a source address of 172.16.2.2
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 28/40/52 ms
R2#ping 192.0.1.1 source lo0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.0.1.1, timeout is 2 seconds:
Packet sent with a source address of 172.16.2.2
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 28/37/48 ms
```

```
R3#ping 192.0.0.1 source lo0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.0.0.1, timeout is 2 seconds:
Packet sent with a source address of 172.16.3.3
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 68/113/128 ms
R3#ping 192.0.1.1 source lo0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.0.1.1, timeout is 2 seconds:
Packet sent with a source address of 172.16.3.3
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 76/105/148 ms
```

```
R4#ping 192.0.0.1 source lo0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.0.0.1, timeout is 2 seconds:
Packet sent with a source address of 172.16.4.4
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 96/132/152 ms
R4#ping 192.0.1.1 source lo0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.0.1.1, timeout is 2 seconds:
Packet sent with a source address of 172.16.4.4
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 116/129/140 ms
R4#
```

**Configure R2 and R4 with a Loopback 20 interface with the IP address 192.168.0.2/32. Next, redistribute this prefix into BGP on R2 and R4 and configure BGP path control so that R1 prefers the prefix originated by R4 over the prefix originated by R1. However, follow the restrictions below:**

**You can NOT modify the AS_PATH length for this prefix on ANY router**
**You can NOT modify default administrative distance values**
**You can NOT modify the WEIGHT or LOCAL_PREF attributes on R1**
**You can only issue ONE single command on R1, i.e. one line of code**
**You MUST use route maps when redistributing this interface on R2 and R4**

**R2**

```
interface loopback 20
ip address 192.168.0.2 255.255.255.255
```

**R4**

```
interface loopback 20
ip address 192.168.0.2 255.255.255.255
```

**If you have read the BGP path selection process. Because we cannot use WEIGHT or LOCAL_PREF, those two attributes are ruled out. Because both prefixes are not originated on the local router, we can skip this step of the path selection process.**
**The next attribute to consider then would be the AS_PATH length. However, the restriction says that we cannot MODIFY the AS_PATH length. However, if the bgp bestpath as-path ignore command is issued on the router, the AS_PATH attribute is not used in BGP best path selection. Also, when comparing this attribute, an AS_SET is counted once, regardless of the number of autonomous systems in the set. And, finally, the AS_CONFED_SEQUENCE is not included in the AS_PATH length.**

**Therefore, we can configure R1 to IGNORE the AS_PATH attribute in best path selection and look at the next attribute in the best path selection process, which is ORIGIN, we can influence the path selection by configuring R1 to ignore the AS_PATH attribute in the path selection process and advertising the prefix from R4 with a better ORIGIN code than that on R2.**

**R1**

```
router bgp 1
 bgp bestpath as-path ignore
```

**Complete your configuration on routers R2 and R4 as follows:**

**R2**

```
route-map LOOPBACK permit 10
 match interface loopback 20

router bgp 2
redistribute connected route-map LOOPBACK
```

**R4**

```
router bgp 2
redistribute connected route-map LOOPBACK

route-map LOOPBACK permit 10
 match interface loopback 20
 set origin igp

router bgp 4
redistribute connected route-map LOOPBACK
```

**Because the AS_PATH attribute is ignored in best path selection on R1, it is omitted in the path selection process and the next valid attribute, ORIGIN, is used instead. Given that an ORIGIN of IGP > EGP > Incomplete, the path from R4 wins and is used instead. The same logic is also applicable to R3, which prefers this same path because of the ORIGIN:**

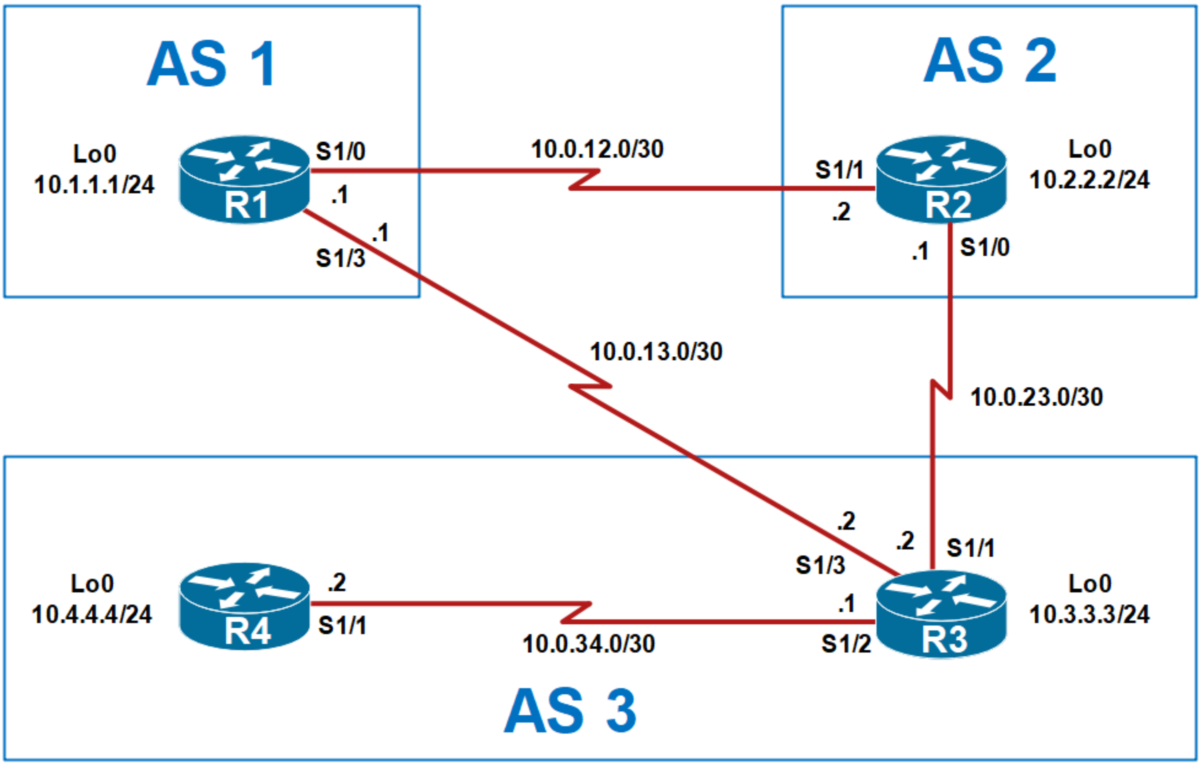
```
R1(config)#do show ip bgp 192.168.0.2 255.255.255.255
BGP routing table entry for 192.168.0.2/32, version 27
Paths: (2 available, best #1, table default)
  Advertised to update-groups:
     8
  Refresh Epoch 2
  3 4
    10.0.13.6 from 10.0.13.6 (3.3.3.3)
      Origin IGP, localpref 100, valid, external, best
      rx pathid: 0, tx pathid: 0x0
  Refresh Epoch 1
  2
    10.0.12.2 from 10.0.12.2 (2.2.2.2)
```

```
      Origin incomplete, metric 0, localpref 100, valid, external
      rx pathid: 0, tx pathid: 0
```

```
R3(config)#do show ip bgp 192.168.0.2 255.255.255.255
BGP routing table entry for 192.168.0.2/32, version 58
Paths: (2 available, best #1, table default)
  Advertised to update-groups:
     1
  Refresh Epoch 1
  4
    10.0.34.14 from 10.0.34.14 (4.4.4.4)
      Origin IGP, metric 0, localpref 100, valid, external, best
      rx pathid: 0, tx pathid: 0x0
  Refresh Epoch 1
  2
    10.0.23.9 from 10.0.23.9 (2.2.2.2)
      Origin incomplete, metric 0, localpref 100, valid, external
      rx pathid: 0, tx pathid: 0
```

```
R1(config)#do ping 192.168.0.2 source 172.16.1.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.0.2, timeout is 2 seconds:
Packet sent with a source address of 172.16.1.1
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 100/119/144 ms
```

## Lab 6: Community Attribute AS-Path Prepend and Default route




**Basic Configuration**

**R1:**

```
interface Loopback0
ip address 10.1.1.1 255.255.255.0
!
interface Serial1/0
ip address 10.0.12.1 255.255.255.252
no shutd
!
interface Serial1/3
ip address 10.0.13.1 255.255.255.252
no shutd
```

**R2:**

```
interface lo0
ip address 10.2.2.2 255.255.255.0
!
interface Serial1/1
ip address 10.0.12.2 255.255.255.252
no shutd
!
interface Serial1/0
ip address 10.0.23.1 255.255.255.252
no shutd
```

**R3:**

```
interface lo0
ip address 10.3.3.3 255.255.255.0
!
interface Serial1/1
ip address 10.0.23.2 255.255.255.252
no shutd
!
interface Serial1/3
ip address 10.0.13.2 255.255.255.252
no shutd
!
interface Serial1/2
ip address 10.0.34.1 255.255.255.252
no shutd
```

**R4:**

```
interface lo0
ip address 10.4.4.4 255.255.255.0
!
interface Serial1/1
ip address 10.0.34.2 255.255.255.252
no shutd
```

**Configure BGP, R1 will peer with R2 and R3. R2 will peer with R1 and R3. R3 will peer with R1, R2 and R4. R4 will peer only with R3 by using their physical interface addresses for BGP peering.**

**R1**

```
router bgp 1
bgp router-id 1.1.1.1
neighbor 10.0.12.2 remote-as 2
neighbor 10.0.13.2 remote-as 3
```

**R2**

```
router bgp 2
bgp router-id 2.2.2.2
neighbor 10.0.12.1 remote-as 1
neighbor 10.0.23.2 remote-as 3
```

**R3**

```
router bgp 3
bgp router-id 3.3.3.3
neighbor 10.0.13.1 remote-as 1
neighbor 10.0.23.1 remote-as 2
neighbor 10.0.34.2 remote-as 3
```

**R4**

```
router bgp 3
bgp router-id 4.4.4.4
neighbor 10.0.34.1 remote-as 3
```

**Verify that the neighboring is established between peers:**

```
R1#show ip bgp summary
BGP router identifier 1.1.1.1, local AS number 1
BGP table version is 1, main routing table version 1
```

```
Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down
State/PfxRcd
10.0.12.2       4            2      10       9        1    0    0 00:06:37
0
10.0.13.2       4            3       2       2        1    0    0 00:00:22
0
```

```
R2#show ip bgp summary
BGP router identifier 2.2.2.2, local AS number 2
BGP table version is 1, main routing table version 1

Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down
State/PfxRcd
10.0.12.1       4            1      10      11        1    0    0 00:07:28
0
10.0.23.2       4            3      10       8        1    0    0 00:05:47
0
```

```
R3#show ip bgp summary
BGP router identifier 3.3.3.3, local AS number 3
BGP table version is 1, main routing table version 1

Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down
State/PfxRcd
10.0.13.1       4            1       4       4        1    0    0 00:01:58
0
10.0.23.1       4            2       9      10        1    0    0 00:06:33
0
10.0.34.2       4            3      11      10        1    0    0 00:07:31
0
```

```
R4#show ip bgp summary
BGP router identifier 4.4.4.4, local AS number 3
BGP table version is 1, main routing table version 1

Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down
State/PfxRcd
10.0.34.1       4            3      11      12        1    0    0 00:08:04
0
```

**Advertise the 10.x.x.x LAN subnets on all routers via BGP. These should be injected using the network command on all routers.**

**R1**

```
router bgp 1
network 10.1.1.0 mask 255.255.255.0
```

**R2**

```
router bgp 2
network 10.2.2.0 mask 255.255.255.0
```

**Because R3 will be receiving prefixes from external peers (R1 and R2) and advertising those same prefixes to an internal peer (R4), you need to change the NEXT_HOP for the prefixes, otherwise R4 will not be able to reach them.**

**R3**

```
router bgp 3
network 10.3.3.0 mask 255.255.255.0
neighbor 10.0.34.2 next-hop-self
```

**R4**

```
router bgp 3
network 10.4.4.0 mask 255.255.255.0
```

**The BGP tables of R1 R2 R3 and R4 shown that the LAN subnets are learned and installed by all routers:**

```
R1#show ip bgp
BGP table version is 5, 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, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>  10.1.1.0/24      0.0.0.0                  0         32768 i
 *   10.2.2.0/24      10.0.13.2                              0 3 2 i
 *>                   10.0.12.2                0             0 2 i
 *   10.3.3.0/24      10.0.12.2                              0 2 3 i
 *>                   10.0.13.2                0             0 3 i
 *   10.4.4.0/24      10.0.12.2                              0 2 3 i
 *>                   10.0.13.2                              0 3 i
```

```
R2#show ip bgp
BGP table version is 5, local router ID is 2.2.2.2
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *   10.1.1.0/24      10.0.23.2                              0 3 1 i
 *>                   10.0.12.1                0             0 1 i
 *>  10.2.2.0/24      0.0.0.0                  0         32768 i
 *   10.3.3.0/24      10.0.12.1                              0 1 3 i
 *>                   10.0.23.2                0             0 3 i
 *   10.4.4.0/24      10.0.12.1                              0 1 3 i
 *>                   10.0.23.2                              0 3 i
```

```
R3#show ip bgp
BGP table version is 5, local router ID is 3.3.3.3
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *   10.1.1.0/24      10.0.23.1                              0 2 1 i
 *>                   10.0.13.1                0             0 1 i
```

```
 *   10.2.2.0/24      10.0.13.1                              0 1 2 i
 *>                   10.0.23.1                0             0 2 i
 *>  10.3.3.0/24      0.0.0.0                  0         32768 i
 *>i 10.4.4.0/24      10.0.34.2                0    100      0 i
```

```
R4#show ip bgp
BGP table version is 5, local router ID is 4.4.4.4
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>i 10.1.1.0/24      10.0.34.1                0    100      0 1 i
 *>i 10.2.2.0/24      10.0.34.1                0    100      0 2 i
 *>i 10.3.3.0/24      10.0.34.1                0    100      0 i
 *>  10.4.4.0/24      0.0.0.0                  0         32768 i
```

**Finally, verify that you have LAN-to-LAN connectivity on all routers using extended pings:**

```
R1#ping 10.2.2.2 source lo0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.2.2.2, timeout is 2 seconds:
Packet sent with a source address of 10.1.1.1
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 204/238/284 ms
R1#
R1#ping 10.3.3.3 source lo0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.3.3.3, timeout is 2 seconds:
Packet sent with a source address of 10.1.1.1
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 132/236/304 ms
R1#
R1#ping 10.4.4.4 source lo0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.4.4.4, timeout is 2 seconds:
Packet sent with a source address of 10.1.1.1
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 240/260/296 ms
```

```
R2#ping 10.1.1.1 source lo0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.1.1.1, timeout is 2 seconds:
Packet sent with a source address of 10.2.2.2
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 208/229/272 ms
R2#
R2#
R2#ping 10.3.3.3 source lo0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.3.3.3, timeout is 2 seconds:
Packet sent with a source address of 10.2.2.2
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 64/247/392 ms
R2#
```

```
R2#ping 10.4.4.4 source lo0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.4.4.4, timeout is 2 seconds:
Packet sent with a source address of 10.2.2.2
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 196/233/276 ms
```

```
R3#ping 10.1.1.1 source lo0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.1.1.1, timeout is 2 seconds:
Packet sent with a source address of 10.3.3.3
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 168/208/304 ms
R3#
R3#ping 10.2.2.2 source lo0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.2.2.2, timeout is 2 seconds:
Packet sent with a source address of 10.3.3.3
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 188/206/244 ms
R3#
R3#ping 10.4.4.4 source lo0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.4.4.4, timeout is 2 seconds:
Packet sent with a source address of 10.3.3.3
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 188/220/268 ms
```

```
R4#ping 10.1.1.1 source lo0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.1.1.1, timeout is 2 seconds:
Packet sent with a source address of 10.4.4.4
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 68/238/436 ms
R4#
R4#ping 10.2.2.2 source lo0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.2.2.2, timeout is 2 seconds:
Packet sent with a source address of 10.4.4.4
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 172/237/280 ms
R4#
R4#ping 10.4.4.4 source lo0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.4.4.4, timeout is 2 seconds:
Packet sent with a source address of 10.4.4.4
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 4/4/8 ms
```

**Configure BGP so that R1 prefers the path via R2 to reach the 10.4.4.0/24 subnet. You are NOT allowed to make any changes on R1 or R2 when completing this task. Ensure that when R2 is down, R1 can still reach the 150.4.4.0/24 subnet. Verify your configuration using the appropriate commands and simulating a R2 failure.**

**Prior to any changes, the BGP RIB on R1 shows the following entries.**

**The current best path for 10.4.4.0/24 is via R3 because of the shorter AS_PATH as shown by the BGP RIB table on R1:**
**NOTE: The greater than sign (>) indicates the current best path in the BGP RIB with the next-hop 10.0.13.2 which is R3:**

```
R1#show ip bgp
BGP table version is 5, 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, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>  10.1.1.0/24      0.0.0.0                  0         32768 i
 *   10.2.2.0/24      10.0.13.2                              0 3 2 i
 *>                   10.0.12.2                0             0 2 i
 *   10.3.3.0/24      10.0.12.2                              0 2 3 i
 *>                   10.0.13.2                0             0 3 i
 *   10.4.4.0/24      10.0.12.2                              0 2 3 i
 *>                   10.0.13.2                              0 3 i
```

**To complete this requirement, prepend the AS_PATH for this prefix on R3 for the neighbor relationship to R1:**

**R3**

```
ip prefix-list R4-LAN seq 5 permit 10.4.4.0/24
!
route-map PATH-PREPEND permit 10
match ip address prefix list R4-LAN
set as-path prepend 3 3
!
route-map PATH-PREPEND permit 20
!
router bgp 3
neighbor 10.0.13.1 route-map PATH-PREPEND out
```

**Following this configuration, the BGP Table on R1 shown that the best path for 10.4.4.0/24 is through R2 because the shorter AS_PATH:**
**The AS_PATH length through R2: 2 3**
**The AS_PATH length through R3: 3 3 3**

```
R1#show ip bgp
BGP table version is 13, 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, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>  10.1.1.0/24      0.0.0.0                  0         32768 i
 *   10.2.2.0/24      10.0.13.2                              0 3 3 3 2 i
 *>                   10.0.12.2                0             0 2 i
 *>  10.3.3.0/24      10.0.12.2                              0 2 3 i
 *                    10.0.13.2                0             0 3 3 3 i
 *>  10.4.4.0/24      10.0.12.2                              0 2 3 i
```

```
 *                    10.0.13.2                              0 3 3 3 i

R1#
```

```
R1#show ip bgp 10.4.4.0/24
BGP routing table entry for 10.4.4.0/24, version 13
Paths: (2 available, best #1, table default)
  Advertised to update-groups:
     1
  Refresh Epoch 1
  2 3
    10.0.12.2 from 10.0.12.2 (2.2.2.2)
      Origin IGP, localpref 100, valid, external, best
      rx pathid: 0, tx pathid: 0x0
  Refresh Epoch 1
  3 3 3
    10.0.13.2 from 10.0.13.2 (3.3.3.3)
      Origin IGP, localpref 100, valid, external
      rx pathid: 0, tx pathid: 0
```

**The traceroute confirms that the packets go through R2:**

```
R1#traceroute 10.4.4.4 so 10.1.1.1
Type escape sequence to abort.
Tracing the route to 10.4.4.4
VRF info: (vrf in name/id, vrf out name/id)
  1 10.0.12.2 52 msec 36 msec 32 msec
  2 10.0.23.2 60 msec 44 msec 40 msec
  3 10.0.34.2 76 msec *  80 msec
```

**Configure the following Loopback interfaces on R1:**
**Loopback 192: IP Address 192.168.1.1/32**
**Loopback 193: IP Address 172.16.1.1/32**

**Advertise the 192.168.1.1/32 subnet only to R2. Ensure that this is NOT re-advertised to R3. Next, advertise the 172.16.1.1/32 subnet only to R3. Ensure that this is NOT re-advertised to R2 or R4.**

```
R1(config)#interface lo192
R1(config-if)#ip address 192.168.1.1 255.255.255.255

R1(config)#interface lo172
R1(config-if)#ip addres 172.16.1.1 255.255.255.255
```

**To do this challenge we will use a route map in conjunction with prefix-list.**

**Create two prefix-lists named LO-192 and LO-172 to identify the 192.168.1.1/32 and 172.16.1.1/32 subnets respectively:**

```
R1(config)#ip prefix-list LO-192 seq 5 permit 192.168.1.1/32
R1(config)#ip prefix-list LO-172 seq 5 permit 172.16.1.1/32
```

**The route-map called OUT-TO-R2 with the sequence 10 will deny the prefix 172.16.1.1 identified by the prefix-list LO-172 from being advertised to R2 and allow other prefixes with the second sequence 20 of the route-map:**

```
R1(config)#route-map OUT-TO-R2 deny 10
```

```
R1(config-route-map)#match ip address prefix-list LO-172
R1(config-route-map)#exit
R1(config)#route-map OUT-TO-R2 permit 20
```

**The route-map called OUT-TO-R3 with the sequence 10 will deny the prefix 192.168.1.1 identified by the prefix-list LO-192 from being advertised to R3 and allow other prefixes with the second sequence 20 of the route-map:**

```
R1(config)#route-map OUT-TO-R3 deny 10
R1(config-route-map)#match ip address prefix-list LO-192
R1(config-route-map)#exit
R1(config)#route-map OUT-TO-R3 permit 20
```

**Let's advertise the prefixes 192.168.1.1/32 and 172.16.1.1/32 and apply the route-maps OUT-TO-R2 and OUT-TO-R3 toward R2 and R3 respectively in the outbound direction:**

```
R1(config)#router bgp 1
R1(config-router)#network 192.168.1.1 mask 255.255.255.255
R1(config-router)#network 172.16.1.1 mask 255.255.255.255
R1(config-router)#neighbor 10.0.12.2 route-map OUT-TO-R2 out
R1(config-router)#neighbor 10.0.13.2 route-map OUT-TO-R3 out
R1(config-router)#exit
```

**Verify the configuration using the show ip bgp neighbors 10.0.12.2 advertised-routes and show ip bgp neighbors 10.0.13.2 advertised-routes commands on R1 to see the prefixes advertised to R2 and R3 respectively:**

**R1 does not advertise 172.16.1.1/32 to R2:**

```
R1#show ip bgp neighbors 10.0.12.2 advertised-routes
BGP table version is 7, 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, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>  10.1.1.0/24      0.0.0.0                  0         32768 i
 *>  192.168.1.1/32   0.0.0.0                  0         32768 i

Total number of prefixes 2
R1#
```

**R1 does not advertise 192.168.1.1/32 to R3:**

```
R1#show ip bgp neighbors 10.0.13.2 advertised-routes
BGP table version is 7, 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, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>  10.1.1.0/24      0.0.0.0                  0         32768 i
 *>  10.2.2.0/24      10.0.12.2                0             0 2 i
```

```
 *>  10.3.3.0/24      10.0.12.2                              0 2 3 i
 *>  10.4.4.0/24      10.0.12.2                              0 2 3 i
 *>  172.16.1.1/32    0.0.0.0                  0         32768 i

Total number of prefixes 5
R1#
```

**Now the challenge is:**
**-ensure that the prefix 192.168.1.1/32 is NOT re-advertised to R3.**
**-ensure that the prefix 172.16.1.1/32 is NOT re-advertised to R2 or R4.**

**To do this challenge we will use the COMMUNITY attribute.**

**By definition:**

**The DOC BGP says that:**

**The BGP well-known communities are communities that have predefined meanings. Cisco IOS software supports four well-known communities which are:**

1. **NO_EXPORT**
2. **NO_ADVERTISE**
3. **INTERNET**
4. **LOCAL_AS**

**1-The NO_EXPORT well-known community prevents BGP prefixes that are specifically assigned this predefined community attribute value from being advertised to any eBGP peers. The prefixes, however, will continue to be advertised to all other BGP speakers within the local AS. In other words, prefixes assigned this community value will remain local to the AS.**

**2-The NO_ADVERTISE community prevents any prefixes that are assigned this predefined community attribute from being advertised to any peer –internal or external-**

**3-The INTERNET community allows all prefixes assigned to this community to be advertised to any and all BGP peers (assuming no filtering, etc, is in place). In Cisco IOS software, all BGP prefixes belong to the INTERNET community by default.**

**4-the LOCAL_AS community is used in a somewhat similar manner to another of the previously described communities: the NO_EXPORT community. If used in a Confederation, the LOCAL_AS community prevents all prefixes assigned this community from being advertised out of the local sub autonomous system. When Confederations are not implemented, the LOCAL_AS community is applied in the same manner as the NO_EXPORT community.**

**In this case use the NO_ADVERTISE community:**

```
R1(config)#route-map OUT-TO-R2 permit 20
R1(config-route-map)#match ip address prefix-list LO-192
R1(config-route-map)#set community no-advertise
R1(config-route-map)#exit
R1(config)#route-map OUT-TO-R2 permit 30
```

```
R1(config)#route-map OUT-TO-R3 permit 20
R1(config-route-map)#match ip address prefix-list LO-172
R1(config-route-map)#set community no-advertise
R1(config-route-map)#exit
R1(config)#route-map OUT-TO-R3 permit 30
```

```
R1(config)#router bgp 1
```

```
R1(config-router)#neighbor 10.0.12.2 send-community standard
R1(config-router)#neighbor 10.0.13.2 send-community standard
R1(config-router)#end
R1#
R1#clear ip bgp * soft out
```

**Next, verify that the prefixes 192.168.1.1/32 and 172.16.1.1/32 are received by R2 and R3 respectively and are not re-advertised:**

```
R2#show ip bgp
BGP table version is 17, local router ID is 2.2.2.2
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *   10.1.1.0/24      10.0.23.2                              0 3 1 i
 *>                   10.0.12.1                0             0 1 i
 *>  10.2.2.0/24      0.0.0.0                  0         32768 i
 *>  10.3.3.0/24      10.0.23.2                0             0 3 i
 *>  10.4.4.0/24      10.0.23.2                              0 3 i
 *>  192.168.1.1/32   10.0.12.1                0             0 1 i
R2#
```

```
R2#show ip bgp 192.168.1.1 255.255.255.255
BGP routing table entry for 192.168.1.1/32, version 16
Paths: (1 available, best #1, table default, not advertised to any peer)
  Not advertised to any peer
  Refresh Epoch 1
  1
    10.0.12.1 from 10.0.12.1 (1.1.1.1)
      Origin IGP, metric 0, localpref 100, valid, external, best
      Community: no-advertise
      rx pathid: 0, tx pathid: 0x0
```

```
R3#show ip bgp
BGP table version is 15, local router ID is 3.3.3.3
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *   10.1.1.0/24      10.0.23.1                              0 2 1 i
 *>                   10.0.13.1                0             0 1 i
 *   10.2.2.0/24      10.0.13.1                              0 1 2 i
 *>                   10.0.23.1                0             0 2 i
 *>  10.3.3.0/24      0.0.0.0                  0         32768 i
 *>i 10.4.4.0/24      10.0.34.2                0    100      0 i
 *>  172.16.1.1/32    10.0.13.1                0             0 1 i
R3#
```

```
R3#show ip bgp 172.16.1.1 255.255.255.255
BGP routing table entry for 172.16.1.1/32, version 14
```

```
Paths: (1 available, best #1, table default, not advertised to any peer)
  Not advertised to any peer
  Refresh Epoch 1
  1
    10.0.13.1 from 10.0.13.1 (1.1.1.1)
      Origin IGP, metric 0, localpref 100, valid, external, best
      Community: no-advertise
      rx pathid: 0, tx pathid: 0x0
```

**The BGP RIB table of R4 does not have the entries for the 192.168.1.1/32 and 172.16.1.1/32 prefixes:**

```
R4#show ip bgp
BGP table version is 15, local router ID is 4.4.4.4
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>i 10.1.1.0/24      10.0.34.1                0    100      0 1 i
 *>i 10.2.2.0/24      10.0.34.1                0    100      0 2 i
 *>i 10.3.3.0/24      10.0.34.1                0    100      0 i
 *>  10.4.4.0/24      0.0.0.0                  0         32768 i
```

**To ensure that R4 can reach the 192.168.1.1/32 and 172.16.1.1/32 from its loopback interface. We will tell to R1 to advertise a default route to R2 and R3. This will allow R4 to always reach these two prefixes either via R1-R3 or R2-R3:**

**R1**

```
router bgp 1
neighbor 10.0.12.2 default-originate
neighbor 10.0.13.2 default-originate
```

**The BGP RIB table of R4 shown that it installs successfully one default route through the path R3-R1 because the shorter AS_PATH:**
**-The AS_PATH length through R3-R1 is: 1**
**-The AS_PATH length through R3-R1 is: 2 1**

```
R4#show ip bgp 0.0.0.0 0.0.0.0
BGP routing table entry for 0.0.0.0/0, version 18
Paths: (1 available, best #1, table default)
  Not advertised to any peer
  Refresh Epoch 1
  1
    10.0.34.1 from 10.0.34.1 (3.3.3.3)
      Origin IGP, metric 0, localpref 100, valid, internal, best
      rx pathid: 0, tx pathid: 0x0
```

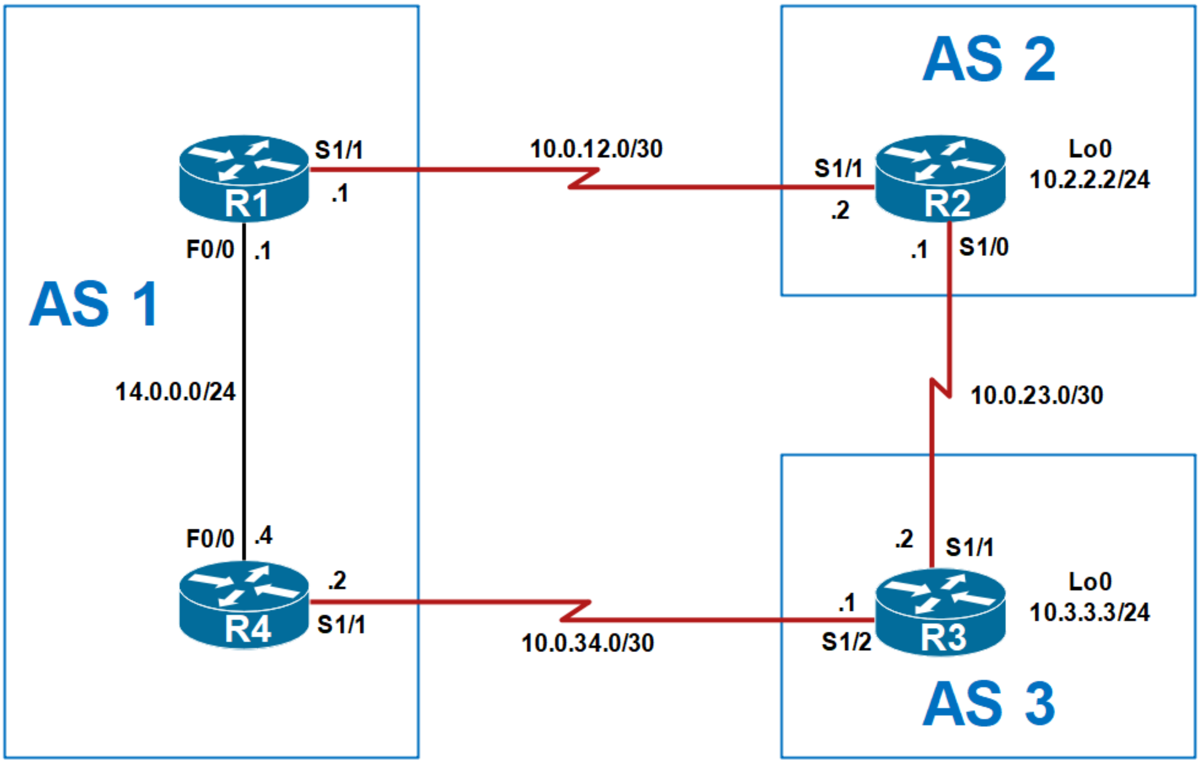
**Now if we disable the link R1-R3 and performing the same test:**

```
R3(config)#int s1/3
R3(config-if)#shutdown
```

**R4 installs a default route learned through AS 1 and 2, in other word the path R1-R2-R3:**

```
R4#show ip bgp 0.0.0.0 0.0.0.0
BGP routing table entry for 0.0.0.0/0, version 20
Paths: (1 available, best #1, table default)
  Not advertised to any peer
  Refresh Epoch 1
  2 1
    10.0.34.1 from 10.0.34.1 (3.3.3.3)
      Origin IGP, metric 0, localpref 100, valid, internal, best
      rx pathid: 0, tx pathid: 0x0
```

## Lab 7: BGP Backdoor and AS-Path Prepend




**Basic Configuration**

**R1:**

```
interface FastEthernet0/0
ip address 14.0.0.1 255.255.255.0
no shutdown
!
interface Serial1/1
ip address 10.0.12.1 255.255.255.252
no shutdown
```

**R2**

```
interface lo0
ip address 10.2.2.2 255.255.255.0
!
interface Serial1/1
ip address 10.0.12.2 255.255.255.252
no shutdown
!
interface Serial1/0
ip address 10.0.23.1 255.255.255.252
no shutdown
```

**R3**

```
interface lo0
ip address 10.3.3.3 255.255.255.0
!
```

```
interface Serial1/1
ip address 10.0.23.2 255.255.255.252
no shutdown
!
interface Serial1/2
ip address 10.0.34.1 255.255.255.252
no shutdown
```

**R4**

```
interface FastEthernet0/0
ip address 14.0.0.4 255.255.255.0
no shutdown
!
interface Serial01/1
ip address 10.0.34.2 255.255.255.252
no shutdown
```

**Configure BGP as illustrated in the topology. R1 will peer with R2. R2 will peer with R1 and R3. R3 will peer with R4. Do NOT peer R1 and R4 even though they exist in the same AS.**

**R1**

```
router bgp 1
bgp router-id 1.1.1.1
neighbor 10.0.12.2 remote-as 2
```

**R2**

```
router bgp 2
bgp router-id 2.2.2.2
neighbor 10.0.12.1 remote-as 1
neighbor 10.0.23.2 remote-as 3
```

**R3**

```
router bgp 3
bgp router-id 3.3.3.3
neighbor 10.0.23.1 remote-as 2
neighbor 10.0.34.2 remote-as 1
```

**R4**

```
router bgp 1
bgp router-id 4.4.4.4
neighbor 10.0.34.1 remote-as 3
```

**Verify the neighbor relationship using the show ip bgp summary command:**

```
R1#show ip bgp summary
BGP router identifier 1.1.1.1, local AS number 1
BGP table version is 1, main routing table version 1

Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down
State/PfxRcd
10.0.12.2       4            2       2       2        1    0    0 00:00:39
0
```

```
R2#show ip bgp summary
BGP router identifier 2.2.2.2, local AS number 2
BGP table version is 1, main routing table version 1
```

```
Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down
State/PfxRcd
10.0.12.1       4            1       5       5        1    0    0 00:02:11
0
10.0.23.2       4            3       5       5        1    0    0 00:02:05
0
```

```
R3#show ip bgp summary
BGP router identifier 3.3.3.3, local AS number 3
BGP table version is 1, main routing table version 1

Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down
State/PfxRcd
10.0.23.1       4            2       9       9        1    0    0 00:06:13
0
10.0.34.2       4            1       9       9        1    0    0 00:06:01
0
```

```
R4#show ip bgp summary
BGP router identifier 4.4.4.4, local AS number 1
BGP table version is 1, main routing table version 1

Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down
State/PfxRcd
10.0.34.1       4            3      10      10        1    0    0 00:06:42
0
```

**Advertise the 10.2.2.0/24 and 10.3.3.0/24 prefixes connected to R2 and R3, respectively, using BGP. Do NOT advertise the 14.0.0.0/24 subnet connected to R1 and R4. However, ensure that both R2 and R3 can still ping this subnet. You are NOT allowed to use static routes.**

**R2**

```
router bgp 2
network 10.2.2.0 mask 255.255.255.0
```

**R3**

```
router bgp 3
network 10.3.3.0 mask 255.255.255.0
```

**However to ensure that both R2 and R3 can reach the subnet 14.0.0.0. We tell to R1 and R4 to advertise a default route to R1 and R3 respectively:**

**R1**

```
router bgp 1
neighbor 10.0.12.2 default-originate
```

**R4**

```
router bgp 1
neighbor 10.0.34.1 default-originate
```

**The prefixes 10.2.2.0/24 and 10.3.3.0/24 are installed in the BGP RIB table of R1 and R4:**

```
R1#show ip bgp
BGP table version is 4, 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, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
     0.0.0.0          0.0.0.0                                0 i
 *>  10.2.2.0/24      10.0.12.2                0             0 2 i
 *>  10.3.3.0/24      10.0.12.2                              0 2 3 i
```

```
R4#show ip bgp
BGP table version is 4, local router ID is 4.4.4.4
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
     0.0.0.0          0.0.0.0                                0 i
 *>  10.2.2.0/24      10.0.34.1                              0 3 2 i
 *>  10.3.3.0/24      10.0.34.1                0             0 3 i
```

**R2 receives two default routes, R1 the default route advertised by R1 because it has the shorter as-path length:**

```
R2#show ip bgp
BGP table version is 4, local router ID is 2.2.2.2
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *   0.0.0.0          10.0.23.2                              0 3 1 i
 *>                   10.0.12.1                              0 1 i
 *>  10.2.2.0/24      0.0.0.0                  0         32768 i
 *>  10.3.3.0/24      10.0.23.2                0             0 3 i
```

**Also R3 receives two default routes, but it prefers the default route advertised by R4 because it has the shorter as-path length:**

```
R3#show ip bgp
BGP table version is 5, local router ID is 3.3.3.3
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>  0.0.0.0          10.0.34.2                              0 1 i
 *                    10.0.23.1                              0 2 1 i
 *>  10.2.2.0/24      10.0.23.1                0             0 2 i
 *>  10.3.3.0/24      0.0.0.0                  0         32768 i
```

**Finally, verify that R2 and R3 can ping the 14.0.0.1/24 and 14.0.0.4/24 addresses from their respective LAN addresses using an extended ping:**

```
R2#ping 14.0.0.1 source lo0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 14.0.0.1, timeout is 2 seconds:
Packet sent with a source address of 10.2.2.2
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 36/37/40 ms
R2#
R2#ping 14.0.0.4 source lo0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 14.0.0.4, timeout is 2 seconds:
Packet sent with a source address of 10.2.2.2
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 48/73/136 ms
```

```
R3#ping 14.0.0.1 source lo0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 14.0.0.1, timeout is 2 seconds:
Packet sent with a source address of 10.3.3.3
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 76/105/140 ms
R3#
R3#ping 14.0.0.4 source lo0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 14.0.0.4, timeout is 2 seconds:
Packet sent with a source address of 10.3.3.3
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 60/67/76 ms
```

**Configure BGP so that R3 prefers the path via R2 to reach the 14.0.0.0/24 subnet. You are only allowed to configure a device in AS 1. You are NOT allowed to advertise the 14.0.0.0/24 prefix when completing this requirement. Verify your configuration and ensure that R2 and R3 can still ping the 14.0.0.1/24 and 14.0.0.4/24 addresses when complete. Use an extended ping that is sourced from R3s LAN IP address.**

**Before configuring the route-map, let's confirm that the packet goes through R1 to reach 14.0.0.0/24 subnet with a traceroute command from R3 toward 14.0.0.1 and 14.0.0.4 with its respective LAN address:**

```
R3#traceroute 14.0.0.1 sou
R3#traceroute 14.0.0.1 source lo0
Type escape sequence to abort.
Tracing the route to 14.0.0.1
VRF info: (vrf in name/id, vrf out name/id)
  1 10.0.23.1 [AS 1] 120 msec 80 msec 8 msec
  2 10.0.12.1 [AS 1] 176 msec *  68 msec
R3#
R3#traceroute 14.0.0.4 source lo0
Type escape sequence to abort.
Tracing the route to 14.0.0.4
VRF info: (vrf in name/id, vrf out name/id)
  1 10.0.23.1 [AS 1] 48 msec 28 msec 28 msec
  2 10.0.12.1 [AS 1] 56 msec 44 msec 48 msec
  3 14.0.0.4 [AS 1] 52 msec *  60 msec
```

**To complete this task, you need to use a route map and AS_PATH prepending to make the default route advertised by R4 longer than that advertised by R1. This route-map should be applied to the default route advertised to R3. This task is completed as follows:**

**R4**

```
route-map PREPEND permit 10
set as-path prepend 1 1 1 1
!
router bgp 1
neighbor 10.0.34.1 default-originate route-map PREPEND
```

**Now R3 prefers the default route advertised by R1 as shown by its BGP RIB table because it has the shorter as-path length:**

```
R3#show ip bgp
BGP table version is 4, local router ID is 3.3.3.3
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *   0.0.0.0          10.0.34.2                              0 1 1 1 1 1 i
 *>                   10.0.23.1                              0 2 1 i
 *>  10.2.2.0/24      10.0.23.1                0             0 2 i
 *>  10.3.3.0/24      0.0.0.0                  0         32768 i
```

**The traceroute confirms that the packet goes through R2 to reach 14.0.0.0/24 subnet:**

```
R3#traceroute 14.0.0.1 source lo0
Type escape sequence to abort.
Tracing the route to 14.0.0.1
VRF info: (vrf in name/id, vrf out name/id)
  1 10.0.34.2 [AS 1] 40 msec 40 msec 40 msec
  2 14.0.0.1 [AS 1] 72 msec *  52 msec
R3#
R3#traceroute 14.0.0.4 source lo0
Type escape sequence to abort.
Tracing the route to 14.0.0.4
VRF info: (vrf in name/id, vrf out name/id)
  1 10.0.34.2 [AS 1] 44 msec *  88 msec
```

**Configure OSPF on the LAN subnet between R1 and R4. Next, configure AS 1 so that R4 will prefer the path via R1 to reach the 10.2.2.0/24 or 10.3.3.0/24 subnets. In the event that the WAN link between R1 and R2 is down, the path via R4 should be used instead. You are NOT allowed to establish an iBGP neighbor relationship between R1 and R4 to complete this requirement. Additionally, you are not allowed to use the distance command to modify any protocol administrative distance values. Instead, use a BGP feature when completing this task.**

**First, you need to enable OSPF between R1 and R4 across their directly connected LAN segment. Following this configuration, verify the OSPF adjacency between the routers using the show ip ospf neighbor command.**

**R1**

```
interface FastEthernet0/0
ip ospf 1 area 0
```

```
!
router ospf 1
router-id 1.1.1.1
```

**R4**

```
interface FastEthernet0/0
ip ospf 1 area 0
!
router ospf 1
router-id 4.4.4.4
```

**Next verify the OSPF adjacencies:**

```
R1#show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address         Interface
4.4.4.4           1   FULL/DR         00:00:31    14.0.0.4        FastEthernet0/0
```

```
R4#show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address         Interface
1.1.1.1           1   FULL/BDR        00:00:36    14.0.0.1        FastEthernet0/0
```

**The second part of this requirement is the use of the redistribution between OSPF and BGP. This allows the LAN subnets connected to R2 and R4 to be advertised across the LAN link connecting R1 and R2. You do NOT need to redistribute OSPF routes into BGP, otherwise you will advertise the LAN subnet between R1 and R4, which is NOT permitted as stated in previous requirements.**

```
R1(config)#router ospf 1
R1(config-router)#redistribute bgp 1 subnets
```

```
R4(config)#router ospf 1
R4(config-router)#redistribute bgp 1 subnets
```

**The routing tables on R1 and R4 show all routes.**
**But the outputs below shown that both routers prefer the BGP routes because of the lower administrative distance of external BGP (20) versus OSPF (110):**

```
R1#show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP
       + - replicated route, % - next hop override

Gateway of last resort is not set

      10.0.0.0/8 is variably subnetted, 4 subnets, 3 masks
C        10.0.12.0/30 is directly connected, Serial1/1
L        10.0.12.1/32 is directly connected, Serial1/1
B        10.2.2.0/24 [20/0] via 10.0.12.2, 00:35:07
B        10.3.3.0/24 [20/0] via 10.0.12.2, 00:12:22
```

```
      14.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C        14.0.0.0/24 is directly connected, FastEthernet0/0
L        14.0.0.1/32 is directly connected, FastEthernet0/0
```

```
R4#show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP
       + - replicated route, % - next hop override

Gateway of last resort is not set

      10.0.0.0/8 is variably subnetted, 4 subnets, 3 masks
C        10.0.34.0/30 is directly connected, Serial1/1
L        10.0.34.2/32 is directly connected, Serial1/1
B        10.2.2.0/24 [20/0] via 10.0.34.1, 00:13:50
B        10.3.3.0/24 [20/0] via 10.0.34.1, 00:13:19
      14.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C        14.0.0.0/24 is directly connected, FastEthernet0/0
L        14.0.0.4/32 is directly connected, FastEthernet0/0
```

**To complete this task, use the BGP network command.**
**The correct command to use in this case would be network <address><mask> backdoor command. The backdoor keyword configures the router to change the administrative distance of the specified external BGP route from 20 to 200. This allows IGP routes to be preferred instead. When the IGP routes are no longer present in the routing table, the BGP route is again used. This configuration is completed as follows:**

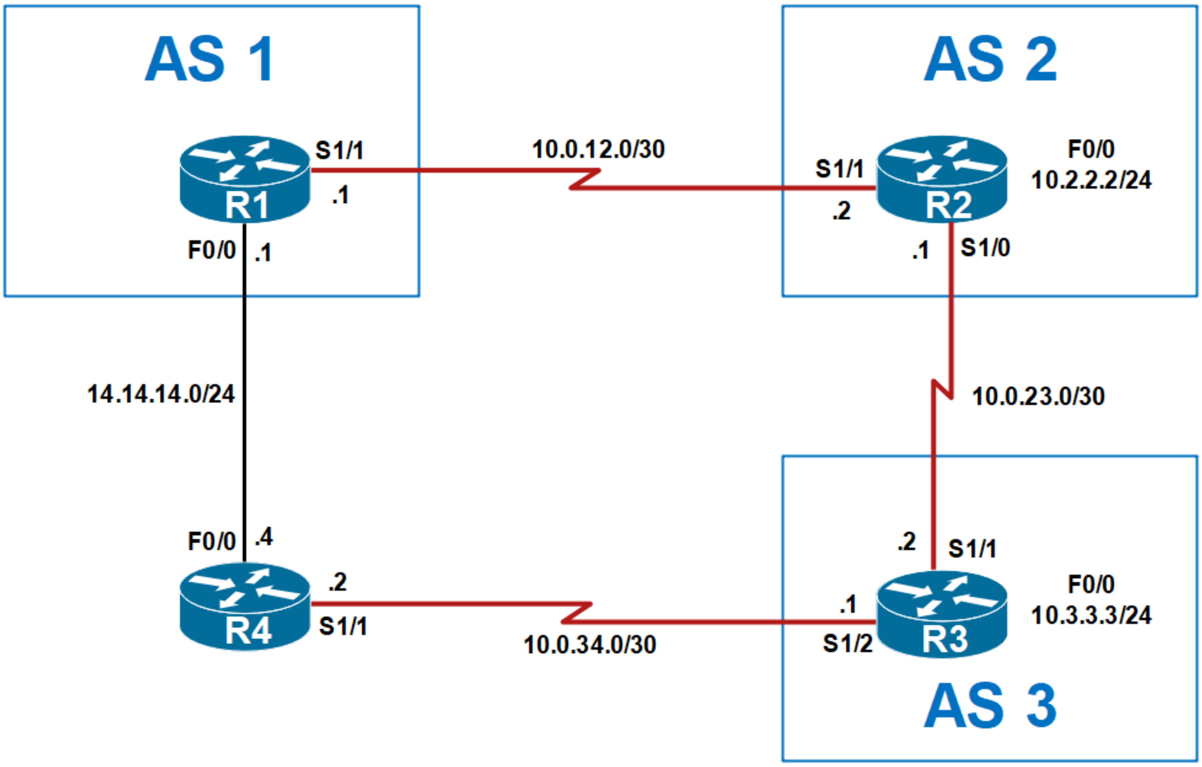
```
R4(config)#router bgp 1
R4(config-router)#network 10.2.2.0 mask 255.255.255.0 backdoor
R4(config-router)#network 10.3.3.0 mask 255.255.255.0 backdoor
```

**The routing table on R4 shows that now it prefers the External OSPF routes through R1 to reach the 10.2.2.0/24 and 15.3.3.0/24:**

```
R4#show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP
       + - replicated route, % - next hop override

Gateway of last resort is not set

      10.0.0.0/8 is variably subnetted, 4 subnets, 3 masks
C        10.0.34.0/30 is directly connected, Serial1/1
L        10.0.34.2/32 is directly connected, Serial1/1
O E2     10.2.2.0/24 [110/1] via 14.0.0.1, 00:00:19, FastEthernet0/0
O E2     10.3.3.0/24 [110/1] via 14.0.0.1, 00:00:11, FastEthernet0/0
      14.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
```

```
C        14.0.0.0/24 is directly connected, FastEthernet0/0
L        14.0.0.4/32 is directly connected, FastEthernet0/0
```

## Lab 8: AS-Path Prepend Weight and Default route




**Basic Configuration**

```
R1(config)#int s1/1
R1(config-if)#ip address 10.0.12.1 255.255.255.252
R1(config-if)#no shutdown
R1(config-if)#int fa0/0
R1(config-if)#ip address 14.14.14.1 255.255.255.0
R1(config-if)#no shutdown
```

```
R2(config-if)#int fa0/0
R2(config-if)#ip address 10.2.2.2 255.255.255.0
R2(config-if)#no shutdown
R2(config-if)#int s1/0
R2(config-if)#ip address 10.0.23.2 255.255.255.252
R2(config-if)#no shutdown
R2(config-if)#int s1/1
R2(config-if)#ip address 10.0.12.2 255.255.255.252
R2(config-if)#no shutdown
```

```
R3(config-if)#int fa0/0
R3(config-if)#ip address 10.3.3.3 255.255.255.0
R3(config-if)#no shutdown
R3(config)#int s1/1
R3(config-if)#ip address 10.0.23.2 255.255.255.252
R3(config-if)#no shutdown
R3(config-if)#int s1/2
R3(config-if)#ip address 10.0.34.1 255.255.255.252
```

```
R3(config-if)#no shutdown
```

```
R4(config)#int fa0/0
R4(config-if)#ip address 14.14.14.4 255.255.255.0
R4(config-if)#no shutdown
R4(config-if)#int s1/1
R4(config-if)#ip address 10.0.34.2 255.255.255.252
R4(config-if)#no shutdown
```

**Configure BGP. R1 will peer with R2. R2 will peer with R1 and R3. R3 will peer with R2.**

```
R1(config)#router bgp 1
R1(config-router)#bgp router-id 1.1.1.1
R1(config-router)#neighbor 10.0.12.2 remote-as 2
```

```
R2(config)#router bgp 2
R2(config-router)#bgp router-id 2.2.2.2
R2(config-router)#neighbor 10.0.12.1 remote-as 1
R2(config-router)#neighbor 10.0.23.2 remote-as 3
```

```
R3(config)#router bgp 3
R3(config-router)#bgp router-id 3.3.3.3
R3(config-router)#neighbor 10.0.23.1 remote-as 2
```

**Verify your configuration using the show ip bgp summary command:**

```
R1#show ip bgp summary
BGP router identifier 1.1.1.1, local AS number 1
BGP table version is 1, main routing table version 1

Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down
State/PfxRcd
10.0.12.2       4            2       7       7        1    0    0 00:03:09
0
R1#
```

```
R2#show ip bgp summary
BGP router identifier 2.2.2.2, local AS number 2
BGP table version is 1, main routing table version 1

Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down
State/PfxRcd
10.0.12.1       4            1       5       4        1    0    0 00:00:52
0
10.0.23.2       4            3       2       2        1    0    0 00:00:10
0
R2#
```

```
R3#show ip bgp summary
BGP router identifier 3.3.3.3, local AS number 3
BGP table version is 1, main routing table version 1

Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down
State/PfxRcd
10.0.23.1       4            2       5       6        1    0    0 00:03:12
0
```

```
R3#
```

**Configure R2 and R3 to advertise their 10.2.2.0/24 and 10.3.3.0/24 prefixes via BGP using the network command. Do NOT advertise the 10.1.1.0/24 subnet via BGP; however, ensure that both R2 and R3 can ping R1's LAN IP address. They do NOT need to be able to ping the LAN address of R4.**
**To allow R2 and R3 to ping the LAN interface address of R1, configure R1 to advertise a default route to R2, which will then advertise it to R3.**

```
R2(config)#router bgp 2
R2(config-router)#network 10.2.2.0 mask 255.255.255.0
```

```
R3(config)#router bgp 3
R3(config-router)#network 10.3.3.0 mask 255.255.255.0
```

```
R1(config)#router bgp 1
R1(config-router)#neighbor 10.0.12.2 default-originate
```

**R1 receives the BGP routes to 10.2.2.0/24 and 10.3.3.0/24 prefixes:**

```
R1#show ip bgp
BGP table version is 4, 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, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
     0.0.0.0          0.0.0.0                                0 i
 *>  10.2.2.0/24      10.0.12.2                0             0 2 i
 *>  10.3.3.0/24      10.0.12.2                              0 2 3 i
R1#
```

**Both R2 and R3 receive a default route from R1:**

```
R2#show ip bgp
BGP table version is 4, local router ID is 2.2.2.2
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>  0.0.0.0          10.0.12.1                              0 1 i
 *>  10.2.2.0/24      0.0.0.0                  0         32768 i
 *>  10.3.3.0/24      10.0.23.2                0             0 3 i
R2#
```

```
R3#show ip bgp
BGP table version is 4, local router ID is 3.3.3.3
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
```

```
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>  0.0.0.0          10.0.23.1                              0 2 1 i
 *>  10.2.2.0/24      10.0.23.1                0             0 2 i
 *>  10.3.3.0/24      0.0.0.0                  0         32768 i
R3#
```

**Verify your configuration using extended pings between R1, R2, and R3:**

```
R1#ping 10.2.2.2 source fastEthernet 0/0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.2.2.2, timeout is 2 seconds:
Packet sent with a source address of 14.14.14.1
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 184/203/224 ms
R1#
```

```
R1#ping 10.3.3.3 source fastEthernet 0/0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.3.3.3, timeout is 2 seconds:
Packet sent with a source address of 14.14.14.1
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 172/200/220 ms
R1#
```

**You would like BGP neighbor relationship between R1 and R3. This should transit R4. Configure a BGP peer relationship between R1s Fa0/0 interface and R3s Se1/2 interface. You are NOT allowed to enable an IGP on R1, R3 or R4; you are NOT allowed to configure BGP or static routing on R4; however, you are allowed to configure a single /32 host route on both R1 and R3. Ensure that when the R1-R2 WAN link is up, R1 prefers the path via R2 to reach the 10.2.2.0/24 and 10.3.3.0/24 prefixes. YOU are NOT allowed to use route maps as part of your solution.**

**The first is that you need to enable BGP between R1 and R3. This should be done across R4 and is completed using two static routes, one on R1 and the other on R3 to establish an external BGP adjacency.**

```
R1(config)#ip route 10.0.34.1 255.255.255.255 14.14.14.4
R1(config)#router bgp 1
R1(config-router)#neighbor 10.0.34.1 remote-as 3
R1(config-router)#neighbor 10.0.34.1 update-source fastethernet 0/0
R1(config-router)#neighbor 10.0.34.1 ebgp-multihop 255
```

```
R3(config)#ip route 14.14.14.1 255.255.255.255 10.0.34.2
R3(config)#router bgp 3
R3(config-router)#neighbor 14.14.14.1 remote-as 1
R3(config-router)#neighbor 14.14.14.1 ebgp-multihop 255
R3(config-router)#neighbor 14.14.14.1 update-source serial 1/2
```

**You should see that the eBGP neighbor relationship is established between R1 and R3:**

```
R1#show ip bgp summary
BGP router identifier 1.1.1.1, local AS number 1
BGP table version is 5, main routing table version 5
3 network entries using 432 bytes of memory
5 path entries using 400 bytes of memory
```

```
5/2 BGP path/bestpath attribute entries using 680 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 1608 total bytes of memory
BGP activity 3/0 prefixes, 5/0 paths, scan interval 60 secs

Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down
State/PfxRcd
10.0.12.2       4            2      48      47        5    0    0 00:38:31
2
10.0.34.1       4            3       8       6        4    0    0 00:00:10
2
R1#
```

```
R3#show ip bgp summary
BGP router identifier 3.3.3.3, local AS number 3
BGP table version is 4, main routing table version 4
3 network entries using 432 bytes of memory
4 path entries using 320 bytes of memory
4/3 BGP path/bestpath attribute entries using 544 bytes of memory
3 BGP AS-PATH entries using 72 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 1368 total bytes of memory
BGP activity 3/0 prefixes, 4/0 paths, scan interval 60 secs

Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down
State/PfxRcd
10.0.23.1       4            2      48      46        4    0    0 00:39:31
2
14.14.14.1      4            1       8       9        4    0    0 00:01:52
1
R3#
```

**The second requirement is that R1 should prefer the path via R2 to reach the 10.2.2.0/24 prefix as well as the 10.3.3.0/24 prefix. By default, R1 will prefer the path via R2 to reach the 10.2.2.0/24 prefix because of the shorter AS_PATH. However, now that an external BGP peer session has been established between R1 and R3, R1 will prefer the path via R3 to reach the 10.3.3.0/24 prefix. Prior to changes on R1, the BGP RIB entry for this prefix shows as follows:**

```
R1#show ip bgp 10.3.3.0 255.255.255.0
BGP routing table entry for 10.3.3.0/24, version 5
Paths: (2 available, best #1, table default)
  Advertised to update-groups:
     2
  Refresh Epoch 2
  3
    10.0.34.1 from 10.0.34.1 (3.3.3.3)
      Origin IGP, metric 0, localpref 100, valid, external, best
      rx pathid: 0, tx pathid: 0x0
  Refresh Epoch 1
  2 3
    10.0.12.2 from 10.0.12.2 (2.2.2.2)
      Origin IGP, localpref 100, valid, external
      rx pathid: 0, tx pathid: 0
R1#
```

**Because we cannot use route maps to set the LOCAL_PREF, we must instead use the neighbor <address> weight <value> command to assign all prefixes received via R1 a higher WEIGHT value. This will ensure that R1 prefers the path via R2 to reach the 10.3.3.0/24 prefix:**

```
R1(config)#router bgp 1
R1(config-router)#neighbor 10.0.12.2 weight 1
```

**Following this change, R1 shows the following BGP Table entry for the 10.3.3.0/24 prefix:**

```
R1#show ip bgp 10.3.3.0 255.255.255.0
BGP routing table entry for 10.3.3.0/24, version 4
Paths: (2 available, best #2, table default)
  Advertised to update-groups:
     5
  Refresh Epoch 2
  3
    10.0.34.1 from 10.0.34.1 (3.3.3.3)
      Origin IGP, metric 0, localpref 100, valid, external
      rx pathid: 0, tx pathid: 0
  Refresh Epoch 2
  2 3
    10.0.12.2 from 10.0.12.2 (2.2.2.2)
      Origin IGP, localpref 100, weight 1, valid, external, best
      rx pathid: 0, tx pathid: 0x0
R1#
```

**Configure your network so that when the R1-R2 link is down, R1s LAN address can still reach the 10.2.2.0/24 and 10.3.3.0/24 subnets and vice-versa. You are NOT allowed to configure static routes or an IGP on R1, R3, or R4. Do NOT configure BGP on R4. You can NOT use PBR on any routers, or create a tunnel between R1 and R3. And finally, do NOT advertise the 14.14.14.0/24 prefix via BGP. Your solution should ensure that when the R1-R2 link is up, R3 will use the path via R2 to reach the 14.14.14.0/24 subnet.**
**When complete, verify your configuration by shutting down the R1-R2 WAN link. After this, verify that R1s LAN interface can ping both the 10.2.2.0/24 and 10.3.3.0/24 subnets and vice-versa. All your pings should be successful.**

**The first requirement is that router R2 and R3 should be able to reach the 14.14.14.0/24 when the R1-R2 link is down. This must be performed in such a manner that router R3 still prefers the path via R2 to reach the 14.14.14.0/24 subnet. Because routers will not compare MED values for prefixes received from different ASes, the AS_PATH attribute must be used instead. This part is completed as follows:**

```
R1(config)#route-map PREPEND permit 10
R1(config-route-map)#set as-path prepend 1 1
R1(config)#router bgp 1
R1(config-router)#neighbor 10.0.34.1 default-originate route-map PREPEND
```

**Following this change, the BGP Tables on R2 and R3 show the following for the default route:**

```
R2#show ip bgp 0.0.0.0 0.0.0.0
BGP routing table entry for 0.0.0.0/0, version 8
Paths: (1 available, best #1, table default)
  Advertised to update-groups:
     1
  Refresh Epoch 1
  1
```

```
    10.0.12.1 from 10.0.12.1 (1.1.1.1)
      Origin IGP, localpref 100, valid, external, best
      rx pathid: 0, tx pathid: 0x0
R2#
```

```
R3#show ip bgp 0.0.0.0 0.0.0.0
BGP routing table entry for 0.0.0.0/0, version 9
Paths: (2 available, best #1, table default)
  Advertised to update-groups:
     1
  Refresh Epoch 2
  2 1
    10.0.23.1 from 10.0.23.1 (2.2.2.2)
      Origin IGP, localpref 100, valid, external, best
      rx pathid: 0, tx pathid: 0x0
  Refresh Epoch 1
  1 1 1
    14.14.14.1 from 14.14.14.1 (1.1.1.1)
      Origin IGP, localpref 100, valid, external
      rx pathid: 0, tx pathid: 0
R3#
```

**If the R1-R2 link is down,R1's LAN address can still reach the 10.2.2.0/24 and 10.3.3.0/24 subnets and vice-versa and when the R1-R2 link is down, the routes are received via R3 as shown by the BGP table of R1 below:**

```
R1(config)#interface Serial1/1
R1(config-if)# shutdown

R1#show ip bgp
BGP table version is 4, 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, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
     0.0.0.0          0.0.0.0                                0 i
 *>  10.2.2.0/24      10.0.34.1                              0 3 2 i
 *>  10.3.3.0/24      10.0.34.1                0             0 3 i
```

**The issue, however, exists on R4. This router is a transit router between R1 and R3; however, it has no routing information for the 10.2.2.0/24 or 10.3.3.0/24 prefixes. Therefore, when a ping from R1 is initiated to either of these subnets, it is dropped by R4 because this router has no routing information for the destination. This is demonstrated by initiating a ping to 10.2.2.2 from R1 while running the debug ip packet [detail] command on R4:**

```
R1#ping 10.2.2.2 source fastEthernet 0/0 repeat 10
Type escape sequence to abort.
Sending 10, 100-byte ICMP Echos to 10.2.2.2, timeout is 2 seconds:
Packet sent with a source address of 14.14.14.1
U.U.U.U.U.
Success rate is 0 percent (0/10)
R1#
```

```
R4#debug ip packet detail
```

```
IP packet debugging is on (detailed)
R4#

*Oct 30 22:19:31.091: IP: s=14.14.14.1 (FastEthernet0/0), d=10.2.2.2, len 100,
unroutable
*Oct 30 22:19:31.091:     ICMP type=8, code=0
*Oct 30 22:19:31.095: IP: tableid=0, s=14.14.14.4 (local), d=14.14.14.1
(FastEthernet0/0), routed via RIB
*Oct 30 22:19:31.095: IP: s=14.14.14.4 (local), d=14.14.14.1 (FastEthernet0/0),
len 56, sending
*Oct 30 22:19:31.099:     ICMP type=3, code=1
*Oct 30 22:19:31.107: IP: s=14.14.14.4 (local), d=14.14.14.1 (FastEthernet0/0),
len 56,
R4# sending full packet
*Oct 30 22:19:31.107:     ICMP type=3, code=1
*Oct 30 22:19:31.243: IP: s=14.14.14.1 (FastEthernet0/0), d=10.2.2.2, len 100,
input feature
*Oct 30 22:19:31.247:     ICMP type=8, code=0, MCI Check(85), rtype 0, forus
FALSE, sendself FALSE, mtu 0, fwdchk FALSE
*Oct 30 22:19:31.247: IP: s=14.14.14.1 (FastEthernet0/0), d=10.2.2.2, len 100,
unroutable
*Oct 30 22:19:31.251:     ICMP type=8, code=0
R4#
*Oct 30 22:19:33.211: IP: s=14.14.14.1 (FastEthernet0/0), d=10.2.2.2, len 100,
input feature
*Oct 30 22:19:33.211:     ICMP type=8, code=0, MCI Check(85), rtype 0, forus
FALSE, sendself FALSE, mtu 0, fwdchk FALSE
*Oct 30 22:19:33.215: IP: s=14.14.14.1 (FastEthernet0/0), d=10.2.2.2, len 100,
unroutable
```

**Because we are not allowed to configure any additional static routes or enable a dynamic routing protocol on R1, R3, and R4. Additionally, the requirements stipulate that we cannot use PBR or a tunnel to complete this task. We must think outside the box and consider other Cisco IOS software features. In essence, based on the debug output, we know that all we need is routing information on R4 pointing to R3 for the 10.2.2.0/24 and 10.3.3.0/24 prefixes. While we cannot use static routes or enable a dynamic routing protocol, there is NO stipulation against using ODR. This is because ODR is NOT a routing protocol, but rather a CDP extension. Therefore, to complete this task, simply configure R3 to advertise a default route via ODR to R1.**

**Because R1 will automatically advertise the 14.14.14.0/24 prefix, we need to filter from R3 so that this path is NOT used to forward traffic to the 14.14.14.0/24 prefix when the R1-R2 link is up. This task is completed by implementing the following configuration on R3:**

```
R3(config)#access-list 1 deny any
R3(config)#router odr
R3(config-router)#distribute-list 1 in
```

**Following this configuration R3s routing table still shows only BGP routes:**

```
R3#show ip route | beg Gate
Gateway of last resort is 14.14.14.1 to network 0.0.0.0

B*    0.0.0.0/0 [20/0] via 14.14.14.1, 00:15:09
      10.0.0.0/8 is variably subnetted, 7 subnets, 3 masks
C        10.0.23.0/30 is directly connected, Serial1/1
L        10.0.23.2/32 is directly connected, Serial1/1
```

```
C        10.0.34.0/30 is directly connected, Serial1/2
L        10.0.34.1/32 is directly connected, Serial1/2
B        10.2.2.0/24 [20/0] via 10.0.23.1, 00:58:08
C        10.3.3.0/24 is directly connected, FastEthernet0/0
L        10.3.3.3/32 is directly connected, FastEthernet0/0
      14.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
o        14.14.14.0/24 [160/1] via 10.0.34.2, 00:00:55, Serial1/2
S        14.14.14.1/32 [1/0] via 10.0.34.2
R3#
```

**The same is also applicable to R2s routing table which only shows BGP routes:**

```
R2#show ip route | beg Gate
Gateway of last resort is 10.0.23.2 to network 0.0.0.0

B*    0.0.0.0/0 [20/0] via 10.0.23.2, 00:16:32
      10.0.0.0/8 is variably subnetted, 5 subnets, 3 masks
C        10.0.23.0/30 is directly connected, Serial1/0
L        10.0.23.1/32 is directly connected, Serial1/0
C        10.2.2.0/24 is directly connected, FastEthernet0/0
L        10.2.2.2/32 is directly connected, FastEthernet0/0
B        10.3.3.0/24 [20/0] via 10.0.23.2, 00:59:32
R2#
```

**R4's routing table, however, now includes a default route received via ODR pointing to R3. This will allow R4 to forward packets sent from R1 destined to 10.2.2.0/24 and 10.3.3.0/24. There is no need to configure any static routes on R3 for R1s LAN IP address because a static route already exists and is pointing to R4. This is the static route used to establish the eBGP neighbor relationship with R1 that was configured earlier in this lab:**

```
R4#show ip route | beg Gate
Gateway of last resort is 10.0.34.1 to network 0.0.0.0

o*    0.0.0.0/0 [160/1] via 10.0.34.1, 00:00:46, Serial1/1
      10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C        10.0.34.0/30 is directly connected, Serial1/1
L        10.0.34.2/32 is directly connected, Serial1/1
      14.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C        14.14.14.0/24 is directly connected, FastEthernet0/0
L        14.14.14.4/32 is directly connected, FastEthernet0/0
R4#
```

**Even though the link R1-R2 is down the ping is successful from R1's LAN interface to the prefixes 10.2.2.0/24 and 10.3.3.0/24:**

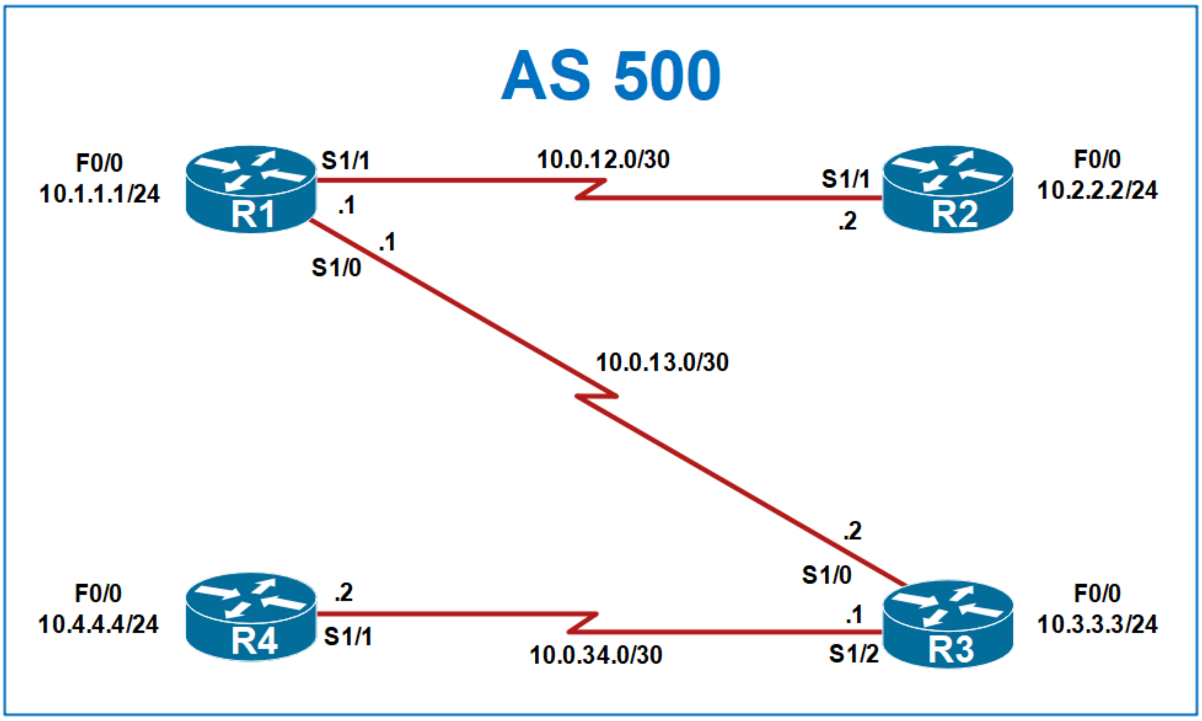
```
R1#ping 10.2.2.2 source fastEthernet 0/0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.2.2.2, timeout is 2 seconds:
Packet sent with a source address of 14.14.14.1
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 184/203/224 ms
R1#
R1#ping 10.3.3.3 source fastEthernet 0/0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.3.3.3, timeout is 2 seconds:
Packet sent with a source address of 14.14.14.1
!!!!!
```

```
Success rate is 100 percent (5/5), round-trip min/avg/max = 172/200/220 ms
R1#
```

**And the traceroute shown that the packets go through the backup path R4:**

```
R1#tracer  10.2.2.2 source fastEthernet 0/0
Type escape sequence to abort.
Tracing the route to 10.2.2.2
VRF info: (vrf in name/id, vrf out name/id)
  1 14.14.14.4 164 msec 60 msec 8 msec
  2 10.0.34.1 420 msec 172 msec 152 msec
  3 10.0.23.1 256 msec *  216 msec
R1#

R1#tracer  10.3.3.3 source fastEthernet 0/0
Type escape sequence to abort.
Tracing the route to 10.3.3.3
VRF info: (vrf in name/id, vrf out name/id)
  1 14.14.14.4 140 msec 12 msec 228 msec
  2 10.0.34.1 196 msec *  176 msec
R1#
```

## Lab 9: Community Attribute and Route Reflector




**Basic Configuration**

**R1:**

```
interface FastEthernet0/0
 ip address 10.1.1.1 255.255.255.0
 no shutdown
!
interface Serial1/0
 ip address 10.0.13.1 255.255.255.252
 no shutdown
!
interface Serial1/1
 ip address 10.0.12.1 255.255.255.252
 no shutdown
```

**R2:**

```
interface FastEthernet0/0
 ip address 10.2.2.2 255.255.255.0
 no shutdown
!
interface Serial1/1
 ip address 10.0.12.2 255.255.255.252
 no shutdown
```

**R3:**

```
interface FastEthernet0/0
 ip address 10.3.3.3 255.255.255.0
 no shutdown
!
```

```
interface Serial1/0
 ip address 10.0.13.2 255.255.255.252
 no shutdown
!
interface Serial1/2
 ip address 10.0.34.1 255.255.255.252
 no shutdown
```

**R4:**

```
interface FastEthernet0/0
 ip address 10.4.4.4 255.255.255.0
 no shutdown
!
interface Serial1/1
 ip address 10.0.34.2 255.255.255.252
 no shutdown
```

**Without using peer groups, configure internal BGP on R1, R2, R3, and R4 as follows:**

- **Statically configure a BGP router ID using the router number, e.g. 1.1.1.1 for R1, etc.**
- **All routers should peer using their physical interface addresses.**
- **R1 should peer to R2 and R3.**
- **R2 should peer to R1.**
- **R3 should peer to R1 and R4.**
- **R4 should peer to R3.**
- **The COMMUNITIES attribute (standard) should be supported.**

**R1:**

```
router bgp 500
bgp router-id 1.1.1.1
neighbor 10.0.12.2 remote-as 500
neighbor 10.0.12.2 send-community standard
neighbor 10.0.13.2 remote-as 500
neighbor 10.0.13.2 send-community standard
```

**R2:**

```
router bgp 500
bgp router-id 2.2.2.2
neighbor 10.0.12.1 remote-as 500
neighbor 10.0.12.1 send-community standard
```

**R3:**

```
router bgp 500
bgp router-id 3.3.3.3
neighbor 10.0.13.1 remote-as 500
neighbor 10.0.13.1 send-community standard
neighbor 10.0.34.2 remote-as 500
neighbor 10.0.34.2 send-community standard
```

**R4:**

```
router bgp 500
bgp router-id 4.4.4.4
neighbor 10.0.34.1 remote-as 500
neighbor 10.0.34.1 send-community standard
```

**Verify your configuration using the show ip bgp summary command:**

```
R1#show ip bgp summary
BGP router identifier 1.1.1.1, local AS number 500
BGP table version is 1, main routing table version 1

Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down
State/PfxRcd
10.0.12.2       4          500       6       5        1    0    0 00:02:54
0
10.0.13.2       4          500       5       5        1    0    0 00:02:43
0
R1#
```

```
R2#show ip bgp summary
BGP router identifier 2.2.2.2, local AS number 500
BGP table version is 1, main routing table version 1

Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down
State/PfxRcd
10.0.12.1       4          500       8       8        1    0    0 00:05:16
0
R2#
```

```
R3#show ip bgp summary
BGP router identifier 3.3.3.3, local AS number 500
BGP table version is 1, main routing table version 1

Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down
State/PfxRcd
10.0.13.1       4          500       9       9        1    0    0 00:06:18
0
10.0.34.2       4          500       9       9        1    0    0 00:05:40
0
R3#
```

```
R4#show ip bgp summary
BGP router identifier 4.4.4.4, local AS number 500
BGP table version is 1, main routing table version 1

Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down
State/PfxRcd
10.0.34.1       4          500      10      10        1    0    0 00:06:33
0
R4#
```

**Advertise the 10.1.1.0/24, 10.2.2.0, and 10.3.3.0/24 subnets on R1, R2, and R3 via BGP. These prefixes must be advertised with the standard community values listed below. You are NOT allowed to redistribute these prefixes into BGP. Additionally, you are NOT allowed to use outbound or inbound route-maps when completing this task. Ensure that the community values are displayed in ASN:nn (RFC 1997 - BGP Communities Attribute) format.**

**The 10.1.1.0/24: community value of 500:111**
**The 10.2.2.0/24: community value of 500:222**
**The 10.3.3.0/24: community value of 500:333**

**BGP allows you to set attributes for prefixes advertised via the network <network> mask <mask> command by appending a route map to this command. The route map can be used to set or modify different BGP attributes for the network. This is completed as follows:**

**R1:**

```
route-map COMMUNITY permit 10
set community 500:111
!
router bgp 500
network 10.1.1.0 mask 255.255.255.0 route-map COMMUNITY
```

**R2:**

```
route-map COMMUNITY permit 10
set community 500:222
!
router bgp 500
network 10.2.2.0 mask 255.255.255.0 route-map COMMUNITY
```

**R3:**

```
route-map COMMUNITY permit 10
set community 500:333
!
router bgp 500
network 10.3.3.0 mask 255.255.255.0 route-map COMMUNITY
```

**Verify your configuration using the show ip bgp command on all routers:**

```
R1#show ip bgp 10.1.1.0 255.255.255.0
BGP routing table entry for 10.1.1.0/24, version 2
Paths: (1 available, best #1, table default)
  Advertised to update-groups:
     1
  Refresh Epoch 1
  Local
    0.0.0.0 from 0.0.0.0 (1.1.1.1)
      Origin IGP, metric 0, localpref 100, weight 32768, valid, sourced, local,
best
      Community: 32768111
      rx pathid: 0, tx pathid: 0x0
R1#
```

**By default, the Cisco default community format is one 32-bit number (as seen above). To ensure that the community conforms to RFC 1997 (BGP Communities Attribute), you need to issue the ip bgp-community new-format command on all routers. This task is completed as follows:**

```
R1(config)#ip bgp-community new-format
R2(config)#ip bgp-community new-format
R3(config)#ip bgp-community new-format
R4(config)#ip bgp-community new-format
```

**We can see now that on all routers the COMMUNITY values are changed and the format is displayed in ASN:nn format:**

```
R1#show ip bgp 10.1.1.0 255.255.255.0
BGP routing table entry for 10.1.1.0/24, version 2
Paths: (1 available, best #1, table default)
```

```
  Advertised to update-groups:
     1
  Refresh Epoch 1
  Local
    0.0.0.0 from 0.0.0.0 (1.1.1.1)
      Origin IGP, metric 0, localpref 100, weight 32768, valid, sourced, local,
best
      Community: 500:111
      rx pathid: 0, tx pathid: 0x0
R1#
```

```
R2#show ip bgp 10.2.2.0 255.255.255.0
BGP routing table entry for 10.2.2.0/24, version 3
Paths: (1 available, best #1, table default)
  Advertised to update-groups:
     1
  Refresh Epoch 1
  Local
    0.0.0.0 from 0.0.0.0 (2.2.2.2)
      Origin IGP, metric 0, localpref 100, weight 32768, valid, sourced, local,
best
      Community: 500:222
      rx pathid: 0, tx pathid: 0x0
R2#
```

```
R3#show ip bgp 10.3.3.0 255.255.255.0
BGP routing table entry for 10.3.3.0/24, version 3
Paths: (1 available, best #1, table default)
  Advertised to update-groups:
     1
  Refresh Epoch 1
  Local
    0.0.0.0 from 0.0.0.0 (3.3.3.3)
      Origin IGP, metric 0, localpref 100, weight 32768, valid, sourced, local,
best
      Community: 500:333
      rx pathid: 0, tx pathid: 0x0
R3#
```

**Another way to verify that the COMMUNITY attribute is sent to peers is to use the show ip bgp neighbors 10.0.12.2 command:**
**Notice the line highlighted "Community attribute sent to this neighbor".**

```
R1#show ip bgp neighbors 10.0.12.2
BGP neighbor is 10.0.12.2,  remote AS 500, internal link
  BGP version 4, remote router ID 2.2.2.2
  BGP state = Established, up for 00:36:09
  Last read 00:00:22, last write 00:00:42, hold time is 180, keepalive interval is
60 seconds
  Neighbor sessions:
    1 active, is not multisession capable (disabled)
  Neighbor capabilities:
    Route refresh: advertised and received(new)
    Four-octets ASN Capability: advertised and received
    Address family IPv4 Unicast: advertised and received
    Enhanced Refresh Capability: advertised and received
    Multisession Capability:
```

```
    Stateful switchover support enabled: NO for session 1
  Message statistics:
    InQ depth is 0
    OutQ depth is 0

                         Sent       Rcvd
    Opens:                 1          1
    Notifications:         0          0
    Updates:               2          2
    Keepalives:           39         40
    Route Refresh:         0          0
    Total:                42         43
  Default minimum time between advertisement runs is 0 seconds

 For address family: IPv4 Unicast
  Session: 10.0.12.2
  BGP table version 4, neighbor version 4/0
  Output queue size : 0
  Index 1, Advertise bit 0
  1 update-group member
  Community attribute sent to this neighbor
  Slow-peer detection is disabled
  Slow-peer split-update-group dynamic is disabled
```

**Configure your network so that all 10.x.x.x/24 subnets can reach each other. You are NOT allowed to use any static routes in your solution. Additionally, you are NOT allowed to advertise or redistribute the 10.4.4.0/24 subnet into BGP on R4. Instead, consider other BGP features to complete this task. You are NOT allowed to configure R2 or R4. Additionally, you are NOT allowed to configure a dynamic routing protocol to complete this task.**

**The requirements of this final task are three-fold. Because we cannot advertise the 10.4.4.0/24 subnet connected to R4 via BGP, we need to configure this router to advertise a default route to the rest of the domain, allowing all other routers to reach this subnet.**
**Therefore, the first part of this task is completed by advertising a default route from R4 so that all other routers can reach the 150.4.4.0/24 subnet since this cannot be advertised or redistributed into BGP. To advertise a default route without one existing in the routing table, use the neighbor <address> default-originate command under BGP.**

**R4:**

```
router bgp 500
neighbor 10.0.34.1 default-originate
```

**A default route is now advertised to R3 by R4 as shown by the following entry:**

```
R3#show ip bgp 0.0.0.0 0.0.0.0
BGP routing table entry for 0.0.0.0/0, version 4
Paths: (1 available, best #1, table default)
  Not advertised to any peer
  Refresh Epoch 1
  Local
    10.0.34.2 from 10.0.34.2 (4.4.4.4)
      Origin IGP, metric 0, localpref 100, valid, internal, best
      rx pathid: 0, tx pathid: 0x0
R3#
```

**The second part of this task is to ensure that routes are advertised between all routers. Since we cannot configure R2 or R4, we need to configure R1 and R3 as route reflectors. This is**

**because, by default, internal BGP (iBGP) speakers will NOT advertise routes received from one iBGP speaker to another iBGP speaker.**
**Because of this default rule, the BGP tables on all routers are incomplete and do not contain all the prefixes. Verify using the show ip bgp command. For example, R1 will not have the default route advertised by R4 in its BGP Table because this default route is received by R3 from another iBGP peer:**

```
R1#show ip bgp 0.0.0.0 0.0.0.0
% Network not in table
R1#
```

**Likewise, R2 will not show an entry for the 10.3.3.0/24 (R3) and 0.0.0.0/0 (R4) prefixes in its BGP Table because the 10.3.3.0/24 prefix is advertised to R1 from an iBGP peer. Likewise, because R1 never receives the default route from R3, this will never show up in R2's BGP Table.**

```
R2#show ip bgp 0.0.0.0 0.0.0.0
% Network not in table
R2#
```

**The same concept is also applicable to R3 and R4. To address this issue, you need to configure R1 and R3 as route reflectors. When doing so, you do NOT need to configure R1 and R3 as clients of each other. This is because, by default, a route reflector will advertise routes received from a client to a non-client and vice versa:**

**R1:**

```
router bgp 500
neighbor 10.0.12.2 route-reflector-client
```

**R3**

```
router bgp 500
neighbor 10.0.34.2 route-reflector-client
```

**R1 and R2 still cannot ping the 10.4.4.0/24 subnet from their LAN interface as shown by the following pings:**

```
R1#ping 10.4.4.4 source fa0/0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.4.4.4, timeout is 2 seconds:
Packet sent with a source address of 10.1.1.1
.....
Success rate is 0 percent (0/5)
R1#
```

```
R2#ping 10.4.4.4 source fa0/0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.4.4.4, timeout is 2 seconds:
Packet sent with a source address of 10.2.2.2
.....
Success rate is 0 percent (0/5)
R2#
```

**However, you will still notice that the routers still cannot ping each other's 10.x.x.x/24 subnets. This is because the NEXT_HOP attribute is NOT changed when these prefixes are advertised between the iBGP peers. For example, on R1, the NEXT_HOP for the 0.0.0.0/0 prefix reflects the IP address of R1 (10.0.34.2). Because there is no route for this prefix, it is considered inaccessible and is not advertised to R2:**

**Because by default the NEXT_HOP attribute is not changed when these prefixes are advertised between the iBGP peers. For example, on R1, the NEXT_HOP for the 0.0.0.0/0 prefix reflects the IP address of R4 (10.0.34.2). Because there is no route to this prefix, it is considered inaccessible as highlighted in the show ip bgp 0.0.0.0 0.0.0.0 command on R1 and is not advertised to R2 as shown by the show ip bgp 0.0.0.0 0.0.0.0 command:**

```
R1#show ip bgp 0.0.0.0 0.0.0.0
BGP routing table entry for 0.0.0.0/0, version 0
Paths: (1 available, no best path)
  Not advertised to any peer
  Refresh Epoch 1
  Local
    10.0.34.2 (inaccessible) from 10.0.13.2 (3.3.3.3)
      Origin IGP, metric 0, localpref 100, valid, internal
      Originator: 4.4.4.4, Cluster list: 3.3.3.3
      rx pathid: 0, tx pathid: 0
R1#
```

```
R2#show ip bgp 0.0.0.0 0.0.0.0
% Network not in table
R2#
```

**The same problem on R4:**

```
R4#show ip bgp 10.1.1.0
BGP routing table entry for 10.1.1.0/24, version 0
Paths: (1 available, no best path)
  Not advertised to any peer
  Refresh Epoch 1
  Local
    10.0.13.1 (inaccessible) from 10.0.34.1 (3.3.3.3)
      Origin IGP, metric 0, localpref 100, valid, internal
      Community: 500:111
      Originator: 1.1.1.1, Cluster list: 3.3.3.3
      rx pathid: 0, tx pathid: 0

R4#
R4#show ip bgp 10.2.2.0
BGP routing table entry for 10.2.2.0/24, version 21
Paths: (1 available, no best path)
  Not advertised to any peer
  Refresh Epoch 1
  Local
    10.0.12.2 (inaccessible) from 10.0.34.1 (3.3.3.3)
      Origin IGP, metric 0, localpref 100, valid, internal
      Community: 500:222
      Originator: 2.2.2.2, Cluster list: 3.3.3.3, 1.1.1.1
      rx pathid: 0, tx pathid: 0
```

**Because the neighbor <address> next-hop-self command will not work due to the route reflector configuration, the only other way to modify the next NEXT_HOP attribute is using an outbound route map. This task is completed as follows:**

**To resolve this issue, you need to either run an IGP or use static routes, which is forbidden in this task, or modify the BGP NEXT_HOP. However, because these updates are from iBGP neighbors, you cannot use the neighbor <address> next-hop-self command. The reason you**

**need to modify the NEXT_HOP using a route-map is because the neighbor <address> next-hop-self command should not be used to modify the NEXT_HOP attribute for a route reflector when this feature is enabled for a route reflector client.**

**It will not work because this command will modify next hop attributes only for routes that are learned from eBGP peers and not the intended routes that are being reflected from the route reflector clients. This means that the NEXT_HOP for all routes received from the iBGP peers will be inaccessible since we are not using an IGP or using static routes in the network. For example, on R1,the NEXT_HOP for the default route advertised by R4 is the IP address of R4'serial 1/1 interface (10.0.34.2),as shown by the show ip bgp 0.0.0.0 0.0.0.0 command displayed above on R1.**

**Because the neighbor "address" next-hop-self command will not work because the route reflector configuration, we should modify the NEXT_HOP attributes by using an outbound route-map as follow:**

**R1:**

```
route-map R2NEXT-HOP permit 10
set ip next-hop 10.0.12.1
!
route-map R3NEXT-HOP permit 10
set ip next-hop 10.0.13.1
!
router bgp 500
neighbor 10.0.12.2 route-map R2NEXT-HOP out
neighbor 10.0.13.2 route-map R3NEXT-HOP out
```

**R3:**

```
route-map R1NEXT-HOP permit 10
set ip next-hop 10.0.13.2
!
route-map R4NEXT-HOP permit 10
set ip next-hop 10.0.34.1
!
router bgp 500
neighbor 10.0.34.2 route-map R4NEXT-HOP out
neighbor 10.0.13.1 route-map R1NEXT-HOP out
```

**Following these changes, the next-hop of the default route advertised by R4 to R1 is changed to be the next-hop R3 (10.0.13.2):**

```
R1#show ip bgp 0.0.0.0 0.0.0.0
BGP routing table entry for 0.0.0.0/0, version 8
Paths: (1 available, best #1, table default)
  Advertised to update-groups:
     5
  Refresh Epoch 1
  Local
    10.0.13.2 from 10.0.13.2 (3.3.3.3)
      Origin IGP, metric 0, localpref 100, valid, internal, best
      Originator: 4.4.4.4, Cluster list: 3.3.3.3
      rx pathid: 0, tx pathid: 0x0
R1#
```

**Now R2 installs a default route in its BGP table with the next-hop R1 (10.0.12.1):**

```
R2#show ip bgp 0.0.0.0 0.0.0.0
```

```
BGP routing table entry for 0.0.0.0/0, version 14
Paths: (1 available, best #1, table default)
  Not advertised to any peer
  Refresh Epoch 1
  Local
    10.0.12.1 from 10.0.12.1 (1.1.1.1)
      Origin IGP, metric 0, localpref 100, valid, internal, best
      Originator: 4.4.4.4, Cluster list: 1.1.1.1, 3.3.3.3
      rx pathid: 0, tx pathid: 0x0
R2#
```

**The show ip bgp command displays all routes installed in the BGP tables of all routers:**

```
R1#show ip bgp
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, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>i 0.0.0.0          10.0.13.2                0    100      0 i
 *>  10.1.1.0/24      0.0.0.0                  0         32768 i
 *>i 10.2.2.0/24      10.0.12.2                0    100      0 i
 *>i 10.3.3.0/24      10.0.13.2                0    100      0 i
R1#
```

```
R2#show ip bgp
BGP table version is 15, local router ID is 2.2.2.2
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>i 0.0.0.0          10.0.12.1                0    100      0 i
 *>i 10.1.1.0/24      10.0.12.1                0    100      0 i
 *>  10.2.2.0/24      0.0.0.0                  0         32768 i
 *>i 10.3.3.0/24      10.0.12.1                0    100      0 i
R2#
```

```
R3#show ip bgp
BGP table version is 5, local router ID is 3.3.3.3
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>i 0.0.0.0          10.0.34.2                0    100      0 i
 *>i 10.1.1.0/24      10.0.13.1                0    100      0 i
 *>i 10.2.2.0/24      10.0.13.1                0    100      0 i
 *>  10.3.3.0/24      0.0.0.0                  0         32768 i
R3#
```

```
R4#show ip bgp
BGP table version is 11, local router ID is 4.4.4.4
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
     0.0.0.0          0.0.0.0                                0 i
 *>i 10.1.1.0/24      10.0.34.1                0    100      0 i
 *>i 10.2.2.0/24      10.0.34.1                0    100      0 i
 *>i 10.3.3.0/24      10.0.34.1                0    100      0 i
R4#
```

**Finally the ping is successful between all LANs subnet:**

```
R1#ping 10.2.2.2 source fa0/0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.2.2.2, timeout is 2 seconds:
Packet sent with a source address of 10.1.1.1
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 64/105/124 ms
R1#
R1#ping 10.3.3.3 source fa0/0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.3.3.3, timeout is 2 seconds:
Packet sent with a source address of 10.1.1.1
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 20/30/44 ms
R1#
R1#ping 10.4.4.4 source fa0/0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.4.4.4, timeout is 2 seconds:
Packet sent with a source address of 10.1.1.1
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 28/40/48 ms
R1#
```

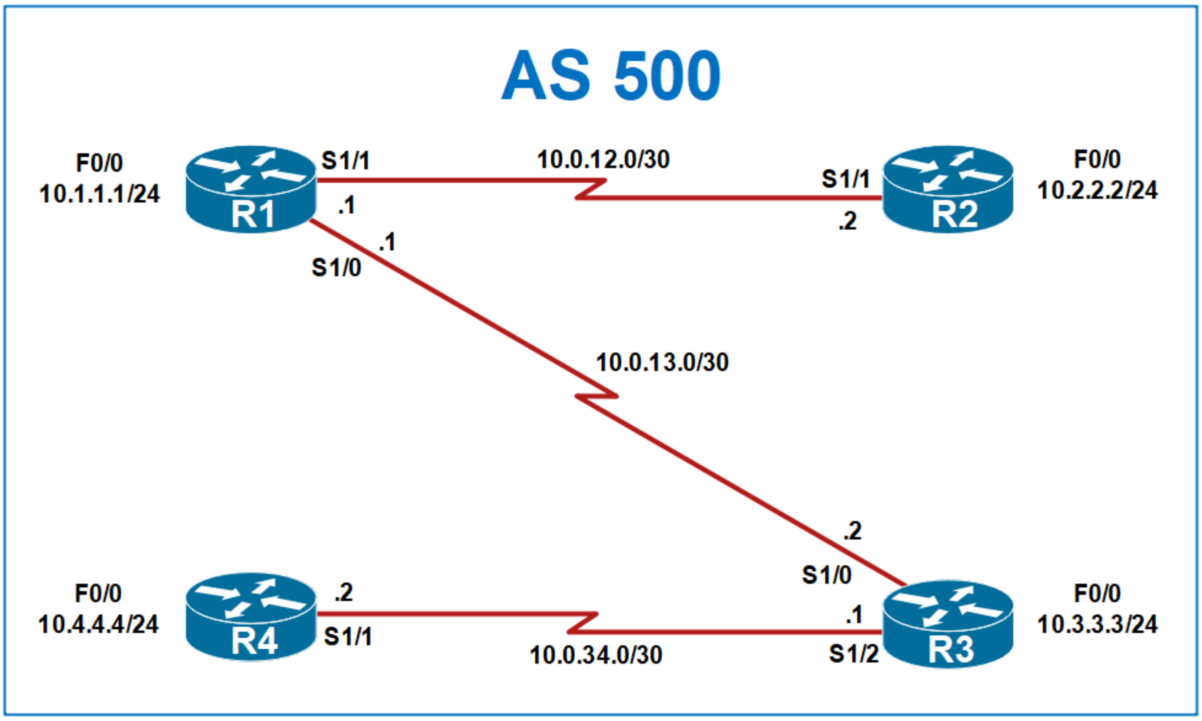
```
R2#ping 10.1.1.1 source fa0/0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.1.1.1, timeout is 2 seconds:
Packet sent with a source address of 10.2.2.2
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 52/87/120 ms
R2#
R2#ping 10.3.3.3 source fa0/0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.3.3.3, timeout is 2 seconds:
Packet sent with a source address of 10.2.2.2
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 24/32/44 ms
R2#
R2#ping 10.4.4.4 source fa0/0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.4.4.4, timeout is 2 seconds:
```

```
Packet sent with a source address of 10.2.2.2
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 44/53/72 ms
R2#
```

```
R3#ping 10.1.1.1 source fa0/0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.1.1.1, timeout is 2 seconds:
Packet sent with a source address of 10.3.3.3
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 32/76/132 ms
R3#
R3#ping 10.2.2.2 source fa0/0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.2.2.2, timeout is 2 seconds:
Packet sent with a source address of 10.3.3.3
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 120/125/136 ms
R3#
R3#ping 10.4.4.4 source fa0/0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.4.4.4, timeout is 2 seconds:
Packet sent with a source address of 10.3.3.3
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 20/35/72 ms
R3#
```

```
R4#ping 10.1.1.1 source fa0/0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.1.1.1, timeout is 2 seconds:
Packet sent with a source address of 10.4.4.4
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 32/71/104 ms
R4#
R4#ping 10.2.2.2 source fa0/0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.2.2.2, timeout is 2 seconds:
Packet sent with a source address of 10.4.4.4
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 48/84/116 ms
R4#
R4#ping 10.3.3.3 source fa0/0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.3.3.3, timeout is 2 seconds:
Packet sent with a source address of 10.4.4.4
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 20/48/80 ms
R4#
```

## Lab 10: BGP Peer Group Community Attribute and Local Preference




**Basic Configuration**

**R1:**

```
int lo0
 ip address 1.1.1.1 255.255.255.255
!
interface FastEthernet0/0
 ip address 10.1.1.1 255.255.255.0
 no shutdown
!
interface Serial1/0
 ip address 10.0.13.1 255.255.255.252
 no shutdown
!
interface Serial1/1
 ip address 10.0.12.1 255.255.255.252
 no shutdown
```

**R2:**

```
int lo0
 ip address 2.2.2.2 255.255.255.255
!
interface FastEthernet0/0
 ip address 10.2.2.2 255.255.255.0
 no shutdown
!
interface Serial1/1
 ip address 10.0.12.2 255.255.255.252
 no shutdown
```

**R3:**

```
int lo0
 ip address 3.3.3.3 255.255.255.255
!
interface FastEthernet0/0
 ip address 10.3.3.3 255.255.255.0
 no shutdown
!
interface Serial1/0
 ip address 10.0.13.2 255.255.255.252
 no shutdown
!
interface Serial1/2
 ip address 10.0.34.1 255.255.255.252
 no shutdown
```

**R4:**

```
int lo0
 ip address 4.4.4.4 255.255.255.255
!
interface FastEthernet0/0
 ip address 10.4.4.4 255.255.255.0
 no shutdown
!
interface Serial1/1
 ip address 10.0.34.2 255.255.255.252
 no shutdown
```

**Configure EIGRP, using AS 100, on all routers and enable EIGRP for all interfaces EXCEPT for the 10.x.x.0/24 LAN subnets connected to R1, R2, R3, and R4.**

**R1:**

```
router eigrp 100
network 1.1.1.1 0.0.0.0
network 10.0.12.1 0.0.0.0
network 10.0.13.1 0.0.0.0
no auto-summary
```

**R2:**

```
router eigrp 100
network 2.2.2.2 0.0.0.0
network 10.0.12.2 0.0.0.0
no auto-summary
```

**R3:**

```
router eigrp 100
network 3.3.3.3 0.0.0.0
network 10.0.13.2 0.0.0.0
network 10.0.34.1 0.0.0.0
no auto-summary
```

**R4:**

```
router eigrp 100
network 4.4.4.4 0.0.0.0
network 10.0.34.2 0.0.0.0
```

```
no auto-summary
```

**The routing tables of the routers should show the following EIGRP route entries:**

```
R1#show ip route eigrp | begin Gate
Gateway of last resort is not set

      2.0.0.0/32 is subnetted, 1 subnets
D        2.2.2.2 [90/2297856] via 10.0.12.2, 00:00:39, Serial1/1
      3.0.0.0/32 is subnetted, 1 subnets
D        3.3.3.3 [90/2297856] via 10.0.13.2, 00:00:31, Serial1/0
      4.0.0.0/32 is subnetted, 1 subnets
D        4.4.4.4 [90/2809856] via 10.0.13.2, 00:00:18, Serial1/0
      10.0.0.0/8 is variably subnetted, 7 subnets, 3 masks
D        10.0.34.0/30 [90/2681856] via 10.0.13.2, 00:00:31, Serial1/0
R1#
```

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

      1.0.0.0/32 is subnetted, 1 subnets
D        1.1.1.1 [90/2297856] via 10.0.12.1, 00:02:27, Serial1/1
      3.0.0.0/32 is subnetted, 1 subnets
D        3.3.3.3 [90/2809856] via 10.0.12.1, 00:02:17, Serial1/1
      4.0.0.0/32 is subnetted, 1 subnets
D        4.4.4.4 [90/3321856] via 10.0.12.1, 00:02:04, Serial1/1
      10.0.0.0/8 is variably subnetted, 6 subnets, 3 masks
D        10.0.13.0/30 [90/2681856] via 10.0.12.1, 00:02:27, Serial1/1
D        10.0.34.0/30 [90/3193856] via 10.0.12.1, 00:02:17, Serial1/1
R2#
```

```
R3#show ip route eigrp | begin Gate
Gateway of last resort is not set

      1.0.0.0/32 is subnetted, 1 subnets
D        1.1.1.1 [90/2297856] via 10.0.13.1, 00:03:37, Serial1/0
      2.0.0.0/32 is subnetted, 1 subnets
D        2.2.2.2 [90/2809856] via 10.0.13.1, 00:03:37, Serial1/0
      4.0.0.0/32 is subnetted, 1 subnets
D        4.4.4.4 [90/2297856] via 10.0.34.2, 00:03:24, Serial1/2
      10.0.0.0/8 is variably subnetted, 7 subnets, 3 masks
D        10.0.12.0/30 [90/2681856] via 10.0.13.1, 00:03:37, Serial1/0
R3#
```

```
R4#show ip route eigrp | begin Gate
Gateway of last resort is not set

      1.0.0.0/32 is subnetted, 1 subnets
D        1.1.1.1 [90/2809856] via 10.0.34.1, 00:04:35, Serial1/1
      2.0.0.0/32 is subnetted, 1 subnets
D        2.2.2.2 [90/3321856] via 10.0.34.1, 00:04:35, Serial1/1
      3.0.0.0/32 is subnetted, 1 subnets
D        3.3.3.3 [90/2297856] via 10.0.34.1, 00:04:35, Serial1/1
      10.0.0.0/8 is variably subnetted, 6 subnets, 3 masks
D        10.0.12.0/30 [90/3193856] via 10.0.34.1, 00:04:35, Serial1/1
D        10.0.13.0/30 [90/2681856] via 10.0.34.1, 00:04:35, Serial1/1
R4#
```

**Configure internal BGP on R1, R2, R3, and R4 shown below. Use peer-group configuration on R2 and R4 but NOT on R1 and R3:**
**All routers should use their Loopback 0 interface addresses as their router IDs**
**All routers should peer using their Loopback 0 interface addresses**
**R1 and R3 should be configured as Route Reflectors**
**R2 should peer with R1 and R3**
**R4 should peer with R1 and R3**
**R1 and R3 belong to the same cluster to reduce the size of the RIB**
**All routers should use TCP MD5 authentication with a password of 'ROUTE'**

**R1:**

```
router bgp 500
neighbor 2.2.2.2 remote-as 500
neighbor 2.2.2.2 update-source loopback 0
neighbor 3.3.3.3 remote-as 500
neighbor 3.3.3.3 update-source loopback 0
neighbor 4.4.4.4 remote-as 500
neighbor 4.4.4.4 update-source loopback 0
```

**R2:**

```
router bgp 500
neighbor INTERNAL peer-group
neighbor INTERNAL remote-as 500
neighbor INTERNAL update-source loopback 0
neighbor 1.1.1.1 peer-group INTERNAL
neighbor 3.3.3.3 peer-group INTERNAL
```

**R3:**

```
router bgp 500
neighbor 1.1.1.1 remote-as 500
neighbor 1.1.1.1 update-source loopback 0
neighbor 2.2.2.2 remote-as 500
neighbor 2.2.2.2 update-source loopback 0
neighbor 4.4.4.4 remote-as 500
neighbor 4.4.4.4 update-source loopback 0
```

**R4:**

```
router bgp 500
neighbor INTERNAL peer-group
neighbor INTERNAL update-source loopback 0
neighbor INTERNAL remote-as 500
neighbor 1.1.1.1 peer-group INTERNAL
neighbor 3.3.3.3 peer-group INTERNAL
```

**Ensure that the routes are advertised between all routers. We need to configure R1 and R3 as route reflectors. This is because, by default, internal BGP (iBGP) peers will not advertise routes received from an iBGP peer to another iBGP peer. Because of this rule, the BGP tables of all routers are incomplete and some prefixes are missing.**

**R1:**

```
router bgp 500
neighbor 2.2.2.2 route-reflector-client
neighbor 4.4.4.4 route-reflector-client
```

**R3:**

```
router bgp 500
```

```
neighbor 2.2.2.2 route-reflector-client
neighbor 4.4.4.4 route-reflector-client
```

**Remember that Route-Reflector has an algorithm to prevent the update from the other RRs. It will not accept the update that has the same Cluster-ID as itself in order to prevent the loop in BGP, it is important to understand that they do not need to be clients of each other. Instead, in the case where there are multiple route reflectors being used for redundancy, you should configure route reflectors in the same cluster using the bgp cluster-id command. This prevents multiple entries in the BGP Table because the route reflectors recognize updates from each other based on the CLUSTER_LIST attribute.**

**Configure R1 and R3 with the same cluster to reduce the size of the RIB**

**R1:**

```
router bgp 500
bgp cluster-id 50.50.50.50
```

**R3:**

```
router bgp 500
bgp cluster-id 50.50.50.50
```

**To authenticate BGP, all routers should use TCP MD5 authentication with a password of "ROUTE"**

**R1:**

```
router bgp 500
neighbor 2.2.2.2 password ROUTE
neighbor 3.3.3.3 password ROUTE
neighbor 4.4.4.4 password ROUTE
```

**R2:**

```
router bgp 500
neighbor INTERNAL password ROUTE
```

**R3:**

```
router bgp 500
neighbor 1.1.1.1 password ROUTE
neighbor 2.2.2.2 password ROUTE
neighbor 4.4.4.4 password ROUTE
```

**R4:**

```
router bgp 500
neighbor INTERNAL password ROUTE
```

**Verify the BGP neighbor relationships:**

```
R1#show ip bgp summary
BGP router identifier 1.1.1.1, local AS number 500
BGP table version is 1, main routing table version 1

Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down
State/PfxRcd
2.2.2.2         4          500       5       3        1    0    0 00:01:07
0
3.3.3.3         4          500       5       5        1    0    0 00:01:10
0
```

```
4.4.4.4         4           500       5       5        1    0    0 00:01:11
0
R1#
```

```
R2#show ip bgp summary
BGP router identifier 2.2.2.2, local AS number 500
BGP table version is 1, main routing table version 1

Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down
State/PfxRcd
1.1.1.1         4           500       7       9        1    0    0 00:04:39
0
3.3.3.3         4           500       9       7        1    0    0 00:04:35
0
R2#
```

```
R3#show ip bgp summary
BGP router identifier 3.3.3.3, local AS number 500
BGP table version is 1, main routing table version 1

Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down
State/PfxRcd
1.1.1.1         4           500      10      10        1    0    0 00:05:55
0
2.2.2.2         4           500       8      10        1    0    0 00:05:48
0
4.4.4.4         4           500       8       8        1    0    0 00:05:31
0
R3#
```

```
R4#show ip bgp summary
BGP router identifier 4.4.4.4, local AS number 500
BGP table version is 1, main routing table version 1

Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down
State/PfxRcd
1.1.1.1         4           500      11      11        1    0    0 00:06:45
0
3.3.3.3         4           500       9       9        1    0    0 00:06:18
0
R4#
```

**Advertise the 10.x.x.0/24 subnets on all routers via BGP. These prefixes should be redistributed into BGP on every router. In the future, there will be external BGP connections to one or more ISPs. Management has decided that the 10.x.x.0/24 subnets should never be advertised to these ISPs. Ensure that these prefixes are NEVER advertised out of AS 100. You are NOT allowed to use prefix lists or any type of filters.**

**To complete this requirement, you need to use the COMMUNITY attribute. This attribute, Attribute Type Code 8, is an optional transitive attribute that is used to group destinations, called communities.**

**By definition this attribute, Attribute Type Code 8, is an optional transitive attribute that is used to group destinations, called communities. Once the destination prefixes have been grouped, routing decisions, such as acceptance, preference, and redistribution, can be applied. The feature called route maps are used to set the community attribute.**

**Well-known communities are communities that have predefined meanings. Cisco IOS software supports four well-known communities which are NO_EXPORT, NO_ADVERTISE, INTERNET, and LOCAL_AS.**

**-The NO_EXPORT well-known community prevents BGP prefixes that are specifically assigned this predefined community attribute value from being advertised to any eBGP peers. The prefixes, however, will continue to be advertised to all other BGP speakers within the local AS. In other words, prefixes assigned this community value will remain local to the Autonomous System (AS).**

**-The NO_ADVERTISE community prevents any prefixes that are assigned this predefined community attribute from being advertised to any peer – internal or external.**

**-The INTERNET community allows all prefixes assigned to this community to be advertised to any and all BGP peers (assuming no filtering, etc, is in place). In Cisco IOS software, all BGP prefixes belong to the INTERNET community by default.**

**The LOCAL_AS community is used in a somewhat similar manner to another of the previously described communities: the NO_EXPORT community. If used in a Confederation, the LOCAL_AS community prevents all prefixes assigned this community from being advertised out of the local sub autonomous system. When Confederations are not implemented, the LOCAL_AS community is applied in the same manner as the NO_EXPORT community.**

**To ensure that the LANs subnet of each router are never advertised out of AS 500 we can use either the LOCAL_AS or NO_EXPORT communities. Use LOCAL_AS attribute as follow:**

**R1:**

```
route-map CONNECTED permit 10
match interface fastethernet 0/0
set community local-as
!
route-map CONNECTED deny 20
!
router bgp 500
redistribute connected route-map CONNECTED
neighbor 2.2.2.2 send-community standard
neighbor 3.3.3.3 send-community standard
neighbor 4.4.4.4 send-community standard
```

**R2:**

```
route-map CONNECTED permit 10
match interface fastethernet 0/0
set community local-as
!
route-map CONNECTED deny 20
!
router bgp 500
redistribute connected route-map CONNECTED
neighbor INTERNAL send-community standard
```

**R3:**

```
route-map CONNECTED permit 10
match interface fastethernet 0/0
set community local-as
!
route-map CONNECTED deny 20
!
router bgp 500
```

```
redistribute connected route-map CONNECTED
neighbor 1.1.1.1 send-community standard
neighbor 2.2.2.2 send-community standard
neighbor 4.4.4.4 send-community standard
```

**R4:**

```
route-map CONNECTED permit 10
match interface fastethernet 0/0
set community local-as
!
route-map CONNECTED deny 20
!
router bgp 500
redistribute connected route-map CONNECTED
neighbor INTERNAL send-community standard
```

**Each routers sets the COMMUNITY Local-AS for its LAN subnet as shown by the following outputs:**

```
R1#show ip bgp 10.1.1.0
BGP routing table entry for 10.1.1.0/24, version 2
Paths: (1 available, best #1, table default, not advertised outside local AS)
  Advertised to update-groups:
     6          7
  Refresh Epoch 1
  Local
    0.0.0.0 from 0.0.0.0 (1.1.1.1)
      Origin incomplete, metric 0, localpref 100, weight 32768, valid, sourced,
best
      Community: local-AS
      rx pathid: 0, tx pathid: 0x0
R1#
```

```
R2#show ip bgp 10.2.2.0
BGP routing table entry for 10.2.2.0/24, version 4
Paths: (1 available, best #1, table default, not advertised outside local AS)
  Advertised to update-groups:
     3
  Refresh Epoch 1
  Local
    0.0.0.0 from 0.0.0.0 (2.2.2.2)
      Origin incomplete, metric 0, localpref 100, weight 32768, valid, sourced,
best
      Community: local-AS
      rx pathid: 0, tx pathid: 0x0
R2#
```

```
R3#show ip bgp 10.3.3.0
BGP routing table entry for 10.3.3.0/24, version 5
Paths: (1 available, best #1, table default, not advertised outside local AS)
  Advertised to update-groups:
     5          6
  Refresh Epoch 1
  Local
    0.0.0.0 from 0.0.0.0 (3.3.3.3)
      Origin incomplete, metric 0, localpref 100, weight 32768, valid, sourced,
best
```

```
      Community: local-AS
      rx pathid: 0, tx pathid: 0x0
R3#
```

```
R4#show ip bgp 10.4.4.0
BGP routing table entry for 10.4.4.0/24, version 8
Paths: (1 available, best #1, table default, not advertised outside local AS)
  Advertised to update-groups:
     3
  Refresh Epoch 1
  Local
    0.0.0.0 from 0.0.0.0 (4.4.4.4)
      Origin incomplete, metric 0, localpref 100, weight 32768, valid, sourced,
best
      Community: local-AS
      rx pathid: 0, tx pathid: 0x0
R4#
```

**Ensure that R2 and R4 always prefer routes received from R3 to those received from R1 for each other's' 10.x.x.0/24 prefixes. You are only allowed to configure ONE router. Your solution should be globally significant; however, you are NOT allowed to modify any of the BGP default administrative distance values.**

**Verify the BGP tables of R2 and R4, R2 and R4 prefer the prefixes 10.4.4.0/24 and 10.2.2.0/24 respectively received from R1:**

```
R2#show ip bgp 10.4.4.0
BGP routing table entry for 10.4.4.0/24, version 7
Paths: (2 available, best #2, table default, not advertised outside local AS)
  Not advertised to any peer
  Refresh Epoch 1
  Local
    4.4.4.4 (metric 3321856) from 3.3.3.3 (3.3.3.3)
      Origin incomplete, metric 0, localpref 100, valid, internal
      Community: local-AS
      Originator: 4.4.4.4, Cluster list: 50.50.50.50
      rx pathid: 0, tx pathid: 0
  Refresh Epoch 1
  Local
    4.4.4.4 (metric 3321856) from 1.1.1.1 (1.1.1.1)
      Origin incomplete, metric 0, localpref 100, valid, internal, best
      Community: local-AS
      Originator: 4.4.4.4, Cluster list: 50.50.50.50
      rx pathid: 0, tx pathid: 0x0
R2#
```

```
R4#show ip bgp 10.2.2.0
BGP routing table entry for 10.2.2.0/24, version 7
Paths: (2 available, best #1, table default, not advertised outside local AS)
  Not advertised to any peer
  Refresh Epoch 1
  Local
    2.2.2.2 (metric 3321856) from 1.1.1.1 (1.1.1.1)
      Origin incomplete, metric 0, localpref 100, valid, internal, best
      Community: local-AS
      Originator: 2.2.2.2, Cluster list: 50.50.50.50
      rx pathid: 0, tx pathid: 0x0
```

```
  Refresh Epoch 1
  Local
    2.2.2.2 (metric 3321856) from 3.3.3.3 (3.3.3.3)
      Origin incomplete, metric 0, localpref 100, valid, internal
      Community: local-AS
      Originator: 2.2.2.2, Cluster list: 50.50.50.50
      rx pathid: 0, tx pathid: 0
R4#
```

**Use the LOCAL_PREF attribute and as a result the route received from R3 is preferred because it has a highest LOCAL_PREF value:**
**Setting the route map in the inbound direction allows the R3 to change the LOCAL_PREF value of all received prefixes to the configured value. Because LOCAL_PREF is included in updates to iBGP peers, this value is propagated to all other routers in the same domain. If you sent LOCAL_PREF in the outbound direction, this is applicable only to routes originated by and advertised by R3. In other words, it will be only applied to the 10.3.3.0/24 subnet.**

**R3:**

```
route-map LOCAL-PREF permit 10
set local-preference 200
!
router bgp 500
neighbor 2.2.2.2 route-map LOCAL-PREF in
neighbor 4.4.4.4 route-map LOCAL-PREF in
```

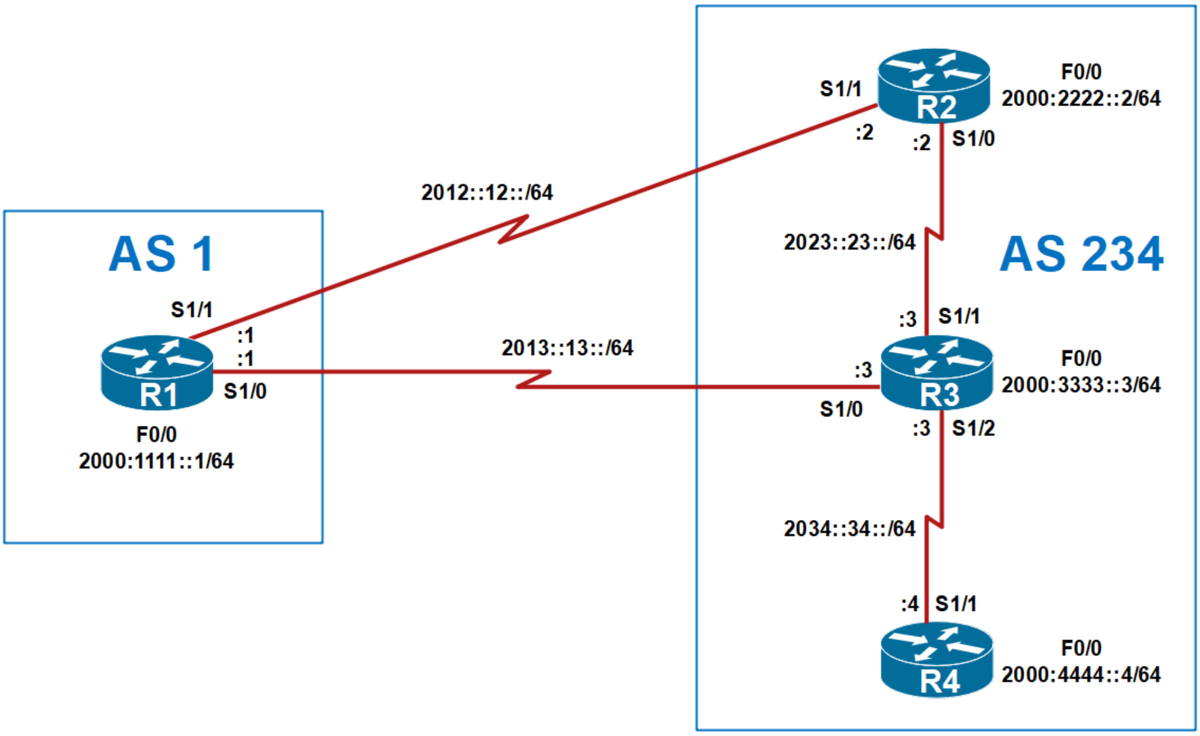
**Verify the BGP tables of R1 and R3 once again:**
**As expected the routes coming from R3 for the prefixes 10.4.4.0/24 and 10.2.2.0/24 are preferred by R2 and R4 respectively:**

```
R2#show ip bgp 10.4.4.0
BGP routing table entry for 10.4.4.0/24, version 10
Paths: (2 available, best #1, table default, not advertised outside local AS)
  Not advertised to any peer
  Refresh Epoch 1
  Local
    4.4.4.4 (metric 3321856) from 3.3.3.3 (3.3.3.3)
      Origin incomplete, metric 0, localpref 200, valid, internal, best
      Community: local-AS
      Originator: 4.4.4.4, Cluster list: 50.50.50.50
      rx pathid: 0, tx pathid: 0x0
  Refresh Epoch 1
  Local
    4.4.4.4 (metric 3321856) from 1.1.1.1 (1.1.1.1)
      Origin incomplete, metric 0, localpref 100, valid, internal
      Community: local-AS
      Originator: 4.4.4.4, Cluster list: 50.50.50.50
      rx pathid: 0, tx pathid: 0
R2#
```

```
R4#show ip bgp 10.2.2.0
BGP routing table entry for 10.2.2.0/24, version 11
Paths: (2 available, best #1, table default, not advertised outside local AS)
  Not advertised to any peer
  Refresh Epoch 1
  Local
    2.2.2.2 (metric 3321856) from 3.3.3.3 (3.3.3.3)
      Origin incomplete, metric 0, localpref 200, valid, internal, best
```

```
      Community: local-AS
      Originator: 2.2.2.2, Cluster list: 50.50.50.50
      rx pathid: 0, tx pathid: 0x0
  Refresh Epoch 1
  Local
    2.2.2.2 (metric 3321856) from 1.1.1.1 (1.1.1.1)
      Origin incomplete, metric 0, localpref 100, valid, internal
      Community: local-AS
      Originator: 2.2.2.2, Cluster list: 50.50.50.50
      rx pathid: 0, tx pathid: 0
R4#
```

## Lab 11: MP-BGP Local Preference Weight and Community Attribute




**Basic Configuration**

**R1:**

```
int fa0/0
ipv6 address 2001:1111::1/64
no shutdown
!
int s1/0
ipv6 address 2013:13:13::1/64
no shutdown
!
int s1/1
ipv6 address 2012:12:12::1/64
no shutdown
```

**R2:**

```
int fa0/0
ipv6 address 2001:2222::2/64
no shutdown
!
int s1/1
ipv6 address 2012:12:12::2/64
no shutdown
!
int s1/0
ipv6 address 2023:23:23::2/64
no shutdown
```

**R3:**

```
int fa0/0
ipv6 address 2001:3333::3/64
no shutdown
!
int s1/0
ipv6 address 2013:13:13::3/64
no shutdown
!
int s1/1
ipv6 address 2023:23:23::3/64
no shutdown
!
int s1/2
ipv6 address 2034:34:34::3/64
no shutdown
```

**R4:**

```
int fa0/0
ipv6 address 2001:4444::4/64
no shutdown
!
int s1/1
ipv6 address 2034:34:34::4/64
no shutdown
```

**Configure MP-BGP on R1. This router will reside in AS 1 and will peer with R2 and R3. Use the global Unicast IPv6 addresses for peering.**

**R1:**

```
router bgp 1
bgp router-id 1.1.1.1
address-family ipv6 unicast
neighbor 2012:12:12::2 remote-as 234
neighbor 2013:13:13::3 remote-as 234
```

**Configure MP-BGP on R2, R3, and R4 in AS 234. R2 and R3 will peer with R1. R2 will peer with R1 and R3. R3 will peer with R1, R2, and R4. R4 will peer only with R3. Use the global Unicast IPv6 addresses for peering. Verify your configuration.**

**R2:**

```
router bgp 234
bgp router-id 2.2.2.2
address-family ipv6 unicast
neighbor 2012:12:12::1 remote-as 1
neighbor 2023:23:23::3 remote-as 234
```

**R3 :**

```
router bgp 234
bgp router-id 3.3.3.3
address-family ipv6 unicast
neighbor 2013:13:13::1 remote-as 1
neighbor 2023:23:23::2 remote-as 234
neighbor 2034:34:34::4 remote-as 234
```

**R4 :**

```
router bgp 234
bgp router-id 4.4.4.4
address-family ipv6 unicast
neighbor 2034:34:34::3 remote-as 234
```

**Verify the configuration using the show bgp ipv6 unicast summary command on all MP-BGP routers.**

```
R1#show bgp ipv6 unicast summary
BGP router identifier 1.1.1.1, local AS number 1
BGP table version is 1, main routing table version 1

Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down
State/PfxRcd
2012:12:12::2   4          234       2       2        1    0    0 00:00:45
0
2013:13:13::3   4          234       2       2        1    0    0 00:00:25
0
R1#
```

```
R2#show bgp ipv6 unicast summary
BGP router identifier 2.2.2.2, local AS number 234
BGP table version is 1, main routing table version 1

Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down
State/PfxRcd
2012:12:12::1   4            1       4       5        1    0    0 00:02:03
0
2023:23:23::3   4          234       4       4        1    0    0 00:01:44
0
R2#
```

```
R3#show bgp ipv6 unicast summary
BGP router identifier 3.3.3.3, local AS number 234
BGP table version is 1, main routing table version 1

Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down
State/PfxRcd
2013:13:13::1   4            1       6       6        1    0    0 00:03:05
0
2023:23:23::2   4          234       6       6        1    0    0 00:03:05
0
2034:34:34::4   4          234       5       6        1    0    0 00:02:52
0
R3#
```

```
R4#show bgp ipv6 unicast summary
BGP router identifier 4.4.4.4, local AS number 234
BGP table version is 1, main routing table version 1

Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down
State/PfxRcd
2034:34:34::3   4          234       7       7        1    0    0 00:04:03
0
R4#
```

**Now the purpose is to advertise the prefix 2001:1111::/64 connected to R1 using MP-BGP. And assign the community value 1:100.**

**Advertise the 2001:1111::/64 prefix connected to R1 using MP-BGP. This prefix should have an ORIGIN code of IGP and should be assigned the community 1:100.**

**By default, all prefixes injected into MP-BGP using the network statement will be assigned an ORIGIN code of IGP. To complete the second requirement of this task, we need to use a route-map to assign this prefix the specified COMMUNITY attribute. In addition to this, we need to configure MP-BGP so that this attribute is included in updates to peers:**

**The ip bgp-community new-format command changes the community format to be AA:NN as specified.**

**R1:**

```
route-map COMMUNITY permit 10
set community 1:100
!
ip bgp-community new-format
!
router bgp 1
address-family ipv6 unicast
network 2001:1111::/64 route-map COMMUNITY
neighbor 2012:12:12::2 send-community standard
neighbor 2013:13:13::3 send-community standard
```

**The community value is 1:100:**

```
R1#show bgp ipv6 unicast 2001:1111::/64
BGP routing table entry for 2001:1111::/64, version 2
Paths: (1 available, best #1, table default)
  Advertised to update-groups:
     2
  Refresh Epoch 1
  Local
    :: from 0.0.0.0 (1.1.1.1)
      Origin IGP, metric 0, localpref 100, weight 32768, valid, sourced, local,
best
      Community: 1:100
      rx pathid: 0, tx pathid: 0x0
R1#
```

**Notice below that if we remove the ip bgp-community new-format command the default community value will be 65636:**

```
R1(config)#no ip bgp-community new-format
```

```
R1#show bgp ipv6 unicast 2001:1111::/64
BGP routing table entry for 2001:1111::/64, version 2
Paths: (1 available, best #1, table default)
  Advertised to update-groups:
     2
  Refresh Epoch 1
  Local
    :: from 0.0.0.0 (1.1.1.1)
```

```
      Origin IGP, metric 0, localpref 100, weight 32768, valid, sourced, local,
best
      Community: 65636
      rx pathid: 0, tx pathid: 0x0
R1#
```

**The same value of community is displayed on R2 and R3 in the updates sent by R1. Notice also that the community attribute is not sent to all internal MP-BGP peers this attribute is not included in updates from R2 to R3, and in updates from R3 to R2 and R4 as shown by the show bgp ipv6 unicast 2001:1111::/64 on R2 R3 an R4:**

```
R2#show bgp ipv6 unicast 2001:1111::/64
BGP routing table entry for 2001:1111::/64, version 3
Paths: (2 available, best #2, table default)
  Advertised to update-groups:
     2
  Refresh Epoch 1
  1
    2013:13:13::1 (inaccessible) from 2023:23:23::3 (3.3.3.3)
      Origin IGP, metric 0, localpref 100, valid, internal
      rx pathid: 0, tx pathid: 0
  Refresh Epoch 1
  1
    2012:12:12::1 (FE80::C800:1BFF:FE7C:8) from 2012:12:12::1 (1.1.1.1)
      Origin IGP, metric 0, localpref 100, valid, external, best
      Community: 65636
      rx pathid: 0, tx pathid: 0x0
R2#
```

```
R3#show bgp ipv6 unicast 2001:1111::/64
BGP routing table entry for 2001:1111::/64, version 3
Paths: (2 available, best #2, table default)
  Advertised to update-groups:
     1
  Refresh Epoch 1
  1
    2012:12:12::1 (inaccessible) from 2023:23:23::2 (2.2.2.2)
      Origin IGP, metric 0, localpref 100, valid, internal
      rx pathid: 0, tx pathid: 0
  Refresh Epoch 2
  1
    2013:13:13::1 (FE80::C800:1BFF:FE7C:8) from 2013:13:13::1 (1.1.1.1)
      Origin IGP, metric 0, localpref 100, valid, external, best
      Community: 65636
      rx pathid: 0, tx pathid: 0x0
R3#
```

**R4 does not receive the community value because R3 does not include by default this attribute in their updates:**

```
R4#show bgp ipv6 unicast 2001:1111::/64
BGP routing table entry for 2001:1111::/64, version 0
Paths: (1 available, no best path)
  Not advertised to any peer
  Refresh Epoch 1
  1
    2013:13:13::1 (inaccessible) from 2034:34:34::3 (3.3.3.3)
```

```
      Origin IGP, metric 0, localpref 100, valid, internal
      rx pathid: 0, tx pathid: 0
R4#
```

**To complete this task, we also therefore need to issue this command on R2, R3, and R4. Also, we need to ensure that the COMMUNITY attribute is sent to all internal MP-BGP peers. In other words, this attribute should be included in updates from R2 to R3, and in updates from R3 to R2 and R4. Since R4 is not receiving and advertising any prefixes with this attribute, it does not need to include it in updates sent to R3. This part of the task is completed as follows:**

```
R2(config)#router bgp 234
R2(config-router)#address-family ipv6 unicast
R2(config-router-af)#neighbor 2023:23:23::3 send-community standard
R2(config-router-af)#exit
R2(config-router)#exit
R2(config)#ip bgp-community new-format
```

```
R3(config)#router bgp 234
R3(config-router)#address-family ipv6 unicast
R3(config-router-af)#neighbor 2023:23:23::2 send-community standard
R3(config-router-af)#neighbor 2034:34:34::4 send-community standard
R3(config-router-af)#exit
R3(config-router)#exit
R3(config)#ip bgp-community new-format
```

```
R4(config)#ip bgp-community new-format
```

**The Community Attribute is now displayed in the BGP RIB on all routers:**

```
R2#show bgp ipv6 unicast 2001:1111::/64
BGP routing table entry for 2001:1111::/64, version 3
Paths: (2 available, best #2, table default)
  Advertised to update-groups:
     3
  Refresh Epoch 1
  1
    2013:13:13::1 (inaccessible) from 2023:23:23::3 (3.3.3.3)
      Origin IGP, metric 0, localpref 100, valid, internal
      Community: 1:100
      rx pathid: 0, tx pathid: 0
  Refresh Epoch 1
  1
    2012:12:12::1 (FE80::C800:1BFF:FE7C:8) from 2012:12:12::1 (1.1.1.1)
      Origin IGP, metric 0, localpref 100, valid, external, best
      Community: 1:100
      rx pathid: 0, tx pathid: 0x0
R2#
```

```
R3#show bgp ipv6 unicast 2001:1111::/64
BGP routing table entry for 2001:1111::/64, version 3
Paths: (2 available, best #2, table default)
  Advertised to update-groups:
     3
  Refresh Epoch 1
  1
    2012:12:12::1 (inaccessible) from 2023:23:23::2 (2.2.2.2)
```

```
      Origin IGP, metric 0, localpref 100, valid, internal
      Community: 1:100
      rx pathid: 0, tx pathid: 0
  Refresh Epoch 2
  1
    2013:13:13::1 (FE80::C800:1BFF:FE7C:8) from 2013:13:13::1 (1.1.1.1)
      Origin IGP, metric 0, localpref 100, valid, external, best
      Community: 1:100
      rx pathid: 0, tx pathid: 0x0
R3#
```

```
R4#show bgp ipv6 unicast 2001:1111::/64
BGP routing table entry for 2001:1111::/64, version 0
Paths: (1 available, no best path)
Flag: 0x820
  Not advertised to any peer
  Refresh Epoch 1
  1
    2013:13:13::1 (inaccessible) from 2034:34:34::3 (3.3.3.3)
      Origin IGP, metric 0, localpref 100, valid, internal
      Community: 1:100
      rx pathid: 0, tx pathid: 0
R4#
```

**Advertise the 2001:2222::/64 prefix as well as the 2000:4444::/64 prefix connected to the LAN interfaces of R2 and R4, respectively, via MP-BGP. Ensure that R2 and R4 can ping each other LAN to LAN following this configuration. You are NOT allowed to configure R3 as a route-reflector, or use confederations. Instead, use BGP default routing. However, ensure that a default route is NEVER advertised to AS 234. Do NOT use any type of filters to complete this task.**

**First, we need to advertise the LAN subnets that are connected to R2 and R4 via MP-BGP:**

**R2:**

```
router bgp 234
address-family ipv6 unicast
network 2001:2222::/64
```

**R4:**

```
router bgp 234
address-family ipv6 unicast
network 2001:4444::/64
```

**Verify your configuration using the show bgp ipv6 unicast command on R2 and R4:**

```
R2#show bgp ipv6 unicast 2001:2222::/64
BGP routing table entry for 2001:2222::/64, version 3
Paths: (1 available, best #1, table default)
  Advertised to update-groups:
     1          2
  Refresh Epoch 1
  Local
    :: from 0.0.0.0 (2.2.2.2)
      Origin IGP, metric 0, localpref 100, weight 32768, valid, sourced, local,
best
      rx pathid: 0, tx pathid: 0x0
```

```
R4#show bgp ipv6 unicast 2001:4444::/64
BGP routing table entry for 2001:4444::/64, version 2
Paths: (1 available, best #1, table default)
  Advertised to update-groups:
     1
  Refresh Epoch 1
  Local
    :: from 0.0.0.0 (4.4.4.4)
      Origin IGP, metric 0, localpref 100, weight 32768, valid, sourced, local,
best
      rx pathid: 0, tx pathid: 0x0
```

**To avoid the IBGP Rule which states that when an IBGP router receives a BGP update from an IBGP peer ,it does not sent this update to another IBGP peer,we can use a route reflector on R3 allowing these prefixes 2001:2222::/64 and 2001:4444::/64 to be advertised to its peers R4 and R2 respectively.**

**However the task states that this is forbidden. To complete this task, we need to use BGP default routing as stated. However, to ensure that the default route is not advertised to AS 234, we need to use the COMMUNITY attribute (LOCAL_AS or NO_EXPORT).**

**R3:**

```
route-map LOCAL-AS permit 10
set community local-AS
!
router bgp 234
address-family ipv6 unicast
neighbor 2023:23:23::2 default-originate route-map LOCAL-AS
neighbor 2034:34:34::4 default-originate
```

**Now R2 and R4 receive a default route, only R2 is receiving this default route with the community: local-AS therefore it is not advertised outside AS 234:**

```
R2#show bgp ipv6 unicast ::/0
BGP routing table entry for ::/0, version 4
Paths: (1 available, best #1, table default, not advertised outside local AS)
  Not advertised to any peer
  Refresh Epoch 1
  Local
    2023:23:23::3 from 2023:23:23::3 (3.3.3.3)
      Origin IGP, metric 0, localpref 100, valid, internal, best
      Community: local-AS
      rx pathid: 0, tx pathid: 0x0
```

```
R4#show bgp ipv6 unicast ::/0
BGP routing table entry for ::/0, version 3
Paths: (1 available, best #1, table default)
  Not advertised to any peer
  Refresh Epoch 1
  Local
    2034:34:34::3 from 2034:34:34::3 (3.3.3.3)
      Origin IGP, metric 0, localpref 100, valid, internal, best
      rx pathid: 0, tx pathid: 0x0
```

**Finally R2 and R4 can ping the LAN of each router:**

```
R2#ping 2001:4444::4 source fastethernet 0/0
```

```
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:4444::4, timeout is 2 seconds:
Packet sent with a source address of 2001:2222::2
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 28/44/80 ms
R2#
```

```
R4#ping 2001:2222::2 source fastethernet 0/0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:2222::2, timeout is 2 seconds:
Packet sent with a source address of 2001:4444::4
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 28/52/112 ms
R4#
```

**Now the purpose is that R2 prefers the path via R3 to reach all prefixes originated from BGP AS 1 only. The direct path to AS 1 via R2 should only be used as a backup if the link R2-R3 is down.**
**AS 1 should also prefer the R1-R3 for all traffic destined to AS 234.**

**We can use the Local Preference attributes on R3 so that it sends updates for prefixes originated in AS 1 with a higher value than the default Local Preference value 100. Now if there are a lot of prefixes from AS 1,it is fastidious, so it is better to use AS_PATH filter on R3.**

**Let's explore the AS_PATH filter:**

**R3:**

```
ip as-path access-list 1 permit ^1$
!
route-map PREF permit 10
match as-path 1
set local-preference 200
!
route-map PREF permit 20
!
router bgp 234
address-family ipv6
neighbor 2023:23:23::2 route-map PREF out
```

**Now R2 prefers to reach the LAN subnet of R1 through the Internal route through R3 (through AS 234) as shown by the the MP-BGP RIB of R2 because R3 is advertising a higher (better) Local Preference 200 than the Local Preference of R1 100:**

```
R2#show bgp ipv6 unicast 2001:1111::/64
BGP routing table entry for 2001:1111::/64, version 9
Paths: (2 available, best #1, table default)
Flag: 0x800
  Not advertised to any peer
  Refresh Epoch 1
  1
    2013:13:13::1 from 2023:23:23::3 (3.3.3.3)
      Origin IGP, metric 0, localpref 200, valid, internal, best
      Community: 1:100
      rx pathid: 0, tx pathid: 0x0
  Refresh Epoch 1
  1
    2012:12:12::1 (FE80::C800:22FF:FE0C:8) from 2012:12:12::1 (1.1.1.1)
```

```
      Origin IGP, metric 0, localpref 100, valid, external
      Community: 1:100
      rx pathid: 0, tx pathid: 0
```

**To ensure that R1 prefers the path via R3 for all prefixes originated from AS 234, we will use the WEIGHT Attribute as follow:**

**R1:**

```
ip as-path access-list 1 permit ^234$
route-map WEIGHT permit 10
match as-path 1
set weight 1
!
route-map WEIGHT permit 20
!
router bgp 1
address-family ipv6
neighbor 2013:13:13::3 route-map WEIGHT in
```

**R1 prefers the path through R3 to reach the LAN subnet of R2 as shown by the MP-BGP RIB of R1 because the better weight value:**

```
R1#show bgp ipv6 unicast 2001:2222::/64
BGP routing table entry for 2001:2222::/64, version 2
Paths: (2 available, best #1, table default)
  Advertised to update-groups:
     2
  Refresh Epoch 1
  234
    2013:13:13::3 (FE80::C803:21FF:FE68:8) from 2013:13:13::3 (3.3.3.3)
      Origin IGP, localpref 100, weight 1, valid, external, best
      rx pathid: 0, tx pathid: 0x0
  Refresh Epoch 1
  234
    2012:12:12::2 (FE80::C801:22FF:FE0C:8) from 2012:12:12::2 (2.2.2.2)
      Origin IGP, metric 0, localpref 100, valid, external
      rx pathid: 0, tx pathid: 0
```

**Verification of the LAN-to-LAN connectivity:**

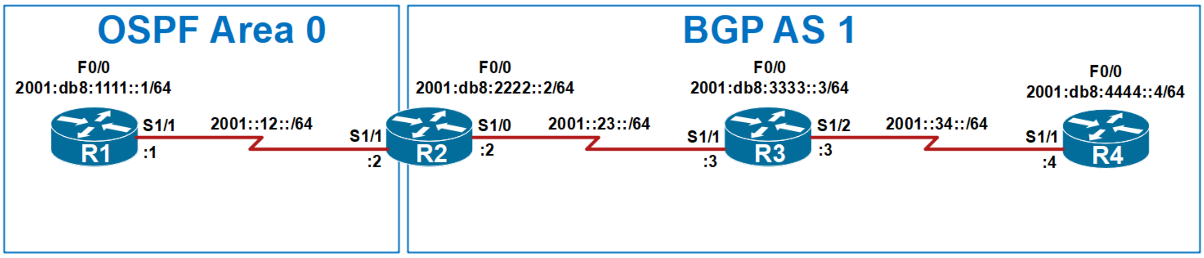
```
R1#ping 2001:2222::2 source fa0/0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:2222::2, timeout is 2 seconds:
Packet sent with a source address of 2001:1111::1
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 40/66/132 ms
R1#
R1#ping 2001:4444::4 source fa0/0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:4444::4, timeout is 2 seconds:
Packet sent with a source address of 2001:1111::1
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 32/59/104 ms
R1#
```

```
R2#ping 2001:1111::1 sou fa0/0
Type escape sequence to abort.
```

```
Sending 5, 100-byte ICMP Echos to 2001:1111::1, timeout is 2 seconds:
Packet sent with a source address of 2001:2222::2
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 36/48/60 ms
R2#
R2#ping 2001:3333::3 sou fa0/0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:3333::3, timeout is 2 seconds:
Packet sent with a source address of 2001:2222::2
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 40/60/100 ms
R2#
R2#ping 2001:4444::4 sou fa0/0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:4444::4, timeout is 2 seconds:
Packet sent with a source address of 2001:2222::2
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 36/64/120 ms
R2#
```

```
R4#ping 2001:1111::1 sou fa0/0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:1111::1, timeout is 2 seconds:
Packet sent with a source address of 2001:4444::4
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 36/42/56 ms
R4#
R4#ping 2001:2222::2 sou fa0/0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:2222::2, timeout is 2 seconds:
Packet sent with a source address of 2001:4444::4
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 28/59/104 ms
R4#
R4#ping 2001:3333::3 sou fa0/0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:3333::3, timeout is 2 seconds:
Packet sent with a source address of 2001:4444::4
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 16/44/104 ms
R4#
```

## Lab 12: MP-BGP OSPFv3 and Attributes Manipulation




**Basic Configuration**

**R1:**

```
interface Lo0
ipv6 address 2001:db8:1111::1/64
!
interface Serial1/1
no ip address
ipv6 address 2001:12::1/64
no shutd
```

**R2:**

```
interface Lo0
ipv6 address 2002:db8:2222::2/64
!
interface Serial1/1
no ip address
ipv6 address 2001:12::2/64
no shutd
!
interface Serial1/0
no ip address
ipv6 address 2001:23::2/64
no shutd
```

**R3:**

```
interface Lo0
ipv6 address 2003:db8:3333::3/64
!
interface Serial1/2
no ip address
ipv6 address 2001:34::3/64
no shutd
!
interface Serial1/1
no ip address
ipv6 address 2001:23::3/64
no shutd
```

**R4:**

```
interface Lo0
ipv6 address 2004:db8:4444::4/64
!
```

```
interface Serial1/1
no ip address
ipv6 address 2001:34::4/64
no shutd
```

**Configure OSPFv3 on R1 and R2. Enable OSPFv3 for the WAN interfaces of R1 and R2. Do NOT advertise R1 or R2's LAN subnet using OSPFv3. Ensure that R1s LAN subnet is advertised as an external Type 1 LSA. Verify the configuration using the appropriate commands.**

**R1:**

```
ipv6 router ospf 1
router-id 1.1.1.1
redistribute connected metric-type 1

interface serial 1/1
ipv6 ospf 1 area 0
```

**R2:**

```
ipv6 router ospf 1
router-id 2.2.2.2

interface serial 1/1
ipv6 ospf 1 area 0
```

**Verification of OSPFv3 adjacencies:**

```
R2#show ipv6 ospf neighbor

            OSPFv3 Router with ID (2.2.2.2) (Process ID 1)

Neighbor ID     Pri   State           Dead Time   Interface ID    Interface
1.1.1.1           0   FULL/  -        00:00:34    5               Serial1/1
```

```
R1#show ipv6 ospf neighbor

            OSPFv3 Router with ID (1.1.1.1) (Process ID 1)

Neighbor ID     Pri   State           Dead Time   Interface ID    Interface
2.2.2.2           0   FULL/  -        00:00:32    5               Serial1/1
```

**Next, verify OSPFv3 redistribution by looking at the external LSA Type-5 entry in the LSDB:**

**R2 receives an LSA Type 5 from R1 toward the prefix 2001:DB8:1111::/64 :**

```
R2#show ipv6 ospf database external

            OSPFv3 Router with ID (2.2.2.2) (Process ID 1)

                Type-5 AS External Link States

  Routing Bit Set on this LSA
  LS age: 313
  LS Type: AS External Link
  Link State ID: 0
  Advertising Router: 1.1.1.1
  LS Seq Number: 80000001
```

```
  Checksum: 0x189B
  Length: 36
  Prefix Address: 2001:DB8:1111::
  Prefix Length: 64, Options: None
  Metric Type: 1 (Comparable directly to link state metric)
  Metric: 20
```

**Configure MP-BGP on R2, R3 and R4. All routers should use Link Local addresses for peering and establishing MP-BGP sessions. Verify your configuration**

**It is important to know that when using a Link Local address for peering, we need use the neighbor "link-local address" update-source "interface" command to ensure that the session will be established because Link-Local addresses are specific to interfaces. This is specific only when using Link-Local addresses for peering.**

**Another point important to remember is that in BGP Link local address cannot be used by default for making BGP neighborship to ensure peering using link-local address, it needs %Interface with exact case, the example is shown on R2:**

```
R2(config-router)#bgp router-id 2.2.2.2
R2(config-router)#neighbor FE80::C802:1BFF:FEE0:8 remote-as 234
% BGP(v6): Invalid scope. Unable to configure link-local peer.
R2(config-router)#
R2(config-router)#! (In BGP Link local address can not be used by default
R2(config-router)#!  for making BGP neighborship)
R2(config-router)#
R2(config-router)#! to ensure peering using link-local address
R2(config-router)#! need %Interface with exact case
R2(config-router)#
R2(config-router)#neighbor FE80::C802:1BFF:FEE0:8%Serial1/0 remote-as 234
R2(config-router)#
```

**Now let's configure MP-BGP as required:**

**R2 :**

```
router bgp 234
bgp router-id 2.2.2.2
neighbor FE80::C802:1BFF:FEE0:8%Serial1/0 remote-as 234
neighbor FE80::C802:1BFF:FEE0:8 update-source serial 1/0
```

**R3 :**

```
router bgp 234
bgp router-id 3.3.3.3
address-family ipv6
neighbor FE80::C801:EFF:FEBC:8%Serial1/1 remote-as 234
neighbor FE80::C801:EFF:FEBC:8 update-source serial 1/1
neighbor FE80::C803:1BFF:FEE0:8%Serial1/2 remote-as 234
neighbor FE80::C803:1BFF:FEE0:8 update-source serial 1/2
```

**R4 :**

```
router bgp 234
bgp router-id 4.4.4.4
address-family ipv6
neighbor FE80::C802:1BFF:FEE0:8%Serial1/1 remote-as 234
neighbor FE80::C802:1BFF:FEE0:8 update-source serial 1/1
```

**Verify your configuration using the show bgp ipv6 unicast summary command:**

```
R2#show bgp ipv6 unicast summary
BGP router identifier 2.2.2.2, local AS number 234
BGP table version is 1, main routing table version 1

Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down
State/PfxRcd
FE80::C802:1BFF:FEE0:8%Serial1/0
                4          234      12      13        1    0    0 00:09:32
0
```

```
R3#show bgp ipv6 unicast summary
BGP router identifier 3.3.3.3, local AS number 234
BGP table version is 1, main routing table version 1

Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down
State/PfxRcd
FE80::C801:EFF:FEBC:8%Serial1/1
                4          234      14      14        1    0    0 00:10:42
0
FE80::C803:1BFF:FEE0:8%Serial1/2
                4          234      14      14        1    0    0 00:10:18
0
```

```
R4#show bgp ipv6 unicast summary
BGP router identifier 4.4.4.4, local AS number 234
BGP table version is 1, main routing table version 1

Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down
State/PfxRcd
FE80::C802:1BFF:FEE0:8%Serial1/1
                4          234      16      15        1    0    0 00:11:54
0
```

**Advertise the LAN subnets of R1, R2, and R3 via MP-BGP. Verify your configuration.**
**To ensure that R2 and R4 do see each others' LAN subnets in their respective BGP RIBs, R3 must be configured as a route reflector. This task is completed as follows:**

**R1:**

```
router bgp 234
address-family ipv6
network 2002:db8:2222::/64
```

**R3:**

```
router bgp 234
address-family ipv6
network 2003:db8:3333::/64
```

**R4:**

```
router bgp 234
address-family ipv6
network 2004:db8:4444::/64
```

**Let's verify the BGP RIB table with the show bgp ipv6 unicast command on all routers:**
**It is important to remember that the loop prevention mechanism IBGP says: Do not advertise iBGP-learned routes to iBGP peers.**

**This is why R2 and R4 do not learn the prefixes 2004:DB8:4444::/64 and 2002:DB8:2222::/64 respectively.**

```
R2#show bgp ipv6 unicast
BGP table version is 3, local router ID is 2.2.2.2
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>  2002:DB8:2222::/64
                       ::                       0         32768 i
 *>i 2003:DB8:3333::/64
                       FE80::C802:1BFF:FEE0:8
                                                0    100      0 i
```

```
R3#show bgp ipv6 unicast
BGP table version is 4, local router ID is 3.3.3.3
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>i 2002:DB8:2222::/64
                       FE80::C801:EFF:FEBC:8
                                                0    100      0 i
 *>  2003:DB8:3333::/64
                       ::                       0         32768 i
 *>i 2004:DB8:4444::/64
                       FE80::C803:1BFF:FEE0:8
                                                0    100      0 i
```

```
R4#show bgp ipv6 unicast
BGP table version is 3, local router ID is 4.4.4.4
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>i 2003:DB8:3333::/64
                       FE80::C802:1BFF:FEE0:8
                                                0    100      0 i
 *>  2004:DB8:4444::/64
                       ::                       0         32768 i
```

**The following outputs shown the details of the BGP routes:**

```
R2#show bgp ipv6 unicast 2002:db8:2222::/64
BGP routing table entry for 2002:DB8:2222::/64, version 2
Paths: (1 available, best #1, table default)
  Advertised to update-groups:
```

```
     1
  Refresh Epoch 1
  Local
    :: from 0.0.0.0 (2.2.2.2)
      Origin IGP, metric 0, localpref 100, weight 32768, valid, sourced, local,
best
      rx pathid: 0, tx pathid: 0x0
```

```
R3#show bgp ipv6 unicast 2003:db8:3333::/64
BGP routing table entry for 2003:DB8:3333::/64, version 3
Paths: (1 available, best #1, table default)
  Advertised to update-groups:
     1
  Refresh Epoch 1
  Local
    :: from 0.0.0.0 (3.3.3.3)
      Origin IGP, metric 0, localpref 100, weight 32768, valid, sourced, local,
best
      rx pathid: 0, tx pathid: 0x0
```

```
R4#show bgp ipv6 unicast 2004:DB8:4444::/64
BGP routing table entry for 2004:DB8:4444::/64, version 3
Paths: (1 available, best #1, table default)
  Advertised to update-groups:
     1
  Refresh Epoch 1
  Local
    :: from 0.0.0.0 (4.4.4.4)
      Origin IGP, metric 0, localpref 100, weight 32768, valid, sourced, local,
best
      rx pathid: 0, tx pathid: 0x0
```

**Redistribute between MP-BGP and OSPFv3 on R2. Ensure that ONLY the LAN subnets are redistributed.**

**By default, when redistributing between IPv6 routing protocols, connected subnets will not be included requiring the adding of the include-connected keyword.**
**In our case we redistribute the connected R2 LAN subnet into OSPF using a route map to match only this subnet to be redistributed.**

**We have two caveats here when redistributing between BGP and OSPF:**

**1-when OSPF routes are redistributed into BGP, only internal routes are redistributed. So we need redistribute ospf 1 match external 1 command under router bgp on R2, in order to redistribute the prefix 2001:DB8:1111::/64 advertised earlier by R1 as an external Metric-Type 1 route**

**2-when BGP routes are redistributed into an IGP, only EBGP routes are redistributed .So we need bgp redistribute-internal command under router BGP on R2 to allow the redistribution of the subnets learned from the IBGP peers.**

**R2:**

```
route-map LO0-R2 permit 10
match interface loopback0
!
route-map LO0-R2 deny 20
!
```

```
ipv6 router ospf 1
redistribute connected route-map LO0-R2
redistribute bgp 234
!
router bgp 234
address-family ipv6
redistribute ospf 1 match external 1
bgp redistribute-internal
```

**Let's verify the configuration by looking at the LSDB on either R1 or R2 for the routes redistributed from BGP-to-OSPF:**
**R2 creates two LSA Type 5 for the prefixes 2003:DB8:3333::/64 and 2002:DB8:2222::/64 and advertises these LSAs to R1.**

**Remember that the prefix 2004:DB8:4444:: which is the LAN's R4 is not yet learned because the IBGP loop-prevention mechanism.**

```
R2#show ipv6 ospf database external self-originate

            OSPFv3 Router with ID (2.2.2.2) (Process ID 1)

                Type-5 AS External Link States

  LS age: 71
  LS Type: AS External Link
  Link State ID: 0
  Advertising Router: 2.2.2.2
  LS Seq Number: 80000001
  Checksum: 0xCDAA
  Length: 36
  Prefix Address: 2003:DB8:3333::
  Prefix Length: 64, Options: None
  Metric Type: 2 (Larger than any link state path)
  Metric: 1

  LS age: 71
  LS Type: AS External Link
  Link State ID: 1
  Advertising Router: 2.2.2.2
  LS Seq Number: 80000001
  Checksum: 0x196E
  Length: 36
  Prefix Address: 2002:DB8:2222::
  Prefix Length: 64, Options: None
  Metric Type: 2 (Larger than any link state path)
  Metric: 20
```

**R1 receives successfully two external routes toward the prefixes 2003:DB8:3333::/64 and 2002:DB8:2222::/64:**

```
R1#show ipv6 route ospf
IPv6 Routing Table - default - 7 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
       B - BGP, R - RIP, H - NHRP, I1 - ISIS L1
       I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary, D - EIGRP
       EX - EIGRP external, ND - ND Default, NDp - ND Prefix, DCE - Destination
       NDr - Redirect, O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1
```

```
       OE2 - OSPF ext 2, ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2, l - LISP
OE2  2002:DB8:2222::/64 [110/20]
     via FE80::C801:EFF:FEBC:8, Serial1/1
OE2  2003:DB8:3333::/64 [110/1]
     via FE80::C801:EFF:FEBC:8, Serial1/1
```

**Let's verify OSPF-to-BGP redistribution by looking at the MP-BGP RIB:**

```
R2#show bgp ipv6 unicast
BGP table version is 4, local router ID is 2.2.2.2
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>  2001:DB8:1111::/64
                       FE80::C800:EFF:FEBC:8
                                                84         32768 ?
 *>  2002:DB8:2222::/64
                       ::                        0         32768 i
 *>i 2003:DB8:3333::/64
                       FE80::C802:1BFF:FEE0:8
                                                 0    100      0 i
```

```
R3#show bgp ipv6 unicast
BGP table version is 4, local router ID is 3.3.3.3
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>i 2002:DB8:2222::/64
                       FE80::C801:EFF:FEBC:8
                                                 0    100      0 i
 *>  2003:DB8:3333::/64
                       ::                        0         32768 i
 *>i 2004:DB8:4444::/64
                       FE80::C803:1BFF:FEE0:8
                                                 0    100      0 i
```

**Configure your network so that all routers can ping each others' LAN subnets from their own local LAN subnet, i.e. LAN-to-LAN pings. Verify your configuration using extended ping. When completing this task, follow the restrictions below:**

**You are NOT allowed to enable an IGP within AS 234**
**You are NOT allowed to configure static routes on R2, R3 and R4**
**You are NOT allowed to create any tunnels**
**You are NOT allowed to advertise the WAN prefixes via BGP**
**You are NOT allowed to use MP-BGP default routing**

**First, it is important to recall that when peering using Link Local addresses, you must use a route map to specify the global Unicast address as the next hop address for the UPDATE**

**messages sent by the local router. To complete this first part, implement the following configuration on R1, R2 and R3:**

**R2:**

```
route-map NEXT-HOP permit 10
set ipv6 next-hop 2001:23::2
!
router bgp 234
address-family ipv6
neighbor FE80::C802:1BFF:FEE0:8 route-map NEXT-HOP out
```

**R3:**

```
route-map R2-NEXT-HOP permit 10
set ipv6 next-hop 2001:23::3
!
route-map R4-NEXT-HOP permit 10
set ipv6 next-hop 2001:34::4
!
router bgp 234
address-family ipv6
neighbor FE80::C801:EFF:FEBC:8 route-map R2-NEXT-HOP out
neighbor FE80::C803:1BFF:FEE0:8 route-map R4-NEXT-HOP out
```

**R4:**

```
route-map NEXT-HOP permit 10
set ipv6 next-hop 2001:34::4
!
router bgp 234
address-family ipv6
neighbor FE80::C802:1BFF:FEE0:8 route-map NEXT-HOP out
```

**Following NEXT_HOP modification, you remember the normal iBGP-to-iBGP advertisement rules. By default, R3 will not advertise prefixes received from R2 to R4 and vice-versa. To override this issue, R3 must be configured as a route reflector as follows:**

**R3:**

```
router bgp 234
address-family ipv6
neighbor FE80::C801:EFF:FEBC:8 route-reflector-client
neighbor FE80::C803:1BFF:FEE0:8 route-reflector-client
```

**The LSDB on R1 and the MP-BGP RIBs on R2, R3, and R4 shown the entries required to be inserted to ensure the LAN-to-LAN connectivity:**

```
R1#show ipv6 ospf database

            OSPFv3 Router with ID (1.1.1.1) (Process ID 1)

                Router Link States (Area 0)

ADV Router       Age         Seq#        Fragment ID  Link count  Bits
 1.1.1.1         1837        0x80000008  0            1           E
 2.2.2.2         1607        0x80000008  0            1           E

                Link (Type-8) Link States (Area 0)

ADV Router       Age         Seq#        Link ID    Interface
```

```
 1.1.1.1         1837        0x80000007  5          Se1/1
 2.2.2.2         1856        0x80000007  5          Se1/1

                Intra Area Prefix Link States (Area 0)

ADV Router       Age         Seq#        Link ID    Ref-lstype  Ref-LSID
 1.1.1.1         1837        0x80000007  0          0x2001      0
 2.2.2.2         1856        0x80000007  0          0x2001      0

                Type-5 AS External Link States

ADV Router       Age         Seq#        Prefix
 1.1.1.1         1837        0x80000007  2001:DB8:1111::/64
 2.2.2.2         56          0x80000004  2003:DB8:3333::/64
 2.2.2.2         1607        0x80000002  2002:DB8:2222::/64
 2.2.2.2         60          0x80000001  2004:DB8:4444::/64
```

**R1 receives the three subnets of R2 R3 and R4:**

```
R1#show ipv route ospf
IPv6 Routing Table - default - 8 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
       B - BGP, R - RIP, H - NHRP, I1 - ISIS L1
       I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary, D - EIGRP
       EX - EIGRP external, ND - ND Default, NDp - ND Prefix, DCE - Destination
       NDr - Redirect, O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1
       OE2 - OSPF ext 2, ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2, l - LISP
OE2 2002:DB8:2222::/64 [110/20]
     via FE80::C801:EFF:FEBC:8, Serial1/1
OE2 2003:DB8:3333::/64 [110/1]
     via FE80::C801:EFF:FEBC:8, Serial1/1
OE2 2004:DB8:4444::/64 [110/1]
     via FE80::C801:EFF:FEBC:8, Serial1/1
```

```
R2#show bgp ipv6 unicast
BGP table version is 10, local router ID is 2.2.2.2
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>  2001:DB8:1111::/64
                       FE80::C800:EFF:FEBC:8
                                               84         32768 ?
 *>  2002:DB8:2222::/64
                       ::                       0         32768 i
 *>i 2003:DB8:3333::/64
                       2001:23::3               0    100      0 i
 *>i 2004:DB8:4444::/64
                       2001:23::3               0    100      0 i
```

```
R3#show bgp ipv6 unicast
BGP table version is 13, local router ID is 3.3.3.3
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
```

```
             x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>i 2001:DB8:1111::/64
                       2001:23::2               84    100      0 ?
 *>i 2002:DB8:2222::/64
                       2001:23::2                0    100      0 i
 *>  2003:DB8:3333::/64
                       ::                        0         32768 i
 *>i 2004:DB8:4444::/64
                       2001:34::4                0    100      0 i
```

```
R4#show bgp ipv6 unicast
BGP table version is 12, local router ID is 4.4.4.4
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>i 2001:DB8:1111::/64
                       2001:34::4               84    100      0 ?
 *>i 2002:DB8:2222::/64
                       2001:34::4                0    100      0 i
 *>i 2003:DB8:3333::/64
                       2001:34::4                0    100      0 i
 *>  2004:DB8:4444::/64
                       ::                        0         32768 i
R4#
```

```
R4#show ipv6 route bgp
IPv6 Routing Table - default - 8 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
       B - BGP, R - RIP, H - NHRP, I1 - ISIS L1
       I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary, D - EIGRP
       EX - EIGRP external, ND - ND Default, NDp - ND Prefix, DCE - Destination
       NDr - Redirect, O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1
       OE2 - OSPF ext 2, ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2, l - LISP
B   2001:DB8:1111::/64 [200/84]
     via FE80::C802:1BFF:FEE0:8, Serial1/1
B   2002:DB8:2222::/64 [200/0]
     via FE80::C802:1BFF:FEE0:8, Serial1/1
B   2003:DB8:3333::/64 [200/0]
     via FE80::C802:1BFF:FEE0:8, Serial1/1
```

**The ping LAN-to-LAN between all routers are success full:**

```
R1#ping 2002:db8:2222::2 sou lo0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2002:DB8:2222::2, timeout is 2 seconds:
Packet sent with a source address of 2001:DB8:1111::1
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 52/65/100 ms
R1#
```

```
R1#ping 2003:db8:3333::3 sou lo0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2003:DB8:3333::3, timeout is 2 seconds:
Packet sent with a source address of 2001:DB8:1111::1
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 64/96/144 ms
R1#
R1#ping 2004:db8:4444::4 sou lo0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2004:DB8:4444::4, timeout is 2 seconds:
Packet sent with a source address of 2001:DB8:1111::1
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 100/114/132 ms
R1#
```

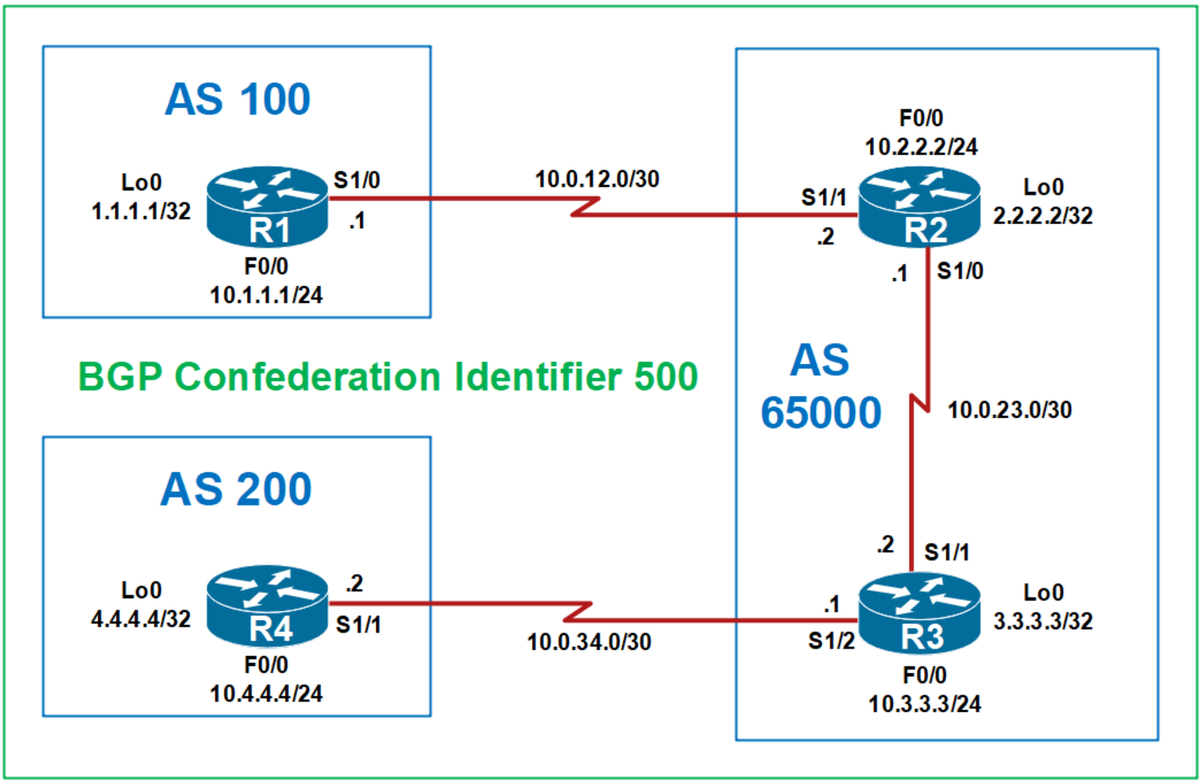
```
R2#ping 2001:db8:1111::1 sou lo0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:DB8:1111::1, timeout is 2 seconds:
Packet sent with a source address of 2002:DB8:2222::2
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 44/84/116 ms
R2#
R2#ping 2003:db8:3333::3 sou lo0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2003:DB8:3333::3, timeout is 2 seconds:
Packet sent with a source address of 2002:DB8:2222::2
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 12/54/128 ms
R2#
R2#ping 2004:db8:4444::4 sou lo0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2004:DB8:4444::4, timeout is 2 seconds:
Packet sent with a source address of 2002:DB8:2222::2
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 72/95/152 ms
R2#
```

```
R3#ping 2001:db8:1111::1 sou lo0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:DB8:1111::1, timeout is 2 seconds:
Packet sent with a source address of 2003:DB8:3333::3
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 60/88/148 ms
R3#
R3#ping 2002:db8:2222::2 sou lo0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2002:DB8:2222::2, timeout is 2 seconds:
Packet sent with a source address of 2003:DB8:3333::3
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 4/67/148 ms
R3#
R3#ping 2004:db8:4444::4 sou lo0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2004:DB8:4444::4, timeout is 2 seconds:
Packet sent with a source address of 2003:DB8:3333::3
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 52/67/100 ms
```

```
R3#
```

```
R4#ping 2001:db8:1111::1 sou lo0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:DB8:1111::1, timeout is 2 seconds:
Packet sent with a source address of 2004:DB8:4444::4
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 44/95/140 ms
R4#
R4#ping 2002:db8:2222::2 sou lo0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2002:DB8:2222::2, timeout is 2 seconds:
Packet sent with a source address of 2004:DB8:4444::4
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 32/84/124 ms
R4#
R4#ping 2003:db8:3333::3 sou lo0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2003:DB8:3333::3, timeout is 2 seconds:
Packet sent with a source address of 2004:DB8:4444::4
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 16/28/40 ms
R4#
```

## Lab 13: BGP Confederation weight and Unsuppress-map




**Basic Configuration**

**R1:**

```
interface Loopback0
 ip address 1.1.1.1 255.255.255.255
!
interface FastEthernet0/0
 ip address 10.1.1.1 255.255.255.0
 no shutdown
!
interface Serial1/1
 ip address 10.0.12.1 255.255.255.252
 no shutdown
```

**R2:**

```
interface Loopback0
 ip address 2.2.2.2 255.255.255.255
!
interface FastEthernet0/0
 ip address 10.2.2.2 255.255.255.0
 no shutdown
!
interface Serial1/1
 ip address 10.0.12.2 255.255.255.252
 no shutdown
!
interface Serial1/0
```

```
 ip address 10.0.23.1 255.255.255.252
 no shutdown
```

**R3:**

```
interface Loopback0
 ip address 3.3.3.3 255.255.255.255
!
interface FastEthernet0/0
 ip address 10.3.3.3 255.255.255.0
 no shutdown
!
interface Serial1/1
 ip address 10.0.23.2 255.255.255.252
 no shutdown
!
interface Serial1/2
 ip address 10.0.34.1 255.255.255.252
 no shutdown
```

**R4:**

```
interface Loopback0
 ip address 4.4.4.4 255.255.255.255
!
interface FastEthernet0/0
 ip address 10.4.4.4 255.255.255.0
 no shutdown
!
interface Serial1/1
 ip address 10.0.34.2 255.255.255.252
 no shutdown
```

**OSPF should only be enabled for the Loopback and WAN subnets. Do NOT enable OSPF for the LAN subnets.**

**R1:**

```
router ospf 1
 network 1.1.1.1 0.0.0.0 area 0
 network 10.0.12.1 0.0.0.0 area 0
```

**R2:**

```
router ospf 1
 network 2.2.2.2 0.0.0.0 area 0
 network 10.0.12.2 0.0.0.0 area 0
 network 10.0.23.1 0.0.0.0 area 0
```

**R3:**

```
router ospf 1
 network 3.3.3.3 0.0.0.0 area 0
 network 10.0.34.1 0.0.0.0 area 0
 network 10.0.23.2 0.0.0.0 area 0
```

**R4:**

```
router ospf 1
 network 4.4.4.4 0.0.0.0 area 0
 network 10.0.34.2 0.0.0.0 area 0
```

**Let's verify the routing tables of all routers:**

```
R1#show ip route ospf | beg Gate
Gateway of last resort is not set

      2.0.0.0/32 is subnetted, 1 subnets
O        2.2.2.2 [110/65] via 10.0.12.2, 00:01:04, Serial1/1
      3.0.0.0/32 is subnetted, 1 subnets
O        3.3.3.3 [110/129] via 10.0.12.2, 00:00:50, Serial1/1
      4.0.0.0/32 is subnetted, 1 subnets
O        4.4.4.4 [110/193] via 10.0.12.2, 00:00:40, Serial1/1
      10.0.0.0/8 is variably subnetted, 6 subnets, 3 masks
O        10.0.23.0/30 [110/128] via 10.0.12.2, 00:01:04, Serial1/1
O        10.0.34.0/30 [110/192] via 10.0.12.2, 00:00:50, Serial1/1
R1#
```

```
R2(config-router)#do show ip route ospf | beg Gate
Gateway of last resort is not set

      1.0.0.0/32 is subnetted, 1 subnets
O        1.1.1.1 [110/65] via 10.0.12.1, 00:01:40, Serial1/1
      3.0.0.0/32 is subnetted, 1 subnets
O        3.3.3.3 [110/65] via 10.0.23.2, 00:01:26, Serial1/0
      4.0.0.0/32 is subnetted, 1 subnets
O        4.4.4.4 [110/129] via 10.0.23.2, 00:01:16, Serial1/0
      10.0.0.0/8 is variably subnetted, 7 subnets, 3 masks
O        10.0.34.0/30 [110/128] via 10.0.23.2, 00:01:26, Serial1/0
R2(config-router)#
```

```
R3(config-router)#do show ip route ospf | beg Gate
Gateway of last resort is not set

      1.0.0.0/32 is subnetted, 1 subnets
O        1.1.1.1 [110/129] via 10.0.23.1, 00:01:53, Serial1/1
      2.0.0.0/32 is subnetted, 1 subnets
O        2.2.2.2 [110/65] via 10.0.23.1, 00:01:53, Serial1/1
      4.0.0.0/32 is subnetted, 1 subnets
O        4.4.4.4 [110/65] via 10.0.34.2, 00:01:43, Serial1/2
      10.0.0.0/8 is variably subnetted, 7 subnets, 3 masks
O        10.0.12.0/30 [110/128] via 10.0.23.1, 00:01:53, Serial1/1
R3(config-router)#
```

```
R4(config-router)#do show ip route ospf | beg Gate
Gateway of last resort is not set

      1.0.0.0/32 is subnetted, 1 subnets
O        1.1.1.1 [110/193] via 10.0.34.1, 00:02:06, Serial1/1
      2.0.0.0/32 is subnetted, 1 subnets
O        2.2.2.2 [110/129] via 10.0.34.1, 00:02:06, Serial1/1
      3.0.0.0/32 is subnetted, 1 subnets
O        3.3.3.3 [110/65] via 10.0.34.1, 00:02:06, Serial1/1
      10.0.0.0/8 is variably subnetted, 6 subnets, 3 masks
O        10.0.12.0/30 [110/192] via 10.0.34.1, 00:02:06, Serial1/1
O        10.0.23.0/30 [110/128] via 10.0.34.1, 00:02:06, Serial1/1
R4(config-router)#
```

**Configure BGP confederations as illustrated in the network topology. Use Loopback interface IP addresses for BGP peering. To the outside world, all routers should appear to be in BGP AS 500.**

**In Cisco IOS software, the following sequence of steps is required to configure and implement BGP confederations:**

- **Configure the local BGP speaker with the desired private AS number using the router bgp [private AS number] global configuration command**

- **Configure the local BGP speaker with the public AS using the bgp confederation identifier [public AS number] router configuration command.**

- **Specify one or more sub-AS peers that this local BGP speaker will peer to using the bgp confederation peers [sub-AS] router configuration command. If the local BGP speaker will not peer to any other sub-AS, this command must be omitted.**

- **Configure the BGP neighbor relationships following the standard steps. However, if a local BGP speaker will be peered to another BGP speaker in a different sub-AS, you must use the neighbor [address] ebgp-multihop command if you will be using Loopback interfaces for the BGP session.**

**R1:**

```
router bgp 100
bgp confederation identifier 500
bgp confederation peers 65000
neighbor 2.2.2.2 remote-as 65000
neighbor 2.2.2.2 update-source loopback 0
neighbor 2.2.2.2 ebgp-multihop 255
```

**R2:**

```
router bgp 65000
bgp confederation identifier 500
bgp confederation peers 100
neighbor 1.1.1.1 remote-as 100
neighbor 1.1.1.1 update-source loopback 0
neighbor 1.1.1.1 ebgp-multihop 255
neighbor 3.3.3.3 remote-as 65000
neighbor 3.3.3.3 update-source loopback 0
neighbor 3.3.3.3 ebgp-multihop 255
```

**R3:**

```
router bgp 65000
bgp confederation identifier 500
bgp confederation peers 400
neighbor 2.2.2.2 remote-as 65000
neighbor 2.2.2.2 update-source loopback 0
neighbor 2.2.2.2 ebgp-multihop
neighbor 4.4.4.4 remote-as 400
neighbor 4.4.4.4 update-source loopback 0
neighbor 4.4.4.4 ebgp-multihop 255
```

**R4:**

```
router bgp 400
bgp confederation identifier 500
bgp confederation peers 65000
neighbor 3.3.3.3 remote-as 65000
```

```
neighbor 3.3.3.3 update-source loopback 0
neighbor 3.3.3.3 ebgp-multihop 255
```

**Verify your configuration using the show ip bgp summary command:**

```
R1#show ip bgp summary
BGP router identifier 1.1.1.1, local AS number 100
BGP table version is 1, main routing table version 1

Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down
State/PfxRcd
2.2.2.2         4        65000       2       2        1    0    0 00:00:35
0
R1#
```

```
R2#show ip bgp summary
BGP router identifier 2.2.2.2, local AS number 65000
BGP table version is 1, main routing table version 1

Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down
State/PfxRcd
1.1.1.1         4          100       2       3        1    0    0 00:00:55
0
3.3.3.3         4        65000       2       2        1    0    0 00:00:43
0
R2#
```

```
R3#show ip bgp summary
BGP router identifier 3.3.3.3, local AS number 65000
BGP table version is 1, main routing table version 1

Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down
State/PfxRcd
2.2.2.2         4        65000       4       4        1    0    0 00:01:15
0
4.4.4.4         4          400       4       4        1    0    0 00:01:05
0
R3#
```

```
R4#show ip bgp summary
BGP router identifier 4.4.4.4, local AS number 400
BGP table version is 1, main routing table version 1

Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down
State/PfxRcd
3.3.3.3         4        65000       4       4        1    0    0 00:01:25
0
R4#
```

**Advertise the 10.x.x.0/24 subnets on R1, R2, R3, and R4 via BGP. Ensure that all routers can ping each other's' LAN subnet from their own LAN subnet. For example, from R1 ping the 10.4.4.4 address using an extended ping sourced from the routers FastEthernet0/0 interface.**

**R1:**

```
router bgp 100
network 10.1.1.0 mask 255.255.255.0
```

**R2**:

```
router bgp 65000
network 10.2.2.0 mask 255.255.255.0
```

**R3**:

```
router bgp 65000
network 10.3.3.0 mask 255.255.255.0
```

**R4**:

```
router bgp 400
network 10.4.4.0 mask 255.255.255.0
```

**Verify your configuration using the show ip bgp command on all routers:**

```
R1#show ip bgp
BGP table version is 7, 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, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>  10.1.1.0/24      0.0.0.0                  0         32768 i
 *>  10.2.2.0/24      2.2.2.2                  0    100      0 (65000) i
 *>  10.3.3.0/24      3.3.3.3                  0    100      0 (65000) i
 *>  10.4.4.0/24      4.4.4.4                  0    100      0 (65000 400) i
R1#
```

```
R2#show ip bgp
BGP table version is 5, local router ID is 2.2.2.2
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>  10.1.1.0/24      1.1.1.1                  0    100      0 (100) i
 *>  10.2.2.0/24      0.0.0.0                  0         32768 i
 *>i 10.3.3.0/24      3.3.3.3                  0    100      0 i
 *>i 10.4.4.0/24      4.4.4.4                  0    100      0 (400) i
R2#
```

```
R3#show ip bgp
BGP table version is 5, local router ID is 3.3.3.3
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>i 10.1.1.0/24      1.1.1.1                  0    100      0 (100) i
 *>i 10.2.2.0/24      2.2.2.2                  0    100      0 i
```

```
 *>  10.3.3.0/24      0.0.0.0                  0         32768 i
 *>  10.4.4.0/24      4.4.4.4                  0    100      0 (400) i
R3#
```

```
R4#show ip bgp
BGP table version is 5, local router ID is 4.4.4.4
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>  10.1.1.0/24      1.1.1.1                  0    100      0 (65000 100) i
 *>  10.2.2.0/24      2.2.2.2                  0    100      0 (65000) i
 *>  10.3.3.0/24      3.3.3.3                  0    100      0 (65000) i
 *>  10.4.4.0/24      0.0.0.0                  0         32768 i
R4#
```

**Verify the LAN-to-LAN connectivity:**

```
R1#ping 10.2.2.2 source fastEthernet 0/0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.2.2.2, timeout is 2 seconds:
Packet sent with a source address of 10.1.1.1
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 88/96/104 ms
R1#
R1#ping 10.3.3.3 source fastEthernet 0/0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.3.3.3, timeout is 2 seconds:
Packet sent with a source address of 10.1.1.1
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 72/103/116 ms
R1#
R1#ping 10.4.4.4 source fastEthernet 0/0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.4.4.4, timeout is 2 seconds:
Packet sent with a source address of 10.1.1.1
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 100/127/148 ms
R1#
```

```
R2#ping 10.1.1.1 source fastEthernet 0/0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.1.1.1, timeout is 2 seconds:
Packet sent with a source address of 10.2.2.2
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 80/115/148 ms
R2#
R2#ping 10.3.3.3 source fastEthernet 0/0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.3.3.3, timeout is 2 seconds:
Packet sent with a source address of 10.2.2.2
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 76/103/132 ms
R2#
```

```
R2#ping 10.4.4.4 source fastEthernet 0/0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.4.4.4, timeout is 2 seconds:
Packet sent with a source address of 10.2.2.2
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 116/123/132 ms
R2#
```

```
R3#ping 10.1.1.1 source fastEthernet 0/0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.1.1.1, timeout is 2 seconds:
Packet sent with a source address of 10.3.3.3
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 104/119/140 ms
R3#
R3#ping 10.2.2.2 source fastEthernet 0/0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.2.2.2, timeout is 2 seconds:
Packet sent with a source address of 10.3.3.3
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 64/120/200 ms
R3#
R3#ping 10.4.4.4 source fastEthernet 0/0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.4.4.4, timeout is 2 seconds:
Packet sent with a source address of 10.3.3.3
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 44/100/212 ms
R3#
```

```
R4#ping 10.1.1.1 source fastEthernet 0/0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.1.1.1, timeout is 2 seconds:
Packet sent with a source address of 10.4.4.4
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 128/146/160 ms
R4#
R4#ping 10.2.2.2 source fastEthernet 0/0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.2.2.2, timeout is 2 seconds:
Packet sent with a source address of 10.4.4.4
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 100/120/136 ms
R4#
R4#ping 10.4.4.4 source fastEthernet 0/0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.4.4.4, timeout is 2 seconds:
Packet sent with a source address of 10.4.4.4
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 8/8/12 ms
R4#
```

**In the future, a link will be provisioned between R1 and R4. However, you decided that R1 and R2 should ALWAYS prefer the path through sub-AS 65500 to reach each others' LAN subnets ONLY. Any other subnets that may be added to additional sub-ASes in the future should be affected by this configuration. For example, if another sub-AS is connected to R4, then R1 should prefer the path directly through R4 to reach this sub-AS since it will have a shorter**

**AS_PATH list than going through sub-AS 65500. You are NOT allowed to use IP ACLs or prefix lists to complete this task.**

**To complete this task, you need to use either the WEIGHT or LOCAL_PREF attributes along with a regular expression (since using IP ACLs and prefix lists is forbidden). In Cisco IOS software, AS path filters are used to perform BGP filtering policy control based on the AS_PATH attribute. The AS path attribute pattern used in these filters is defined by a regular expression string that is configured using the ip as-path access-list [number] [permit | deny] <regexp> global configuration command. The configured filter list may then be applied directly on a per-neighbor basis using the neighbor [address] filter-list <as_path_acl_number> router configuration command or indirectly on a per-neighbor basis by referencing an route map which matches one or more AS path filters using the match as-path <as_path_acl_number> route map match clause.**

**From cisco: The following table shows some basic regular expression:**

| Regular Expression | Matches |
|---|---|
| .* | This regular expression is used to match all prefixes |
| ^$ | This regular expression matches only prefixes local to the AS |
| _500$ | This regular expression matches only prefixes that originate in AS 500 |
| ^500_ [0-9]*$ | This regular expression matches prefixes received from directly connected AS 500 and any ASes directly attached to AS 500 |
| _500_ | This regular expression matches prefixes that have traversed AS 500 |
| ^500$ | This regular expression matches prefixes only originated from directly connected AS 500 |

**We can verify which prefixes will match your AS_PATH ACL Filter using the show ip bgp regexp command as follows:**

```
R1#show ip bgp regexp _\(65000 400\)$
BGP table version is 7, 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, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>  10.4.4.0/24      4.4.4.4                  0    100      0 (65000 400) i
R1#
```

```
R4#show ip bgp regexp _\(65000 100\)$
BGP table version is 5, local router ID is 4.4.4.4
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>  10.1.1.0/24      1.1.1.1                  0    100      0 (65000 100) i
R4#
```

**This task is completed as follows:**

**Configure as-path filters on R1 and R4 with regular expressions and the route-map to match the prefixes originated from sub-AS 100 and sub-AS 400 ,then set the WEIGHT attribute value in the route-map.**

**R1:**

```
ip as-path access-list 1 permit _\(65000 400\)$
route-map WEIGHT permit 10
match as-path 1
set weight 1500
!
route-map WEIGHT permit 20
!
router bgp 100
neighbor 2.2.2.2 route-map WEIGHT in
```

**R4:**

```
ip as-path access-list 1 permit _\(65000 100\)$
route-map WEIGHT permit 10
match as-path 1
set weight 1500
!
route-map WEIGHT permit 20
!
router bgp 400
neighbor 3.3.3.3 route-map WEIGHT in
```

**We can see that R1 sets the weight value to 1500 for the prefix 10.4.4.0/24:**

```
R1#show ip bgp
BGP table version is 5, 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, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>  10.1.1.0/24      0.0.0.0                  0         32768 i
 *>  10.2.2.0/24      2.2.2.2                  0    100      0 (65000) i
 *>  10.3.3.0/24      3.3.3.3                  0    100      0 (65000) i
 *>  10.4.4.0/24      4.4.4.4                  0    100   1500 (65000 400) i
R1#
```

**R4 sets the weight value to 1500 for the prefix 10.1.1.0/24:**

```
R4#show ip bgp
BGP table version is 7, local router ID is 4.4.4.4
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>  10.1.1.0/24      1.1.1.1                  0    100   1500 (65000 100) i
 *>  10.2.2.0/24      2.2.2.2                  0    100      0 (65000) i
 *>  10.3.3.0/24      3.3.3.3                  0    100      0 (65000) i
 *>  10.4.4.0/24      0.0.0.0                  0         32768 i
R4#
```

**Configure sub-AS 65500 to advertise a single prefix instead of the two 10.2.2.0/24 as well as the 10.3.3.0/24 prefixes connected to R2 and R3s LAN interfaces to R1 and R4.**
**Note: Use the neighbor <address> unsuppress-map <route-map-name> command on R2 and R3 to allow these prefixes to be advertised within sub AS 65500 so that R2 and R3 still have LAN-to-LAN connectivity.**

**This task is completed as follow:**

**Configure the sub-AS 65000 to summarize two prefixes 10.2.2.0/24 and 10.3.3./24 using the aggregate-address command. By default, this command will advertise both the aggregate (summary) and the more specific prefixes. To advertise only the summary, we need to add the summary-only keyword. This keyword instructs the router to advertise the aggregate or the summary route only and suppress the more specific routes that belong to the summary.**

**R2:**

```
router bgp 65000
aggregate-address 10.2.0.0 255.254.0.0 summary-only
```

**R3:**

```
router bgp 65000
aggregate-address 10.2.0.0 255.254.0.0 summary-only
```

**Let's verify the BGP tables of R2 and R3:**
**We can see that both R2 and R3 are advertising a summary or an aggregate route to 10.2.2.0/24 and 10.3.3.0/24 prefixes:**
**Note after adding the summary-only keyword, R2 and R3 suppress the prefixes 10.2.2.0/24 10.3.3.0/24 respectively as denoted by the letter "S" in the first column:**

```
R2#show ip bgp
BGP table version is 6, local router ID is 2.2.2.2
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>  10.1.1.0/24      1.1.1.1                  0    100      0 (100) i
 * i 10.2.0.0/15      3.3.3.3                  0    100      0 i
 *>                   0.0.0.0                            32768 i
 s>  10.2.2.0/24      0.0.0.0                  0         32768 i
 *>i 10.4.4.0/24      4.4.4.4                  0    100      0 (400) i
R2#
```

```
R3#show ip bgp
BGP table version is 11, local router ID is 3.3.3.3
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>i 10.1.1.0/24      1.1.1.1                  0    100      0 (100) i
 *>  10.2.0.0/15      0.0.0.0                            32768 i
 * i                  2.2.2.2                  0    100      0 i
 s>  10.3.3.0/24      0.0.0.0                  0         32768 i
```

```
 *>  10.4.4.0/24      4.4.4.4                  0    100      0 (400) i
R3#
```

**As a result R1 and R4 receive only the aggregate route 10.2.0.0/15 as shown by the BGP tables displayed below:**

```
R1#show ip bgp
BGP table version is 12, 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, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>  10.1.1.0/24      0.0.0.0                  0         32768 i
 *>  10.2.0.0/15      2.2.2.2                  0    100      0 (65000) i
 *>  10.4.4.0/24      4.4.4.4                  0    100   1500 (65000 400) i
R1#
```

```
R4#show ip bgp
BGP table version is 15, local router ID is 4.4.4.4
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>  10.1.1.0/24      1.1.1.1                  0    100   1500 (65000 100) i
 *>  10.2.0.0/15      3.3.3.3                  0    100      0 (65000) i
 *>  10.4.4.0/24      0.0.0.0                  0         32768 i
R4#
```

**In the BGP tables displayed above on R2 and R3 notice that R2 does not have a specific route to 10.3.3.0/24 and R3 does not have a route to 10.2.2.0/24.**
**In order to allow these prefixes to be advertised within sub AS 65000, we will use the neighbor "IP address" unsuppress-map "route-map" command to unsuppress (leak) these routes between the routers R2 and R3. this feature is similar to EIGRP route leaking.**

**R2:**

```
ip prefix-list LAN-R2 seq 5 permit 10.2.2.0/24
route-map UNSUPRESS-R2 permit 10
match ip addres prefix-list LAN-R2
!
router bgp 65000
neighbor 3.3.3.3 unsuppress-map UNSUPRESS-R2
```

**R3:**

```
ip prefix-list LAN-R3 seq 5 permit 10.3.3.0/24
route-map UNSUPRESS-R3 permit 10
match ip addres prefix-list LAN-R3
!
router bgp 65000
neighbor 2.2.2.2 unsuppress-map UNSUPRESS-R3
```

**Notice that the specific subnet 10.3.3.0/24 is installed in the BGP table of R2:**

```
R2#show ip bgp
BGP table version is 13, local router ID is 2.2.2.2
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>  10.1.1.0/24      1.1.1.1                  0    100      0 (100) i
 * i 10.2.0.0/15      3.3.3.3                  0    100      0 i
 *>                   0.0.0.0                            32768 i
 s>  10.2.2.0/24      0.0.0.0                  0         32768 i
 *>i 10.3.3.0/24      3.3.3.3                  0    100      0 i
 *>i 10.4.4.0/24      4.4.4.4                  0    100      0 (400) i
R2#
```

**The specific subnet 10.2.2.0/24 is installed in the BGP table of R3:**

```
R3#show ip bgp
BGP table version is 9, local router ID is 3.3.3.3
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>i 10.1.1.0/24      1.1.1.1                  0    100      0 (100) i
 *>  10.2.0.0/15      0.0.0.0                            32768 i
 * i                  2.2.2.2                  0    100      0 i
 s>i 10.2.2.0/24      2.2.2.2                  0    100      0 i
 s>  10.3.3.0/24      0.0.0.0                  0         32768 i
 *>  10.4.4.0/24      4.4.4.4                  0    100      0 (400) i
R3#
```

**Even though the specific subnets are advertised within sub-AS 65000 between R2 and R3, we can see that only a single prefix is received by R1 and R4 from R2 and R3 respectively:**

```
R1#show ip bgp
BGP table version is 19, 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, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>  10.1.1.0/24      0.0.0.0                  0         32768 i
 *>  10.2.0.0/15      2.2.2.2                  0    100      0 (65000) i
 *>  10.4.4.0/24      4.4.4.4                  0    100   1500 (65000 400) i
R1#
```

```
R4#show ip bgp
BGP table version is 21, local router ID is 4.4.4.4
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
```

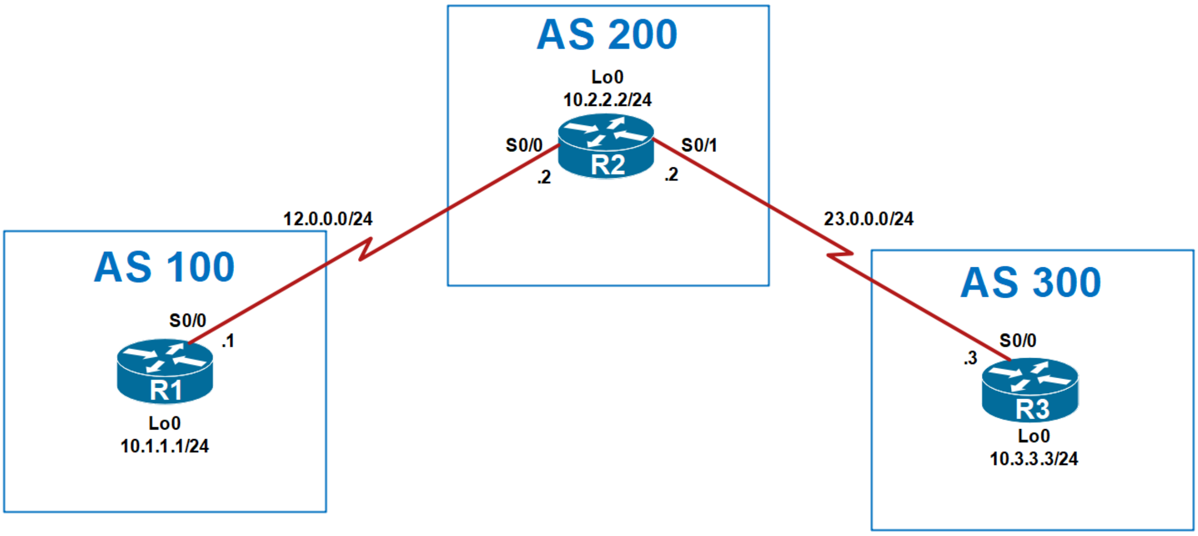
```
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>  10.1.1.0/24      1.1.1.1                  0    100   1500 (65000 100) i
 *>  10.2.0.0/15      3.3.3.3                  0    100      0 (65000) i
 *>  10.4.4.0/24      0.0.0.0                  0         32768 i
R4#
```

**Finally let's verify that R1 and R4 can still reach the 10.2.2.0/24 and 10.3.3.0/24 prefixes:**

```
R1#ping 10.2.2.2 source fa0/0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.2.2.2, timeout is 2 seconds:
Packet sent with a source address of 10.1.1.1
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 24/53/72 ms
R1#
R1#ping 10.3.3.3 source fa0/0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.3.3.3, timeout is 2 seconds:
Packet sent with a source address of 10.1.1.1
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 72/89/108 ms
R1#
```

```
R4#ping 10.2.2.2 source fa0/0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.2.2.2, timeout is 2 seconds:
Packet sent with a source address of 10.4.4.4
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 36/53/72 ms
R4#
R4#ping 10.3.3.3 source fa0/0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.3.3.3, timeout is 2 seconds:
Packet sent with a source address of 10.4.4.4
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 24/40/52 ms
R4#
```

## Lab 14: BGP Conditional advertisement




**Basic Configuration**

**R1:**

```
interface Loopback0
 ip address 10.1.1.1 255.255.255.0
!
interface Serial0/0
 ip address 12.0.0.1 255.255.255.0
 no shutdown
```

**R2:**

```
interface Loopback0
 ip address 10.2.2.2 255.255.255.0
!
interface Serial0/0
 ip address 12.0.0.2 255.255.255.0
 no shutdown
!
interface Serial0/1
 ip address 23.0.0.2 255.255.255.0
 no shutdown
```

**R3:**

```
interface Loopback0
 ip address 10.3.3.3 255.255.255.0
!
interface Serial0/0
 ip address 23.0.0.3 255.255.255.0
 no shutdown
```

**Configuration of BGP:**

**R1:**

```
router bgp 65100
```

```
bgp router-id 1.1.1.1
neighbor 12.0.0.2 remote-as 65200
```

**R2:**

```
router bgp 65200
bgp router-id 2.2.2.2
neighbor 12.0.0.1 remote-as 65100
neighbor 23.0.0.3 remote-as 65300
```

**R3:**

```
router bgp 65300
bgp router-id 3.3.3.3
neighbor 23.0.0.2 remote-as 65200
```

**Let's verify the neighbor relationship:**

```
R1#show ip bgp summary
BGP router identifier 1.1.1.1, local AS number 65100
BGP table version is 1, main routing table version 1

Neighbor        V    AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
12.0.0.2        4 65200       6       6        1    0    0 00:02:11        0
R1#
```

```
R2#show ip bgp summary
BGP router identifier 2.2.2.2, local AS number 65200
BGP table version is 1, main routing table version 1

Neighbor        V    AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
12.0.0.1        4 65100      11      10        1    0    0 00:01:22        0
23.0.0.3        4 65300      11      10        1    0    0 00:01:21        0
R2#
```

```
R3#show ip bgp summary
BGP router identifier 3.3.3.3, local AS number 65300
BGP table version is 1, main routing table version 1

Neighbor        V    AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
23.0.0.2        4 65200      11      12        1    0    0 00:02:16        0
R3#
```

**Let's advertise the loopback prefixes on each router:**
**In addition R2 advertises the prefix 192.168.2.0/24**

**R1:**

```
router bgp 65100
network 10.1.1.0 mask 255.255.255.0
```

**R2:**

```
router bgp 65200
network 10.2.2.0 mask 255.255.255.0
network 192.168.2.0 mask 255.255.255.0
!
ip route 192.168.2.0 255.255.255.0 null 0
```

**R3:**

```
router bgp 65300
network 10.3.3.0 mask 255.255.255.0
```

**Let's verify the BGP tables of all routers:**
**All possible routes are learned.**

```
R1#show ip bgp
BGP table version is 5, 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
*> 10.1.1.0/24      0.0.0.0                  0         32768 i
*> 10.2.2.0/24      12.0.0.2                 0             0 65200 i
*> 10.3.3.0/24      12.0.0.2                               0 65200 65300 i
*> 192.168.2.0      12.0.0.2                 0             0 65200 i
R1#
```

```
R2#show ip bgp
BGP table version is 5, 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
*> 10.1.1.0/24      12.0.0.1                 0             0 65100 i
*> 10.2.2.0/24      0.0.0.0                  0         32768 i
*> 10.3.3.0/24      23.0.0.3                 0             0 65300 i
*> 192.168.2.0      0.0.0.0                  0         32768 i
R2#
```

```
R3#show ip bgp
BGP table version is 5, local router ID is 3.3.3.3
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
*> 10.1.1.0/24      23.0.0.2                               0 65200 65100 i
*> 10.2.2.0/24      23.0.0.2                 0             0 65200 i
*> 10.3.3.0/24      0.0.0.0                  0         32768 i
*> 192.168.2.0      23.0.0.2                 0             0 65200 i
R3#
```

**Now let's configure the Conditional Advertisement:**
**We should advertise the routes matched in the route-map called "ADVERTISE" (10.2.2.0/24) only if the routes matched in route-map called "NON-EXIST" (10.3.3.0/24) do not exist in the BGP table.**

**R2:**

```
router bgp 65200
neighbor 12.0.0.1 advertise-map ADVERTISE non-exist-map NON-EXIST
!
ip prefix-list PREFIX-Lo0-R2 seq 5 permit 10.2.2.0/24
!
ip prefix-list PREFIX-Lo0-R3 seq 5 permit 10.3.3.0/24
```

```
!
route-map NON-EXIST permit 10
 match ip address prefix-list PREFIX-Lo0-R3
!
route-map ADVERTISE permit 10
 match ip address prefix-list PREFIX-Lo0-R2
```

**Let's clear the bgp neighbor relationship:**

```
R2#clear ip bgp *
R2#
*Mar  1 00:48:06.479: %BGP-5-ADJCHANGE: neighbor 12.0.0.1 Down User reset
*Mar  1 00:48:06.483: %BGP-5-ADJCHANGE: neighbor 23.0.0.3 Down User reset
R2#
*Mar  1 00:48:08.655: %BGP-5-ADJCHANGE: neighbor 23.0.0.3 Up
*Mar  1 00:48:08.663: %BGP-5-ADJCHANGE: neighbor 12.0.0.1 Up
R2#
```

**Let's see the BGP tables:**

**R2 has still the prefix 10.3.3.0/24 in its BGP table:**

```
R2#show ip bgp
BGP table version is 6, 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
*> 10.1.1.0/24      12.0.0.1                 0             0 65100 i
*> 10.2.2.0/24      0.0.0.0                  0         32768 i
*> 10.3.3.0/24      23.0.0.3                 0             0 65300 i
*> 192.168.2.0      0.0.0.0                  0         32768 i
R2#
```

**Since 10.3.3.0/24 is present it the BGP table of R2, then R2 should not advertise the prefix 10.2.2.0/24 to R1 as shown by the show ip bgp neighbors 12.0.0.1 advertised-routes command on R2:**

```
R2#show ip bgp neighbors 12.0.0.1 advertised-routes
BGP table version is 6, 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
*> 10.3.3.0/24      23.0.0.3                 0             0 65300 i
*> 192.168.2.0      0.0.0.0                  0         32768 i

Total number of prefixes 2
R2#
```

**We can confirm by looking the BGP table of R1.**
**The prefix 10.2.2.0/24 is not present in the BGP table of R1.**

```
R1#show ip bgp
BGP table version is 10, 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
*> 10.1.1.0/24      0.0.0.0                  0         32768 i
*> 10.3.3.0/24      12.0.0.2                               0 65200 65300 i
*> 192.168.2.0      12.0.0.2                 0             0 65200 i
R1#
```

**Another command that can help us to confirm the result is the show ip bgp neighbors 12.0.0.1 command.**
**This command shows that the conditional advertisement is "withdrawn" or removed and the prefix that match the route-map called "ADVERTISE" are not advertised to the neighbor 12.0.0.1.**

```
R2#show ip bgp neighbors 12.0.0.1
BGP neighbor is 12.0.0.1,  remote AS 65100, external link
  BGP version 4, remote router ID 1.1.1.1
  BGP state = Established, up for 00:07:17
  Last read 00:00:17, last write 00:00:17, 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:                  3          3
    Notifications:          0          0
    Updates:                5          2
    Keepalives:            24         25
    Route Refresh:          0          0
    Total:                 32         30
  Default minimum time between advertisement runs is 30 seconds

 For address family: IPv4 Unicast
  BGP table version 6, neighbor version 6/0
 Output queue size : 0
  Index 2, Offset 0, Mask 0x4
  2 update-group member
  Condition-map NON-EXIST, Advertise-map ADVERTISE, status: Withdraw
                                 Sent       Rcvd
  Prefix activity:               ----       ----
    Prefixes Current:               2          1 (Consumes 52 bytes)
    Prefixes Total:                 2          1
    Implicit Withdraw:              0          0
    Explicit Withdraw:              0          0
    Used as bestpath:             n/a          1
    Used as multipath:            n/a          0
```

**Let's verify the conditional advertisement operation by disabling the loopback interface of R3 and let's activate the debugging of BGP updates on R2:**

```
R2#debug ip bgp updates
BGP updates debugging is on for address family: IPv4 Unicast
```

```
R2#
```

```
R3(config)#int loopback 0
R3(config-if)#shu
R3(config-if)#shutdown
```

**Let's see the result of the debug ip bgp updates command:**

```
R2#
*Mar  1 01:04:46.887: BGP(0): 23.0.0.3 rcv UPDATE about 10.3.3.0/24 -- withdrawn
*Mar  1 01:04:46.887: BGP(0): no valid path for 10.3.3.0/24
*Mar  1 01:04:46.891: BGP(0): nettable_walker 10.3.3.0/24 no best path
*Mar  1 01:04:46.891: BGP(0): 12.0.0.1 send unreachable 10.3.3.0/24
*Mar  1 01:04:46.891: BGP(0): 12.0.0.1 send UPDATE 10.3.3.0/24 -- unreachable
R2#show ip bgp neighbors 12.0.0.1
*Mar  1 01:05:35.503: BPG(0): Condition NON-EXIST changes to Advertise
*Mar  1 01:05:35.503: BPG(0): Condition NON-EXIST changes to Advertise
*Mar  1 01:05:35.503: BGP(0): net 10.2.2.0/24 matches ADV MAP ADVERTISE: bump
version to 12
*Mar  1 01:05:36.495: BGP(0): nettable_walker 10.2.2.0/24 route sourced locally
*Mar  1 01:05:36.495: BGP(0): 12.0.0.1 10.2.2.0/24 matches advertise map
ADVERTISE, state: Advertise
*Mar  1 01:05:36.499: BGP(0): 12.0.0.1 send UPDATE (format) 10.2.2.0/24, next
12.0.0.2, metric 0, path Local
*Mar  1 01:05:36.499: BGP(0): 23.0.0.3 skip UPDATE 10.2.2.0/24 (chgflags: 0x0),
next 0.0.0.0, path
R2#
```

**As result the prefix 10.3.3.0/24 is not learned by R2 as shown by the BGP table of R2:**

```
R2#show ip bgp
BGP table version is 8, 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
*> 10.1.1.0/24      12.0.0.1                 0             0 65100 i
*> 10.2.2.0/24      0.0.0.0                  0         32768 i
*> 192.168.2.0      0.0.0.0                  0         32768 i
R2#
```

**Let's verify the conditional advertisement state on R2 for the neighbor R1 12.0.0.1 using the show ip bgp neighbors 12.0.0.1 command:**
**the state of the conditional advertisement is "Advertise"**

```
R2#show ip bgp neighbors 12.0.0.1
BGP neighbor is 12.0.0.1,  remote AS 65100, external link
  BGP version 4, remote router ID 1.1.1.1
  BGP state = Established, up for 00:19:28
  Last read 00:00:27, last write 00:00:28, 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:                  3          3
    Notifications:          0          0
    Updates:               11          2
    Keepalives:            36         37
    Route Refresh:          0          0
    Total:                 50         42
  Default minimum time between advertisement runs is 30 seconds

 For address family: IPv4 Unicast
  BGP table version 12, neighbor version 12/0
 Output queue size : 0
  Index 2, Offset 0, Mask 0x4
  2 update-group member
  Condition-map NON-EXIST, Advertise-map ADVERTISE, status: Advertise
                                 Sent       Rcvd
  Prefix activity:               ----       ----
    Prefixes Current:               2          1 (Consumes 52 bytes)
    Prefixes Total:                 5          1
    Implicit Withdraw:              0          0
    Explicit Withdraw:              3          0
    Used as bestpath:             n/a          1
    Used as multipath:            n/a          0
```

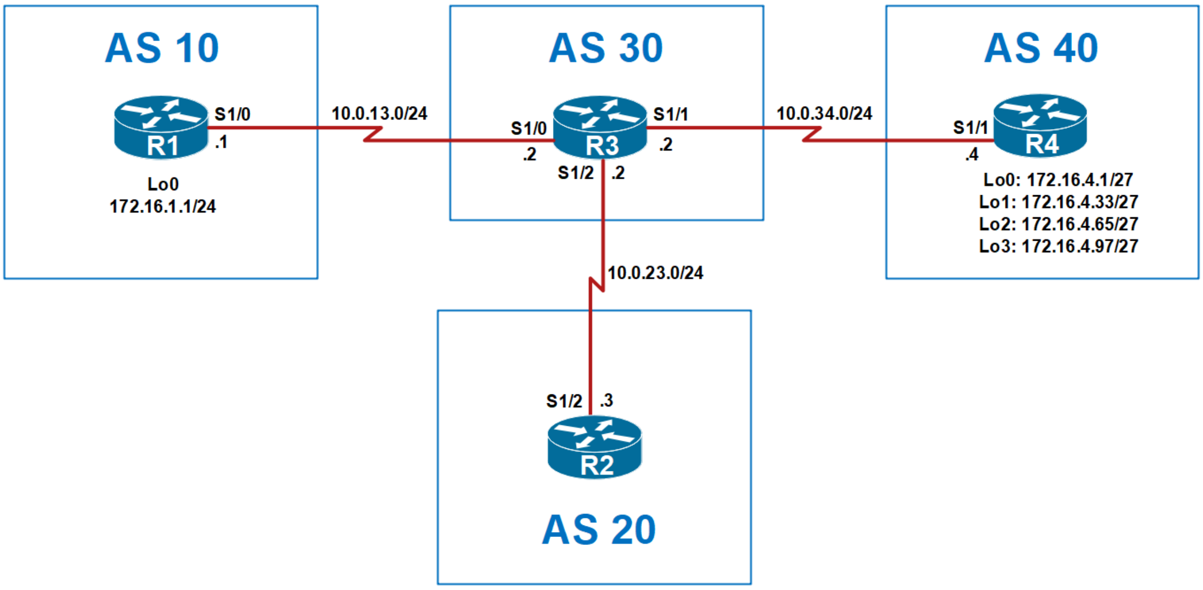
**Because R2 has no longer a BGP route toward the prefix 10.3.3.0/24 it advertises successfully the prefix 10.2.2.0/24 to R1 as shown by the following output:**

```
R2#show ip bgp neighbors 12.0.0.1 advertised-routes
BGP table version is 12, 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
*> 10.2.2.0/24      0.0.0.0                  0         32768 i
*> 192.168.2.0      0.0.0.0                  0         32768 i

Total number of prefixes 2
R2#
```

**And the BGP table of R1 below shown that the prefix 10.2.2.0/24 is installed:**

```
R1#show ip bgp
BGP table version is 16, 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
*> 10.1.1.0/24      0.0.0.0                  0         32768 i
*> 10.2.2.0/24      12.0.0.2                 0             0 65200 i
*> 192.168.2.0      12.0.0.2                 0             0 65200 i
R1#
```

## Lab 15: Route Aggregation Attribute-map and Advertise-map




**Basic Configuration**

**R1:**

```
interface Loopback0
 ip address 172.16.1.1 255.255.255.0
!
interface Serial1/0
 ip address 10.0.13.1 255.255.255.0
 no shutdown
!
router bgp 10
 network 172.16.1.0 mask 255.255.255.0
 neighbor 10.0.13.3 remote-as 30
```

**R2:**

```
interface Serial1/2
 ip address 10.0.23.2 255.255.255.0
 no shutdown
!
router bgp 20
 neighbor 10.0.23.3 remote-as 30
```

**R3:**

```
interface Serial1/0
 ip address 10.0.13.3 255.255.255.0
 no shutdown
!
interface Serial1/1
 ip address 10.0.34.3 255.255.255.0
 no shutdown
!
interface Serial1/2
```

```
 ip address 10.0.23.3 255.255.255.0
 no shutdown
!
router bgp 30
 neighbor 10.0.13.1 remote-as 10
 neighbor 10.0.23.2 remote-as 20
 neighbor 10.0.34.4 remote-as 40
```

**R4:**

```
interface Loopback0
 ip address 172.16.4.1 255.255.255.224
!
interface Loopback1
 ip address 172.16.4.33 255.255.255.224
!
interface Loopback2
 ip address 172.16.4.65 255.255.255.224
!
interface Loopback3
 ip address 172.16.4.97 255.255.255.224
!
interface Serial1/1
 ip address 10.0.34.4 255.255.255.0
 no shutdown
!
router bgp 40
 bgp log-neighbor-changes
 network 172.16.4.0 mask 255.255.255.224
 network 172.16.4.32 mask 255.255.255.224
 network 172.16.4.64 mask 255.255.255.224
 network 172.16.4.96 mask 255.255.255.224
 neighbor 10.0.34.3 remote-as 30
```

**First we should verify that all routers are peering:**

```
R3#show ip bgp summary
BGP router identifier 10.0.34.3, local AS number 30
BGP table version is 2, main routing table version 2
1 network entries using 144 bytes of memory
1 path entries using 80 bytes of memory
1/1 BGP path/bestpath attribute entries using 136 bytes of memory
1 BGP AS-PATH entries using 24 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 384 total bytes of memory
BGP activity 1/0 prefixes, 1/0 paths, scan interval 60 secs

Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down
State/PfxRcd
10.0.13.1       4           10      14      13        2    0    0 00:08:41
1
10.0.23.2       4           20       9      11        2    0    0 00:05:13
0
10.0.34.4       4           40      10      14        2    0    0 00:07:12
0
R3#
```

**Now let's look the BGP table of the routers R1, R2 and R3:**
**We can see that these routers receives the four loopback networks of R4.**

```
R1#show ip bgp
BGP table version is 6, 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, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>  172.16.1.0/24    0.0.0.0                  0         32768 i
 *>  172.16.4.0/27    10.0.13.3                              0 30 40 i
 *>  172.16.4.32/27   10.0.13.3                              0 30 40 i
 *>  172.16.4.64/27   10.0.13.3                              0 30 40 i
 *>  172.16.4.96/27   10.0.13.3                              0 30 40 i
R1#
```

```
R2#show ip bgp
BGP table version is 6, local router ID is 10.0.23.2
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>  172.16.1.0/24    10.0.23.3                              0 30 10 i
 *>  172.16.4.0/27    10.0.23.3                              0 30 40 i
 *>  172.16.4.32/27   10.0.23.3                              0 30 40 i
 *>  172.16.4.64/27   10.0.23.3                              0 30 40 i
 *>  172.16.4.96/27   10.0.23.3                              0 30 40 i
R2#
```

```
R3#show ip bgp
BGP table version is 6, local router ID is 10.0.34.3
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>  172.16.1.0/24    10.0.13.1                0             0 10 i
 *>  172.16.4.0/27    10.0.34.4                0             0 40 i
 *>  172.16.4.32/27   10.0.34.4                0             0 40 i
 *>  172.16.4.64/27   10.0.34.4                0             0 40 i
 *>  172.16.4.96/27   10.0.34.4                0             0 40 i
R3(config-router)#
```

**R3 should summarize the four loopback networks's R4 using the aggregate-address command:**

```
R3(config)#router bgp 30
R3(config-router)#aggregate-address 172.16.4.0 255.255.255.128 summary-only
```

**R3 (AS 30) aggregates the routes 172.16.4.0/27, 172.16.4.32/27, 172.16.4.64/27 and 172.16.4.96/27 that come from and AS 20. This action occurs because we have configured the summary-only argument on R3. R3 only announces the aggregate 172.16.4.0/25 to R1 and R2. The more specific 172.16.4.0/27, 172.16.4.32/27, 172.16.4.64/27 and 172.16.4.96/27 routes are suppressed as shown by the BGP table of R3:**

```
R3#show ip bgp
BGP table version is 11, local router ID is 10.0.34.3
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>  172.16.1.0/24    10.0.13.1                0             0 10 i
 s>  172.16.4.0/27    10.0.34.4                0             0 40 i
 *>  172.16.4.0/25    0.0.0.0                            32768 i
 s>  172.16.4.32/27   10.0.34.4                0             0 40 i
 s>  172.16.4.64/27   10.0.34.4                0             0 40 i
 s>  172.16.4.96/27   10.0.34.4                0             0 40 i
R3#
```

**The aggregate route 172.16.4.0/25 is considered to have originated from AS 30 with origin code IGP.**
**The route has lost all the specific AS_PATH information of the individual prefixes 172.16.4.0/27, 172.16.4.32/27, 172.16.4.64/27 and 172.16.4.96/27 of AS 40.**

```
R1#show ip bgp
BGP table version is 11, 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, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>  172.16.1.0/24    0.0.0.0                  0         32768 i
 *>  172.16.4.0/25    10.0.13.3                0             0 30 i
R1#
```

```
R2#show ip bgp
BGP table version is 11, local router ID is 10.0.23.2
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>  172.16.1.0/24    10.0.23.3                              0 30 10 i
 *>  172.16.4.0/25    10.0.23.3                0             0 30 i
R2#
```

**Let's aggregate these routes with the as-set Argument**

**With the as-set argument, the path information in the BGP table for the aggregate route changes to include a set from 30 {40}. This set indicates that the aggregate actually summarizes routes that have passed through AS 40. The as-set information becomes important in the avoidance of routing loops because the information records where the route has been.**

```
R3(config)#router bgp 30
R3(config-router)#aggregate-address 172.16.4.0 255.255.255.128 summary-only as-set
```

```
R1#show ip bgp
BGP table version is 12, 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, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>  172.16.1.0/24    0.0.0.0                  0         32768 i
 *>  172.16.4.0/25    10.0.13.3                0             0 30 40 i
R1#
```

```
R2#show ip bgp
BGP table version is 12, local router ID is 10.0.23.2
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>  172.16.1.0/24    10.0.23.3                              0 30 10 i
 *>  172.16.4.0/25    10.0.23.3                0             0 30 40 i
R2#
```

**Now let's summarize the Loopback networks's R4 using the summary address 172.16.0.0/16:**

```
R3(config)#router bgp 30
R3(config-router)#aggregate-address 172.16.0.0 255.255.0.0 summary-only as-set
```

**R3 only announces the aggregate 172.16.0.0/16 to R2 as shown by the BGP and routing tables of R2:**

```
R2#show ip bgp
BGP table version is 17, local router ID is 10.0.23.2
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>  172.16.0.0       10.0.23.3                0             0 30 40 i
R2#
```

```
R2#show ip route
```

```
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP
       + - replicated route, % - next hop override

Gateway of last resort is not set

      10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C        10.0.23.0/24 is directly connected, Serial1/2
L        10.0.23.2/32 is directly connected, Serial1/2
B     172.16.0.0/16 [20/0] via 10.0.23.3, 00:00:26
R2#
```

**Now we should configure so that R1 sets the community attribute no-export to network 172.16.0.0/16 and advertises this prefix to R3.**
**R3 inherits the community attribute no-export while the router aggregates 172.6.0.0/16. Therefore, there is no advertisement of 172.16.1.0.0/16 to R2:**

**R2:**

```
router bgp 10
 neighbor 10.0.13.3 send-community
 neighbor 10.0.13.3 route-map NO_EXPORT out
!
access-list 1 permit 172.16.0.0 0.0.255.255
!
route-map NO_EXPORT permit 10
 match ip address 1
 set community no-export
```

```
R3#show ip bgp 172.16.0.0
BGP routing table entry for 172.16.0.0/16, version 41
Paths: (1 available, best #1, table default, not advertised to EBGP peer)
  Not advertised to any peer
  Refresh Epoch 1
  {10,40}, (aggregated by 30 10.0.34.3)
    0.0.0.0 from 0.0.0.0 (10.0.34.3)
      Origin IGP, localpref 100, weight 32768, valid, aggregated, local, best
      Community: no-export
      rx pathid: 0, tx pathid: 0x0
R3#
```

**The community no-export stops R3 announcement of the aggregate route to eBGP peer R2. The routing table of R2 shows that it has not learned the prefix 172.16.0.0/16 from R3:**

```
R2#show ip bgp 172.16.0.0
% Network not in table
R2#
```

**We can configure the attribute-map argument at R3 in order to manipulate the community attribute of the aggregate route from no-export to none.**
**This solution allows the advertisement of the aggregate to R2.**

**R3:**

```
router bgp 30
  aggregate-address 172.16.0.0 255.255.0.0 as-set summary-only attribute-map MAP
 !
 route-map MAP permit 10
  set community none
```

**Now, look at the BGP table of R3 for 172.16.0.0/19.**
**Because there is no community set for the aggregate route, R3 advertises the prefix 172.16.0.0/16 to R2.**

```
R3(config-router)#do show ip bgp 172.16.0.0
BGP routing table entry for 172.16.0.0/16, version 7
Paths: (1 available, best #1, table default)
  Advertised to update-groups:
     8
  Refresh Epoch 1
  {10,40}, (aggregated by 30 10.0.34.3)
    0.0.0.0 from 0.0.0.0 (10.0.34.3)
      Origin IGP, localpref 100, weight 32768, valid, aggregated, local, best
      rx pathid: 0, tx pathid: 0x0
R3(config-router)#
```

**The BGP table of R2 shows that it has learned the aggregate route 172.16.0.0/16 from R3.**

```
R2#show ip bgp
BGP table version is 28, local router ID is 10.0.23.2
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>  172.16.0.0       10.0.23.3                0             0 30 {10,40} i
R2#
```

```
R2#show ip bgp 172.16.0.0/16
BGP routing table entry for 172.16.0.0/16, version 24
Paths: (1 available, best #1, table default)
  Not advertised to any peer
  Refresh Epoch 1
  30 {10,40}, (aggregated by 30 10.0.34.3)
    10.0.23.3 from 10.0.23.3 (10.0.34.3)
      Origin IGP, metric 0, localpref 100, valid, external, best
      rx pathid: 0, tx pathid: 0x0
R2#
```

**Now let's aggregate a Subset of Specific Routes**
**We want to exclude a particular prefix for example 172.16.4.32/27 prefix using the advertise-map.**

**R3:**

```
router bgp 30
  aggregate-address 172.16.0.0 255.255.0.0 as-set summary-only advertise-map
SPECIFIC-ROUTE
 !
 access-list 1 permit 172.16.4.32 0.0.0.31
```

```
!
route-map SPECIFIC-ROUTE permit 10
 match ip address 1
```

**Only AS 40 is part of the AS_PATH information of the aggregate; AS 10 is not part of the information. Also, there is no inheritance of the community no-export from 172.16.0.0/16. Therefore, the aggregate route is announced to R2:**

```
R3#show ip bgp 172.16.0.0
BGP routing table entry for 172.16.0.0/16, version 7
Paths: (1 available, best #1, table default)
  Advertised to update-groups:
     7
  Refresh Epoch 1
  40, (aggregated by 30 10.0.34.3)
    0.0.0.0 from 0.0.0.0 (10.0.34.3)
      Origin IGP, localpref 100, weight 32768, valid, aggregated, local, atomic-
aggregate, best
      rx pathid: 0, tx pathid: 0x0
R3#
```

```
R2#show ip bgp
BGP table version is 38, local router ID is 10.0.23.2
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>  172.16.0.0       10.0.23.3                0             0 30 40 i
```

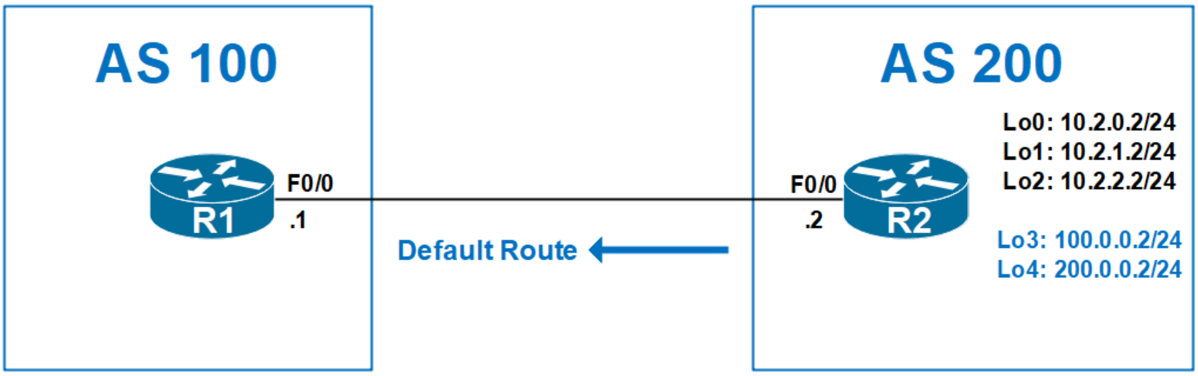
```
R2#show ip bgp 172.16.0.0
BGP routing table entry for 172.16.0.0/16, version 34
Paths: (1 available, best #1, table default)
  Not advertised to any peer
  Refresh Epoch 1
  30 40, (aggregated by 30 10.0.34.3)
    10.0.23.3 from 10.0.23.3 (10.0.34.3)
      Origin IGP, metric 0, localpref 100, valid, external, atomic-aggregate, best
      rx pathid: 0, tx pathid: 0x0
R2#
```

**Because the aggregate as-set has AS 40 only, R1 in AS 10 accepts the aggregate route and installs the route in the routing table. The BGP loop detection mechanism causes this route acceptance.**
**The BGP loop detection mechanism does not detect its own AS in as-set.**

```
R1#show ip bgp
BGP table version is 57, local router ID is 172.16.1.1
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
```

```
 *>  172.16.0.0       10.0.13.3                0             0 30 40 i
 *>  172.16.1.0/24    0.0.0.0                  0         32768 i
R1#
```

## Lab 16: BGP ORF (Outbound Route Filtering) capability




**Basic Configuration**

**R1:**

```
interface Fa0/0
 ip address 12.0.0.1 255.255.255.0
 no shutdown
!
router bgp 100
 neighbor 12.0.0.2 remote-as 200
```

**R2:**

```
interface lo0
 ip address 10.2.0.2 255.255.255.0
!
interface lo1
 ip address 10.2.1.2 255.255.255.0
!
interface lo2
 ip address 10.2.2.2 255.255.255.0
!
interface lo3
 ip address 100.0.0.2 255.255.255.0
!
interface lo4
 ip address 200.0.0.2 255.255.255.0
!
interface Fa0/0
 ip address 12.0.0.2 255.255.255.0
 no shutdown
!
router bgp 200
 neighbor 12.0.0.1 remote-as 100
 network 10.2.0.0 mask 255.255.255.0
 network 10.2.1.0 mask 255.255.255.0
 network 10.2.2.0 mask 255.255.255.0
 network 100.0.0.0 mask 255.255.255.0
 network 200.0.0.0 mask 255.255.255.0
```

**What is BGP ORF (Outbound Route Filtering) capability? It's a feature uses BGP outbound route filter (ORF) send and receive capabilities to minimize the number of BGP updates that**

**are sent between BGP peers. Configuring this feature can help reduce the amount of system resources required for generating and processing routing updates by filtering out unwanted routing updates at the source.**

**We can see that R1 have learned 6 routes from R2:**

```
R1#show ip bgp
BGP table version is 7, local router ID is 12.0.0.1
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>  0.0.0.0          12.0.0.2                               0 200 i
 *>  10.2.0.0/24      12.0.0.2                 0             0 200 i
 *>  10.2.1.0/24      12.0.0.2                 0             0 200 i
 *>  10.2.2.0/24      12.0.0.2                 0             0 200 i
 *>  100.0.0.0/24     12.0.0.2                 0             0 200 i
 *>  200.0.0.0        12.0.0.2                 0             0 200 i
R1#
```

**Now R1 wants only default route and 10.2.0.0/24, 10.2.1.0/24 and 10.2.2.0/24 subnets no other subnet (100.0.0.0/24 and 200.0.0.0/24).**
**Let's configure prefix-list and route-map, and then apply to BGP neighbor.**

```
R1(config)#ip prefix-list FILTER-LO3-LO4 seq 5 permit 10.0.0.0/8 le 24
R1(config)#ip prefix-list FILTER-LO3-LO4 seq 5 permit 0.0.0.0/0
R1(config)#ip prefix-list FILTER-LO3-LO4 seq 15 deny 0.0.0.0/0 le 32
```

```
R1(config)#route-map FILTER_LO3_LO4 permit
R1(config-route-map)#match ip address prefix-list FILTER-LO3-LO4
```

```
R1(config)#router bgp 100
R1(config-router)#neighbor 12.0.0.2 route-map FILTER_LO3_LO4 in
```

**Now verify BGP table after applying route-map, there are no routes to 100.0.0.0/24 and 200.0.0.0/24:**

```
R1#show ip bgp
BGP table version is 5, local router ID is 12.0.0.1
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>  0.0.0.0          12.0.0.2                               0 200 i
 *>  10.2.0.0/24      12.0.0.2                 0             0 200 i
 *>  10.2.1.0/24      12.0.0.2                 0             0 200 i
 *>  10.2.2.0/24      12.0.0.2                 0             0 200 i
R1#
```

```
R1#show ip bgp neighbors 12.0.0.2 received-routes
```

```
% Inbound soft reconfiguration not enabled on 12.0.0.2
R1#

R1(config)#router bgp 100
R1(config-router)#neighbor 12.0.0.2 soft-reconfiguration inbound
```

**Let's execute the debug ip  bgp updates command and clear BGP updates.**
**We can see after applying route-map only 4 prefixes we needed in BGP table but R2 is sending entire BGP table to R1, R1 has to process all BGP updates coming from R2 and then filters as per configured list which is potentially wasting CE CPU.**

```
R1#debug ip bgp updates 12.0.0.2 in
BGP updates debugging is on for neighbor 12.0.0.2 (inbound) for address family:
IPv4 Unicast
R1#clear ip bgp *
R1#
*Oct 11 15:00:46.923: %BGP-5-ADJCHANGE: neighbor 12.0.0.2 Down User reset
*Oct 11 15:00:46.923: %BGP_SESSION-5-ADJCHANGE: neighbor 12.0.0.2 IPv4 Unicast
topology base removed from session  User reset
*Oct 11 15:00:47.539: %BGP-5-ADJCHANGE: neighbor 12.0.0.2 Up
R1#
*Oct 11 15:00:47.707: BGP(0): 12.0.0.2 rcvd UPDATE w/ attr: nexthop 12.0.0.2,
origin i, metric 0, merged path 200, AS_PATH
*Oct 11 15:00:47.715: BGP(0): 12.0.0.2 rcvd 10.2.0.0/24
*Oct 11 15:00:47.715: BGP(0): 12.0.0.2 rcvd 10.2.1.0/24
*Oct 11 15:00:47.719: BGP(0): 12.0.0.2 rcvd 10.2.2.0/24
*Oct 11 15:00:47.719: BGP(0): 12.0.0.2 rcvd 100.0.0.0/24 -- DENIED due to: route-
map;
*Oct 11 15:00:47.723: BGP(0): 12.0.0.2 rcvd 200.0.0.0/24 -- DENIED due to: route-
map;
*Oct 11 15:00:47.727: BGP(0): 12.0.0.2 rcvd UPDATE w/ attr: nexthop 12.0.0.2,
origin i, merged path 200, AS_PATH
*Oct 11 15:00:47.735: BGP(0): 12.0.0.2 rcvd 0.0.0.0/0
R1#
*Oct 11 15:00:48.307: BGP(0): no valid path for 100.0.0.0/24
*Oct 11 15:00:48.307: BGP(0): no valid path for 200.0.0.0/24
*Oct 11 15:00:48.311: BGP(0): Revise route installing 1 of 1 routes for 0.0.0.0/0
-> 12.0.0.2(global) to main IP table
*Oct 11 15:00:48.315: BGP(0): Revise route installing 1 of 1 routes for
10.2.0.0/24 -> 12.0.0.2(global) to main IP table
*Oct 11 15:00:48.319: BGP(0): Revise route installing 1 of 1 routes for
10.2.1.0/24 -> 12.0.0.2(global) to main IP table
*Oct 11 15:00:48.319: BGP(0): Revise route installing 1 of 1 routes for
10.2.2.0/24 -> 12.0.0.2(global) to main IP table
R1#
R1#undebug all
All possible debugging has been turned off
R1#
```

**We can also verify this using the show ip bgp neighbors 12.0.0.2 received-routes command on R1 or the show ip bgp neighbors 12.0.0.1 advertised-routes command on R2:**

```
R1#show ip bgp neighbors 12.0.0.2 received-routes
BGP table version is 5, local router ID is 12.0.0.1
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
```

```
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>  0.0.0.0          12.0.0.2                               0 200 i
 *>  10.2.0.0/24      12.0.0.2                 0             0 200 i
 *>  10.2.1.0/24      12.0.0.2                 0             0 200 i
 *>  10.2.2.0/24      12.0.0.2                 0             0 200 i
 *   100.0.0.0/24     12.0.0.2                 0             0 200 i
 *   200.0.0.0        12.0.0.2                 0             0 200 i

Total number of prefixes 6
R1#
```

```
R2#show ip bgp neighbors 12.0.0.1 advertised-routes
BGP table version is 7, local router ID is 12.0.0.2
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

Originating default network 0.0.0.0

     Network          Next Hop            Metric LocPrf Weight Path
 *>  10.2.0.0/24      0.0.0.0                  0         32768 i
 *>  10.2.1.0/24      0.0.0.0                  0         32768 i
 *>  10.2.2.0/24      0.0.0.0                  0         32768 i
 *>  100.0.0.0/24     0.0.0.0                  0         32768 i
 *>  200.0.0.0        0.0.0.0                  0         32768 i

Total number of prefixes 5
R2#
```

**So R1 is receiving 100.0.0.0/24 and 200.0.0.0/24 prefixes, process them and then filtered it.**

**Let’s now apply BGP ORF and See what’s happened. This can be configured on a router to send or receive ORF capabilities with either the send or receive keywords. This feature can also be configured on a router to both "send and receive" ORF capabilities with the both keyword.**
**The BGP ORF only supports prefix-list not route-map or any other filtering mechanism therefore we need to remove the route-map and apply the prefix-list instead.**

```
R1(config)#router bgp 100
R1(config-router)#neighbor 12.0.0.2 prefix-list FILTER-LO3-LO4 in
R1(config-router)#no neighbor 12.0.0.2 route-map FILTER_LO3_LO4 in
R1(config-router)#neighbor 12.0.0.2 capability orf prefix-list send
```

```
R2(config)#router bgp 200
R2(config-router)#neighbor 12.0.0.1 capability orf prefix-list receive
```

**Verification after Applying ORF capability on R1 et R2:**

```
R1#show ip bgp neighbors 12.0.0.2 received-routes
BGP table version is 13, local router ID is 12.0.0.1
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
```

```
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>  0.0.0.0          12.0.0.2                               0 200 i
 *>  10.2.0.0/24      12.0.0.2                 0             0 200 i
 *>  10.2.1.0/24      12.0.0.2                 0             0 200 i
 *>  10.2.2.0/24      12.0.0.2                 0             0 200 i

Total number of prefixes 4
R1#
```

```
R2#show ip bgp neighbors 12.0.0.1 advertised-routes
BGP table version is 7, local router ID is 12.0.0.2
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

Originating default network 0.0.0.0

     Network          Next Hop            Metric LocPrf Weight Path
 *>  10.2.0.0/24      0.0.0.0                  0         32768 i
 *>  10.2.1.0/24      0.0.0.0                  0         32768 i
 *>  10.2.2.0/24      0.0.0.0                  0         32768 i

Total number of prefixes 3
R2#
```

**From the debug output, we can see that with BGP ORF R1 dynamically tells the R2 what routes to filter “outbound”. This means that the R1 will only receive update messages about the prefixes that it wants.**

```
R1#debug ip bgp updates 12.0.0.2 in
BGP updates debugging is on for neighbor 12.0.0.2 (inbound) for address family:
IPv4 Unicast
R1#
R1#clear ip bgp *
R1#
*Oct 11 15:44:10.267: %BGP-5-ADJCHANGE: neighbor 12.0.0.2 Down User reset
*Oct 11 15:44:10.271: %BGP_SESSION-5-ADJCHANGE: neighbor 12.0.0.2 IPv4 Unicast
topology base removed from session  User reset
*Oct 11 15:44:11.179: %BGP-5-ADJCHANGE: neighbor 12.0.0.2 Up
R1#
*Oct 11 15:44:12.003: BGP(0): 12.0.0.2 rcvd UPDATE w/ attr: nexthop 12.0.0.2,
origin i, metric 0, merged path 200, AS_PATH
*Oct 11 15:44:12.007: BGP(0): 12.0.0.2 rcvd 10.2.0.0/24
*Oct 11 15:44:12.011: BGP(0): 12.0.0.2 rcvd 10.2.1.0/24
*Oct 11 15:44:12.011: BGP(0): 12.0.0.2 rcvd 10.2.2.0/24
*Oct 11 15:44:12.015: BGP(0): 12.0.0.2 rcvd UPDATE w/ attr: nexthop 12.0.0.2,
origin i, merged path 200, AS_PATH
*Oct 11 15:44:12.019: BGP(0): 12.0.0.2 rcvd 0.0.0.0/0
*Oct 11 15:44:12.871: BGP(0): Revise route installing 1 of 1 routes for 0.0.0.0/0
-> 12.0.0.2(global) to main IP table
R1#
```

```
*Oct 11 15:44:12.875: BGP(0): Revise route installing 1 of 1 routes for
10.2.0.0/24 -> 12.0.0.2(global) to main IP table
*Oct 11 15:44:12.879: BGP(0): Revise route installing 1 of 1 routes for
10.2.1.0/24 -> 12.0.0.2(global) to main IP table
*Oct 11 15:44:12.883: BGP(0): Revise route installing 1 of 1 routes for
10.2.2.0/24 -> 12.0.0.2(global) to main IP table
R1#
R1#undebug all
All possible debugging has been turned off
R1#
```

**Verify the reachability:**

```
R1#ping 100.0.0.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 100.0.0.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 72/127/308 ms
R1#
R1#ping 200.0.0.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 200.0.0.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 72/82/88 ms
R1#
```