



# Advanced Cisco Networking Academy: Designing a Multiprotocol Network with Internal/External BGP

Colin J. Faletto, CCNA

## Purpose

This lab is intended to expand upon our knowledge of the BGP routing protocol by teaching the internal variation of the protocol. It adds an extra layer of difficulty by peering two iBGP-enabled routers that aren't directly connected. The lab also tests previously taught skills such as how to implement eBGP and how to connect BGP to other routing protocols such as OSPF, IS-IS, and EIGRP.

## Background

Border Gateway Protocol, or BGP, is a routing protocol used to exchange routers in between routers on internal networks and on the internet. It was developed in 1989 by the Internet Engineering Task Force, or IETF, a group that develops standards and operates under the Internet Society non-profit organization. BGP for IPv4 was originally specified in RFC 1105, and BGP for IPv6 was originally specified in RFC 1654. The most recent version of the protocol, BGP-4, is specified in RFC 4271.

BGP uses TCP connections between routers on port 179 and sends hello messages every 30 seconds by default. Internal BGP, or iBGP, sends routing information between routers in the same autonomous system, while external BGP, or eBGP, sends information between autonomous systems. Confusingly, eBGP sounds very similar to EGP, or Exterior Gateway Protocol, which is the predecessor to BGP. BGP is mainly designed to allow routers managed by different companies to exchange routes with each other, which is why eBGP is much more commonly used than iBGP.

A helpful characteristic of BGP is that BGP-enabled routers can peer with each other even if they aren't directly connected. As long as the routers have a route to each other, they can become BGP neighbors irrelevant of the number of hops between them.

BGP routers go through 6 exchange states: Idle, Connect, Active, OpenSent, OpenConfirm, and Established. By default, if the protocol is given multiple routes to a destination, it will count the number of AS jumps to the destination between each route and use the route with the lowest number.

One of BGP's major vulnerabilities is that routers, by default, BGP-enabled routers will put any advertised routes into the routing table. While this is normally useful, it also leaves routers vulnerable to hijacking, and makes it somewhat trivial for a malicious actor to redirect traffic to their own servers by introducing a lower-metric route

Open Shortest Path First is a routing protocol that uses link state advertisements to automatically build a network topology and provide end-to-end connectivity across networks. It was developed by the IETF. This lab uses both OSPFv2 and OSPFv3, which operate similarly but use IPv4 and IPv6 addresses respectively. OSPFv2 is specified in RFC 2328 and OSPFv3 is specified in RFC 5320.

OSPF-enabled routers can have two different types of relationships with each other: neighbor relationships and adjacencies. Neighbor relationships, which are automatically formed in P2P, broadcast, and point-to-multipoint networks, are formed using hello messages and simply inform routers of each other's existence on the

network. Adjacencies are a more complex type of relationship that allows routers to exchange routing information with each other.

Intermediate System to Intermediate System, or IS-IS, is an interior gateway link-state routing protocol. Unlike most routing protocols, it was standardized by the International Standards Organization instead of the IETF. More specifically, it was defined in ISO/IEC 10589:2002. IS-IS can send 4 types of packets: Hello PDUs, Link State PDUs, Complete Sequence Number PDUs, and Partial Sequence Number PDUs. IS-IS uses Dijkstra's algorithm, like OSPF, to find the optimal routes through a network.

Enhanced Interior Gateway Routing Protocol, or EIGRP, is a proprietary routing protocol developed by Cisco. In 2013, the EIGRP protocol was made partially open, as Cisco released documentation for a stripped-down version of the protocol for use with other vendors' routers. Unlike OSPF and IS-IS, EIGRP uses the diffusing update algorithm, or DUAL, to determine the best path between routers. EIGRP uses the term "successor" to describe the best next-hop route to a destination and keeps a log of feasible successors to use in the case that a successor goes down.

## Lab Summary

In this lab, we configured two remote autonomous systems (one running OSPF codenamed "Optimus", one running EIGRP codenamed "Prime") to be connected via BGP. This BGP network, codenamed "Bumble", was unique as it contained two BGP peers that were connected via iBGP through a non-BGP enabled router. This middle router, named "Bumble-2", instead used IS-IS to route traffic between the BGP peers. The Optimus and Prime networks had two routers each, and each endpoint router ran a DHCP server that connected to a single host. The network had full mesh connectivity, and we tested it by running the `tracert` command between the two hosts on opposite ends of the network.

## Lab Commands

### Configuring BGP (Basic)

`Router(config)#router bgp <as>`

Enters BGP configuration mode. `<as>` represents the router's BGP autonomous system number.

`Router(config-router)#bgp router-id <id>`

Configures the router's BGP router ID.

`Router(config-router)#neighbor <ip> remote-as <remote-as>`

Configures a BGP neighbor. IP can be IPv4 or IPv6. `<remote-as>` is the autonomous system number of the neighbor. If the `<remote-as>` number matches the local AS number, iBGP is being configured. Otherwise, eBGP is being configured.

`Router(config-router)#neighbor <ip> description <desc>`

Configures a description for a neighbor.

`Router(config-router)#address-family [ipv4|ipv6]`

Enters address family configuration mode for the specified IP version.

`Router(config-router-af)#network <network> mask <subnet-mask>`

Configures the network where a neighbor can be found.

`Router(config-router-af)#redistribute connected subnets`

Redistributes networks from directly connected interfaces into BGP.

```
Router(config-router-af) #redistribute ospf <pid> metric <metric>
```

Redistributes information into BGP from OSPF using the given process ID.

Redistributed routes will be given the specified metric.

```
Router(config-router-af) #redistribute isis <tag> [level-1|level-2|level-1-2] metric <metric>
```

Redistributes information into BGP from IS-IS using the given area tag. Routes from level 1 (intra-area), level 2 (inter-area), or both levels can be redistributed. Redistributed routes will be given the specified metric.

```
Router(config-router-af) #neighbor <ip> activate
```

Activates a neighbor in address family configuration mode.

```
Router(config-router-af) #distance bgp <ead> <iad> <lad>
```

Changes the administrative distance for routes learned via BGP. <ead>, <iad>, and <lad> correspond to the distance for external, internal, and local BGP routes respectively.

### **Configuring EIGRP**

```
Router(config) #[ipv6] router eigrp <as>
```

Enters EIGRP router configuration mode using the specified autonomous system number. IPv4 and IPv6 have separate router configuration modes.

```
Router(config-router) #eigrp router-id <x.x.x.x>
```

Sets an EIGRP router ID.

```
Router(config-router) #network <x.x.x.x>
```

Specifies a network to be advertised into EIGRP. This command only works for IPv4 addresses.

```
Router(config-if) #ipv6 eigrp <as>
```

Specifies an interface's network to be advertised into EIGRP. This command only works for IPv6 addresses.

### **Configuring OSPF**

```
Router(config) #[ipv6] router ospf <pid>
```

Enters OSPF router configuration mode using the specified process ID. IPv4 and IPv6 have separate router configuration modes.

```
Router(config-router) #router-id <id>
```

Configures an OSPF router ID.

```
Router(config-router) #redistribute bgp <as> subnets
```

Redistributes routes into OSPF from BGP using the specified autonomous system number.

```
Router(config-if) #[ip|ipv6] ospf <pid> area <area>
```

Configures OSPF on an interface using the specified process ID and area.

### **Configuring IS-IS**

```
Router(config) #router isis <tag>
```

Enters IS-IS configuration mode with the specified area tag.

```
Router(config-router) #net <net>
```

Configures an IS-IS Network Entity Title. This parameter works similarly to a router ID in other routing protocols.

```

Router(config-router) #metric-style wide
Configures IS-IS to use larger metrics in best-path calculations.
Router(config-router) #redistribute bgp <as>
Redistributes into IS-IS from the given BGP autonomous system number.

```

### Configuring BGP (Route Map)

```

Router(config) #ip prefix-list <list> seq <number> [permit|deny]
<ip>/<mask>

```

Configures a prefix list with the name <list> to permit or deny a certain range of IP addresses. Since a prefix list can consist of multiple lines, the sequence number determines the order in which the lines are read.

```

Router(config) #route-map <map-name> [permit|deny] <seq-number>

```

Configures a route map with the name <map-name> to permit or deny addresses. The sequence number determines the order in which the route map instructions are read.

```

Router(config-route-map) #match ip address prefix-list <prefix-
list>

```

Sets a route map to permit/deny addresses specified in a prefix list.

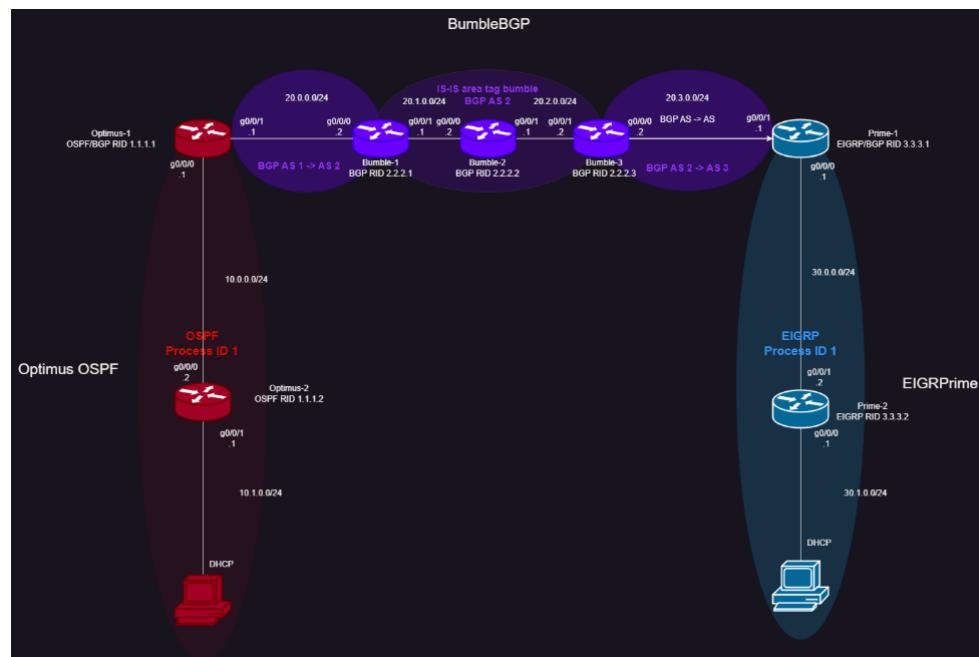
```

Router(config-router-af) #neighbor <ip> route-map <route-map>
[in|out]

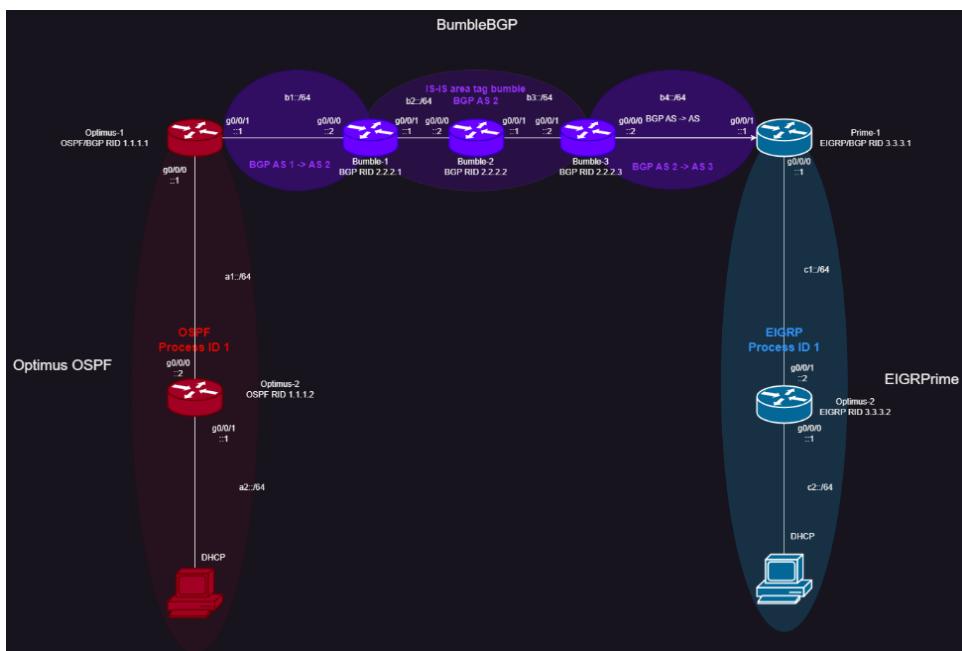
```

Sets the routes given to/from a BGP neighbor to be passed through a specific route map for filtering/manipulation.

### Network Diagram (IPv4)



## Network Diagram (IPv6)



## Configurations

### Optimus-1:

```

version 16.9
service timestamps debug datetime msec
service timestamps log datetime msec
platform qfp utilization monitor load 80
platform punt-keepalive disable-kernel-core
hostname Optimus-1
boot-start-marker
boot-end-marker
vrf definition Mgmt-intf
  address-family ipv4
  exit-address-family
  address-family ipv6
  exit-address-family
no aaa new-model
no ip domain lookup
login on-success log
subscriber templating
vtp domain cisco
vtp mode transparent
ipv6 unicast-routing
multilink bundle-name authenticated
crypto pki trustpoint TP-self-signed-859896477
  enrollment selfsigned
  subject-name cn=IOS-Self-Signed-Certificate-859896477
  revocation-check none

```

```
rsakeypair TP-self-signed-859896477
license udi pid ISR4321/K9 sn FLM240608PJ
no license smart enable
diagnostic bootup level minimal
spanning-tree extend system-id
redundancy
  mode none
interface GigabitEthernet0/0/0
  ip address 10.0.0.1 255.255.255.0
  ip ospf 1 area 0
  negotiation auto
  ipv6 address A1::1/64
  ipv6 ospf 1 area 0
interface GigabitEthernet0/0/1
  ip address 20.0.0.1 255.255.255.0
  negotiation auto
  ipv6 address B1::1/64
interface GigabitEthernet0/1/0
  no ip address
  shutdown
  negotiation auto
interface GigabitEthernet0/1/1
  no ip address
  shutdown
  negotiation auto
interface GigabitEthernet0
  vrf forwarding Mgmt-intf
  no ip address
  shutdown
  negotiation auto
router ospf 1
  router-id 1.1.1.1
  redistribute connected subnets
  redistribute bgp 1 metric 10 subnets
router bgp 1
  bgp router-id 1.1.1.1
  bgp log-neighbor-changes
  neighbor B1::2 remote-as 2
  neighbor 20.0.0.2 remote-as 2
  address-family ipv4
    redistribute connected metric 10
    redistribute ospf 1 metric 10
    no neighbor B1::2 activate
    neighbor 20.0.0.2 activate
  exit-address-family
  address-family ipv6
    redistribute connected metric 10
```

```

    redistribute ospf 1 metric 10
    neighbor B1::2 activate
    exit-address-family
    ip forward-protocol nd
    ip http server
    ip http authentication local
    ip http secure-server
    ip tftp source-interface GigabitEthernet0
    ipv6 router ospf 1
    router-id 1.1.1.1
    redistribute connected
    redistribute bgp 1 metric 10
control-plane
banner motd ^CUnauthorized access is lowk illegal^C
line con 0
    transport input none
    stopbits 1
line aux 0
    stopbits 1
line vty 0 4
    login
end
Optimus-2:
version 16.9
service timestamps debug datetime msec
service timestamps log datetime msec
platform qfp utilization monitor load 80
platform punt-keepalive disable-kernel-core
hostname Optimus-2
boot-start-marker
boot-end-marker
vrf definition Mgmt-intf
    address-family ipv4
    exit-address-family
    address-family ipv6
    exit-address-family
no aaa new-model
no ip domain lookup
ip dhcp excluded-address 10.1.0.1
ip dhcp pool OPTIMUS
    network 10.1.0.0 255.255.255.0
    default-router 10.1.0.1
login on-success log
subscriber templating
ipv6 unicast-routing
ipv6 dhcp pool OPTIMUS6
    address prefix A2::/64 lifetime infinite infinite

```

```
multilink bundle-name authenticated
license udi pid ISR4321/K9 sn FDO214414VU
no license smart enable
diagnostic bootup level minimal
spanning-tree extend system-id
redundancy
  mode none
interface GigabitEthernet0/0/0
  ip address 10.0.0.2 255.255.255.0
  ip ospf 1 area 0
  negotiation auto
  ipv6 address A1::2/64
  ipv6 ospf 1 area 0
interface GigabitEthernet0/0/1
  ip address 10.1.0.1 255.255.255.0
  ip ospf 1 area 0
  negotiation auto
  ipv6 address A2::1/64
  ipv6 dhcp server OPTIMUS6
  ipv6 ospf 1 area 0
interface Serial0/1/0
  no ip address
interface Serial0/1/1
  no ip address
interface GigabitEthernet0/2/0
  no ip address
  shutdown
  negotiation auto
interface GigabitEthernet0/2/1
  no ip address
  shutdown
  negotiation auto
interface GigabitEthernet0
  vrf forwarding Mgmt-intf
  no ip address
  shutdown
  negotiation auto
router ospf 1
  router-id 1.1.1.2
ip forward-protocol nd
ip http server
ip http authentication local
ip http secure-server
ip tftp source-interface GigabitEthernet0
ipv6 router ospf 1
ipv6 router ospf 2
  router-id 1.1.1.2
```

```

control-plane
banner motd ^CUnauthorized access is lowk illegal^C
line con 0
  transport input none
  stopbits 1
line aux 0
  stopbits 1
line vty 0 4
  login
end
Bumble-1:
version 16.9
service timestamps debug datetime msec
service timestamps log datetime msec
platform qfp utilization monitor load 80
platform punt-keepalive disable-kernel-core
hostname Bumble-1
boot-start-marker
boot-end-marker
vrf definition Mgmt-intf
  address-family ipv4
  exit-address-family
  address-family ipv6
  exit-address-family
no aaa new-model
no ip domain lookup
login on-success log
subscriber templating
vtp domain cisco
vtp mode transparent
ipv6 unicast-routing
multilink bundle-name authenticated
license udi pid ISR4321/K9 sn FLM2406090M
no license smart enable
diagnostic bootup level minimal
spanning-tree extend system-id
redundancy
  mode none
interface GigabitEthernet0/0/0
  ip address 20.0.0.2 255.255.255.0
  negotiation auto
  ipv6 address B1::2/64
interface GigabitEthernet0/0/1
  ip address 20.1.0.1 255.255.255.0
  ip router isis bumble
  negotiation auto
  ipv6 address B2::1/64

```

```

ipv6 router isis bumble
interface GigabitEthernet0
  vrf forwarding Mgmt-intf
  no ip address
  shutdown
  negotiation auto
router isis bumble
  net 49.0012.0000.0000.0001.00
  metric-style wide
  redistribute connected metric 10 level-1
  redistribute bgp 2 metric 10 level-1
  address-family ipv6
    redistribute connected metric 10 level-1
    redistribute bgp 2 metric 10 level-1
  exit-address-family
router bgp 2
  bgp log-neighbor-changes
  neighbor B1::1 remote-as 1
  neighbor B3::2 remote-as 2
  neighbor 20.0.0.1 remote-as 1
  neighbor 20.2.0.2 remote-as 2
  address-family ipv4
    network 20.0.0.0 mask 255.255.255.0
    redistribute connected metric 10
    redistribute isis bumble level-1 metric 10
    no neighbor B1::1 activate
    no neighbor B3::2 activate
    neighbor 20.0.0.1 activate
    neighbor 20.2.0.2 activate
    neighbor 20.2.0.2 route-map FIX-IBGP in
    distance bgp 10 10 10
  exit-address-family
  address-family ipv6
    redistribute connected metric 10
    redistribute isis bumble metric 10 level-2
    distance bgp 30 30 30
    network B1::/64
    neighbor B1::1 activate
    neighbor B3::2 activate
    neighbor B3::2 route-map FIX-IBGP6 in
  exit-address-family
ip forward-protocol nd
ip http server
ip http authentication local
ip http secure-server
ip tftp source-interface GigabitEthernet0
ip prefix-list FIX-IBGP seq 5 deny 20.2.0.0/24

```

```

ip prefix-list FIX-IBGP seq 10 permit 0.0.0.0/0 le 32
ipv6 prefix-list FIX-IBGP6 seq 1 deny B3::/64
ipv6 prefix-list FIX-IBGP6 seq 2 permit ::/0 le 128
route-map FIX-IBGP6 permit 10
  match ipv6 address prefix-list FIX-IBGP6
route-map FIX-IBGP permit 10
  match ip address prefix-list FIX-IBGP
control-plane
banner motd ^CUnauthorized access is lowk illegal^C
line con 0
  transport input none
  stopbits 1
line aux 0
  stopbits 1
line vty 0 4
  login
end
Bumble-2:
version 16.9
service timestamps debug datetime msec
service timestamps log datetime msec
platform qfp utilization monitor load 80
platform punt-keepalive disable-kernel-core
hostname Bumble-2
boot-start-marker
boot-end-marker
vrf definition Mgmt-intf
  address-family ipv4
  exit-address-family
  address-family ipv6
  exit-address-family
no aaa new-model
no ip domain lookup
login on-success log
subscriber templating
vtp domain cisco
vtp mode transparent
ipv6 unicast-routing
multilink bundle-name authenticated
license udi pid ISR4321/K9 sn FLM240608H7
no license smart enable
diagnostic bootup level minimal
spanning-tree extend system-id
redundancy
  mode none
interface GigabitEthernet0/0/0
  ip address 20.1.0.2 255.255.255.0

```

```

ip router isis bumble
negotiation auto
ipv6 address B2::2/64
ipv6 router isis bumble
interface GigabitEthernet0/0/1
  ip address 20.2.0.1 255.255.255.0
  ip router isis bumble
  negotiation auto
  ipv6 address B3::1/64
  ipv6 router isis bumble
interface GigabitEthernet0
  vrf forwarding Mgmt-intf
  no ip address
  shutdown
  negotiation auto
  router isis bumble
  net 49.0012.0000.0000.0002.00
  metric-style wide
  redistribute connected metric 5 level-1
  address-family ipv6
    redistribute connected metric 5 level-1
  exit-address-family
  ip forward-protocol nd
  ip http server
  ip http authentication local
  ip http secure-server
  ip tftp source-interface GigabitEthernet0

control-plane
banner motd ^CUnauthorized access is lowk illegal^C
line con 0
  transport input none
  stopbits 1
line aux 0
  stopbits 1
line vty 0 4
  login
end
Bumble-3:
version 16.9
service timestamps debug datetime msec
service timestamps log datetime msec
platform qfp utilization monitor load 80
platform punt-keepalive disable-kernel-core
hostname Bumble-3
boot-start-marker
boot-end-marker

```

```
vrf definition Mgmt-intf
  address-family ipv4
  exit-address-family
  address-family ipv6
  exit-address-family
no aaa new-model
no ip domain lookup
login on-success log
subscriber templating
vtp domain cisco
vtp mode transparent
ipv6 unicast-routing
multilink bundle-name authenticated
license udi pid ISR4321/K9 sn FDO21482HZX
license boot level appxk9
no license smart enable
diagnostic bootup level minimal
spanning-tree extend system-id
redundancy
  mode none
interface GigabitEthernet0/0/0
  ip address 20.3.0.2 255.255.255.0
  negotiation auto
  ipv6 address B4::2/64
interface GigabitEthernet0/0/1
  ip address 20.2.0.2 255.255.255.0
  ip router isis bumble
  negotiation auto
  ipv6 address B3::2/64
  ipv6 router isis bumble
interface Serial0/1/0
  no ip address
  shutdown
interface Serial0/1/1
  no ip address
  shutdown
interface GigabitEthernet0
  vrf forwarding Mgmt-intf
  no ip address
  shutdown
  negotiation auto
  router isis bumble
  net 49.0012.0000.0000.0003.00
  metric-style wide
  redistribute connected metric 10 level-1
  redistribute bgp 2 metric 10 level-1
  address-family ipv6
```

```

    redistribute connected metric 10 level-1
    redistribute bgp 2 metric 10 level-1
  exit-address-family
router bgp 2
  bgp log-neighbor-changes
  neighbor B2::1 remote-as 2
  neighbor B4::1 remote-as 3
  neighbor 20.1.0.1 remote-as 2
  neighbor 20.3.0.1 remote-as 3
  address-family ipv4
    redistribute connected metric 10
    redistribute isis bumble level-2 metric 10
    no neighbor B2::1 activate
    no neighbor B4::1 activate
    neighbor 20.1.0.1 activate
    neighbor 20.1.0.1 route-map FIX-IBGP in
    neighbor 20.3.0.1 activate
    distance bgp 10 10 10
  exit-address-family
  address-family ipv6
    redistribute connected metric 10
    redistribute isis bumble metric 10 level-2
    neighbor B2::1 activate
    neighbor B2::1 route-map FIX-IBGP6 in
    neighbor B4::1 activate
    distance bgp 10 10 10
  exit-address-family
ip forward-protocol nd
ip http server
ip http authentication local
ip http secure-server
ip tftp source-interface GigabitEthernet0
ip prefix-list FIX-IBGP seq 5 deny 20.1.0.0/24
ip prefix-list FIX-IBGP seq 10 permit 0.0.0.0/0 le 32
ipv6 prefix-list FIX-IBGP6 seq 1 deny B2::/64
ipv6 prefix-list FIX-IBGP6 seq 2 permit ::/0 le 128
route-map FIX-IBGP6 permit 10
  match ipv6 address prefix-list FIX-IBGP6
route-map FIX-IBGP permit 10
  match ip address prefix-list FIX-IBGP
control-plane
banner motd ^CUnauthorized access is lowk illegal^C
line con 0
  transport input none
  stopbits 1
line aux 0
  stopbits 1

```

```

line vty 0 4
login
end
Prime-1:
version 16.9
service timestamps debug datetime msec
service timestamps log datetime msec
platform qfp utilization monitor load 80
platform punt-keepalive disable-kernel-core
hostname Prime-1
boot-start-marker
boot-end-marker
vrf definition Mgmt-intf
  address-family ipv4
  exit-address-family
  address-family ipv6
  exit-address-family
no aaa new-model
no ip domain lookup
login on-success log
subscriber templating
vtp domain cisco
vtp mode transparent
ipv6 unicast-routing
multilink bundle-name authenticated
license udi pid ISR4321/K9 sn FDO21482DWJ
license boot level appxk9
no license smart enable
diagnostic bootup level minimal
spanning-tree extend system-id
redundancy
  mode none
interface GigabitEthernet0/0/0
  ip address 30.0.0.1 255.255.255.0
  negotiation auto
  ipv6 address C1::1/64
  ipv6 eigrp 1
interface GigabitEthernet0/0/1
  ip address 20.3.0.1 255.255.255.0
  negotiation auto
  ipv6 address B4::1/64
interface Serial0/1/0
  no ip address
  shutdown
interface Serial0/1/1
  no ip address
  shutdown

```

```

interface GigabitEthernet0
vrf forwarding Mgmt-intf
no ip address
shutdown
negotiation auto
router eigrp 1
  network 30.0.0.0 0.0.0.255
  redistribute connected
  redistribute bgp 3 metric 10 10 255 255 1
  eigrp router-id 3.3.3.1
router bgp 3
  bgp router-id 3.3.3.1
  bgp log-neighbor-changes
  neighbor B4::2 remote-as 2
  neighbor 20.3.0.2 remote-as 2
  address-family ipv4
    redistribute connected metric 10
    redistribute eigrp 1 metric 10
    no neighbor B4::2 activate
    neighbor 20.3.0.2 activate
  exit-address-family
  address-family ipv6
    redistribute connected metric 10
    redistribute eigrp 1 metric 10
    neighbor B4::2 activate
  exit-address-family
ip forward-protocol nd
ip http server
ip http authentication local
ip http secure-server
ip tftp source-interface GigabitEthernet0
ipv6 router eigrp 1
  eigrp router-id 3.3.3.1
  redistribute connected
  redistribute bgp 3 metric 10 10 255 255 1
control-plane
banner motd ^CUnauthorized access is lowk illegal^C
line con 0
  transport input none
  stopbits 1
line aux 0
  stopbits 1
line vty 0 4
  login
end
Prime-2:
version 16.9

```

```
service timestamps debug datetime msec
service timestamps log datetime msec
platform qfp utilization monitor load 80
platform punt-keepalive disable-kernel-core
hostname Prime-2
boot-start-marker
boot-end-marker
vrf definition Mgmt-intf
  address-family ipv4
    exit-address-family
    address-family ipv6
    exit-address-family
no logging console
no aaa new-model
no ip domain lookup
ip dhcp excluded-address 30.1.0.1
ip dhcp pool PRIME
  network 30.1.0.0 255.255.255.0
  default-router 30.1.0.1
login on-success log
subscriber templating
vtp domain cisco
vtp mode transparent
ipv6 unicast-routing
ipv6 dhcp pool PRIME6
  address prefix C2::/64 lifetime infinite infinite
multilink bundle-name authenticated
license udi pid ISR4321/K9 sn FDO214421CH
no license smart enable
diagnostic bootup level minimal
spanning-tree extend system-id
redundancy
  mode none
interface GigabitEthernet0/0/0
  ip address 30.1.0.1 255.255.255.0
  negotiation auto
  ipv6 address C2::1/64
  ipv6 eigrp 1
  ipv6 dhcp server PRIME6
interface GigabitEthernet0/0/1
  ip address 30.0.0.2 255.255.255.0
  negotiation auto
  ipv6 address C1::2/64
  ipv6 eigrp 1
interface Serial0/1/0
  no ip address
  shutdown
```

```

interface Serial0/1/1
  no ip address
  shutdown
interface Service-Engine0/2/0
interface GigabitEthernet0
  vrf forwarding Mgmt-intf
  no ip address
  shutdown
  negotiation auto
router eigrp 1
  network 30.0.0.0 0.0.0.255
  network 30.1.0.0 0.0.0.255
  eigrp router-id 3.3.3.2
ip forward-protocol nd
ip http server
ip http authentication local
ip http secure-server
ip tftp source-interface GigabitEthernet0
ipv6 router eigrp 1
  eigrp router-id 3.3.3.2
control-plane
banner motd ^CUnauthorized access is lowk illegal^C
line con 0
  transport input none
  stopbits 1
line aux 0
  stopbits 1
line vty 0 4
  login
end

```

## **Routing Tables**

### **Optimus-1:**

Gateway of last resort is not set

```

  10.0.0.0/8 is variably subnetted, 3 subnets, 2 masks
C      10.0.0.0/24 is directly connected, GigabitEthernet0/0/0
L      10.0.0.1/32 is directly connected, GigabitEthernet0/0/0
O      10.1.0.0/24 [110/2] via 10.0.0.2, 00:10:20,
GigabitEthernet0/0/0
  20.0.0.0/8 is variably subnetted, 5 subnets, 2 masks
C      20.0.0.0/24 is directly connected, GigabitEthernet0/0/1
L      20.0.0.1/32 is directly connected, GigabitEthernet0/0/1
B      20.1.0.0/24 [20/10] via 20.0.0.2, 06:05:54
B      20.2.0.0/24 [20/0] via 20.0.0.2, 06:11:51
B      20.3.0.0/24 [20/0] via 20.0.0.2, 05:22:51
  30.0.0.0/24 is subnetted, 1 subnets
B      30.0.0.0 [20/0] via 20.0.0.2, 05:22:20

```

```

B      30.1.0.0 [20/0] via 20.0.0.2, 00:00:47
C    A1::/64 [0/0]
      via GigabitEthernet0/0/0, directly connected
L    A1::1/128 [0/0]
      via GigabitEthernet0/0/0, receive
O    A2::/64 [110/2]
      via FE80::B6A8:B9FF:FE47:96B0, GigabitEthernet0/0/0
C    B1::/64 [0/0]
      via GigabitEthernet0/0/1, directly connected
L    B1::1/128 [0/0]
      via GigabitEthernet0/0/1, receive
B    B2::/64 [20/10]
      via FE80::CE7F:76FF:FEC8:A1F0, GigabitEthernet0/0/1
B    B4::/64 [20/0]
      via FE80::CE7F:76FF:FEC8:A1F0, GigabitEthernet0/0/1
B    C1::/64 [20/0]
      via FE80::CE7F:76FF:FEC8:A1F0, GigabitEthernet0/0/1
B    C2::/64 [20/0]
      via FE80::CE7F:76FF:FEC8:A1F0, GigabitEthernet0/0/1
L    FF00::/8 [0/0]
      via Null0, receive

```

### **Optimus-2:**

Gateway of last resort is not set

```

          10.0.0.0/8 is variably subnetted, 4 subnets, 2 masks
C            10.0.0.0/24 is directly connected, GigabitEthernet0/0/0
L            10.0.0.2/32 is directly connected, GigabitEthernet0/0/0
C            10.1.0.0/24 is directly connected, GigabitEthernet0/0/1
L            10.1.0.1/32 is directly connected, GigabitEthernet0/0/1
              20.0.0.0/24 is subnetted, 4 subnets
O E2      20.0.0.0 [110/20] via 10.0.0.1, 06:37:44,
GigabitEthernet0/0/0
O E2      20.1.0.0 [110/10] via 10.0.0.1, 06:14:22,
GigabitEthernet0/0/0
O E2      20.2.0.0 [110/10] via 10.0.0.1, 06:20:19,
GigabitEthernet0/0/0
O E2      20.3.0.0 [110/10] via 10.0.0.1, 05:47:12,
GigabitEthernet0/0/0
              30.0.0.0/24 is subnetted, 2 subnets
O E2      30.0.0.0 [110/10] via 10.0.0.1, 05:47:12,
GigabitEthernet0/0/0
O E2      30.1.0.0 [110/10] via 10.0.0.1, 00:05:01,
GigabitEthernet0/0/0
C    A1::/64 [0/0]
      via GigabitEthernet0/0/0, directly connected
L    A1::2/128 [0/0]
      via GigabitEthernet0/0/0, receive

```

```

C    A2::/64 [0/0]
      via GigabitEthernet0/0/1, directly connected
L    A2::1/128 [0/0]
      via GigabitEthernet0/0/1, receive
OE2 B1::/64 [110/20]
      via FE80::CE7F:76FF:FECE:9BF0, GigabitEthernet0/0/0
OE2 B2::/64 [110/10]
      via FE80::CE7F:76FF:FECE:9BF0, GigabitEthernet0/0/0
OE2 B4::/64 [110/10]
      via FE80::CE7F:76FF:FECE:9BF0, GigabitEthernet0/0/0
OE2 C1::/64 [110/10]
      via FE80::CE7F:76FF:FECE:9BF0, GigabitEthernet0/0/0
OE2 C2::/64 [110/10]
      via FE80::CE7F:76FF:FECE:9BF0, GigabitEthernet0/0/0
L    FF00::/8 [0/0]
      via Null0, receive

```

**Bumble-1:**

Gateway of last resort is not set

```

          10.0.0.0/24 is subnetted, 2 subnets
B        10.0.0.0 [10/10] via 20.0.0.1, 00:24:20
B        10.1.0.0 [10/10] via 20.0.0.1, 00:24:20
          20.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
C        20.0.0.0/24 is directly connected, GigabitEthernet0/0/0
L        20.0.0.2/32 is directly connected, GigabitEthernet0/0/0
C        20.1.0.0/24 is directly connected, GigabitEthernet0/0/1
L        20.1.0.1/32 is directly connected, GigabitEthernet0/0/1
i L1     20.2.0.0/24 [115/20] via 20.1.0.2, 00:07:55,
GigabitEthernet0/0/1
i L1     20.3.0.0/24 [115/30] via 20.1.0.2, 00:07:52,
GigabitEthernet0/0/1
          30.0.0.0/24 is subnetted, 2 subnets
B        30.0.0.0 [10/10] via 20.3.0.1, 00:07:20
B        30.1.0.0 [10/10] via 20.3.0.1, 00:07:20
B    A1::/64 [30/10]
      via FE80::CE7F:76FF:FECE:9BF1, GigabitEthernet0/0/0
B    A2::/64 [30/10]
      via FE80::CE7F:76FF:FECE:9BF1, GigabitEthernet0/0/0
C    B1::/64 [0/0]
      via GigabitEthernet0/0/0, directly connected
L    B1::2/128 [0/0]
      via GigabitEthernet0/0/0, receive
C    B2::/64 [0/0]
      via GigabitEthernet0/0/1, directly connected
L    B2::1/128 [0/0]
      via GigabitEthernet0/0/1, receive
I1   B3::/64 [115/20]

```

```

        via FE80::CE7F:76FF:FECE:7FD0, GigabitEthernet0/0/1
B    B4::/64 [30/10]
        via B3::2
B    C1::/64 [30/10]
        via B4::1
B    C2::/64 [30/10]
        via B4::1
L    FF00::/8 [0/0]
        via Null0, receive

```

**Bumble-2:**

Gateway of last resort is not set

```

        10.0.0.0/24 is subnetted, 2 subnets
i L1      10.0.0.0 [115/20] via 20.1.0.1, 05:22:55,
GigabitEthernet0/0/0
i L1      10.1.0.0 [115/20] via 20.1.0.1, 00:16:59,
GigabitEthernet0/0/0
        20.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
i L1      20.0.0.0/24 [115/20] via 20.1.0.1, 05:23:00,
GigabitEthernet0/0/0
C          20.1.0.0/24 is directly connected, GigabitEthernet0/0/0
L          20.1.0.2/32 is directly connected, GigabitEthernet0/0/0
C          20.2.0.0/24 is directly connected, GigabitEthernet0/0/1
L          20.2.0.1/32 is directly connected, GigabitEthernet0/0/1
i L1      20.3.0.0/24 [115/20] via 20.2.0.2, 05:28:11,
GigabitEthernet0/0/1
        30.0.0.0/24 is subnetted, 2 subnets
i L1      30.0.0.0 [115/20] via 20.2.0.2, 05:27:56,
GigabitEthernet0/0/1
i L1      30.1.0.0 [115/20] via 20.2.0.2, 00:01:56,
GigabitEthernet0/0/1
I1 A1::/64 [115/20]
        via FE80::CE7F:76FF:FEC8:A1F1, GigabitEthernet0/0/0
I1 A2::/64 [115/20]
        via FE80::CE7F:76FF:FEC8:A1F1, GigabitEthernet0/0/0
I1 B1::/64 [115/20]
        via FE80::CE7F:76FF:FEC8:A1F1, GigabitEthernet0/0/0
C B2::/64 [0/0]
        via GigabitEthernet0/0/0, directly connected
L B2::2/128 [0/0]
        via GigabitEthernet0/0/0, receive
C B3::/64 [0/0]
        via GigabitEthernet0/0/1, directly connected
L B3::1/128 [0/0]
        via GigabitEthernet0/0/1, receive
I1 B4::/64 [115/20]
        via FE80::267E:12FF:FE4D:F6E1, GigabitEthernet0/0/1

```

```
I1  C1::/64 [115/20]
    via FE80::267E:12FF:FE4D:F6E1, GigabitEthernet0/0/1
I1  C2::/64 [115/20]
    via FE80::267E:12FF:FE4D:F6E1, GigabitEthernet0/0/1
L   FF00::/8 [0/0]
    via Null0, receive
```

**Bumble-3:**

Gateway of last resort is not set

```
      10.0.0.0/24 is subnetted, 1 subnets
B        10.0.0.0 [10/10] via 20.0.0.1, 00:00:40
          20.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
B            20.0.0.0/24 [10/0] via 20.1.0.1, 00:00:40
i L1      20.1.0.0/24 [115/20] via 20.2.0.1, 00:00:45,
GigabitEthernet0/0/1
C            20.2.0.0/24 is directly connected, GigabitEthernet0/0/1
L            20.2.0.2/32 is directly connected, GigabitEthernet0/0/1
C            20.3.0.0/24 is directly connected, GigabitEthernet0/0/0
L            20.3.0.2/32 is directly connected, GigabitEthernet0/0/0
          30.0.0.0/24 is subnetted, 2 subnets
B            30.0.0.0 [10/10] via 20.3.0.1, 00:00:40
B            30.1.0.0 [10/10] via 20.3.0.1, 00:00:40
B      A1::/64 [10/10]
        via B1::1
B      A2::/64 [10/10]
        via B1::1
B      B1::/64 [10/10]
        via B2::1
I1  B2::/64 [115/20]
    via FE80::CE7F:76FF:FECE:7FD1, GigabitEthernet0/0/1
C  B3::/64 [0/0]
    via GigabitEthernet0/0/1, directly connected
L  B3::2/128 [0/0]
    via GigabitEthernet0/0/1, receive
C  B4::/64 [0/0]
    via GigabitEthernet0/0/0, directly connected
L  B4::2/128 [0/0]
    via GigabitEthernet0/0/0, receive
B  C1::/64 [10/10]
    via FE80::267E:12FF:FE4D:F771, GigabitEthernet0/0/0
B  C2::/64 [10/10]
    via FE80::267E:12FF:FE4D:F771, GigabitEthernet0/0/0
L  FF00::/8 [0/0]
    via Null0, receive
```

**Prime-1:**

Gateway of last resort is not set

```

        10.0.0.0/24 is subnetted, 2 subnets
B          10.0.0.0 [20/0] via 20.3.0.2, 05:46:46
B          10.1.0.0 [20/0] via 20.3.0.2, 00:19:39
        20.0.0.0/8 is variably subnetted, 5 subnets, 2 masks
B          20.0.0.0/24 [20/0] via 20.3.0.2, 05:26:27
B          20.1.0.0/24 [20/0] via 20.3.0.2, 06:13:26
B          20.2.0.0/24 [20/10] via 20.3.0.2, 05:47:17
C          20.3.0.0/24 is directly connected, GigabitEthernet0/0/1
L          20.3.0.1/32 is directly connected, GigabitEthernet0/0/1
        30.0.0.0/8 is variably subnetted, 3 subnets, 2 masks
C          30.0.0.0/24 is directly connected, GigabitEthernet0/0/0
L          30.0.0.1/32 is directly connected, GigabitEthernet0/0/0
D          30.1.0.0/24 [90/3072] via 30.0.0.2, 00:04:47,
GigabitEthernet0/0/0
B          A1::/64 [20/0]
            via FE80::267E:12FF:FE4D:F6E0, GigabitEthernet0/0/1
B          A2::/64 [20/0]
            via FE80::267E:12FF:FE4D:F6E0, GigabitEthernet0/0/1
B          B1::/64 [20/0]
            via FE80::267E:12FF:FE4D:F6E0, GigabitEthernet0/0/1
B          B3::/64 [20/10]
            via FE80::267E:12FF:FE4D:F6E0, GigabitEthernet0/0/1
C          B4::/64 [0/0]
            via GigabitEthernet0/0/1, directly connected
L          B4::1/128 [0/0]
            via GigabitEthernet0/0/1, receive
C          C1::/64 [0/0]
            via GigabitEthernet0/0/0, directly connected
L          C1::1/128 [0/0]
            via GigabitEthernet0/0/0, receive
D          C2::/64 [90/3072]
            via FE80::B6A8:B9FF:FE01:B5A1, GigabitEthernet0/0/0
L          FF00::/8 [0/0]
            via Null0, receive

```

**Prime-2:**

Gateway of last resort is not set

```

        10.0.0.0/24 is subnetted, 2 subnets
D EX      10.0.0.0 [170/256002816] via 30.0.0.1, 05:47:26,
GigabitEthernet0/0/1
D EX      10.1.0.0 [170/256002816] via 30.0.0.1, 00:20:18,
GigabitEthernet0/0/1
        20.0.0.0/24 is subnetted, 4 subnets
D EX      20.0.0.0 [170/256002816] via 30.0.0.1, 05:47:26,
GigabitEthernet0/0/1
D EX      20.1.0.0 [170/256002816] via 30.0.0.1, 06:20:59,
GigabitEthernet0/0/1

```

```

D EX      20.2.0.0 [170/256002816] via 30.0.0.1, 05:47:56,
GigabitEthernet0/0/1
D EX      20.3.0.0 [170/3072] via 30.0.0.1, 06:58:22,
GigabitEthernet0/0/1
            30.0.0.0/8 is variably subnetted, 4 subnets, 2 masks
C          30.0.0.0/24 is directly connected, GigabitEthernet0/0/1
L          30.0.0.2/32 is directly connected, GigabitEthernet0/0/1
C          30.1.0.0/24 is directly connected, GigabitEthernet0/0/0
L          30.1.0.1/32 is directly connected, GigabitEthernet0/0/0
EX  A1::/64 [170/256002816]
        via FE80::267E:12FF:FE4D:F770, GigabitEthernet0/0/1
EX  A2::/64 [170/256002816]
        via FE80::267E:12FF:FE4D:F770, GigabitEthernet0/0/1
EX  B1::/64 [170/256002816]
        via FE80::267E:12FF:FE4D:F770, GigabitEthernet0/0/1
EX  B3::/64 [170/256002816]
        via FE80::267E:12FF:FE4D:F770, GigabitEthernet0/0/1
EX  B4::/64 [170/3072]
        via FE80::267E:12FF:FE4D:F770, GigabitEthernet0/0/1
C  C1::/64 [0/0]
        via GigabitEthernet0/0/1, directly connected
L  C1::2/128 [0/0]
        via GigabitEthernet0/0/1, receive
C  C2::/64 [0/0]
        via GigabitEthernet0/0/0, directly connected
L  C2::1/128 [0/0]
        via GigabitEthernet0/0/0, receive
L  FF00::/8 [0/0]
        via Null0, receive

```

### **Other Show Commands**

Bumble-1# show bgp topology \*

For address family: IPv4 Unicast

```

BGP table version is 902, local router ID is 20.0.0.2
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,
        t secondary path, L long-lived-stale,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

```

Network Path	Next Hop	Metric	LocPrf	Weight
-----------------	----------	--------	--------	--------

```

*> 10.0.0.0/24      20.0.0.1          10          0
1 ?
*> 10.1.0.0/24     20.0.0.1          10          0
1 ?
* 20.0.0.0/24      20.0.0.1          10          0
1 ?
*>                   0.0.0.0           0          32768
i
*> 20.1.0.0/24     0.0.0.0           10          32768
?
*> 20.2.0.0/24     20.1.0.2          10          32768
?
* i 20.3.0.0/24     20.2.0.2          10        100          0
?
*>                   20.1.0.2          10          32768
?
*>i 30.0.0.0/24     20.3.0.1          10        100          0
3 ?
*>i 30.1.0.0/24     20.3.0.1          10        100          0
3 ?3 ?

```

### **Bumble-1# show bgp neighbors 20.2.0.2**

```

BGP neighbor is 20.2.0.2, remote AS 2, internal link
  BGP version 4, remote router ID 20.3.0.2
  BGP state = Established, up for 23:40:52
  Last read 00:00:16, last write 00:00:37, 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:	109	104
Keepalives:	1545	1547
Route Refresh:	0	1
Total:	1657	1653

Do log neighbor state changes (via global configuration)

Default minimum time between advertisement runs is 0 seconds

For address family: IPv4 Unicast  
Session: 20.2.0.2  
BGP table version 902, neighbor version 902/0  
Output queue size : 0  
Index 71, Advertise bit 0  
71 update-group member  
Inbound path policy configured  
Route map for incoming advertisements is FIX-IBGP  
Slow-peer detection is disabled  
Slow-peer split-update-group dynamic is disabled

	Sent	Rcvd
<b>Prefix activity:</b>	----	----
Prefixes Current:	6	3 (Consumes 408 bytes)
Prefixes Total:	24	84
Implicit Withdraw:	0	16
Explicit Withdraw:	21	65
Used as bestpath:	n/a	2
Used as multipath:	n/a	0
Used as secondary:	n/a	0

	Outbound	Inbound
<b>Local Policy Denied Prefixes:</b>	-----	-----
route-map:	0	8
Bestpath from this peer:	24	n/a
Total:	24	8

Number of NLRI's in the update sent: max 4, min 0  
Last detected as dynamic slow peer: never  
Dynamic slow peer recovered: never  
Refresh Epoch: 1  
Last Sent Refresh Start-of-rib: 23:18:58  
Last Sent Refresh End-of-rib: 23:18:58  
Refresh-Out took 0 seconds  
Last Received Refresh Start-of-rib: never  
Last Received Refresh End-of-rib: never

	Sent	Rcvd
<b>Refresh activity:</b>	----	----
Refresh Start-of-RIB	1	0
Refresh End-of-RIB	1	0

Address tracking is enabled, the RIB does have a route to 20.2.0.2  
Route to peer address reachability Up: 66; Down: 112  
Last notification 22:52:52  
Connections established 54; dropped 53

```
Last reset 23:40:59, due to BGP Notification received of session 1, hold time expired
Interface associated: (none) (peering address NOT in same link)
Transport(tcp) path-mtu-discovery is enabled
Graceful-Restart is disabled
SSO is disabled
Connection state is ESTAB, I/O status: 1, unread input bytes: 0
Connection is ECN Disabled, Mininum incoming TTL 0, Outgoing TTL 255
Local host: 20.1.0.1, Local port: 179
Foreign host: 20.2.0.2, Foreign port: 42832
Connection tableid (VRF): 0
Maximum output segment queue size: 50
```

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

```
Event Timers (current time is 0x5C7F078):
Timer      Starts      Wakeups      Next
Retrans      1613        18        0x0
TimeWait      0          0        0x0
AckHold      1603      1552        0x0
SendWnd      0          0        0x0
KeepAlive     10         0        0x0
GiveUp        0          0        0x0
PmtuAger      0          0        0x0
DeadWait      0          0        0x0
Linger        0          0        0x0
ProcessQ      0          0        0x0
```

```
iss: 2058513017  snduna: 2058547547  sndnxt: 2058547547
irs: 2899963848  rcvnxt: 2899998108
```

```
sndwnd: 15954  scale:      0  maxrcvwnd: 16384
rcvwnd: 15816  scale:      0  delrcvwnd: 568
```

```
SRTT: 1000 ms, RTTO: 1003 ms, RTV: 3 ms, KRTT: 0 ms
minRTT: 1 ms, maxRTT: 1000 ms, ACK hold: 200 ms
uptime: 85252400 ms, Sent idletime: 16650 ms, Receive idletime:
16850 ms
Status Flags: passive open, gen tcbs
Option Flags: nagle, path mtu capable
IP Precedence value : 6
```

```
Datagrams (max data segment is 1460 bytes):
```

```

Rcvd: 3205 (out of order: 15), with data: 1614, total data
bytes: 34259
Sent: 3237 (retransmit: 18, fastretransmit: 0, partialack: 0,
Second Congestion: 1), with data: 1629, total data bytes: 34529

    Packets received in fast path: 0, fast processed: 0, slow path:
0
    fast lock acquisition failures: 0, slow path: 0
TCP Semaphore          0x7F3714902D10   FREE
Bumble-3# show bgp topology *
      Network           Next Hop            Metric LocPrf Weight Path
  *->i  10.0.0.0/24       20.0.0.1          10     100      0
1 ?
  *->i  10.1.0.0/24       20.0.0.1          10     100      0
1 ?
  *->i  20.0.0.0/24       20.1.0.1          0     100      0
i
  * i  20.2.0.0/24       20.1.0.2          10     100      0
?
  *>                          0.0.0.0          10             32768
?
  * i  20.3.0.0/24       20.1.0.2          10     100      0
?
  *                         20.3.0.1          10             0
3 ?
  *>                          0.0.0.0          10             32768
?
  *>  30.0.0.0/24       20.3.0.1          10             0
3 ?
  *>  30.1.0.0/24       20.3.0.1          10             0
3 ?

Bumble-3# show bgp neighbors 20.1.0.1
BGP neighbor is 20.1.0.1, remote AS 2, internal link
  BGP version 4, remote router ID 20.0.0.2
  BGP state = Established, up for 01:01:45
  Last read 00:00:31, last write 00:00:26, 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:	60	77
Keepalives:	62	61
Route Refresh:	1	0
Total:	124	141

Do log neighbor state changes (via global configuration)  
Default minimum time between advertisement runs is 0 seconds

For address family: IPv4 Unicast

Session: 20.1.0.1

BGP table version 869, neighbor version 869/0

Output queue size : 0

Index 70, Advertise bit 0

70 update-group member

Inbound path policy configured

Route map for incoming advertisements is FIX-IBGP

Slow-peer detection is disabled

Slow-peer split-update-group dynamic is disabled

	Sent	Rcvd
Prefix activity:	----	----
Prefixes Current:	4	5 (Consumes 680 bytes)
Prefixes Total:	6	38
Implicit Withdraw:	0	12
Explicit Withdraw:	5	21
Used as bestpath:	n/a	3
Used as multipath:	n/a	0
Used as secondary:	n/a	0

	Outbound	Inbound
Local Policy Denied Prefixes:	-----	-----
route-map:	0	37
Bestpath from this peer:	5	n/a
Total:	5	37

Number of NLRI's in the update sent: max 4, min 0

Last detected as dynamic slow peer: never

Dynamic slow peer recovered: never

Refresh Epoch: 2

Last Sent Refresh Start-of-rib: never

Last Sent Refresh End-of-rib: never

Last Received Refresh Start-of-rib: 00:39:51

Last Received Refresh End-of-rib: 00:39:51

Refresh-In took 0 seconds

	Sent	Rcvd
Refresh activity:	----	----
Refresh Start-of-RIB	0	1
Refresh End-of-RIB	0	1

Address tracking is enabled, the RIB does have a route to 20.1.0.1

Route to peer address reachability Up: 61; Down: 105

    Last notification 00:13:44

Connections established 54; dropped 53

Last reset 01:01:53, due to BGP Notification received of session 1, hold time expired

Interface associated: (none) (peering address NOT in same link)

Transport(tcp) path-mtu-discovery is enabled

Graceful-Restart is disabled

SSO is disabled

Connection state is ESTAB, I/O status: 1, unread input bytes: 0

Connection is ECN Disabled, Mininum incoming TTL 0, Outgoing TTL 255

Local host: 20.2.0.2, Local port: 42832

Foreign host: 20.1.0.1, Foreign port: 179

Connection tableid (VRF): 0

Maximum output segment queue size: 50

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

Event Timers (current time is 0xEB9CB6):

Timer	Starts	Wakeups	Next
Retrans	105	21	0x0
TimeWait	0	0	0x0
AckHold	86	69	0x0
SendWnd	0	0	0x0
KeepAlive	0	0	0x0
GiveUp	0	0	0x0
PmtuAger	163	163	0x0
DeadWait	0	0	0x0
Linger	0	0	0x0
ProcessQ	0	0	0x0

iss: 2899963848 snduna: 2899968053 sndnxt: 2899968053

irs: 2058513017 rcvnxt: 2058517979

sndwnd: 15119 scale: 0 maxrcvwnd: 16384

rcvwnd: 16213 scale: 0 delrcvwnd: 171

```

SRTT: 1000 ms, RTTO: 1003 ms, RTV: 3 ms, KRTT: 0 ms
minRTT: 1 ms, maxRTT: 1000 ms, ACK hold: 200 ms
uptime: 3705792 ms, Sent idletime: 26237 ms, Receive idletime:
26036 ms
Status Flags: active open
Option Flags: nagle, path mtu capable
IP Precedence value : 6

Datagrams (max data segment is 1460 bytes):
Rcvd: 197 (out of order: 14), with data: 88, total data bytes:
4961
Sent: 211 (retransmit: 21, fastretransmit: 0, partialack: 0,
Second Congestion: 2), with data: 115, total data bytes: 4204

Packets received in fast path: 0, fast processed: 0, slow path:
0
fast lock acquisition failures: 0, slow path: 0
TCP Semaphore          0x7FA955363A48   FREE

```

## Problems

- **Interface Statements on EIGRP**

We tried to configure EIGRP in IPv4 with interface statements. As this behavior is only permitted for IPv6 EIGRP, we had to replace the `ip eigrp <as>` command with the `network <x.x.x.x>` command.

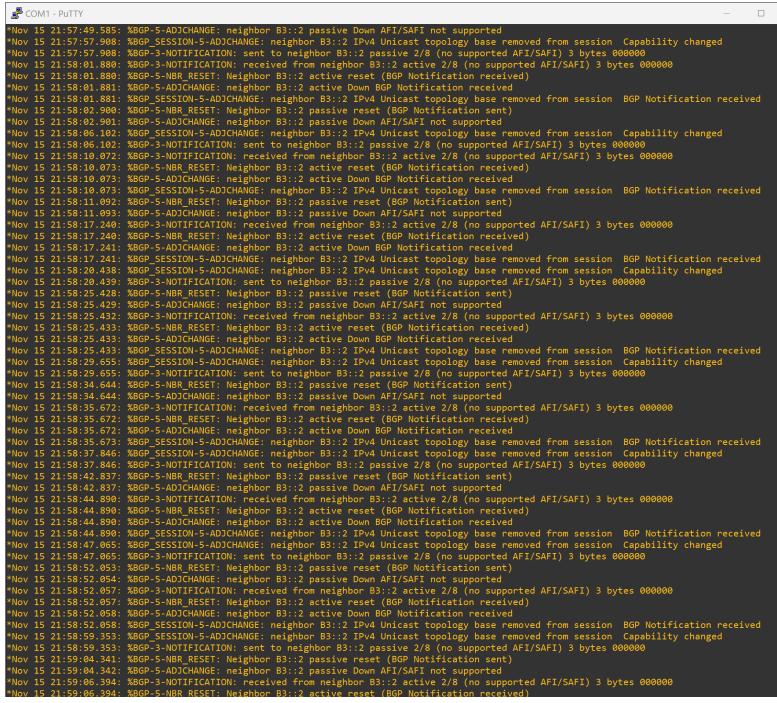
- **EIGRP Information requirement**

We originally tried to redistribute from BGP into EIGRP with the command `redistribute bgp <as> metric <metric>`. This raised an error, as EIGRP requires much more information than this to redistribute routes. The actual command looks like this: `redistribute bgp <as> metric <metric> <delay> <reliability> <bandwidth> <mtu>`, as shown below:

```
redistribute bgp 3 metric 10 10 255 255 1
```

- **BGP neighbor statements**

We accidentally added the command `neighbor b3::2 activate` in the `address-family ipv4` section of Bumble-1, resulting in the wall of error messages seen below. We fixed this by moving the command to the `address-family ipv6` section.



```

COM1 - Putty
*BGP-5-ADJCHANGE: neighbor B3::2 passive Down AFI/SAFI not supported
*Nov 15 21:57:17.985: %BGP-5-ADJCHANGE: neighbor B3::2 IPv4 Unicast topology base removed from session Capability changed
*Nov 15 21:58:01.988: %BGP-3-NOTIFICATION: sent to neighbor B3::2 active 2/8 (no supported AFI/SAFI) 3 bytes 000000
*Nov 15 21:58:01.989: %BGP-5-NBR_RESET: Neighbor B3::2 active reset (BGP Notification received)
*Nov 15 21:58:01.990: %BGP-5-NBR_RESET: Neighbor B3::2 active Down BGP Notification received
*Nov 15 21:58:01.991: %BGP-5-ADJCHANGE: neighbor B3::2 active Down BGP Notification received
*Nov 15 21:58:02.990: %BGP-3-NOTIFICATION: sent to neighbor B3::2 active 2/8 (no supported AFI/SAFI) 3 bytes 000000
*Nov 15 21:58:02.991: %BGP-5-NBR_RESET: Neighbor B3::2 passive Down BGP Notification received
*Nov 15 21:58:02.992: %BGP-5-ADJCHANGE: neighbor B3::2 passive Down BGP Notification received
*Nov 15 21:58:06.102: %BGP-5-SESSION-5-ADJCHANGE: neighbor B3::2 IPv4 Unicast topology base removed from session Capability changed
*Nov 15 21:58:06.102: %BGP-3-NOTIFICATION: sent to neighbor B3::2 passive 2/8 (no supported AFI/SAFI) 3 bytes 000000
*Nov 15 21:58:10.072: %BGP-3-NOTIFICATION: received from neighbor B3::2 active 2/8 (no supported AFI/SAFI) 3 bytes 000000
*Nov 15 21:58:10.073: %BGP-5-NBR_RESET: Neighbor B3::2 active reset (BGP Notification received)
*Nov 15 21:58:10.074: %BGP-5-NBR_RESET: Neighbor B3::2 active Down BGP Notification received
*Nov 15 21:58:10.075: %BGP-5-ADJCHANGE: neighbor B3::2 active Down BGP Notification received
*Nov 15 21:58:11.092: %BGP-5-ADJCHANGE: neighbor B3::2 passive reset (BGP Notification sent)
*Nov 15 21:58:11.093: %BGP-3-NOTIFICATION: received from neighbor B3::2 active 2/8 (no supported AFI/SAFI) 3 bytes 000000
*Nov 15 21:58:17.240: %BGP-3-NOTIFICATION: sent to neighbor B3::2 active 2/8 (no supported AFI/SAFI) 3 bytes 000000
*Nov 15 21:58:17.241: %BGP-5-ADJCHANGE: neighbor B3::2 active Down BGP Notification received
*Nov 15 21:58:20.430: %BGP-5-ADJCHANGE: neighbor B3::2 IPv4 Unicast topology base removed from session BGP Notification received
*Nov 15 21:58:20.430: %BGP-3-NOTIFICATION: sent to neighbor B3::2 passive 2/8 (no supported AFI/SAFI) 3 bytes 000000
*Nov 15 21:58:25.428: %BGP-5-NBR_RESET: Neighbor B3::2 passive reset (BGP Notification sent)
*Nov 15 21:58:25.429: %BGP-5-ADJCHANGE: neighbor B3::2 active Down BGP Notification received
*Nov 15 21:58:25.432: %BGP-3-NOTIFICATION: received from neighbor B3::2 active 2/8 (no supported AFI/SAFI) 3 bytes 000000
*Nov 15 21:58:25.432: %BGP-5-NBR_RESET: Neighbor B3::2 active reset (BGP Notification received)
*Nov 15 21:58:25.433: %BGP-5-ADJCHANGE: neighbor B3::2 active Down BGP Notification received
*Nov 15 21:58:25.433: %BGP-5-SESSION-5-ADJCHANGE: neighbor B3::2 IPv4 Unicast topology base removed from session BGP Notification received
*Nov 15 21:58:29.433: %BGP-5-ADJCHANGE: neighbor B3::2 active Down BGP Notification received
*Nov 15 21:58:34.640: %BGP-5-NBR_RESET: Neighbor B3::2 passive Down AFI/SAFI not supported
*Nov 15 21:58:34.640: %BGP-5-ADJCHANGE: neighbor B3::2 passive reset (BGP Notification sent)
*Nov 15 21:58:34.641: %BGP-3-NOTIFICATION: received from neighbor B3::2 active 2/8 (no supported AFI/SAFI) 3 bytes 000000
*Nov 15 21:58:34.642: %BGP-5-NBR_RESET: Neighbor B3::2 active Down BGP Notification received
*Nov 15 21:58:35.672: %BGP-5-ADJCHANGE: neighbor B3::2 active Down BGP Notification received
*Nov 15 21:58:35.673: %BGP-5-ADJCHANGE: neighbor B3::2 active Down BGP Notification received
*Nov 15 21:58:35.674: %BGP-5-ADJCHANGE: neighbor B3::2 active Down BGP Notification received
*Nov 15 21:58:35.675: %BGP-5-ADJCHANGE: neighbor B3::2 IPv4 Unicast topology base removed from session BGP Notification received
*Nov 15 21:58:35.675: %BGP-3-NOTIFICATION: sent to neighbor B3::2 active 2/8 (no supported AFI/SAFI) 3 bytes 000000
*Nov 15 21:58:37.840: %BGP-5-ADJCHANGE: neighbor B3::2 active Down BGP Notification received
*Nov 15 21:58:42.837: %BGP-5-NBR_RESET: Neighbor B3::2 passive Down AFI/SAFI not supported
*Nov 15 21:58:42.837: %BGP-5-ADJCHANGE: neighbor B3::2 passive reset (BGP Notification sent)
*Nov 15 21:58:44.890: %BGP-5-ADJCHANGE: neighbor B3::2 active Down BGP Notification received
*Nov 15 21:58:44.890: %BGP-5-ADJCHANGE: neighbor B3::2 active Down BGP Notification received
*Nov 15 21:58:44.890: %BGP-5-NBR_RESET: Neighbor B3::2 active reset (BGP Notification received)
*Nov 15 21:58:44.890: %BGP-5-ADJCHANGE: neighbor B3::2 active Down BGP Notification received
*Nov 15 21:58:44.890: %BGP-5-ADJCHANGE: neighbor B3::2 active Down BGP Notification received
*Nov 15 21:58:44.890: %BGP-5-ADJCHANGE: neighbor B3::2 active Down BGP Notification received
*Nov 15 21:58:44.890: %BGP-5-ADJCHANGE: neighbor B3::2 IPv4 Unicast topology base removed from session BGP Notification received
*Nov 15 21:58:44.890: %BGP-3-NOTIFICATION: sent to neighbor B3::2 active 2/8 (no supported AFI/SAFI) 3 bytes 000000
*Nov 15 21:58:52.053: %BGP-5-NBR_RESET: Neighbor B3::2 passive Down AFI/SAFI not supported
*Nov 15 21:58:52.053: %BGP-5-ADJCHANGE: neighbor B3::2 passive reset (BGP Notification sent)
*Nov 15 21:58:52.057: %BGP-3-NOTIFICATION: received from neighbor B3::2 active 2/8 (no supported AFI/SAFI) 3 bytes 000000
*Nov 15 21:58:52.057: %BGP-5-ADJCHANGE: neighbor B3::2 active Down BGP Notification received
*Nov 15 21:58:52.058: %BGP-5-ADJCHANGE: neighbor B3::2 active Down BGP Notification received
*Nov 15 21:58:52.058: %BGP-5-ADJCHANGE: neighbor B3::2 active Down BGP Notification received
*Nov 15 21:58:52.058: %BGP-5-ADJCHANGE: neighbor B3::2 active Down BGP Notification received
*Nov 15 21:58:52.058: %BGP-5-ADJCHANGE: neighbor B3::2 IPv4 Unicast topology base removed from session BGP Notification received
*Nov 15 21:58:52.058: %BGP-3-NOTIFICATION: sent to neighbor B3::2 active 2/8 (no supported AFI/SAFI) 3 bytes 000000
*Nov 15 21:58:59.353: %BGP-5-NBR_RESET: Neighbor B3::2 passive Down AFI/SAFI not supported
*Nov 15 21:58:59.353: %BGP-5-ADJCHANGE: neighbor B3::2 passive reset (BGP Notification sent)
*Nov 15 21:59:04.341: %BGP-5-NBR_RESET: Neighbor B3::2 passive Down AFI/SAFI not supported
*Nov 15 21:59:04.341: %BGP-5-ADJCHANGE: neighbor B3::2 passive reset (BGP Notification sent)
*Nov 15 21:59:06.394: %BGP-3-NOTIFICATION: received from neighbor B3::2 active 2/8 (no supported AFI/SAFI) 3 bytes 000000
*Nov 15 21:59:06.394: %BGP-5-NBR_RESET: Neighbor B3::2 active reset (BGP Notification received)

```

## - IS-IS route flapping

We had route flapping issues with IS-IS on Bumble-2. The solution was to specify level-1 routes in our redistribute commands.

## - BGP AD/route loops

We had an issue where our IS-IS routes would override our iBGP routes on Bumble-1 and Bumble-3, which defeated the point of using iBGP in the first place as its routes weren't used. We fixed this by using the `distance` command in BGP's address-family config to lower the AD for internal BGP routes.

Unfortunately, this led to another issue, where the BGP routes to each other would result in a routing loop, as shown on Bumble-1 in the picture below. To fix this, we applied route maps to the BGP configurations on Bumble-1 and Bumble-3 that would block them from learning routes to each other via iBGP. Instead, they would send traffic to each other via an IS-IS route while preserving the other routes as iBGP, as intended.

```

Nov 18 21:58:19.797: %BGP-5-ADJCHANGE: neighbor B3::2 up
Bumble-1(config)#do sh ip route loops
->default:ipv4:base 20.2.0.0/24 -> base 20.2.0.2 bgp 00:03:02 N
->default:ipv6:base B3::/64 -> base B3::2 bgp 02:31:40 N
Bumble-1(config)#

```

## Conclusion

To wrap up, this lab was a great expansion on our previous BGP lab by teaching us the final remaining section of BGP we have yet to learn: internal peering. Adding a non-BGP router between the two iBGP routers was also a unique challenge that I enjoyed taking on. I'm hopeful that this more complete understanding of both external

and internal BGP, and how they communicate with both Cisco-proprietary and open standard routing protocols, will aid me in my networking ability in the future. By far, the most challenging part of this lab was keeping iBGP routes working between Bumble-1 and Bumble-3 while eliminating routing loops, but figuring out how to fix this problem using a route map was by far the most satisfying part of the lab, greatly improving my understanding of the optional characteristics of BGP.

## Signoff

