

# INTERNAL BORDER GATEWAY PROTOCOL (IBGP)

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# Purpose

The purpose of this lab is to explore the functions of internal BGP in routing large networks. We already have experience with configuring external BGP, so this was an opportunity to incorporate internal BGP and gain more experience with the versatile routing protocol.

# Background

Imagine that you are a waiter at a large restaurant. You have been working at the restaurant for a long time, so you know where every table is located and how to get to each table. Each night, when a customer places an order to the chef, you pass the information from the guest's table to the kitchen. When the order is ready, the kitchen tells you where to send the food, and you bring it to the guest's table. The guest and the chef do not know how to get to each other. When you deliver an order to a customer in your area, the chef knows to send it to your area, but does not know exactly where. Only you have that information. The same is true in an iBGP network. There are some routers, like the customer and the chef, that do not have information on all networks. However, they have information on either end of the network. The waiter is like the iBGP routers. They carry all the information on all routes in the network, learned through external BGP and other internal routing protocols. Only the waiter is able to carry an order from the customer to the chef, similarly, only the iBGP router has the network information to send information from one end of the network to another.

# Lab Summary

First, I created my topology. I set R1, R2, and R6 in the OSPF autonomous system 1, R3, R4, and R5 in EIGRP AS 2, and R7 & R8 in EIGRP AS 1. Then, I assigned IPv4 and IPv6 addresses to each of the connected interfaces on all routers. Next, I configured the appropriate routing protocol in their respective autonomous systems. On the edge routers (R4 and R3), I made sure to advertise the connected network through EIGRP. Once the routers created network adjacencies and recognized the appropriate routers as neighbors in OSPF or EIGRP, I began the BGP configuration. R3, R4, and R5 are in the internal BGP network. I configured R4 to be neighbors with R6, R5, and R3, even though it is not directly connected to R3. Similarly, on R3, I configured neighbors with R4, R5, and R7. Then, I activated the neighbors in the appropriate address families. After BGP was configured on the AS 200, I configured eBGP on R6 and R7. In addition, I issued the redistribute command on R6 and R7 to redistribute the EIGRP networks. In the EIGRP configuration, I also issued the redistribute bgp command. To test the configuration, I tried to ping from R1 to R7 in both IPv4 and IPv6. I issued a traceroute from R1 to R7 to show that the packet was travelling through the whole network. In addition, when looking at the routing table, R3, R4, and R5 had information on all networks (192.168.1.0 through 192.168.7.0), whereas all other routers only had information on the non-iBGP networks (192.168.1.0, 192.168.2.0, 192.168.3.0, 192.168.6.0, and 192.168.7.0).

# Lab Commands

```
R1(config)#router bgp [AS number]
```

This command allows you to create a BGP autonomous system and enter router configuration mode.

```
R1(config-router)#neighbor [IP address] remote-as [AS number]
```

This command configures BGP neighbors for IPv4 or IPv6 for the correct autonomous system. This is where the differentiation between internal and external BGP occurs.

```
R1(config-router)#address-family [ipv4 / ipv6]
```

Command to enter the address family configuration for standard IPv4/IPv6 prefixes.

```
R1(config-router)#neighbor [ipv4/ipv6 address] activate
```

This command activates the configured neighbor into the address family

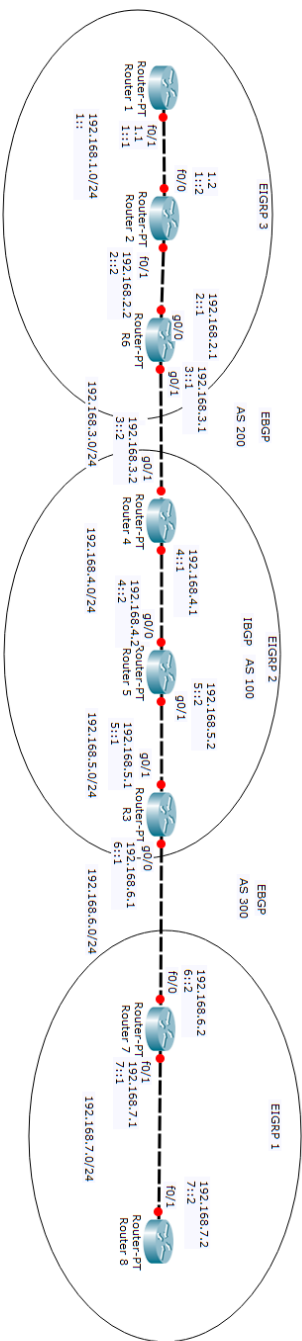
```
R1(config-router)#redistribute [routing protocol] [AS number]
```

Command entered in routing protocol configuration to redistribute an internal routing protocol, like OSPF, EIGRP, or BGP.

```
R1(config-router)#no bgp default ipv4-unicast
```

This command prepares the router to use multiple protocols and not only advertise the IPv4 unicast family, which is the default.

# Network Diagram



# Configurations

## R1 show run:

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

Current configuration : 1604 bytes
version 12.4
no service password-encryption
hostname R1
no aaa new-model
no ip domain lookup
ipv6 unicast-routing
ipv6 cef
interface FastEthernet0/0
  no ip address
  shutdown
  duplex auto
  speed auto
interface FastEthernet0/1
  ip address 192.168.1.1 255.255.255.0
  duplex auto
  speed auto
  ipv6 address 1::1/64
  ipv6 eigrp 30
router eigrp 3
  network 192.168.1.0
  auto-summary
ip forward-protocol nd
ipv6 router eigrp 30
  eigrp router-id 1.1.1.1
  no shutdown
line con 0
line aux 0
line vty 0 4
  login
scheduler allocate 20000 1000
end
```

## R2 show run:

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

Current configuration : 1380 bytes
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
hostname R2
boot-start-marker
boot-end-marker
logging message-counter syslog
no aaa new-model
no ip domain lookup
ipv6 unicast-routing
ipv6 cef
interface FastEthernet0/0
  ip address 192.168.1.2 255.255.255.0
  duplex auto
  speed auto
  ipv6 address 1::2/64
  ipv6 eigrp 30
interface FastEthernet0/1
  ip address 192.168.2.2 255.255.255.0
  duplex auto
  speed auto
  ipv6 address 2::2/64
  ipv6 eigrp 30
router eigrp 3
  network 192.168.1.0
  network 192.168.2.0
  auto-summary
ipv6 router eigrp 30
  no shutdown
line con 0
line aux 0
line vty 0 4
  login
scheduler allocate 20000 1000
end
```

### **R3 show run:**

```
R3#sh run
Building configuration...
Current configuration : 2245 bytes
Last configuration change at 16:16:11
UTC Thu Mar 30 2017
version 15.2
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
hostname R3
boot-start-marker
boot-end-marker
no ip domain lookup
ipv6 unicast-routing
ipv6 cef
interface GigabitEthernet0/0
 ip address 192.168.6.1 255.255.255.0
 duplex auto
 speed auto
 ipv6 address 6::1/64
 ipv6 eigrp 20
interface GigabitEthernet0/1
 ip address 192.168.5.1 255.255.255.0
 duplex auto
 speed auto
 ipv6 address 5::1/64
 ipv6 eigrp 20
router eigrp 2
 network 192.168.5.0
 network 192.168.6.0
 eigrp router-id 3.3.3.3
router bgp 100
 bgp log-neighbor-changes
 no bgp default ipv4-unicast
 neighbor 4::1 remote-as 100
 neighbor 5::2 remote-as 100
 neighbor 6::2 remote-as 300
 neighbor 192.168.4.1 remote-as 100
 neighbor 192.168.5.2 remote-as 100
 neighbor 192.168.6.2 remote-as 300
 address-family ipv4
  neighbor 192.168.4.1 activate
  neighbor 192.168.5.2 activate
  neighbor 192.168.6.2 activate
 exit-address-family
 address-family ipv6
  neighbor 4::1 activate
  neighbor 5::2 activate
  neighbor 6::2 activate
 exit-address-family
```

```
ip forward-protocol nd
ipv6 router eigrp 20
 eigrp router-id 3.3.3.3
line con 0
line aux 0
line 2
 no activation-character
 no exec
 transport preferred none
 transport output lat pad telnet rlogin
 lapb-ta mop udptn v120 ssh
 stopbits 1
line vty 0 4
 login
 transport input all
scheduler allocate 20000 1000
End
```

### **R4 show run:**

```
R4#sh run
Building configuration...
Current configuration : 2327 bytes
Last configuration change at 15:49:16
UTC Thu Mar 30 2017
version 15.2
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
hostname R4
no ip domain lookup
ipv6 unicast-routing
ipv6 cef
interface GigabitEthernet0/0
 ip address 192.168.4.1 255.255.255.0
 duplex auto
 speed auto
 ipv6 address 4::1/64
 ipv6 eigrp 20
interface GigabitEthernet0/1
 ip address 192.168.3.2 255.255.255.0
 duplex auto
 speed auto
 ipv6 address 3::2/64
 ipv6 eigrp 20
router eigrp 2
 network 192.168.3.0
 network 192.168.4.0
 eigrp router-id 4.4.4.4
router bgp 100
 bgp log-neighbor-changes
 no bgp default ipv4-unicast
```

```

neighbor 3::1 remote-as 200
neighbor 4::2 remote-as 100
neighbor 5::1 remote-as 100
neighbor 192.168.3.1 remote-as 200
neighbor 192.168.4.2 remote-as 100
neighbor 192.168.5.1 remote-as 100
address-family ipv4
  neighbor 192.168.3.1 activate
  neighbor 192.168.4.2 activate
  neighbor 192.168.5.1 activate
exit-address-family
address-family ipv6
  neighbor 3::1 activate
  neighbor 4::2 activate
  neighbor 5::1 activate
exit-address-family
ipv6 router eigrp 20
  eigrp router-id 4.4.4.4
line con 0
line aux 0
line 2
  no activation-character
  no exec
  transport preferred none
  transport output lat pad telnet rlogin
lapb-ta mop udptn v120 ssh
  stopbits 1
line vty 0 4
  login
  transport input all
scheduler allocate 20000 1000
End

```

#### **R5 show run:**

```

R5#sh run
Building configuration...
Current configuration : 2394 bytes
Last configuration change at 15:53:39
UTC Thu Mar 30 2017
version 15.2
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
hostname R5
no ip domain lookup
ipv6 unicast-routing
ipv6 cef
interface GigabitEthernet0/0
  ip address 192.168.4.2 255.255.255.0
  ip broadcast-address 192.168.4.0

```

```

duplex auto
speed auto
ipv6 address 4::2/64
ipv6 eigrp 20
interface GigabitEthernet0/1
  ip address 192.168.5.2 255.255.255.0
  ip broadcast-address 192.168.5.0
  duplex auto
  speed auto
  ipv6 address 5::2/64
  ipv6 eigrp 20
router eigrp 2
  network 192.168.4.0
  network 192.168.5.0
  eigrp router-id 5.5.5.5
router bgp 100
  bgp log-neighbor-changes
  no bgp default ipv4-unicast
  neighbor 4::1 remote-as 100
  neighbor 5::1 remote-as 100
  neighbor 192.168.4.1 remote-as 100
  neighbor 192.168.5.1 remote-as 100
  address-family ipv4
    neighbor 192.168.4.1 activate
    neighbor 192.168.5.1 activate
  exit-address-family
  address-family ipv6
    neighbor 4::1 activate
    neighbor 5::1 activate
  exit-address-family
  ipv6 router eigrp 20
    eigrp router-id 5.5.5.5
  line con 0
  line aux 0
  line 2
    no activation-character
    no exec
    transport preferred none
    transport output lat pad telnet rlogin
  lapb-ta mop udptn v120 ssh
    stopbits 1
  line vty 0 4
    login
    transport input all
  scheduler allocate 20000 1000
End

```



**R6 show run:**

```
R6#sh run
Building configuration...
Current configuration : 2262 bytes
Last configuration change at 17:03:50
UTC Thu Mar 30 2017
version 15.2
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
hostname R6
no ip domain lookup
ipv6 unicast-routing
ipv6 cef
interface GigabitEthernet0/0
 ip address 192.168.2.1 255.255.255.0
 duplex auto
 speed auto
 ipv6 address 2::1/64
 ipv6 eigrp 30
interface GigabitEthernet0/1
 ip address 192.168.3.1 255.255.255.0
 duplex auto
 speed auto
 ipv6 address 3::1/64
router eigrp 3
 network 192.168.2.0
 network 192.168.3.0
 redistribute bgp 200 metric 100 1 255
255 1
 eigrp router-id 6.6.6.6
router bgp 200
 bgp log-neighbor-changes
 no bgp default ipv4-unicast
 neighbor 3::2 remote-as 100
 neighbor 192.168.3.2 remote-as 100
 address-family ipv4
  redistribute eigrp 3
  neighbor 192.168.3.2 activate
 exit-address-family
 address-family ipv6
  redistribute connected
  redistribute eigrp 30
  neighbor 3::2 activate
 exit-address-family
ipv6 router eigrp 30
 redistribute bgp 200 metric 100 1 255
255 1
line con 0
line aux 0
line 2
```

```
no activation-character
no exec
transport preferred none
transport output lat pad telnet rlogin
lapb-ta mop udptn v120 ssh
stopbits 1
line vty 0 4
 login
 transport input all
scheduler allocate 20000 1000
end
```

**R7 show run:**

```
R7#sh run
Building configuration...
Current configuration : 1888 bytes
Last configuration change at 17:38:58
UTC Thu Mar 30 2017
version 15.1
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
hostname R7
no ip domain lookup
ipv6 unicast-routing
ipv6 cef
interface FastEthernet0/0
 ip address 192.168.6.2 255.255.255.0
 duplex auto
 speed auto
 ipv6 address 6::2/64
interface FastEthernet0/1
 ip address 192.168.7.1 255.255.255.0
 duplex auto
 speed auto
 ipv6 address 7::1/64
 ipv6 eigrp 10
router eigrp 1
 network 192.168.6.0
 network 192.168.7.0
 redistribute bgp 300 metric 100 1 255
255 1
 eigrp router-id 7.7.7.7
router bgp 300
 bgp log-neighbor-changes
 no bgp default ipv4-unicast
 neighbor 6::1 remote-as 100
 neighbor 192.168.6.1 remote-as 100
 address-family ipv4
  redistribute eigrp 1
  neighbor 192.168.6.1 activate
```

```

exit-address-family
address-family ipv6
    redistribute connected
    redistribute eigrp 10
    neighbor 6::1 activate
exit-address-family
ipv6 router eigrp 10
    redistribute bgp 300 metric 100 1 255
255 1
line con 0
line aux 0
line vty 0 4
    login
    transport input all
scheduler allocate 20000 1000
end

```

### **R8 show run:**

```

R8#sh run
Building configuration...
Current configuration : 1420 bytes
Last configuration change at 17:54:06
UTC Thu Mar 30 2017
version 15.1
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
hostname R8
no ip domain lookup
ipv6 unicast-routing
ipv6 cef
interface FastEthernet0/0
    no ip address
    shutdown
    duplex auto
    speed auto
interface FastEthernet0/1
    ip address 192.168.7.2 255.255.255.0
    duplex auto
    speed auto
    ipv6 address 7::2/64
    ipv6 eigrp 10
router eigrp 1
    network 192.168.7.0
    eigrp router-id 8.8.8.8
ipv6 router eigrp 10
line con 0
line aux 0
line vty 0 4
    login
    transport input all

```

### **R1 show ip route:**

R1#sh ip route

Codes: 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

Gateway of last resort is not set

D EX 192.168.6.0/24 [170/25605376] via 192.168.1.2, 00:29:11, FastEthernet0/1

D EX 192.168.7.0/24 [170/25605376] via 192.168.1.2, 00:29:11, FastEthernet0/1

C 192.168.1.0/24 is directly connected, FastEthernet0/1

D 192.168.2.0/24 [90/30720] via 192.168.1.2, 00:41:21, FastEthernet0/1

D 192.168.3.0/24 [90/30976] via 192.168.1.2, 00:41:18, FastEthernet0/1

### **R1 show ipv6 route:**

R1#sh ipv6 route

IPv6 Routing Table - Default - 6 entries

Codes: C - Connected, L - Local, S - Static, U - Per-user Static route

B - BGP, M - MIPv6, R - RIP, I1 - ISIS L1

I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary, D - EIGRP

EX - EIGRP external

O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2

ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2

C 1::/64 [0/0]

via FastEthernet0/1, directly connected

L 1::1/128 [0/0]

via FastEthernet0/1, receive

D 2::/64 [90/30720]

via FE80::215:C6FF:FE78:D5A0, FastEthernet0/1

EX 6::/64 [170/25605376]

via FE80::215:C6FF:FE78:D5A0, FastEthernet0/1

EX 7::/64 [170/25605376]

via FE80::215:C6FF:FE78:D5A0, FastEthernet0/1

L FF00::/8 [0/0]

via Null0, receive

### **R1 traceroute to R8:**

R1#traceroute 192.168.7.2

Type escape sequence to abort.

Tracing the route to 192.168.7.2

```
 1 192.168.1.2 0 msec 0 msec 4 msec
 2 192.168.2.1 0 msec 0 msec 0 msec
 3 192.168.3.2 0 msec 0 msec 0 msec
 4 192.168.4.2 0 msec 0 msec 4 msec
 5 192.168.5.1 0 msec 4 msec 0 msec
 6 192.168.6.2 4 msec 0 msec 4 msec
 7 192.168.7.2 4 msec * 0 msec
```

### **R1 ping to R8:**

R1#ping 192.168.7.2

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 192.168.7.2, timeout is 2 seconds:

!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 1/2/4 ms

R1#ping 7::2

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 7::2, timeout is 2 seconds:

!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 0/2/4 ms

### **R2 show ip route:**

R2#sh ip route

Codes: 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

Gateway of last resort is not set

D EX 192.168.6.0/24 [170/25605376] via 192.168.1.2, 00:29:11, FastEthernet0/1

D EX 192.168.7.0/24 [170/25605376] via 192.168.1.2, 00:29:11, FastEthernet0/1

C 192.168.1.0/24 is directly connected, FastEthernet0/0

C 192.168.2.0/24 is directly connected, FastEthernet0/1

D 192.168.3.0/24 [90/30976] via 192.168.2.1, 00:41:18, FastEthernet0/1

## R2 show ipv6 route:

R2#sh ipv6 route

IPv6 Routing Table - Default - 6 entries

Codes: C - Connected, L - Local, S - Static, U - Per-user Static route

B - BGP, M - MIPv6, R - RIP, I1 - ISIS L1

I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary, D - EIGRP

EX - EIGRP external

O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2

ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2

```
C 1::/64 [0/0]
    via FastEthernet0/1, directly connected
L 1::1/128 [0/0]
    via FastEthernet0/1, receive
C 2::/64 [0/0]
    Via FastEthernet0/0, directly connected
D 3::/64 [90/30720]
    via FE80::215:C6FF:FE78:D5A0, FastEthernet0/1
EX 6::/64 [170/25605376]
    via FE80::215:C6FF:FE78:D5A0, FastEthernet0/1
EX 7::/64 [170/25605376]
    via FE80::215:C6FF:FE78:D5A0, FastEthernet0/1
L FF00::/8 [0/0]
    via Null0, receive
```

## R3#sh 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

```
B 192.168.1.0/24 [200/30720] via 192.168.3.1, 00:39:32
B 192.168.2.0/24 [200/0] via 192.168.3.1, 00:39:32
D 192.168.3.0/24 [90/3328] via 192.168.5.2, 00:40:38, GigabitEthernet0/1
D 192.168.4.0/24 [90/3072] via 192.168.5.2, 00:40:38, GigabitEthernet0/1
192.168.5.0/24 is variably subnetted, 2 subnets, 2 masks
C 192.168.5.0/24 is directly connected, GigabitEthernet0/1
L 192.168.5.1/32 is directly connected, GigabitEthernet0/1
192.168.6.0/24 is variably subnetted, 2 subnets, 2 masks
C 192.168.6.0/24 is directly connected, GigabitEthernet0/0
L 192.168.6.1/32 is directly connected, GigabitEthernet0/0
B 192.168.7.0/24 [20/0] via 192.168.6.2, 00:36:14
```

### R3#sh ipv6 route:

IPv6 Routing Table - default - 10 entries

Codes: C - Connected, L - Local, S - Static, U - Per-user Static route

B - BGP, HA - Home Agent, MR - Mobile Router, R - RIP

H - NHRP, I1 - ISIS L1, I2 - ISIS L2, IA - ISIS interarea

IS - ISIS summary, D - EIGRP, EX - EIGRP external, NM - NEMO

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, I - LISP

```
B 1::/64 [200/30720]
    via 3::1
B 2::/64 [200/0]
    via 3::1
D 3::/64 [90/3328]
    via FE80::32E4:DBFF:FE67:1779, GigabitEthernet0/1
D 4::/64 [90/3072]
    via FE80::32E4:DBFF:FE67:1779, GigabitEthernet0/1
C 5::/64 [0/0]
    via GigabitEthernet0/1, directly connected
L 5::1/128 [0/0]
    via GigabitEthernet0/1, receive
C 6::/64 [0/0]
    via GigabitEthernet0/0, directly connected
L 6::1/128 [0/0]
    via GigabitEthernet0/0, receive
B 7::/64 [20/0]
    via FE80::222:90FF:FE0C:DCF0, GigabitEthernet0/0
L FF00::/8 [0/0]
    via Null0, receive
```

### R3 show ip bgp:

R3#sh ip bgp

BGP table version is 10, local router ID is 192.168.6.1

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	192.168.1.0	192.168.3.1	30720	100	0	200 ?
*>i	192.168.2.0	192.168.3.1	0	100	0	200 ?
r>i	192.168.3.0	192.168.3.1	0	100	0	200 ?
r>	192.168.6.0	192.168.6.2	0		0	300 ?
*>	192.168.7.0	192.168.6.2	0		0	300 ?

**R3#sh bgp ipv4 unicast neighbors | include BGP:**

BGP neighbor is 192.168.4.1, remote AS 100, internal link  
BGP version 4, remote router ID 192.168.4.1  
BGP state = Established, up for 00:41:25  
BGP table version 10, neighbor version 10/0  
BGP neighbor is 192.168.5.2, remote AS 100, internal link  
BGP version 4, remote router ID 192.168.5.2  
BGP state = Established, up for 00:41:27  
BGP table version 10, neighbor version 10/0  
BGP neighbor is 192.168.6.2, remote AS 300, external link  
BGP version 4, remote router ID 192.168.7.1  
BGP state = Established, up for 00:41:12  
BGP table version 10, neighbor version 10/0

**R3#sh bgp ipv6 unicast neighbors | include BGP:**

BGP neighbor is 4::1, remote AS 100, internal link  
BGP version 4, remote router ID 192.168.4.1  
BGP state = Established, up for 00:41:38  
BGP table version 6, neighbor version 6/0  
BGP neighbor is 5::2, remote AS 100, internal link  
BGP version 4, remote router ID 192.168.5.2  
BGP state = Established, up for 00:41:36  
BGP table version 6, neighbor version 6/0  
BGP neighbor is 6::2, remote AS 300, external link  
BGP version 4, remote router ID 192.168.7.1  
BGP state = Established, up for 00:41:25  
BGP table version 6, neighbor version 6/0

**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

B 192.168.1.0/24 [20/30720] via 192.168.3.1, 00:46:24  
B 192.168.2.0/24 [20/0] via 192.168.3.1, 00:46:54  
192.168.3.0/24 is variably subnetted, 2 subnets, 2 masks  
C 192.168.3.0/24 is directly connected, GigabitEthernet0/1  
L 192.168.3.2/32 is directly connected, GigabitEthernet0/1  
192.168.4.0/24 is variably subnetted, 2 subnets, 2 masks  
C 192.168.4.0/24 is directly connected, GigabitEthernet0/0  
L 192.168.4.1/32 is directly connected, GigabitEthernet0/0  
D 192.168.5.0/24 [90/3072] via 192.168.4.2, 00:43:09, GigabitEthernet0/0  
D 192.168.6.0/24 [90/28672] via 192.168.4.2, 00:42:51, GigabitEthernet0/0  
B 192.168.7.0/24 [200/0] via 192.168.6.2, 00:38:41

#### **R4#show ipv6 route:**

IPv6 Routing Table - default - 10 entries

Codes: C - Connected, L - Local, S - Static, U - Per-user Static route

B - BGP, HA - Home Agent, MR - Mobile Router, R - RIP

H - NHRP, I1 - ISIS L1, I2 - ISIS L2, IA - ISIS interarea

IS - ISIS summary, D - EIGRP, EX - EIGRP external, NM - NEMO

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 1::/64 [20/30720]
    via FE80::4255:39FF:FED2:3691, GigabitEthernet0/1
B 2::/64 [20/0]
    via FE80::4255:39FF:FED2:3691, GigabitEthernet0/1
C 3::/64 [0/0]
    via GigabitEthernet0/1, directly connected
L 3::2/128 [0/0]
    via GigabitEthernet0/1, receive
C 4::/64 [0/0]
    via GigabitEthernet0/0, directly connected
L 4::1/128 [0/0]
    via GigabitEthernet0/0, receive
D 5::/64 [90/3072]
    via FE80::32E4:DBFF:FE67:1778, GigabitEthernet0/0
D 6::/64 [90/28672]
    via FE80::32E4:DBFF:FE67:1778, GigabitEthernet0/0
B 7::/64 [200/0]
    via 6::2
L FF00::/8 [0/0]
    via Null0, receive
```

#### **R4#show ip bgp:**

BGP table version is 12, local router ID is 192.168.4.1

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
*>	192.168.1.0	192.168.3.1	30720		0 200	?
*>	192.168.2.0	192.168.3.1	0		0 200	?
r>	192.168.3.0	192.168.3.1	0		0 200	?
r>i	192.168.6.0	192.168.6.2	0	100	0 300	?
*>i	192.168.7.0	192.168.6.2	0	100	0 300	?



**R4#show bgp ipv4 unicast neighbors | include BGP:**

BGP neighbor is 192.168.3.1, remote AS 200, external link  
BGP version 4, remote router ID 192.168.3.1  
BGP state = Established, up for 01:11:35  
BGP table version 12, neighbor version 12/0  
BGP neighbor is 192.168.4.2, remote AS 100, internal link  
BGP version 4, remote router ID 192.168.5.2  
BGP state = Established, up for 01:07:46  
BGP table version 12, neighbor version 12/0  
Bestpath from iBGP peer: 4 n/a  
BGP neighbor is 192.168.5.1, remote AS 100, internal link  
BGP version 4, remote router ID 192.168.6.1  
BGP state = Established, up for 00:44:04  
BGP table version 12, neighbor version 12/0  
Bestpath from iBGP peer: 4 n/a

**R4#show bgp ipv6 unicast neighbors | include BGP:**

BGP neighbor is 3::1, remote AS 200, external link  
BGP version 4, remote router ID 192.168.3.1  
BGP state = Established, up for 01:11:52  
BGP table version 8, neighbor version 8/0  
BGP neighbor is 4::2, remote AS 100, internal link  
BGP version 4, remote router ID 192.168.5.2  
BGP state = Established, up for 01:07:57  
BGP table version 8, neighbor version 8/0  
Bestpath from iBGP peer: 2 n/a  
BGP neighbor is 5::1, remote AS 100, internal link  
BGP version 4, remote router ID 192.168.6.1  
BGP state = Established, up for 00:44:20  
BGP table version 8, neighbor version 8/0  
Bestpath from iBGP peer: 2 n/a

**R5#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

B 192.168.1.0/24 [200/30720] via 192.168.3.1, 00:48:44  
B 192.168.2.0/24 [200/0] via 192.168.3.1, 00:49:15  
D 192.168.3.0/24 [90/3072] via 192.168.4.1, 00:55:32, GigabitEthernet0/0  
192.168.4.0/24 is variably subnetted, 2 subnets, 2 masks  
C 192.168.4.0/24 is directly connected, GigabitEthernet0/0  
L 192.168.4.2/32 is directly connected, GigabitEthernet0/0  
192.168.5.0/24 is variably subnetted, 2 subnets, 2 masks  
C 192.168.5.0/24 is directly connected, GigabitEthernet0/1  
L 192.168.5.2/32 is directly connected, GigabitEthernet0/1  
D 192.168.6.0/24 [90/28416] via 192.168.5.1, 00:45:12, GigabitEthernet0/1  
B 192.168.7.0/24 [200/0] via 192.168.6.2, 00:41:02

**R5#show ipv6 route:**

IPv6 Routing Table - default - 10 entries

Codes: C - Connected, L - Local, S - Static, U - Per-user Static route

B - BGP, HA - Home Agent, MR - Mobile Router, R - RIP

H - NHRP, I1 - ISIS L1, I2 - ISIS L2, IA - ISIS interarea

IS - ISIS summary, D - EIGRP, EX - EIGRP external, NM - NEMO

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 1::/64 [200/30720]
    via 3::1
B 2::/64 [200/0]
    via 3::1
D 3::/64 [90/3072]
    via FE80::7ADA:6EFF:FE99:AB20, GigabitEthernet0/0
C 4::/64 [0/0]
    via GigabitEthernet0/0, directly connected
L 4::2/128 [0/0]
    via GigabitEthernet0/0, receive
C 5::/64 [0/0]
    via GigabitEthernet0/1, directly connected
L 5::2/128 [0/0]
    via GigabitEthernet0/1, receive
D 6::/64 [90/28416]
    via FE80::26E9:B3FF:FE3C:1C61, GigabitEthernet0/1
B 7::/64 [200/0]
    via 6::2
L FF00::/8 [0/0]
    via Null0, receive
```

**R5#show ip bgp:**

BGP table version is 16, local router ID is 192.168.5.2

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	192.168.1.0	192.168.3.1	30720	100	0	200 ?
*>i	192.168.2.0	192.168.3.1	0	100	0	200 ?
r>i	192.168.3.0	192.168.3.1	0	100	0	200 ?
r>i	192.168.6.0	192.168.6.2	0	100	0	300 ?
*>i	192.168.7.0	192.168.6.2	0	100	0	300 ?

**R5#show bgp ipv4 unicast neighbors | include BGP:**

BGP neighbor is 192.168.4.1, remote AS 100, internal link  
BGP version 4, remote router ID 192.168.4.1  
BGP state = Established, up for 01:14:19  
BGP table version 16, neighbor version 16/0  
Bestpath from iBGP peer: 4 n/a  
BGP neighbor is 192.168.5.1, remote AS 100, internal link  
BGP version 4, remote router ID 192.168.6.1  
BGP state = Established, up for 00:50:39  
BGP table version 16, neighbor version 16/0  
Bestpath from iBGP peer: 4 n/a

**R5#show bgp ipv6 unicast neighbors | include BGP:**

BGP neighbor is 4::1, remote AS 100, internal link  
BGP version 4, remote router ID 192.168.4.1  
BGP state = Established, up for 01:14:25  
BGP table version 12, neighbor version 12/0  
Bestpath from iBGP peer: 2 n/a  
BGP neighbor is 5::1, remote AS 100, internal link  
BGP version 4, remote router ID 192.168.6.1  
BGP state = Established, up for 00:50:47  
BGP table version 12, neighbor version 12/0  
Bestpath from iBGP peer: 2 n/a

**R6#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

D 192.168.1.0/24 [90/30720] via 192.168.2.2, 00:55:25, GigabitEthernet0/0  
192.168.2.0/24 is variably subnetted, 2 subnets, 2 masks  
C 192.168.2.0/24 is directly connected, GigabitEthernet0/0  
L 192.168.2.1/32 is directly connected, GigabitEthernet0/0  
192.168.3.0/24 is variably subnetted, 2 subnets, 2 masks  
C 192.168.3.0/24 is directly connected, GigabitEthernet0/1  
L 192.168.3.1/32 is directly connected, GigabitEthernet0/1  
B 192.168.6.0/24 [20/0] via 192.168.3.2, 00:50:34  
B 192.168.7.0/24 [20/0] via 192.168.3.2, 00:47:17

### **R6#show ipv6 route:**

IPv6 Routing Table - default - 8 entries

Codes: C - Connected, L - Local, S - Static, U - Per-user Static route

B - BGP, HA - Home Agent, MR - Mobile Router, R - RIP

H - NHRP, I1 - ISIS L1, I2 - ISIS L2, IA - ISIS interarea

IS - ISIS summary, D - EIGRP, EX - EIGRP external, NM - NEMO

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

```
D 1::/64 [90/30720]
    via FE80::215:C6FF:FE78:D5A1, GigabitEthernet0/0
C 2::/64 [0/0]
    via GigabitEthernet0/0, directly connected
L 2::1/128 [0/0]
    via GigabitEthernet0/0, receive
C 3::/64 [0/0]
    via GigabitEthernet0/1, directly connected
L 3::1/128 [0/0]
    via GigabitEthernet0/1, receive
B 6::/64 [20/0]
    via FE80::7ADA:6EFF:FE99:AB21, GigabitEthernet0/1
B 7::/64 [20/0]
    via FE80::7ADA:6EFF:FE99:AB21, GigabitEthernet0/1
L FF00::/8 [0/0]
    via Null0, receive
```

### **R7#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

```
B 192.168.1.0/24 [20/0] via 192.168.6.1, 00:51:35
B 192.168.2.0/24 [20/0] via 192.168.6.1, 00:51:35
B 192.168.3.0/24 [20/0] via 192.168.6.1, 00:51:35
  192.168.6.0/24 is variably subnetted, 2 subnets, 2 masks
C 192.168.6.0/24 is directly connected, FastEthernet0/0
L 192.168.6.2/32 is directly connected, FastEthernet0/0
  192.168.7.0/24 is variably subnetted, 2 subnets, 2 masks
C 192.168.7.0/24 is directly connected, FastEthernet0/1
L 192.168.7.1/32 is directly connected, FastEthernet0/1
```

### **R7#show ipv6 route:**

IPv6 Routing Table - default - 8 entries

Codes: C - Connected, L - Local, S - Static, U - Per-user Static route  
B - BGP, HA - Home Agent, MR - Mobile Router, R - RIP  
I1 - ISIS L1, I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary  
D - EIGRP, EX - EIGRP external, NM - NEMO, ND - Neighbor Discovery  
l - LISP  
O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2  
ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2

B 1::/64 [20/0]  
via FE80::26E9:B3FF:FE3C:1C60, FastEthernet0/0

B 2::/64 [20/0]  
via FE80::26E9:B3FF:FE3C:1C60, FastEthernet0/0

B 3::/64 [20/0]  
via FE80::26E9:B3FF:FE3C:1C60, FastEthernet0/0

C 6::/64 [0/0]  
via FastEthernet0/0, directly connected

L 6::2/128 [0/0]  
via FastEthernet0/0, receive

C 7::/64 [0/0]  
via FastEthernet0/1, directly connected

L 7::1/128 [0/0]  
via FastEthernet0/1, receive

L FF00::/8 [0/0]  
via Null0, receive

### **R8#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

D EX 192.168.1.0/24 [170/25602816] via 192.168.7.1, 00:49:25, FastEthernet0/1  
D EX 192.168.2.0/24 [170/25602816] via 192.168.7.1, 00:49:25, FastEthernet0/1  
D EX 192.168.3.0/24 [170/25602816] via 192.168.7.1, 00:49:25, FastEthernet0/1  
D 192.168.6.0/24 [90/30720] via 192.168.7.1, 00:49:25, FastEthernet0/1  
192.168.7.0/24 is variably subnetted, 2 subnets, 2 masks  
C 192.168.7.0/24 is directly connected, FastEthernet0/1  
L 192.168.7.2/32 is directly connected, FastEthernet0/1

**R8#show ipv6 route:**

IPv6 Routing Table - default - 6 entries

Codes: C - Connected, L - Local, S - Static, U - Per-user Static route

B - BGP, HA - Home Agent, MR - Mobile Router, R - RIP

I1 - ISIS L1, I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary

D - EIGRP, EX - EIGRP external, NM - NEMO, ND - Neighbor Discovery

l - LISP

O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2

ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2

```
EX 1::/64 [170/25602816]
    via FE80::222:90FF:FE0C:DCF1, FastEthernet0/1
EX 2::/64 [170/25602816]
    via FE80::222:90FF:FE0C:DCF1, FastEthernet0/1
EX 3::/64 [170/25602816]
    via FE80::222:90FF:FE0C:DCF1, FastEthernet0/1
C 7::/64 [0/0]
    via FastEthernet0/1, directly connected
L 7::2/128 [0/0]
    via FastEthernet0/1, receive
L FF00::/8 [0/0]
    via Null0, receive
```

# Problems

I mainly had layer 1 issues on this lab. After pasting all my configurations into the correct routers, the link light was up for interface f0/0, but the protocol would not go up. I tried shutting down the interface and turning it back on again, but the state just went from administratively down to down. Next, I switched the cable, because I knew a faulty protocol state had to be a layer 1 issue. However, the port light still did not turn on. Then, I entered the reload command, thinking there was something in the router configuration that was interfering with the interface. After looking online to confirm that a protocol error was a layer 1 issue, I tried switching the cable again. The link state and protocol state were finally both up.

Another issue I had was with redistribution between OSPF and iBGP. For some reason, I was unable to redistribute the routes from R6 into the internal BGP network. The router directly connected to R6, R4, was able to get the routes, but they were not passed along to R5 and R3. I tried various forms of the redistribute command. I also tried resetting BGP using the clear ip bgp command. Then, thinking it was an issue with OSPF, I switched my internal BGP network to EIGRP. In that switch, BGP neighbor adjacencies appeared and the routes appeared under the show ip bgp command, but they still did not show in the routing table. Then, I realized that on R4, I did not advertise the link between R3 and R4 in EIGRP. After adding the network statement, the networks 192.168.1.0, 192.168.2.0, and 192.168.3.0 appeared in the routing table for R3 and R5, and subsequently, R7 and R8.

# Conclusion

BGP is a very versatile, but also very meticulous routing protocol. Internal BGP is a very useful feature that allows for much freedom in a large network, but configuration can be tricky. I am glad I had the opportunity to configure internal BGP and review my configuration of OSPF and EIGRP. I have a greater understanding of how to lessen the traffic on large networks by using an internal core and a IGP on the outside.