

eBGP

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**Purpose**

The purpose of this lab is to configure BGP to enable communications between two separate autonomous systems. EBGP or exterior border gateway protocol is used to transport information to different autonomous systems with BGP enabled.

**Background Information on lab concepts**

eBGP is an extension of the routing protocol BGP. It is used between different autonomous systems while its counterpart iBGP is used inside the autonomous systems. It enables connections between different autonomous systems in the network that have BGP. It is mainly implemented on the edge or border router that provides connectivity for two or more autonomous systems.

Since eBGP is an extension of BGP I'll explain how BGP works first. BGP manages how packets get routed between networks through the exchange of reachability and routing information between edge routers. It creates stability within its network by making sure routers can adapt to route failures. For example, when one route goes down, a new route is quicky found. It makes routing decisions based on paths, which are defined by rules or network policies that network administrators set. BGP is generally used in connecting individual networks managed by a large organization to other groups of networks managed by large organizations. These network groups are also called autonomous systems (AS). Each AS creates different rules and policies on how they want traffic to move in its network. Different AS organizations arrange peering agreements that allow traffic to travel in their networks. In BGP, the BGP routers at the edge of AS networks advertise to peers the prefixes of the IP addresses, they can send traffic to. These routers regularly send advertisements through network-prefix announcements so they can update each other's routing table. It works by using decision-making algorithms to analyze the data they gather. They then decide which peer is best to send each packet to. Generally, the path with the fewest number of hops is chosen, but if there is delay and congestion on that route, BGP may choose a longer router if it’s faster. Once traffic moves across an autonomous system and gets to another BGP router connected to a different autonomous system. This process is repeated until the data reaches the autonomous system where its destination is. For network operators to control routing in their networks and to exchange routing information with other internet server providers, they need autonomous system numbers (ASN). These numbers are assigned by IANA or the Internet Assigned Numbers Authority. Just like an IP address, ASNs are both 16-bit and 32-bit numbers.  
 There are many things that make eBGP different from iBGP. First, eBGp goes between two BGP in different autonomous systems. It also has an administrative distance of 20 compared to iBGPs 200. EBGP routes that are received from an eBGP peer can be advertised to eBGP and iBGP peers while in iBGP, routes received from an iBGP peer cannot be advertised to other iBGP peers, but they can be advertised to eBGP peers. Another thing is that eBGP doesn’t require a full mesh topology while iBGP does. eBGP is also used between organization or between organization and ISP, and its default peers have a TTL of 1 while iBGP has a default TTL of 255. These are some of the things that make eBGP different from iBGP but the main difference is that eBGP is used between autonomous systems while iBGP is used inside autonomous systems.

**Lab Summary**

In this lab, I used six 4321 Cisco Routers and five copper-straight through cables. Each router, except for the two border routers had two copper-straight throughs connected to them. One cable went in the GigabitEthernet 0/0/0 interface and the other went in the GigabitEthernet 0/0/1 interface. After that, I assigned the interfaces of each router an IPv4 and IPv6 address and configured loopback addresses on the routers. Then, I configured BGP on the routers. Finally, I pinged my routers with each other to verify connectivity and did other commands like show ip protocols and show ip bgp summary to ensure that BGP was working.

**Lab Commands**

Router(config)**#ipv6 unicast-routing**

This command globally enables IPv6 routing.

Router(config)**#**router **bgp <AS Number>**

This command enables BGP on the router and enters BGP configuration mode. The AS (autonomous system) number identifies the router’s BGP configuration group. When you configure external BGP, two connected routers should not have the same AS number, as that will signal they are in different groups.

Router(config-router) **#no bgp default ipv4-unicast**

This command disables the default behavior of BGPv4 to advertise only IPv4 unicast routes and enables multi-protocol BGP mode.

Router(config-router) **#address-family <Address Family>**

This command enters BGP address-family configuration mode. The address family parameter covers ipv4 and ipv6. Each one brings the router to its respective configuration mode for either BGPv4 or BGPv6.

Router(config-router)**#neighbor <IP Address> remote-as <Neighbor AS Number>**

This command configures a BGP neighbor. It can be either an IPv4 or IPv6 address. The Neighbor AS Number parameter requires the AS number of the adjacent router. This command statically configures BGP to create a neighbor connection. This command needs to be entered correctly on both routers in order for a neighbor connection to be formed. This command needs to be entered twice, once for IPv4 and once for IPv6, for dual stack operation.

Router(config-router-af)**#neighbor <IP Address> activate**

This command activates the BGP neighbor connection. It can be either an IPv4 or IPv6 address. You can enter it in either the IPv4 or IPv6 address family configuration mode to activate respective neighbor connections.

Router(config-router-af)**#network <IPv4 Address> mask <Subnet Mask>**

This command activates an IPv4 network for BGP information distribution.

Router(config-router-af)**#network <IPv6 Address>**

This command activates an IPv6 network for BGP information distribution.

Router(config-router-af)**#redistribute <protocol> <protocol number>**

This command allows BGP to distribute information from a different protocol. It can be either OSPF or EIGRP. The protocol number is the process-id of OSPF or the AS number of EIGRP.

Router(config-router)**#redistribute <protocol> <protocol number>**

This command is used in OSPF or EIGRP router configuration mode and allows them to distribute information from different routing protocols. The protocol parameter is only BGP. The protocol number is the AS number of the local BGP connection.

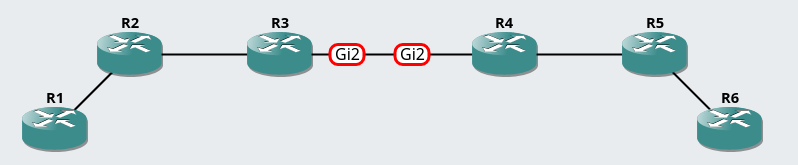
Router**#show ip/ipv6 protocols**

This command shows a summary of all the configured IPv4 and IPv6 protocols on the router.

Router**#show ip bgp**

This command displays entries in the bgp routing table.

**Network Diagram with IP's**



|  |  |  |  |
| --- | --- | --- | --- |
| **Device** | **Interface** | **IP Address** | **IPv6 Address** |
| R1 | G0/0/0 | 10.0.0.1 /24 | 100:1::1/64 |
| Loopback 0 | 192.168.1.1 /24 | 100:1::1/64 |
| R2 | G0/0/0 | 10.0.1.1 /24 | 10:2::1/64 |
| G0/0/1 | 10.0.0.2 /24 | 10:1::2/64 |
| Loopback 0 | 192.168.2.1 /24 | 100:2::1/64 |
| R3 | G0/0/0 | 10.0.2.1 /24 | 10:3::1/64 |
| G0/0/1 | 10.0.1.2 /24 | 10:2::2/64 |
| Loopback 0 | 192.168.3.1 /24 | 100:3::1/64 |
| R4 | G0/0/0 | 10.0.3.1 /24 | 10:4::1/64 |
| G0/0/1 | 10.0.2.2 /24 | 10:3::2/64 |
| Loopback 0 | 192.168.4.1 /24 | 100:4::1/64 |
| R5 | G0/0/0 | 10.0.4.1 /24 | 10:5::1/64 |
| G0/0/1 | 10.0.3.2 /24 | 10:4::2/64 |
| Loopback 0 | 192.168.5.1 /24 | 100:5::1/64 |
| R6 | G0/0/1 | 10.0.4.2 /24 | 10:5::2/64 |
| Loopback 0 | 192.168.6.1 /24 | 100:6::1/64 |

**Configurations**

**Router 1**

**show run**

R1#show run

Building configuration...

Current configuration : 1743 bytes

!

! Last configuration change at 17:11:38 UTC Fri Dec 3 2021

!

version 15.5

service timestamps debug datetime msec

service timestamps log datetime msec

no platform punt-keepalive disable-kernel-core

!

hostname R1

!

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

!

ipv6 unicast-routing

!

subscriber templating

multilink bundle-name authenticated

!

license udi pid ISR4321/K9 sn FDO214811ZM

!

spanning-tree extend system-id

!

redundancy

mode none

!

vlan internal allocation policy ascending

!

interface Loopback0

ip address 192.168.1.1 255.255.255.0

ipv6 address 100:1::1/64

ipv6 eigrp 1

!

interface GigabitEthernet0/0/0

ip address 10.0.0.1 255.255.255.0

negotiation auto

ipv6 address 10:1::1/64

ipv6 eigrp 1

!

interface GigabitEthernet0/0/1

no ip address

shutdown

negotiation auto

!

interface Serial0/1/0

no ip address

shutdown

!

interface Serial0/1/1

no ip address

shutdown

!

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

!

interface Vlan1

no ip address

shutdown

!

router eigrp 1

network 10.0.0.0 0.0.0.255

network 192.168.1.0

eigrp router-id 1.1.1.1

!

ip forward-protocol nd

no ip http server

no ip http secure-server

ip tftp source-interface GigabitEthernet0

!

ipv6 router eigrp 1

eigrp router-id 1.1.1.1

!

control-plane

!

line con 0

stopbits 1

line aux 0

stopbits 1

line vty 0 4

login

!

end

**show ip/ipv6 route**

R1#show ip route

Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP

D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area

N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2

E1 - OSPF external type 1, E2 - OSPF external type 2

i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2

ia - IS-IS inter area, \* - candidate default, U - per-user static route

o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP

a - application route

+ - replicated route, % - next hop override, p - overrides from PfR

Gateway of last resort is not set

10.0.0.0/8 is variably subnetted, 6 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

D 10.0.1.0/24 [90/3072] via 10.0.0.2, 00:40:08, GigabitEthernet0/0/0

D 10.0.2.0/24 [90/3328] via 10.0.0.2, 00:39:10, GigabitEthernet0/0/0

D EX 10.0.3.0/24 [170/282112] via 10.0.0.2, 00:28:00, GigabitEthernet0/0/0

D EX 10.0.4.0/24 [170/282112] via 10.0.0.2, 00:28:00, GigabitEthernet0/0/0

192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks

C 192.168.1.0/24 is directly connected, Loopback0

L 192.168.1.1/32 is directly connected, Loopback0

D 192.168.2.0/24 [90/130816] via 10.0.0.2, 00:40:08, GigabitEthernet0/0/0

D 192.168.3.0/24 [90/131072] via 10.0.0.2, 00:39:10, GigabitEthernet0/0/0

D EX 192.168.4.0/24 [170/282112] via 10.0.0.2, 00:28:00, GigabitEthernet0/0/0

192.168.5.0/32 is subnetted, 1 subnets

D EX 192.168.5.1 [170/282112] via 10.0.0.2, 00:28:00, GigabitEthernet0/0/0

192.168.6.0/32 is subnetted, 1 subnets

D EX 192.168.6.1 [170/282112] via 10.0.0.2, 00:28:00, GigabitEthernet0/0/0

R1#show ipv6 route

IPv6 Routing Table - default - 12 entries

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

B - BGP, R - RIP, I1 - ISIS L1, I2 - ISIS L2

IA - ISIS interarea, IS - ISIS summary, D - EIGRP, EX - EIGRP external

ND - ND Default, NDp - ND Prefix, DCE - Destination, NDr - Redirect

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

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

C 10:1::/64 [0/0]

via GigabitEthernet0/0/0, directly connected

L 10:1::1/128 [0/0]

via GigabitEthernet0/0/0, receive

D 10:2::/64 [90/3072]

via FE80::B6A8:B9FF:FE47:9471, GigabitEthernet0/0/0

D 10:3::/64 [90/3328]

via FE80::B6A8:B9FF:FE47:9471, GigabitEthernet0/0/0

EX 10:5::/64 [170/282112]

via FE80::B6A8:B9FF:FE47:9471, GigabitEthernet0/0/0

C 100:1::/64 [0/0]

via Loopback0, directly connected

L 100:1::1/128 [0/0]

via Loopback0, receive

D 100:2::/64 [90/130816]

via FE80::B6A8:B9FF:FE47:9471, GigabitEthernet0/0/0

D 100:3::/64 [90/131072]

via FE80::B6A8:B9FF:FE47:9471, GigabitEthernet0/0/0

EX 100:5::1/128 [170/282112]

via FE80::B6A8:B9FF:FE47:9471, GigabitEthernet0/0/0

EX 100:6::1/128 [170/282112]

via FE80::B6A8:B9FF:FE47:9471, GigabitEthernet0/0/0

L FF00::/8 [0/0]

via Null0, receive

**show ip/ipv6 protocols**

R1#show ip protocols

\*\*\* IP Routing is NSF aware \*\*\*

Routing Protocol is "application"

Sending updates every 0 seconds

Invalid after 0 seconds, hold down 0, flushed after 0

Outgoing update filter list for all interfaces is not set

Incoming update filter list for all interfaces is not set

Maximum path: 32

Routing for Networks:

Routing Information Sources:

Gateway Distance Last Update

Distance: (default is 4)

Routing Protocol is "eigrp 1"

Outgoing update filter list for all interfaces is not set

Incoming update filter list for all interfaces is not set

Default networks flagged in outgoing updates

Default networks accepted from incoming updates

EIGRP-IPv4 Protocol for AS(1)

Metric weight K1=1, K2=0, K3=1, K4=0, K5=0

Soft SIA disabled

NSF-aware route hold timer is 240

EIGRP NSF disabled

NSF signal timer is 20s

NSF converge timer is 120s

Router-ID: 1.1.1.1

Topology : 0 (base)

Active Timer: 3 min

Distance: internal 90 external 170

Maximum path: 4

Maximum hopcount 100

Maximum metric variance 1

Automatic Summarization: disabled

Maximum path: 4

Routing for Networks:

10.0.0.0/24

192.168.1.0

Routing Information Sources:

Gateway Distance Last Update

10.0.0.2 90 00:28:54

Distance: internal 90 external 170

R1#show ipv6 protocols

IPv6 Routing Protocol is "connected"

IPv6 Routing Protocol is "application"

IPv6 Routing Protocol is "ND"

IPv6 Routing Protocol is "eigrp 1"

EIGRP-IPv6 Protocol for AS(1)

Metric weight K1=1, K2=0, K3=1, K4=0, K5=0

Soft SIA disabled

NSF-aware route hold timer is 240

EIGRP NSF disabled

NSF signal timer is 20s

NSF converge timer is 120s

Router-ID: 1.1.1.1

Topology : 0 (base)

Active Timer: 3 min

Distance: internal 90 external 170

Maximum path: 16

Maximum hopcount 100

Maximum metric variance 1

Interfaces:

Loopback0

GigabitEthernet0/0/0

Redistribution:

None

**Router 2**

**show run**

R2#show run

Building configuration...

Current configuration : 1820 bytes

!

! Last configuration change at 15:48:54 UTC Mon Dec 6 2021

!

version 15.5

service timestamps debug datetime msec

service timestamps log datetime msec

no platform punt-keepalive disable-kernel-core

!

hostname R2

!

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

!

ipv6 unicast-routing

!

subscriber templating

multilink bundle-name authenticated

!

license udi pid ISR4321/K9 sn FDO214414TX

!

spanning-tree extend system-id

redundancy

mode none

vlan internal allocation policy ascending

!

interface Loopback0

ip address 192.168.2.1 255.255.255.0

ipv6 address 100:2::1/64

ipv6 eigrp 1

!

interface GigabitEthernet0/0/0

ip address 10.0.1.1 255.255.255.0

negotiation auto

ipv6 address 10:2::1/64

ipv6 eigrp 1

!

interface GigabitEthernet0/0/1

ip address 10.0.0.2 255.255.255.0

negotiation auto

ipv6 address 10:1::2/64

ipv6 eigrp 1

!

interface Serial0/1/0

no ip address

shutdown

!

interface Serial0/1/1

no ip address

shutdown

!

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

!

interface Vlan1

no ip address

shutdown

!

router eigrp 1

network 10.0.0.0 0.0.0.255

network 10.0.1.0 0.0.0.255

network 192.168.2.0

eigrp router-id 2.2.2.2

!

ip forward-protocol nd

no ip http server

no ip http secure-server

ip tftp source-interface GigabitEthernet0

!

ipv6 router eigrp 1

eigrp router-id 2.2.2.2

!

control-plane

!

line con 0

stopbits 1

line aux 0

stopbits 1

line vty 0 4

login

end

**show ip/ipv6 route**

R2#show ip route

Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP

D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area

N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2

E1 - OSPF external type 1, E2 - OSPF external type 2

i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2

ia - IS-IS inter area, \* - candidate default, U - per-user static route

o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP

a - application route

+ - replicated route, % - next hop override, p - overrides from PfR

Gateway of last resort is not set

10.0.0.0/8 is variably subnetted, 7 subnets, 2 masks

C 10.0.0.0/24 is directly connected, GigabitEthernet0/0/1

L 10.0.0.2/32 is directly connected, GigabitEthernet0/0/1

C 10.0.1.0/24 is directly connected, GigabitEthernet0/0/0

L 10.0.1.1/32 is directly connected, GigabitEthernet0/0/0

D 10.0.2.0/24 [90/3072] via 10.0.1.2, 00:05:49, GigabitEthernet0/0/0

D EX 10.0.3.0/24 [170/281856] via 10.0.1.2, 00:04:50, GigabitEthernet0/0/0

D EX 10.0.4.0/24 [170/281856] via 10.0.1.2, 00:04:50, GigabitEthernet0/0/0

D 192.168.1.0/24 [90/130816] via 10.0.0.1, 00:05:44, GigabitEthernet0/0/1

192.168.2.0/24 is variably subnetted, 2 subnets, 2 masks

C 192.168.2.0/24 is directly connected, Loopback0

L 192.168.2.1/32 is directly connected, Loopback0

D 192.168.3.0/24 [90/130816] via 10.0.1.2, 00:05:49, GigabitEthernet0/0/0

D EX 192.168.4.0/24 [170/281856] via 10.0.1.2, 00:04:50, GigabitEthernet0/0/0

192.168.5.0/32 is subnetted, 1 subnets

D EX 192.168.5.1 [170/281856] via 10.0.1.2, 00:04:50, GigabitEthernet0/0/0

192.168.6.0/32 is subnetted, 1 subnets

D EX 192.168.6.1 [170/281856] via 10.0.1.2, 00:04:50, GigabitEthernet0/0/0

R2#show ipv6 route

IPv6 Routing Table - default - 13 entries

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

B - BGP, R - RIP, I1 - ISIS L1, I2 - ISIS L2

IA - ISIS interarea, IS - ISIS summary, D - EIGRP, EX - EIGRP external

ND - ND Default, NDp - ND Prefix, DCE - Destination, NDr - Redirect

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

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

C 10:1::/64 [0/0]

via GigabitEthernet0/0/1, directly connected

L 10:1::2/128 [0/0]

via GigabitEthernet0/0/1, receive

C 10:2::/64 [0/0]

via GigabitEthernet0/0/0, directly connected

L 10:2::1/128 [0/0]

via GigabitEthernet0/0/0, receive

D 10:3::/64 [90/3072]

via FE80::227:90FF:FED4:F31, GigabitEthernet0/0/0

EX 10:5::/64 [170/281856]

via FE80::227:90FF:FED4:F31, GigabitEthernet0/0/0

D 100:1::/64 [90/130816]

via FE80::267E:12FF:FE55:5720, GigabitEthernet0/0/1

C 100:2::/64 [0/0]

via Loopback0, directly connected

L 100:2::1/128 [0/0]

via Loopback0, receive

D 100:3::/64 [90/130816]

via FE80::227:90FF:FED4:F31, GigabitEthernet0/0/0

EX 100:5::1/128 [170/281856]

via FE80::227:90FF:FED4:F31, GigabitEthernet0/0/0

EX 100:6::1/128 [170/281856]

via FE80::227:90FF:FED4:F31, GigabitEthernet0/0/0

L FF00::/8 [0/0]

via Null0, receive

**show ip/ipv6 protocols**

R2#show ip protocols

\*\*\* IP Routing is NSF aware \*\*\*

Routing Protocol is "application"

Sending updates every 0 seconds

Invalid after 0 seconds, hold down 0, flushed after 0

Outgoing update filter list for all interfaces is not set

Incoming update filter list for all interfaces is not set

Maximum path: 32

Routing for Networks:

Routing Information Sources:

Gateway Distance Last Update

Distance: (default is 4)

Routing Protocol is "eigrp 1"

Outgoing update filter list for all interfaces is not set

Incoming update filter list for all interfaces is not set

Default networks flagged in outgoing updates

Default networks accepted from incoming updates

EIGRP-IPv4 Protocol for AS(1)

Metric weight K1=1, K2=0, K3=1, K4=0, K5=0

Soft SIA disabled

NSF-aware route hold timer is 240

EIGRP NSF disabled

NSF signal timer is 20s

NSF converge timer is 120s

Router-ID: 2.2.2.2

Topology : 0 (base)

Active Timer: 3 min

Distance: internal 90 external 170

Maximum path: 4

Maximum hopcount 100

Maximum metric variance 1

Automatic Summarization: disabled

Maximum path: 4

Routing for Networks:

10.0.0.0/24

10.0.1.0/24

192.168.2.0

Routing Information Sources:

Gateway Distance Last Update

10.0.1.2 90 00:05:22

10.0.0.1 90 00:05:22

Distance: internal 90 external 170

R2#show ipv6 protocols

IPv6 Routing Protocol is "connected"

IPv6 Routing Protocol is "application"

IPv6 Routing Protocol is "ND"

IPv6 Routing Protocol is "eigrp 1"

EIGRP-IPv6 Protocol for AS(1)

Metric weight K1=1, K2=0, K3=1, K4=0, K5=0

Soft SIA disabled

NSF-aware route hold timer is 240

EIGRP NSF disabled

NSF signal timer is 20s

NSF converge timer is 120s

Router-ID: 2.2.2.2

Topology : 0 (base)

Active Timer: 3 min

Distance: internal 90 external 170

Maximum path: 16

Maximum hopcount 100

Maximum metric variance 1

Interfaces:

Loopback0

GigabitEthernet0/0/0

GigabitEthernet0/0/1

Redistribution:

None

**Router 3**

**show run**

R3#show run

Building configuration...

Current configuration : 2087 bytes

!

version 15.5

service timestamps debug datetime msec

service timestamps log datetime msec

no platform punt-keepalive disable-kernel-core

!

hostname R3

!

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

!

ipv6 unicast-routing

!

subscriber templating

multilink bundle-name authenticated

!

license udi pid ISR4321/K9 sn FDO214328EH

!

spanning-tree extend system-id

!

redundancy

mode none

!

vlan internal allocation policy ascending

!

interface Loopback0

ip address 192.168.3.1 255.255.255.0

ipv6 address 100:3::1/64

ipv6 eigrp 1

!

interface GigabitEthernet0/0/0

ip address 10.0.2.1 255.255.255.0

negotiation auto

ipv6 address 10:3::1/64

ipv6 eigrp 1

!

interface GigabitEthernet0/0/1

ip address 10.0.1.2 255.255.255.0

negotiation auto

ipv6 address 10:2::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

!

interface Vlan1

no ip address

shutdown

!

router eigrp 1

network 10.0.1.0 0.0.0.255

network 10.0.2.0 0.0.0.255

network 192.168.3.0

redistribute bgp 1 metric 10000 100 255 240 65535

eigrp router-id 3.3.3.3

!

router bgp 1

bgp log-neighbor-changes

neighbor 10:3::2 remote-as 2

neighbor 10.0.2.2 remote-as 2

!

address-family ipv4

redistribute eigrp 1

no neighbor 10:3::2 activate

neighbor 10.0.2.2 activate

exit-address-family

!

address-family ipv6

redistribute eigrp 1

network 10:3::/64

neighbor 10:3::2 activate

exit-address-family

!

ip forward-protocol nd

no ip http server

no ip http secure-server

ip tftp source-interface GigabitEthernet0

!

ipv6 router eigrp 1

eigrp router-id 3.3.3.3

redistribute bgp 1 metric 10000 100 255 240 65535

!

control-plane

!

line con 0

stopbits 1

line aux 0

stopbits 1

line vty 0 4

login

!

end

**show ip/ipv6 route**

R3#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

a - application route

+ - replicated route, % - next hop override, p - overrides from PfR

Gateway of last resort is not set

10.0.0.0/8 is variably subnetted, 7 subnets, 2 masks

D 10.0.0.0/24 [90/3072] via 10.0.1.1, 00:08:06, GigabitEthernet0/0/1

C 10.0.1.0/24 is directly connected, GigabitEthernet0/0/1

L 10.0.1.2/32 is directly connected, GigabitEthernet0/0/1

C 10.0.2.0/24 is directly connected, GigabitEthernet0/0/0

L 10.0.2.1/32 is directly connected, GigabitEthernet0/0/0

B 10.0.3.0/24 [20/0] via 10.0.2.2, 00:07:09

B 10.0.4.0/24 [20/2] via 10.0.2.2, 00:07:09

D 192.168.1.0/24 [90/131072] via 10.0.1.1, 00:08:04, GigabitEthernet0/0/1

D 192.168.2.0/24 [90/130816] via 10.0.1.1, 00:08:06, GigabitEthernet0/0/1

192.168.3.0/24 is variably subnetted, 2 subnets, 2 masks

C 192.168.3.0/24 is directly connected, Loopback0

L 192.168.3.1/32 is directly connected, Loopback0

B 192.168.4.0/24 [20/0] via 10.0.2.2, 00:07:09

192.168.5.0/32 is subnetted, 1 subnets

B 192.168.5.1 [20/2] via 10.0.2.2, 00:07:09

192.168.6.0/32 is subnetted, 1 subnets

B 192.168.6.1 [20/3] via 10.0.2.2, 00:07:09

R3#show ipv6 route

IPv6 Routing Table - default - 13 entries

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

B - BGP, R - RIP, I1 - ISIS L1, I2 - ISIS L2

IA - ISIS interarea, IS - ISIS summary, D - EIGRP, EX - EIGRP external

ND - ND Default, NDp - ND Prefix, DCE - Destination, NDr - Redirect

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

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

D 10:1::/64 [90/3072]

via FE80::B6A8:B9FF:FE47:9470, GigabitEthernet0/0/1

C 10:2::/64 [0/0]

via GigabitEthernet0/0/1, directly connected

L 10:2::2/128 [0/0]

via GigabitEthernet0/0/1, receive

C 10:3::/64 [0/0]

via GigabitEthernet0/0/0, directly connected

L 10:3::1/128 [0/0]

via GigabitEthernet0/0/0, receive

B 10:5::/64 [20/2]

via FE80::2C1:B1FF:FED5:5331, GigabitEthernet0/0/0

D 100:1::/64 [90/131072]

via FE80::B6A8:B9FF:FE47:9470, GigabitEthernet0/0/1

D 100:2::/64 [90/130816]

via FE80::B6A8:B9FF:FE47:9470, GigabitEthernet0/0/1

C 100:3::/64 [0/0]

via Loopback0, directly connected

L 100:3::1/128 [0/0]

via Loopback0, receive

B 100:5::1/128 [20/1]

via FE80::2C1:B1FF:FED5:5331, GigabitEthernet0/0/0

B 100:6::1/128 [20/2]

via FE80::2C1:B1FF:FED5:5331, GigabitEthernet0/0/0

L FF00::/8 [0/0]

via Null0, receive

**show ip/ipv6 protocols**

R3#show ip protocols

\*\*\* IP Routing is NSF aware \*\*\*

Routing Protocol is "application"

Sending updates every 0 seconds

Invalid after 0 seconds, hold down 0, flushed after 0

Outgoing update filter list for all interfaces is not set

Incoming update filter list for all interfaces is not set

Maximum path: 32

Routing for Networks:

Routing Information Sources:

Gateway Distance Last Update

Distance: (default is 4)

Routing Protocol is "eigrp 1"

Outgoing update filter list for all interfaces is not set

Incoming update filter list for all interfaces is not set

Default networks flagged in outgoing updates

Default networks accepted from incoming updates

Redistributing: bgp 1

EIGRP-IPv4 Protocol for AS(1)

Metric weight K1=1, K2=0, K3=1, K4=0, K5=0

Soft SIA disabled

NSF-aware route hold timer is 240

EIGRP NSF disabled

NSF signal timer is 20s

NSF converge timer is 120s

Router-ID: 3.3.3.3

Topology : 0 (base)

Active Timer: 3 min

Distance: internal 90 external 170

Maximum path: 4

Maximum hopcount 100

Maximum metric variance 1

Automatic Summarization: disabled

Maximum path: 4

Routing for Networks:

10.0.1.0/24

10.0.2.0/24

192.168.3.0

Routing Information Sources:

Gateway Distance Last Update

10.0.1.1 90 00:12:54

Distance: internal 90 external 170

Routing Protocol is "bgp 1"

Outgoing update filter list for all interfaces is not set

Incoming update filter list for all interfaces is not set

IGP synchronization is disabled

Automatic route summarization is disabled

Redistributing: eigrp 1

Neighbor(s):

Address FiltIn FiltOut DistIn DistOut Weight RouteMap

10.0.2.2

Maximum path: 1

Routing Information Sources:

Gateway Distance Last Update

10.0.2.2 20 00:12:02

Distance: external 20 internal 200 local 200

R3#show ipv6 protocols

IPv6 Routing Protocol is "connected"

IPv6 Routing Protocol is "application"

IPv6 Routing Protocol is "ND"

IPv6 Routing Protocol is "bgp 1"

IGP synchronization is disabled

Redistribution:

Redistributing protocol eigrp 1

Neighbor(s):

Address FiltIn FiltOut Weight RoutemapIn RoutemapOut

10:3::2

IPv6 Routing Protocol is "eigrp 1"

EIGRP-IPv6 Protocol for AS(1)

Metric weight K1=1, K2=0, K3=1, K4=0, K5=0

Soft SIA disabled

NSF-aware route hold timer is 240

EIGRP NSF disabled

NSF signal timer is 20s

NSF converge timer is 120s

Router-ID: 3.3.3.3

Topology : 0 (base)

Active Timer: 3 min

Distance: internal 90 external 170

Maximum path: 16

Maximum hopcount 100

Maximum metric variance 1

Interfaces:

Loopback0

GigabitEthernet0/0/0

GigabitEthernet0/0/1

Redistribution:

Redistributing protocol bgp 1 with metric 10000 100 255 240 65535

**show ip bgp**

R3#show ip bgp

BGP table version is 12, local router ID is 192.168.3.1

Status codes: s suppressed, d damped, h history, \* valid, > best, i - internal,

r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,

x best-external, a additional-path, c RIB-compressed,

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

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

Network Next Hop Metric LocPrf Weight Path

\*> 10.0.0.0/24 10.0.1.1 3072 32768 ?

\*> 10.0.1.0/24 0.0.0.0 0 32768 ?

\*> 10.0.2.0/24 0.0.0.0 0 32768 ?

\*> 10.0.3.0/24 10.0.2.2 0 0 2 ?

\*> 10.0.4.0/24 10.0.2.2 2 0 2 ?

\*> 192.168.1.0 10.0.1.1 131072 32768 ?

\*> 192.168.2.0 10.0.1.1 130816 32768 ?

\*> 192.168.3.0 0.0.0.0 0 32768 ?

\*> 192.168.4.0 10.0.2.2 0 0 2 ?

\*> 192.168.5.1/32 10.0.2.2 2 0 2 ?

\*> 192.168.6.1/32 10.0.2.2 3 0 2 ?

**show ip bgp summary**

R3#show ip bgp summary

BGP router identifier 192.168.3.1, local AS number 1

BGP table version is 12, main routing table version 12

11 network entries using 2728 bytes of memory

11 path entries using 1320 bytes of memory

7/7 BGP path/bestpath attribute entries using 1736 bytes of memory

1 BGP AS-PATH entries using 24 bytes of memory

0 BGP route-map cache entries using 0 bytes of memory

0 BGP filter-list cache entries using 0 bytes of memory

BGP using 5808 total bytes of memory

BGP activity 18/0 prefixes, 19/0 paths, scan interval 60 secs

Neighbor V AS MsgRcvd MsgSent TblVer InQ OutQ Up/Down State/PfxRcd

10.0.2.2 4 2 17 18 12 0 0 00:10:22 5

**Router 4**

**show run**

R4#show run

Building configuration...

Current configuration : 2111 bytes

!

version 15.5

service timestamps debug datetime msec

service timestamps log datetime msec

no platform punt-keepalive disable-kernel-core

!

hostname R4

!

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

!

ipv6 unicast-routing

!

subscriber templating

multilink bundle-name authenticated

!

license udi pid ISR4321/K9 sn FDO210907U3

!

spanning-tree extend system-id

!

redundancy

mode none

!

vlan internal allocation policy ascending

!

interface Loopback0

ip address 192.168.4.1 255.255.255.0

ipv6 address 100:4::1/64

ipv6 ospf 2 area 0

!

interface GigabitEthernet0/0/0

ip address 10.0.3.1 255.255.255.0

negotiation auto

ipv6 address 10:4::1/64

ipv6 ospf 2 area 0

!

interface GigabitEthernet0/0/1

ip address 10.0.2.2 255.255.255.0

negotiation auto

ipv6 address 10:3::2/64

!

interface Serial0/1/0

no ip address

shutdown

!

interface Serial0/1/1

no ip address

shutdown

!

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

!

interface Vlan1

no ip address

shutdown

!

router ospf 2

router-id 4.4.4.4

redistribute bgp 2 subnets

network 10.0.3.0 0.0.0.255 area 0

network 192.168.4.0 0.0.0.255 area 0

!

router bgp 2

bgp log-neighbor-changes

neighbor 10:3::1 remote-as 1

neighbor 10.0.2.1 remote-as 1

!

address-family ipv4

redistribute ospf 2

no neighbor 10:3::1 activate

neighbor 10.0.2.1 activate

exit-address-family

!

address-family ipv6

redistribute ospf 2

network 10:3::/64

neighbor 10:3::1 activate

exit-address-family

!

ip forward-protocol nd

no ip http server

no ip http secure-server

ip tftp source-interface GigabitEthernet0

!

ipv6 router ospf 2

redistribute bgp 2

!

ipv6 router ospf 1

!

control-plane

!

line con 0

stopbits 1

line aux 0

stopbits 1

line vty 0 4

login

!

end

**show ip/ipv6 route**

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

a - application route

+ - replicated route, % - next hop override, p - overrides from PfR

Gateway of last resort is not set

10.0.0.0/8 is variably subnetted, 7 subnets, 2 masks

B 10.0.0.0/24 [20/3072] via 10.0.2.1, 00:15:18

B 10.0.1.0/24 [20/0] via 10.0.2.1, 00:15:18

C 10.0.2.0/24 is directly connected, GigabitEthernet0/0/1

L 10.0.2.2/32 is directly connected, GigabitEthernet0/0/1

C 10.0.3.0/24 is directly connected, GigabitEthernet0/0/0

L 10.0.3.1/32 is directly connected, GigabitEthernet0/0/0

O 10.0.4.0/24 [110/2] via 10.0.3.2, 00:15:33, GigabitEthernet0/0/0

B 192.168.1.0/24 [20/131072] via 10.0.2.1, 00:15:18

B 192.168.2.0/24 [20/130816] via 10.0.2.1, 00:15:18

B 192.168.3.0/24 [20/0] via 10.0.2.1, 00:15:18

192.168.4.0/24 is variably subnetted, 2 subnets, 2 masks

C 192.168.4.0/24 is directly connected, Loopback0

L 192.168.4.1/32 is directly connected, Loopback0

192.168.5.0/32 is subnetted, 1 subnets

O 192.168.5.1 [110/2] via 10.0.3.2, 00:15:33, GigabitEthernet0/0/0

192.168.6.0/32 is subnetted, 1 subnets

O 192.168.6.1 [110/3] via 10.0.3.2, 00:15:33, GigabitEthernet0/0/0

R4#show ipv6 route

IPv6 Routing Table - default - 13 entries

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

B - BGP, R - RIP, I1 - ISIS L1, I2 - ISIS L2

IA - ISIS interarea, IS - ISIS summary, D - EIGRP, EX - EIGRP external

ND - ND Default, NDp - ND Prefix, DCE - Destination, NDr - Redirect

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

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

B 10:1::/64 [20/3072]

via FE80::227:90FF:FED4:F30, GigabitEthernet0/0/1

C 10:3::/64 [0/0]

via GigabitEthernet0/0/1, directly connected

L 10:3::2/128 [0/0]

via GigabitEthernet0/0/1, receive

C 10:4::/64 [0/0]

via GigabitEthernet0/0/0, directly connected

L 10:4::1/128 [0/0]

via GigabitEthernet0/0/0, receive

O 10:5::/64 [110/2]

via FE80::B6A8:B9FF:FE01:B5A1, GigabitEthernet0/0/0

B 100:1::/64 [20/131072]

via FE80::227:90FF:FED4:F30, GigabitEthernet0/0/1

B 100:2::/64 [20/130816]

via FE80::227:90FF:FED4:F30, GigabitEthernet0/0/1

C 100:4::/64 [0/0]

via Loopback0, directly connected

L 100:4::1/128 [0/0]

via Loopback0, receive

O 100:5::1/128 [110/1]

via FE80::B6A8:B9FF:FE01:B5A1, GigabitEthernet0/0/0

O 100:6::1/128 [110/2]

via FE80::B6A8:B9FF:FE01:B5A1, GigabitEthernet0/0/0

L FF00::/8 [0/0]

via Null0, receive

**show ip/ipv6 protocols**

R4#show ip protocols

\*\*\* IP Routing is NSF aware \*\*\*

Routing Protocol is "application"

Sending updates every 0 seconds

Invalid after 0 seconds, hold down 0, flushed after 0

Outgoing update filter list for all interfaces is not set

Incoming update filter list for all interfaces is not set

Maximum path: 32

Routing for Networks:

Routing Information Sources:

Gateway Distance Last Update

Distance: (default is 4)

Routing Protocol is "ospf 2"

Outgoing update filter list for all interfaces is not set

Incoming update filter list for all interfaces is not set

Router ID 4.4.4.4

It is an autonomous system boundary router

Redistributing External Routes from,

bgp 2, includes subnets in redistribution

Number of areas in this router is 1. 1 normal 0 stub 0 nssa

Maximum path: 4

Routing for Networks:

10.0.3.0 0.0.0.255 area 0

192.168.4.0 0.0.0.255 area 0

Routing Information Sources:

Gateway Distance Last Update

5.5.5.5 110 00:14:39

6.6.6.6 110 00:14:39

Distance: (default is 110)

Routing Protocol is "bgp 2"

Outgoing update filter list for all interfaces is not set

Incoming update filter list for all interfaces is not set

IGP synchronization is disabled

Automatic route summarization is disabled

Redistributing: ospf 2 (internal)

Neighbor(s):

Address FiltIn FiltOut DistIn DistOut Weight RouteMap

10.0.2.1

Maximum path: 1

Routing Information Sources:

Gateway Distance Last Update

10.0.2.1 20 00:14:26

Distance: external 20 internal 200 local 200

R4#show ipv6 protocols

IPv6 Routing Protocol is "connected"

IPv6 Routing Protocol is "application"

IPv6 Routing Protocol is "ND"

IPv6 Routing Protocol is "ospf 2"

Router ID 192.168.4.1

Autonomous system boundary router

Number of areas: 1 normal, 0 stub, 0 nssa

Interfaces (Area 0):

Loopback0

GigabitEthernet0/0/0

Redistribution:

Redistributing protocol bgp 2

IPv6 Routing Protocol is "bgp 2"

IGP synchronization is disabled

Redistribution:

Redistributing protocol ospf 2 (internal)

Neighbor(s):

Address FiltIn FiltOut Weight RoutemapIn RoutemapOut

10:3::1

IPv6 Routing Protocol is "ospf 1"

Router ID 192.168.4.1

Number of areas: 0 normal, 0 stub, 0 nssa

Redistribution:

None

**show ip bgp**

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

\*> 10.0.0.0/24 10.0.2.1 3072 0 1 ?

\*> 10.0.1.0/24 10.0.2.1 0 0 1 ?

r> 10.0.2.0/24 10.0.2.1 0 0 1 ?

\*> 10.0.3.0/24 0.0.0.0 0 32768 ?

\*> 10.0.4.0/24 10.0.3.2 2 32768 ?

\*> 192.168.1.0 10.0.2.1 131072 0 1 ?

\*> 192.168.2.0 10.0.2.1 130816 0 1 ?

\*> 192.168.3.0 10.0.2.1 0 0 1 ?

\*> 192.168.4.0 0.0.0.0 0 32768 ?

\*> 192.168.5.1/32 10.0.3.2 2 32768 ?

\*> 192.168.6.1/32 10.0.3.2 3 32768 ?

**show ip bgp summary**

R4#show ip bgp summary

BGP router identifier 192.168.4.1, local AS number 2

BGP table version is 12, main routing table version 12

11 network entries using 2728 bytes of memory

11 path entries using 1320 bytes of memory

7/7 BGP path/bestpath attribute entries using 1736 bytes of memory

1 BGP AS-PATH entries using 24 bytes of memory

0 BGP route-map cache entries using 0 bytes of memory

0 BGP filter-list cache entries using 0 bytes of memory

BGP using 5808 total bytes of memory

BGP activity 18/0 prefixes, 19/0 paths, scan interval 60 secs

Neighbor V AS MsgRcvd MsgSent TblVer InQ OutQ Up/Down State/PfxRcd

10.0.2.1 4 1 23 21 12 0 0 00:14:32 6

**Router 5**

**show run**

R5#show run

Building configuration...

Current configuration : 1653 bytes

!

version 15.5

service timestamps debug datetime msec

service timestamps log datetime msec

no platform punt-keepalive disable-kernel-core

!

hostname R5

!

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

!

ipv6 unicast-routing

!

subscriber templating

multilink bundle-name authenticated

!

license udi pid ISR4321/K9 sn FDO214421CH

!

spanning-tree extend system-id

!

redundancy

mode none

!

vlan internal allocation policy ascending

!

interface Loopback0

ip address 192.168.5.1 255.255.255.0

ipv6 address 100:5::1/64

ipv6 ospf 2 area 0

!

interface GigabitEthernet0/0/0

ip address 10.0.4.1 255.255.255.0

negotiation auto

ipv6 address 10:5::1/64

ipv6 ospf 2 area 0

!

interface GigabitEthernet0/0/1

ip address 10.0.3.2 255.255.255.0

negotiation auto

ipv6 address 10:4::2/64

ipv6 ospf 2 area 0

!

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

!

interface Vlan1

no ip address

shutdown

!

router ospf 2

router-id 5.5.5.5

network 10.0.3.0 0.0.0.255 area 0

network 10.0.4.0 0.0.0.255 area 0

network 192.168.5.0 0.0.0.255 area 0

!

ip forward-protocol nd

no ip http server

no ip http secure-server

ip tftp source-interface GigabitEthernet0

!

ipv6 router ospf 2

!

control-plane

!

line con 0

stopbits 1

line aux 0

stopbits 1

line vty 0 4

login

!

end

**show ip/ipv6 route**

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

a - application route

+ - replicated route, % - next hop override, p - overrides from PfR

Gateway of last resort is not set

10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks

O E2 10.0.0.0/24 [110/1] via 10.0.3.1, 00:17:06, GigabitEthernet0/0/1

O E2 10.0.1.0/24 [110/1] via 10.0.3.1, 00:17:06, GigabitEthernet0/0/1

C 10.0.3.0/24 is directly connected, GigabitEthernet0/0/1

L 10.0.3.2/32 is directly connected, GigabitEthernet0/0/1

C 10.0.4.0/24 is directly connected, GigabitEthernet0/0/0

L 10.0.4.1/32 is directly connected, GigabitEthernet0/0/0

O E2 192.168.1.0/24 [110/1] via 10.0.3.1, 00:17:06, GigabitEthernet0/0/1

O E2 192.168.2.0/24 [110/1] via 10.0.3.1, 00:17:06, GigabitEthernet0/0/1

O E2 192.168.3.0/24 [110/1] via 10.0.3.1, 00:17:06, GigabitEthernet0/0/1

192.168.4.0/32 is subnetted, 1 subnets

O 192.168.4.1 [110/2] via 10.0.3.1, 00:17:16, GigabitEthernet0/0/1

192.168.5.0/24 is variably subnetted, 2 subnets, 2 masks

C 192.168.5.0/24 is directly connected, Loopback0

L 192.168.5.1/32 is directly connected, Loopback0

192.168.6.0/32 is subnetted, 1 subnets

O 192.168.6.1 [110/2] via 10.0.4.2, 00:17:26, GigabitEthernet0/0/0

R5#show ipv6 route

IPv6 Routing Table - default - 12 entries

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

B - BGP, R - RIP, I1 - ISIS L1, I2 - ISIS L2

IA - ISIS interarea, IS - ISIS summary, D - EIGRP, EX - EIGRP external

ND - ND Default, NDp - ND Prefix, DCE - Destination, NDr - Redirect

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

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

OE2 10:1::/64 [110/1]

via FE80::2C1:B1FF:FED5:5330, GigabitEthernet0/0/1

C 10:4::/64 [0/0]

via GigabitEthernet0/0/1, directly connected

L 10:4::2/128 [0/0]

via GigabitEthernet0/0/1, receive

C 10:5::/64 [0/0]

via GigabitEthernet0/0/0, directly connected

L 10:5::1/128 [0/0]

via GigabitEthernet0/0/0, receive

OE2 100:1::/64 [110/1]

via FE80::2C1:B1FF:FED5:5330, GigabitEthernet0/0/1

OE2 100:2::/64 [110/1]

via FE80::2C1:B1FF:FED5:5330, GigabitEthernet0/0/1

O 100:4::1/128 [110/1]

via FE80::2C1:B1FF:FED5:5330, GigabitEthernet0/0/1

C 100:5::/64 [0/0]

via Loopback0, directly connected

L 100:5::1/128 [0/0]

via Loopback0, receive

O 100:6::1/128 [110/1]

via FE80::B6A8:B9FF:FE47:96B1, GigabitEthernet0/0/0

L FF00::/8 [0/0]

via Null0, receive

**show ip/ipv6 protocols**

R5#show ip protocols

\*\*\* IP Routing is NSF aware \*\*\*

Routing Protocol is "application"

Sending updates every 0 seconds

Invalid after 0 seconds, hold down 0, flushed after 0

Outgoing update filter list for all interfaces is not set

Incoming update filter list for all interfaces is not set

Maximum path: 32

Routing for Networks:

Routing Information Sources:

Gateway Distance Last Update

Distance: (default is 4)

Routing Protocol is "ospf 2"

Outgoing update filter list for all interfaces is not set

Incoming update filter list for all interfaces is not set

Router ID 5.5.5.5

Number of areas in this router is 1. 1 normal 0 stub 0 nssa

Maximum path: 4

Routing for Networks:

10.0.3.0 0.0.0.255 area 0

10.0.4.0 0.0.0.255 area 0

192.168.5.0 0.0.0.255 area 0

Routing Information Sources:

Gateway Distance Last Update

4.4.4.4 110 00:16:42

6.6.6.6 110 00:17:02

Distance: (default is 110)

R5#show ipv6 protocols

IPv6 Routing Protocol is "connected"

IPv6 Routing Protocol is "application"

IPv6 Routing Protocol is "ND"

IPv6 Routing Protocol is "ospf 2"

Router ID 192.168.5.1

Number of areas: 1 normal, 0 stub, 0 nssa

Interfaces (Area 0):

Loopback0

GigabitEthernet0/0/1

GigabitEthernet0/0/0

Redistribution:

None

**Router 6**

**show run**

R6#show run

Building configuration...

Current configuration : 1531 bytes

!

version 15.5

service timestamps debug datetime msec

service timestamps log datetime msec

no platform punt-keepalive disable-kernel-core

!

hostname R6

!

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

!

ipv6 unicast-routing

!

subscriber templating

multilink bundle-name authenticated

!

license udi pid ISR4321/K9 sn FDO214414VU

!

spanning-tree extend system-id

!

redundancy

mode none

!

vlan internal allocation policy ascending

!

interface Loopback0

ip address 192.168.6.1 255.255.255.0

ipv6 address 100:6::1/64

ipv6 ospf 2 area 0

!

interface GigabitEthernet0/0/0

no ip address

shutdown

negotiation auto

!

interface GigabitEthernet0/0/1

ip address 10.0.4.2 255.255.255.0

negotiation auto

ipv6 address 10:5::2/64

ipv6 ospf 2 area 0

!

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

!

interface Vlan1

no ip address

shutdown

!

router ospf 2

router-id 6.6.6.6

network 10.0.4.0 0.0.0.255 area 0

network 192.168.6.0 0.0.0.255 area 0

!

ip forward-protocol nd

no ip http server

no ip http secure-server

ip tftp source-interface GigabitEthernet0

!

ipv6 router ospf 2

!

control-plane

!

line con 0

stopbits 1

line aux 0

stopbits 1

line vty 0 4

login

!

end

**show ip/ipv6 route**

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

a - application route

+ - replicated route, % - next hop override, p - overrides from PfR

Gateway of last resort is not set

10.0.0.0/8 is variably subnetted, 5 subnets, 2 masks

O E2 10.0.0.0/24 [110/1] via 10.0.4.1, 00:23:55, GigabitEthernet0/0/1

O E2 10.0.1.0/24 [110/1] via 10.0.4.1, 00:23:55, GigabitEthernet0/0/1

O 10.0.3.0/24 [110/2] via 10.0.4.1, 00:24:15, GigabitEthernet0/0/1

C 10.0.4.0/24 is directly connected, GigabitEthernet0/0/1

L 10.0.4.2/32 is directly connected, GigabitEthernet0/0/1

O E2 192.168.1.0/24 [110/1] via 10.0.4.1, 00:23:55, GigabitEthernet0/0/1

O E2 192.168.2.0/24 [110/1] via 10.0.4.1, 00:23:55, GigabitEthernet0/0/1

O E2 192.168.3.0/24 [110/1] via 10.0.4.1, 00:23:55, GigabitEthernet0/0/1

192.168.4.0/32 is subnetted, 1 subnets

O 192.168.4.1 [110/3] via 10.0.4.1, 00:24:05, GigabitEthernet0/0/1

192.168.5.0/32 is subnetted, 1 subnets

O 192.168.5.1 [110/2] via 10.0.4.1, 00:24:15, GigabitEthernet0/0/1

192.168.6.0/24 is variably subnetted, 2 subnets, 2 masks

C 192.168.6.0/24 is directly connected, Loopback0

L 192.168.6.1/32 is directly connected, Loopback0

R6#show ipv6 route

IPv6 Routing Table - default - 11 entries

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

B - BGP, R - RIP, I1 - ISIS L1, I2 - ISIS L2

IA - ISIS interarea, IS - ISIS summary, D - EIGRP, EX - EIGRP external

ND - ND Default, NDp - ND Prefix, DCE - Destination, NDr - Redirect

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

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

OE2 10:1::/64 [110/1]

via FE80::B6A8:B9FF:FE01:B5A0, GigabitEthernet0/0/1

O 10:4::/64 [110/2]

via FE80::B6A8:B9FF:FE01:B5A0, GigabitEthernet0/0/1

C 10:5::/64 [0/0]

via GigabitEthernet0/0/1, directly connected

L 10:5::2/128 [0/0]

via GigabitEthernet0/0/1, receive

OE2 100:1::/64 [110/1]

via FE80::B6A8:B9FF:FE01:B5A0, GigabitEthernet0/0/1

OE2 100:2::/64 [110/1]

via FE80::B6A8:B9FF:FE01:B5A0, GigabitEthernet0/0/1

O 100:4::1/128 [110/2]

via FE80::B6A8:B9FF:FE01:B5A0, GigabitEthernet0/0/1

O 100:5::1/128 [110/1]

via FE80::B6A8:B9FF:FE01:B5A0, GigabitEthernet0/0/1

C 100:6::/64 [0/0]

via Loopback0, directly connected

L 100:6::1/128 [0/0]

via Loopback0, receive

L FF00::/8 [0/0]

via Null0, receive

**show ip/ipv6 protocols**

R6#show ip protocols

\*\*\* IP Routing is NSF aware \*\*\*

Routing Protocol is "application"

Sending updates every 0 seconds

Invalid after 0 seconds, hold down 0, flushed after 0

Outgoing update filter list for all interfaces is not set

Incoming update filter list for all interfaces is not set

Maximum path: 32

Routing for Networks:

Routing Information Sources:

Gateway Distance Last Update

Distance: (default is 4)

Routing Protocol is "ospf 2"

Outgoing update filter list for all interfaces is not set

Incoming update filter list for all interfaces is not set

Router ID 6.6.6.6

Number of areas in this router is 1. 1 normal 0 stub 0 nssa

Maximum path: 4

Routing for Networks:

10.0.4.0 0.0.0.255 area 0

192.168.6.0 0.0.0.255 area 0

Routing Information Sources:

Gateway Distance Last Update

4.4.4.4 110 00:21:17

5.5.5.5 110 00:21:36

Distance: (default is 110)

R6#show ipv6 protocols

IPv6 Routing Protocol is "connected"

IPv6 Routing Protocol is "application"

IPv6 Routing Protocol is "ND"

IPv6 Routing Protocol is "ospf 2"

Router ID 192.168.6.1

Number of areas: 1 normal, 0 stub, 0 nssa

Interfaces (Area 0):

Loopback0

GigabitEthernet0/0/1

Redistribution:

None

**Problems**

A problem I faced was that my middle BGP routers didn’t have IPv6 routes to networks directly connected to the other BGP router. I concluded that because the only routes missing were the ones directly connected to the other BGP router, the problem was probably that BGP was unable to communicate with the directly connected routes. After looking for different ways to fix this, I ran the **redistribute connected** command so BGP could send its directly connected routes to the other router with BGP. After running this command, I checked my BGP routers’ routing tables and they were fixed, and when I looked at my IPv6 routes for the middle routers, they were there.

**Conclusion**

EBGP is an extension of the BGP routing protocol and is used to transport information to different autonomous systems with BGP enabled. To configure eBGP you need to use BGP specific commands such as **router bgp <AS Number>** and **redistribute <protocol> <protocol number>.** There are also some BGP specific show commands that are helpful to verify BGP is working correctly after configuring it. These include **show ip bgp** and **show ip bgp summary.** I was able to configure an eBGP network that enabled communications between two separate autonomous systems, on 6 Cisco 4321 routers. Although I had some problems with my IPv6 routes, I was able to troubleshoot them to get BGP to work. Through this lab, I learned how to configure BGP in both ipv6 and ipv6, as well as develop a deeper understanding of everything needed to make it work.

**Teacher Signoff Page of Lab Completed**

**Evan Choi has completed this BGP Lab**

**December 3, 2021**

