CCNP ROUTING AND SWITCHING

Configuring eBGP Redistribution

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Purpose:

The purpose of this lab is to configure eBGP on the link between two different autonomous systems each with three routers, one running EIGRP and one running OSPF, configuring redistribution. Both would run with IPv4 and IPv6. Students will learn how to configure BGP and how to redistribute the routes through BGP.

Background:

Dynamic Routing Protocol Classifications:

The Internet basically consists of interconnected networks and autonomous systems. An autonomous system is a network or group of networks that are managed and administered by a single entity. There are two types of dynamic routing protocols, Interior Gateway Protocols (IGPs) or Exterior Gateway Protocols (EGPs). Interior Gateway Protocols, also known as intradomain routing protocols, are used within autonomous systems are routing protocols like OSPF or EIGRP that exchange routes within a single autonomous system. Not all IGPs are created equal as they use different algorithms to find paths and routes. Nevertheless, the main goal of IGPs is to use the most efficient routes depending on the metric. Some IGPs that I have used include EIGRP and OSPF, which use bandwidth and cost respectively.

Exterior Gateway Protocols, or interdomain routing protocols are used for routing between domains or autonomous systems. The main EGP protocol used on the Internet is BGP. BGP not only allows for routing between AS's, but also can enforce many routing policies not possible through IGPs, and not just finding the best route. BGP then selects a single path that is the best path to a network based on these constraints. You can also load balance over BGP. However, in this lab we will only cover routing between AS.

BGP Overview

Border Gateway Protocol (BGP) is an EGP designed to exchange loop-free routes across the Internet between different autonomous systems. Routers which connect different autonomous systems are called border gateways hence the name Border Gateway Protocol. Because BGP is the main standard which routes are exchanged across the Internet, it is important for network administrators of organizations that have connections to ISPs or ISPs who interact with other service providers to know how BGP works. BGP uses path-vector routing, and this algorithm combines both distance-vector routing and loop detection. Each router must maintain a table storing distance and vector to remote networks. BGP uses many factors to make routing decisions, including paths, network policies, or rules set by administrators.

BGP neighbors or peers are established when two routers establish a BGP connection. These BGP sessions use TCP or Transmission Control Protocol. The two different types of BGP are Interior BGP (IBGP) and Exterior BGP (EBGP). IBGP is used with BGP peers that exchange routes within the same autonomous systems. EBGP is used with BGP peers that exchange routes between different autonomous systems. We will be using EBGP to redistribute EIGRP and OSPF routes between two autonomous systems

In order to start BGP routing, you need to assign an autonomous system number. For our lab, there are two BGP autonomous systems, one attached to the EIGRP side of the network and one attached to the OSPF side. The ASN uniquely identifies the BGP domain. Since we are routing between separate BGP autonomous systems, BGP will use eBGP or external BGP routes (AD of 20). In order to exchange routing information with neighbors or BGP "peers", BGP does not do this automatically and you have to manually establish neighbor adjacencies through entering neighbor addresses. BGP is required to have a unique router id in order to establish connections with BGP peers.

MPBGP

Configured in an IPv4 network, BGP establishes sessions using IPv4 and BGP peers have IPv4 addresses. Advertised routes also include IPv4 addresses. Multiprotocol BGP was introduced to allow BGP to use other protocols like IPv6 unicast. To do this, address families are used. Address families help separate different families of addresses like IPv4 or IPv6 and allow for family specific configurations. Use the router address-family and neighbor address-family configuration modes to support multiprotocol BGP configurations. MP-BGP maintains separate RIBs for each configured address family, such as a unicast RIB and a multicast RIB for BGP.

BGP Redistribution

When using BGP, it is usually necessary to use IGP routes, so redistribution must be configured to both redistribute IGP routes into BGP and BGP routes into IGPs. BGP is also capable of redistributing IGPs into different IGPs between autonomous systems. The example we will use in this lab is EIGRP routes to OSPF routes. Do note that redistribution should be done with caution, as it is easy to end up accidentally distributing thousands of Internet routes into your IGP. To simplify this route redistribution, it is better to distribute a few summary routes using network statements. You can configure as many network statements as you need.

Lab Summary:

When configuring this BGP lab, I set up six 4321 Cisco Routers connected with copper crossover cables between their Gig 0/0/0 and 0/0/1 interfaces. Routers used the IPv4 network of 10.0.0.0 with a /30 subnet from 10.0.0.0-10.0.0.18. They also used the IPv6 network of 2001:db8:acad::/64. Loopback addresses are used in the place of LANs. Loopbacks have IPv4 addresses in the 192.168.0.0/16 network and are subnetted into /30s. They use IPv6 addresses in the 2001:db8:acad:0::1/64 network. I also configured OSPFv2 and OSPFv3 on three routers. I then configured EIGRP for IPv4 and IPv6 for the other three routers. I set loopback interfaces as passive interfaces. I configured BGP on the link between the EIGRP and OSPF autonomous systems, redistributing their routes. I also pinged all addresses in the network to ensure routes and BGP was working.

Lab Commands:

`Router(config)#`**`router bgp asn`**

Definition: Enables BGP and assigns an autonomous system number.

`Router(config-router)#`**`bgp router-id RID`**

Definition: Configures BGP router ID and uniquely identifies BGP router.

`Router(config-router)#`**`neighbor # remote-as ASN`**

Definition: Identifies BGP peer using their IPv4 or IPv6 address and ASN.

`Router(config-router)#`**`address-family ipv4/ipv6`**

Definition: Enters neighbor address family configuration mode for ipv4 or ipv6.

`Router(config-router-af)#`**`redistribute eigrp ASN`**

Definition: Command redistributes IPv4 or IPv6 EIGRP routes connected to router interface across BGP, and advertises them to peers.

`Router(config-router-af)#`**`neighbor IPV4#/IPV6 activate`**

Definition: This command is used to notify other BGP peers which family-address they support.

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

Definition: This command redistributes connected routes.

`Router(config-router)#`**`redistribute bgp ASN metric # # # # #`**

Definition: Redistributes BGP routes over EIGRP network.

`Router(config-router)#`**`redistribute bgp ASN metric #`**

Definition: Redistributes BGP routes over OSPF network.

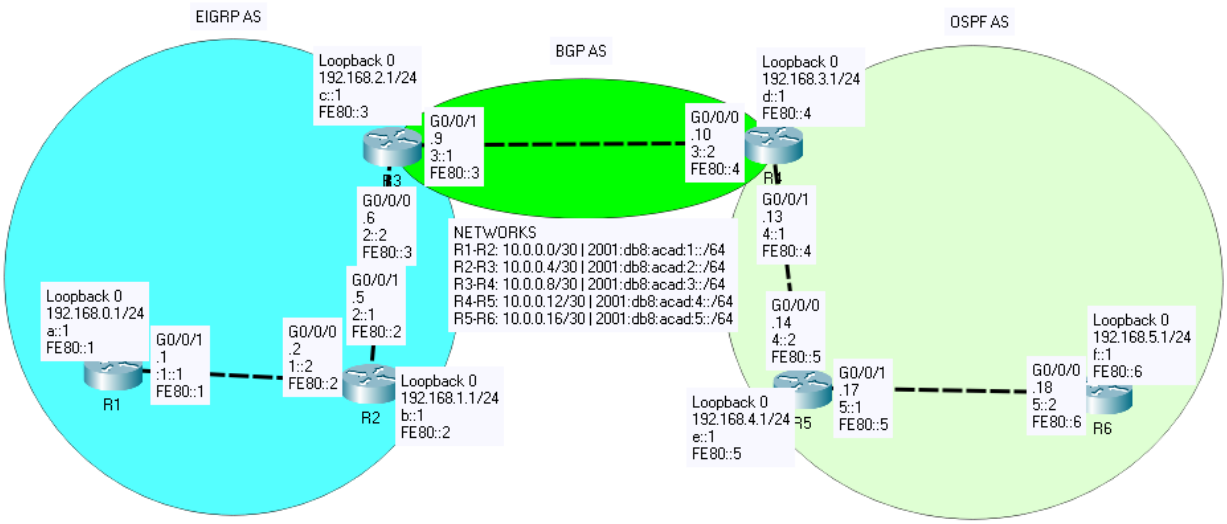
`Router#`**`show ip bgp`**

Definition: Displays contents of BGP routing table.

```
Router#show bgp ipv6 unicast
```

Definition: Shows content of IPv6 BGP routing table.

Topology Diagram:



Addressing Table:

Device	Interface	IP Address	IPv6 Address	Link-Local Addresses
R1	G 0/0/1	10.0.0.1/30	2001:db8:acad:1::1/64	fe80::1
	Loopback 0	192.168.0.1/24	2001:db8:acad:a::1/64	fe80::1
R2	G 0/0/0	10.0.0.2/30	2001:db8:acad:1::2/64	fe80::2
	G 0/0/1	10.0.0.5/30	2001:db8:acad:2::1/64	fe80::2
	Loopback 0	192.168.1.1/24	2001:db8:acad:b::1/64	fe80::2
R3	G 0/0/0	10.0.0.6/30	2001:db8:acad:2::2/64	fe80::3
	G 0/0/1	10.0.0.9/30	2001:db8:acad:3::1/64	fe80::3
	Loopback 0	192.168.2.1/24	2001:db8:acad:c::1/64	fe80::3
R4	G 0/0/0	10.0.0.10/30	2001:db8:acad:3::2/64	fe80::4
	G 0/0/1	10.0.0.13/30	2001:db8:acad:4::1/64	fe80::4
	Loopback 0	192.168.3.1/24	2001:db8:acad:d::1/64	fe80::4
R5	G 0/0/0	10.0.0.14/30	2001:db8:acad:4::2/64	fe80::5
	G 0/0/1	10.0.0.17/30	2001:db8:acad:5::1/64	fe80::5
	Loopback 0	192.168.4.1/32	2001:db8:acad:e::1/64	fe80::5
R6	G 0/0/0	10.0.0.18/32	2001:db8:acad:5::2/64	fe80::6
	Loopback 0	192.168.5.1/32	2001:db8:acad:f::1/64	fe80::6

Pings:

```
R1#      ping 10.0.0.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.0.0.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
R1#ping 10.0.0.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.0.0.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
R1#ping 10.0.0.5
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.0.0.5, timeout is 2 seconds:
```

```
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
R1#ping 10.0.0.6
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.0.0.6, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
R1#ping 10.0.0.9
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.0.0.9, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
R1#ping 10.0.0.10
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.0.0.10, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
R1#ping 10.0.0.13
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.0.0.13, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
R1#ping 10.0.0.14
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.0.0.14, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
R1#ping 10.0.0.17
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.0.0.17, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
R1#ping 10.0.0.18
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.0.0.18, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

R1#ping 192.168.0.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.0.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
R1#ping 192.168.1.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.1.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
R1#ping 192.168.2.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.2.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
R1#ping 192.168.3.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.3.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
R1#ping 192.168.4.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.4.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
R1#ping 192.168.5.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.5.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/2 ms


R1#ping 2001:db8:acad:1::1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:1::1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
R1#ping 2001:db8:acad:1::2
Type escape sequence to abort.
```

```
Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:1::2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/4/18 ms
R1#ping 2001:db8:acad:2::1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:2::1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
R1#ping 2001:db8:acad:2::2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:2::2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/2/7 ms
R1#ping 2001:db8:acad:3::1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:3::1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/2 ms
R1#ping 2001:db8:acad:3::2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:3::2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
R1#ping 2001:db8:acad:4::1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:4::1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
R1#ping 2001:db8:acad:4::2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:4::2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 3/6/15 ms
R1#ping 2001:db8:acad:5::1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:5::1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
R1#ping 2001:db8:acad:5::2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:5::2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

R1#ping 2001:db8:acad:a::1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:A::1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
R1#ping 2001:db8:acad:b::1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:B::1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
R1#ping 2001:db8:acad:c::1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:C::1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
R1#ping 2001:db8:acad:d::1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:D::1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
R1#ping 2001:db8:acad:e::1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:E::1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
R1#ping 2001:db8:acad:f::1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:F::1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/2 ms
```

Router 1 Config

```
version 15.5
no service timestamps debug uptime
no service timestamps log uptime
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
!
ipv6 unicast-routing
!
subscriber templating
multilink bundle-name authenticated
!
license udi pid ISR4321/K9 sn FDO21400XZX
!
spanning-tree mode pvst
spanning-tree extend system-id
!
redundancy
 mode none
!
vlan internal allocation policy ascending
!
interface Loopback0
 ip address 192.168.0.1 255.255.255.0
 ipv6 address FE80::1 link-local
 ipv6 address 2001:DB8:ACAD:A::1/64
 ipv6 eigrp 10
!
interface GigabitEthernet0/0/0
 no ip address
 negotiation auto
!
interface GigabitEthernet0/0/1
 ip address 10.0.0.1 255.255.255.252
 negotiation auto
 ipv6 address FE80::1 link-local
 ipv6 address 2001:DB8:ACAD:1::1/64
 ipv6 eigrp 10
!
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 eigrp 1
 network 10.0.0.0 0.0.0.3
 network 192.168.0.0
 passive-interface Loopback0
 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 10
 passive-interface Loopback0
 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
```

```
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        10.0.0.0/30 is directly connected, GigabitEthernet0/0/1
L        10.0.0.1/32 is directly connected, GigabitEthernet0/0/1
D        10.0.0.4/30 [90/3072] via 10.0.0.2, 01:09:15, GigabitEthernet0/0/1
D        10.0.0.8/30 [90/3328] via 10.0.0.2, 01:04:19, GigabitEthernet0/0/1
D EX     10.0.0.12/30
           [170/2560768] via 10.0.0.2, 00:47:46, GigabitEthernet0/0/1
D EX     10.0.0.16/30
           [170/2560768] via 10.0.0.2, 00:47:46, GigabitEthernet0/0/1
      192.168.0.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.0.0/24 is directly connected, Loopback0
L        192.168.0.1/32 is directly connected, Loopback0
D     192.168.1.0/24 [90/130816] via 10.0.0.2, 01:09:58, GigabitEthernet0/0/1
D     192.168.2.0/24 [90/131072] via 10.0.0.2, 01:09:13, GigabitEthernet0/0/1
D EX  192.168.3.0/24
           [170/2560768] via 10.0.0.2, 00:47:46, GigabitEthernet0/0/1
      192.168.4.0/32 is subnetted, 1 subnets
D EX     192.168.4.1
           [170/2560768] via 10.0.0.2, 00:47:46, GigabitEthernet0/0/1
      192.168.5.0/32 is subnetted, 1 subnets
D EX     192.168.5.1
           [170/2560768] via 10.0.0.2, 00:47:46, GigabitEthernet0/0/1
R1#  show ipv6 route
IPv6 Routing Table - default - 14 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   2001:DB8:ACAD:1::/64 [0/0]
     via GigabitEthernet0/0/1, directly connected
L   2001:DB8:ACAD:1::1/128 [0/0]
     via GigabitEthernet0/0/1, receive
D   2001:DB8:ACAD:2::/64 [90/3072]
     via FE80::2, GigabitEthernet0/0/1
D   2001:DB8:ACAD:3::/64 [90/3328]
     via FE80::2, GigabitEthernet0/0/1
EX  2001:DB8:ACAD:4::/64 [170/3328]
     via FE80::2, GigabitEthernet0/0/1
EX  2001:DB8:ACAD:5::/64 [170/3328]
     via FE80::2, GigabitEthernet0/0/1
C   2001:DB8:ACAD:A::/64 [0/0]
     via Loopback0, directly connected
L   2001:DB8:ACAD:A::1/128 [0/0]
```

```
     via Loopback0, receive
D   2001:DB8:ACAD:B::/64 [90/130816]
     via FE80::2, GigabitEthernet0/0/1
D   2001:DB8:ACAD:C::/64 [90/131072]
     via FE80::2, GigabitEthernet0/0/1
EX  2001:DB8:ACAD:D::/64 [170/3328]
     via FE80::2, GigabitEthernet0/0/1
EX  2001:DB8:ACAD:E::1/128 [170/3328]
     via FE80::2, GigabitEthernet0/0/1
EX  2001:DB8:ACAD:F::1/128 [170/3328]
     via FE80::2, GigabitEthernet0/0/1
L   FF00::/8 [0/0]
     via Null0, receive
R1# show ip protocol
*** 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: ospf 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: 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:
    10.0.0.0/30
    192.168.0.0
  Passive Interface(s):
    Loopback0
  Routing Information Sources:
    Gateway         Distance      Last Update
    10.0.0.2              90      00:47:56
  Distance: internal 90 external 170

R1#show ipv6 protocol
IPv6 Routing Protocol is "connected"
IPv6 Routing Protocol is "application"
IPv6 Routing Protocol is "ND"
IPv6 Routing Protocol is "eigrp 10"
EIGRP-IPv6 Protocol for AS(10)
  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:
    GigabitEthernet0/0/1
    Loopback0 (passive)
  Redistribution:
    None
```

Router 2 Config

```
version 15.5
no service timestamps debug uptime
no service timestamps log uptime
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
!
ipv6 unicast-routing
!
subscriber templating
multilink bundle-name authenticated
!
license udi pid ISR4321/K9 sn FDO21491FHX
!
spanning-tree mode pvst
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 2001:DB8:ACAD:B::1/64
 ipv6 eigrp 10
!
interface GigabitEthernet0/0/0
 ip address 10.0.0.2 255.255.255.252
 negotiation auto
 ipv6 address FE80::2 link-local
 ipv6 address 2001:DB8:ACAD:1::2/64
 ipv6 eigrp 10
!
interface GigabitEthernet0/0/1
 ip address 10.0.0.5 255.255.255.252
 negotiation auto
 ipv6 address FE80::2 link-local
 ipv6 address 2001:DB8:ACAD:2::1/64
 ipv6 eigrp 10
!
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 eigrp 1
 network 10.0.0.0 0.0.0.3
 network 10.0.0.4 0.0.0.3
 network 192.168.1.0
 passive-interface Loopback0
 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 10
 passive-interface Loopback0
 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
```

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        10.0.0.0/30 is directly connected, GigabitEthernet0/0/0
L        10.0.0.2/32 is directly connected, GigabitEthernet0/0/0
C        10.0.0.4/30 is directly connected, GigabitEthernet0/0/1
L        10.0.0.5/32 is directly connected, GigabitEthernet0/0/1
D        10.0.0.8/30 [90/3072] via 10.0.0.6, 01:05:55, GigabitEthernet0/0/1
D EX     10.0.0.12/30
           [170/2560512] via 10.0.0.6, 00:49:22, GigabitEthernet0/0/1
D EX     10.0.0.16/30
           [170/2560512] via 10.0.0.6, 00:49:22, GigabitEthernet0/0/1
D     192.168.0.0/24 [90/130816] via 10.0.0.1, 01:11:29, 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 10.0.0.6, 01:10:49, GigabitEthernet0/0/1
D EX  192.168.3.0/24
           [170/2560512] via 10.0.0.6, 00:49:22, GigabitEthernet0/0/1
      192.168.4.0/32 is subnetted, 1 subnets
D EX     192.168.4.1
           [170/2560512] via 10.0.0.6, 00:49:22, GigabitEthernet0/0/1
      192.168.5.0/32 is subnetted, 1 subnets
D EX     192.168.5.1
           [170/2560512] via 10.0.0.6, 00:49:22, GigabitEthernet0/0/1
```

R2# show ipv6 route

```
IPv6 Routing Table - default - 15 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   2001:DB8:ACAD:1::/64 [0/0]
     via GigabitEthernet0/0/0, directly connected
L   2001:DB8:ACAD:1::2/128 [0/0]
     via GigabitEthernet0/0/0, receive
C   2001:DB8:ACAD:2::/64 [0/0]
     via GigabitEthernet0/0/1, directly connected
L   2001:DB8:ACAD:2::1/128 [0/0]
     via GigabitEthernet0/0/1, receive
D   2001:DB8:ACAD:3::/64 [90/3072]
     via FE80::3, GigabitEthernet0/0/1
EX  2001:DB8:ACAD:4::/64 [170/3072]
     via FE80::3, GigabitEthernet0/0/1
EX  2001:DB8:ACAD:5::/64 [170/3072]
     via FE80::3, GigabitEthernet0/0/1
D   2001:DB8:ACAD:A::/64 [90/130816]
     via FE80::1, GigabitEthernet0/0/0
C   2001:DB8:ACAD:B::/64 [0/0]
     via Loopback0, directly connected
L   2001:DB8:ACAD:B::1/128 [0/0]
     via Loopback0, receive
D   2001:DB8:ACAD:C::/64 [90/130816]
     via FE80::3, GigabitEthernet0/0/1
EX  2001:DB8:ACAD:D::/64 [170/3072]
     via FE80::3, GigabitEthernet0/0/1
EX  2001:DB8:ACAD:E::1/128 [170/3072]
     via FE80::3, GigabitEthernet0/0/1
EX  2001:DB8:ACAD:F::1/128 [170/3072]
     via FE80::3, GigabitEthernet0/0/1
L   FF00::/8 [0/0]
     via Null0, receive
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:
    10.0.0.0/30
    10.0.0.4/30
    192.168.1.0
  Passive Interface(s):
    Loopback0
  Routing Information Sources:
    Gateway         Distance      Last Update
    10.0.0.1              90      00:49:31
    10.0.0.6              90      00:49:31
```

```
  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 10"
EIGRP-IPv6 Protocol for AS(10)
  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:
    GigabitEthernet0/0/0
    GigabitEthernet0/0/1
    Loopback0 (passive)
  Redistribution:
    None
```

Router 3 Config

```
version 15.5
no service timestamps debug uptime
no service timestamps log uptime
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
!
ipv6 unicast-routing
!
subscriber templating
multilink bundle-name authenticated
!
license udi pid ISR4321/K9 sn FDO214421CU
!
spanning-tree mode pvst
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 FE80::3 link-local
 ipv6 address 2001:DB8:ACAD:C::1/64
 ipv6 eigrp 10
!
interface GigabitEthernet0/0/0
 ip address 10.0.0.6 255.255.255.252
 negotiation auto
 ipv6 address FE80::3 link-local
 ipv6 address 2001:DB8:ACAD:2::2/64
```

```
 ipv6 eigrp 10
!
interface GigabitEthernet0/0/1
 ip address 10.0.0.9 255.255.255.252
 negotiation auto
 ipv6 address FE80::3 link-local
 ipv6 address 2001:DB8:ACAD:3::1/64
 ipv6 eigrp 10
!
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 eigrp 1
 network 10.0.0.4 0.0.0.3
 network 10.0.0.8 0.0.0.3
 network 192.168.2.0
 passive-interface Loopback0
 redistribute bgp 200 metric 10000 1 255 1 1500
 eigrp router-id 3.3.3.3
!
router bgp 200
 bgp router-id 3.3.3.3
 bgp log-neighbor-changes
 neighbor 10.0.0.10 remote-as 100
 neighbor 2001:DB8:ACAD:3::2 remote-as 100
 !
 address-family ipv4
  redistribute eigrp 1
  neighbor 10.0.0.10 activate
 exit-address-family
 !
 address-family ipv6
  redistribute eigrp 10
  redistribute connected
  neighbor 2001:DB8:ACAD: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 10
 no shut
 passive-interface Loopback0
 eigrp router-id 3.3.3.3
 redistribute bgp 200 metric 1000000 1 255 1 1500
!
control-plane
!
line con 0
 stopbits 1
line aux 0
 stopbits 1
line vty 0 4
 login
!
end
```

```
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        10.0.0.0/30 [90/3072] via 10.0.0.5, 00:53:54, GigabitEthernet0/0/0
C        10.0.0.4/30 is directly connected, GigabitEthernet0/0/0
L        10.0.0.6/32 is directly connected, GigabitEthernet0/0/0
C        10.0.0.8/30 is directly connected, GigabitEthernet0/0/1
L        10.0.0.9/32 is directly connected, GigabitEthernet0/0/1
B        10.0.0.12/30 [20/0] via 10.0.0.10, 00:49:00
B        10.0.0.16/30 [20/2] via 10.0.0.10, 00:48:10
D     192.168.0.0/24 [90/131072] via 10.0.0.5, 00:53:54, GigabitEthernet0/0/0
D     192.168.1.0/24 [90/130816] via 10.0.0.5, 00:53:54, GigabitEthernet0/0/0
      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
B     192.168.3.0/24 [20/0] via 10.0.0.10, 00:49:00
      192.168.4.0/32 is subnetted, 1 subnets
B        192.168.4.1 [20/2] via 10.0.0.10, 00:48:10
      192.168.5.0/32 is subnetted, 1 subnets
B        192.168.5.1 [20/3] via 10.0.0.10, 00:48:10
R3#      show ipv6 route
IPv6 Routing Table - default - 15 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   2001:DB8:ACAD:1::/64 [90/3072]
     via FE80::2, GigabitEthernet0/0/0
C   2001:DB8:ACAD:2::/64 [0/0]
     via GigabitEthernet0/0/0, directly connected
L   2001:DB8:ACAD:2::2/128 [0/0]
     via GigabitEthernet0/0/0, receive
C   2001:DB8:ACAD:3::/64 [0/0]
     via GigabitEthernet0/0/1, directly connected
L   2001:DB8:ACAD:3::1/128 [0/0]
     via GigabitEthernet0/0/1, receive
B   2001:DB8:ACAD:4::/64 [20/0]
     via FE80::4, GigabitEthernet0/0/1
B   2001:DB8:ACAD:5::/64 [20/2]
     via FE80::4, GigabitEthernet0/0/1
D   2001:DB8:ACAD:A::/64 [90/131072]
     via FE80::2, GigabitEthernet0/0/0
D   2001:DB8:ACAD:B::/64 [90/130816]
     via FE80::2, GigabitEthernet0/0/0
C   2001:DB8:ACAD:C::/64 [0/0]
     via Loopback0, directly connected
L   2001:DB8:ACAD:C::1/128 [0/0]

R3# show ip protocol
*** 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 200, ospf 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:
    10.0.0.4/30
    10.0.0.8/30
    192.168.2.0
  Passive Interface(s):
    Loopback0
  Routing Information Sources:
    Gateway         Distance      Last Update
    10.0.0.5              90      00:54:03
  Distance: internal 90 external 170

Routing Protocol is "bgp 200"
  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
    10.0.0.10
  Maximum path: 1
  Routing Information Sources:
    Gateway         Distance      Last Update
    10.0.0.10             20      00:48:21
  Distance: external 20 internal 200 local 200

R3# show ipv6 protocol
IPv6 Routing Protocol is "connected"
IPv6 Routing Protocol is "application"
IPv6 Routing Protocol is "ND"
IPv6 Routing Protocol is "bgp 200"
  IGP synchronization is disabled
  Redistribution:
    Redistributing protocol connected
    Redistributing protocol eigrp 10
  Neighbor(s):
    Address                    FiltIn FiltOut Weight RoutemapIn RoutemapOut
    2001:DB8:ACAD:3::2
IPv6 Routing Protocol is "eigrp 10"
EIGRP-IPv6 Protocol for AS(10)
  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:
    GigabitEthernet0/0/0
    GigabitEthernet0/0/1
    Loopback0 (passive)
  Redistribution:
```

```
    Redistributing protocol bgp 200 with metric 1000000 1 255 1 1500
```

```
R3#  show ip bgp
BGP table version is 12, local router ID is 3.3.3.3
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>  10.0.0.0/30      10.0.0.5              3072         32768 ?
 *>  10.0.0.4/30      0.0.0.0                  0         32768 ?
 *   10.0.0.8/30      10.0.0.10                0             0 100 ?
 *>                   0.0.0.0                  0         32768 ?
 *>  10.0.0.12/30     10.0.0.10                0             0 100 ?
 *>  10.0.0.16/30     10.0.0.10                2             0 100 ?
 *>  192.168.0.0      10.0.0.5            131072         32768 ?
 *>  192.168.1.0      10.0.0.5            130816         32768 ?
 *>  192.168.2.0      0.0.0.0                  0         32768 ?
 *>  192.168.3.0      10.0.0.10                0             0 100 ?
 *>  192.168.4.1/32   10.0.0.10                2             0 100 ?
 *>  192.168.5.1/32   10.0.0.10                3             0 100 ?
```

```
R3#  show bgp ipv6 unicast
BGP table version is 31, local router ID is 3.3.3.3
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>  2001:DB8:ACAD:1::/64
                      FE80::2                3072         32768 ?
 *>  2001:DB8:ACAD:2::/64
                      ::                        0         32768 ?
 *   2001:DB8:ACAD:3::/64
                      2001:DB8:ACAD:3::2
                                                0             0 100 ?
 *>                   ::                        0         32768 ?
 *>  2001:DB8:ACAD:4::/64
                      2001:DB8:ACAD:3::2
                                                0             0 100 ?
 *>  2001:DB8:ACAD:5::/64
                      2001:DB8:ACAD:3::2
                                                2             0 100 ?
     Network          Next Hop            Metric LocPrf Weight Path
 *>  2001:DB8:ACAD:A::/64
                      FE80::2              131072         32768 ?
 *>  2001:DB8:ACAD:B::/64
                      FE80::2              130816         32768 ?
 *>  2001:DB8:ACAD:C::/64
                      ::                        0         32768 ?
 *>  2001:DB8:ACAD:D::/64
                      2001:DB8:ACAD:3::2
                                                0             0 100 ?
 *>  2001:DB8:ACAD:E::1/128
                      2001:DB8:ACAD:3::2
                                                1             0 100 ?
 *>  2001:DB8:ACAD:F::1/128
                      2001:DB8:ACAD:3::2
                                                2             0 100 ?
```

Router 4 Config

```
version 15.5
no service timestamps debug uptime
no service timestamps log uptime
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 FDO214420G3
!
spanning-tree mode pvst
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 FE80::4 link-local
 ipv6 address 2001:DB8:ACAD:D::1/64
 ipv6 ospf 10 area 0
!
interface GigabitEthernet0/0/0
 ip address 10.0.0.10 255.255.255.252
 negotiation auto
 ipv6 address FE80::4 link-local
 ipv6 address 2001:DB8:ACAD:3::2/64
 ipv6 ospf 10 area 0
!
interface GigabitEthernet0/0/1
 ip address 10.0.0.13 255.255.255.252
 negotiation auto
 ipv6 address FE80::4 link-local
 ipv6 address 2001:DB8:ACAD:4::1/64
 ipv6 ospf 10 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 1
 router-id 4.4.4.4
 passive-interface Loopback0
 redistribute bgp 100 metric 100000
 network 10.0.0.8 0.0.0.3 area 0
 network 10.0.0.12 0.0.0.3 area 0
 network 192.168.3.0 0.0.0.255 area 0
!
router bgp 100
 bgp router-id 4.4.4.4
 bgp log-neighbor-changes
 neighbor 10.0.0.9 remote-as 200
 neighbor 2001:DB8:ACAD:3::1 remote-as 200
 !
 address-family ipv4
```

```
  redistribute ospf 1
  neighbor 10.0.0.9 activate
 exit-address-family
 !
 address-family ipv6
  redistribute ospf 10
  redistribute connected
  neighbor 2001:DB8:ACAD: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 10
 router-id 4.4.4.4
 passive-interface Loopback0
 redistribute bgp 100 metric 1000000
!
control-plane
!
line con 0
 stopbits 1
line aux 0
 stopbits 1
line vty 0 4
 login
!
end


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        10.0.0.0/30 [20/3072] via 10.0.0.9, 00:47:30
B        10.0.0.4/30 [20/0] via 10.0.0.9, 00:47:30
C        10.0.0.8/30 is directly connected, GigabitEthernet0/0/0
L        10.0.0.10/32 is directly connected, GigabitEthernet0/0/0
C        10.0.0.12/30 is directly connected, GigabitEthernet0/0/1
L        10.0.0.13/32 is directly connected, GigabitEthernet0/0/1
O        10.0.0.16/30 [110/2] via 10.0.0.14, 00:46:41, GigabitEthernet0/0/1
B     192.168.0.0/24 [20/131072] via 10.0.0.9, 00:47:30
B     192.168.1.0/24 [20/130816] via 10.0.0.9, 00:47:30
B     192.168.2.0/24 [20/0] via 10.0.0.9, 00:47:30
      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
      192.168.4.0/32 is subnetted, 1 subnets
O        192.168.4.1 [110/2] via 10.0.0.14, 00:46:41, GigabitEthernet0/0/1
      192.168.5.0/32 is subnetted, 1 subnets
O        192.168.5.1 [110/3] via 10.0.0.14, 00:46:41, GigabitEthernet0/0/1
R4#  show ipv6 route
IPv6 Routing Table - default - 15 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   2001:DB8:ACAD:1::/64 [20/3072]
     via FE80::3, GigabitEthernet0/0/0
B   2001:DB8:ACAD:2::/64 [20/0]
     via FE80::3, GigabitEthernet0/0/0
C   2001:DB8:ACAD:3::/64 [0/0]
     via GigabitEthernet0/0/0, directly connected
```

```
L   2001:DB8:ACAD:3::2/128 [0/0]
     via GigabitEthernet0/0/0, receive
C   2001:DB8:ACAD:4::/64 [0/0]
     via GigabitEthernet0/0/1, directly connected
L   2001:DB8:ACAD:4::1/128 [0/0]
     via GigabitEthernet0/0/1, receive
O   2001:DB8:ACAD:5::/64 [110/2]
     via FE80::5, GigabitEthernet0/0/1
B   2001:DB8:ACAD:A::/64 [20/131072]
     via FE80::3, GigabitEthernet0/0/0
B   2001:DB8:ACAD:B::/64 [20/130816]
     via FE80::3, GigabitEthernet0/0/0
B   2001:DB8:ACAD:C::/64 [20/0]
     via FE80::3, GigabitEthernet0/0/0
C   2001:DB8:ACAD:D::/64 [0/0]
     via Loopback0, directly connected
L   2001:DB8:ACAD:D::1/128 [0/0]
     via Loopback0, receive
O   2001:DB8:ACAD:E::1/128 [110/1]
     via FE80::5, GigabitEthernet0/0/1
O   2001:DB8:ACAD:F::1/128 [110/2]
     via FE80::5, GigabitEthernet0/0/1
L   FF00::/8 [0/0]
     via Null0, receive
R4#  show ip protocol
*** 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 1"
  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 100 with metric mapped to 100000, includes subnets in redistribution
  Number of areas in this router is 1. 1 normal 0 stub 0 nssa
  Maximum path: 4
  Routing for Networks:
    10.0.0.8 0.0.0.3 area 0
    10.0.0.12 0.0.0.3 area 0
    192.168.3.0 0.0.0.255 area 0
  Passive Interface(s):
    Loopback0
  Routing Information Sources:
    Gateway         Distance      Last Update
    5.5.5.5              110      00:46:48
    6.6.6.6              110      00:46:48
  Distance: (default is 110)

Routing Protocol is "bgp 100"
  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 1 (internal)

  Neighbor(s):
    Address          FiltIn FiltOut DistIn DistOut Weight RouteMap
    10.0.0.9
  Maximum path: 1
  Routing Information Sources:
    Gateway         Distance      Last Update
    10.0.0.9             20      00:47:37
  Distance: external 20 internal 200 local 200

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: 192.168.3.1
    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:
  Routing Information Sources:
    Gateway         Distance      Last Update
  Distance: internal 90 external 170

R4# show ipv6 protocol
IPv6 Routing Protocol is "connected"
IPv6 Routing Protocol is "application"
IPv6 Routing Protocol is "ND"
IPv6 Routing Protocol is "ospf 10"
  Router ID 4.4.4.4
  Autonomous system boundary router
  Number of areas: 1 normal, 0 stub, 0 nssa
  Interfaces (Area 0):
    Loopback0
    GigabitEthernet0/0/1
    GigabitEthernet0/0/0
  Redistribution:
    Redistributing protocol bgp 100 with metric 1000000
IPv6 Routing Protocol is "bgp 100"
  IGP synchronization is disabled
  Redistribution:
    Redistributing protocol connected
    Redistributing protocol ospf 10 (internal)
  Neighbor(s):
    Address                    FiltIn FiltOut Weight RoutemapIn RoutemapOut
    2001:DB8:ACAD:3::1
R4# show ip bgp
BGP table version is 12, local router ID is 4.4.4.4
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>  10.0.0.0/30      10.0.0.9              3072             0 200 ?
 *>  10.0.0.4/30      10.0.0.9                 0             0 200 ?
 *   10.0.0.8/30      10.0.0.9                 0             0 200 ?
 *>                   0.0.0.0                  0         32768 ?
 *>  10.0.0.12/30     0.0.0.0                  0         32768 ?
 *>  10.0.0.16/30     10.0.0.14                2         32768 ?
 *>  192.168.0.0      10.0.0.9            131072             0 200 ?
 *>  192.168.1.0      10.0.0.9            130816             0 200 ?
 *>  192.168.2.0      10.0.0.9                 0             0 200 ?
 *>  192.168.3.0      0.0.0.0                  0         32768 ?
 *>  192.168.4.1/32   10.0.0.14                2         32768 ?
 *>  192.168.5.1/32   10.0.0.14                3         32768 ?
R4# show bgp ipv6 unicast
BGP table version is 20, local router ID is 4.4.4.4
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
```

```
 *>  2001:DB8:ACAD:1::/64
                      2001:DB8:ACAD:3::1
                                           3072             0 200 ?
 *>  2001:DB8:ACAD:2::/64
                      2001:DB8:ACAD:3::1
                                              0             0 200 ?
 *   2001:DB8:ACAD:3::/64
                      2001:DB8:ACAD:3::1
                                              0             0 200 ?
 *>                   ::                        0         32768 ?
 *>  2001:DB8:ACAD:4::/64
                      ::                        0         32768 ?
 *>  2001:DB8:ACAD:5::/64
                      FE80::5                   2         32768 ?
     Network          Next Hop            Metric LocPrf Weight Path
 *>  2001:DB8:ACAD:A::/64
                      2001:DB8:ACAD:3::1
                                           131072             0 200 ?
 *>  2001:DB8:ACAD:B::/64
                      2001:DB8:ACAD:3::1
                                           130816             0 200 ?
 *>  2001:DB8:ACAD:C::/64
                      2001:DB8:ACAD:3::1
                                              0             0 200 ?
 *>  2001:DB8:ACAD:D::/64
                      ::                        0         32768 ?
 *>  2001:DB8:ACAD:E::1/128
                      FE80::5                   1         32768 ?
 *>  2001:DB8:ACAD:F::1/128
                      FE80::5                   2         32768 ?
```

Router 5 Config

```
version 16.9
no service timestamps debug uptime
no service timestamps log uptime
platform qfp utilization monitor load 80
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
!
login on-success log
!
subscriber templating
ipv6 unicast-routing
multilink bundle-name authenticated
!
crypto pki trustpoint TP-self-signed-3458782570
 enrollment selfsigned
 subject-name cn=IOS-Self-Signed-Certificate-3458782570
 revocation-check none
 rsakeypair TP-self-signed-3458782570
!
crypto pki certificate chain TP-self-signed-3458782570
 certificate self-signed 01
  30820330 30820218 A0030201 02020101 300D0609 2A864886 F70D0101 05050030
  31312F30 2D060355 04031326 494F532D 53656C66 2D536967 6E65642D 43657274
  69666963 6174652D 33343538 37383235 3730301E 170D3231 31313034 31353038
  35375A17 0D333030 31303130 30303030 305A3031 312F302D 06035504 03132649
  4F532D53 656C662D 5369676E 65642D43 65727469 66696361 74652D33 34353837
  38323537 30308201 22300D06 092A8648 86F70D01 01010500 0382010F 00308201
  0A028201 0100A6B5 5097C9AC C37D341E C21241CF 409D4190 0F762B16 F0CB6032
  864029E1 D20B2871 968745E7 DDC4D59C 41805B04 80ED3327 05AA59FE 4CEA3C95
  646CFC06 81373924 65ABE69B B65998FD B385A171 C75E88B2 301BEDB6 92132D2C
```

```
  7B1B28A7 7C10ABA6 BD441923 4F4DD1FD 0FFE1B43 EF5BA1E2 361092DE ADC5FF11
  51F3638A CEFC470E A6F667FC 681C2D6F 1C8E0CF6 93DBADF5 4008A6FD FBA910FA
  66937DF3 1A3A4000 B64D7319 D9B26421 E34E507E BA027D51 4510981F AE0E60B5
  2AB1D2C4 A9700E4A 5A0FA7B8 DCAFB4EC 658A26F5 BAC0F181 02955BC5 A9496E40
  5FE9F6C1 3C84165A 583FC836 A6F9D977 F55C1E23 68EA0E16 BF9BE296 911E2556
  01C2A9B4 26670203 010001A3 53305130 0F060355 1D130101 FF040530 030101FF
  301F0603 551D2304 18301680 1424DD9B CD20C65E 538483EE 08D7BFAB B0B87929
  3B301D06 03551D0E 04160414 24DD9BCD 20C65E53 8483EE08 D7BFABB0 B879293B
  300D0609 2A864886 F70D0101 05050003 82010100 22215972 023D34F5 8F028120
  DF1A0AB8 CAB98D4D 55F78430 CBD01029 1A047ABA 42247872 B6C87D6D 89756C2D
  E2AE4333 BED02A42 7449D6E8 7E6DB9E5 5309C8E6 11921214 646C6292 B9A8F7E3
  FAEDB1B8 BCFD6236 715FDBD6 5F68B6CE 0DBDB893 754AE8A7 5DFC6A36 6059CEBA
  2F4FE98D B82A6E25 B4CF13DC B471BE9F 19266551 2AC3EE8E 04EB459D 625D5A84
  96BFA069 5142441B 3267CBE7 9F9166E2 466816E5 391D1A91 4BFD1D34 7A2704C3
  BD6541D7 9599A31B 18C51C7E 85FDEA7E 9FFC44D6 402E2916 1E485577 7EB95BF8
  29E44DBF 98E5C6FB DE21975A 51E54F21 AA83AD06 C63E6664 581EFED1 90B3892E
  3815C6E9 A6DCF071 81385CBA 0016CAFC A10B43D9
        quit
!
license udi pid ISR4321/K9 sn FLM240800D6
no license smart enable
diagnostic bootup level minimal
!
spanning-tree mode pvst
spanning-tree extend system-id
!
redundancy
 mode none
!
interface Loopback0
 ip address 192.168.4.1 255.255.255.0
 ipv6 address FE80::5 link-local
 ipv6 address 2001:DB8:ACAD:E::1/64
 ipv6 ospf 10 area 0
!
interface GigabitEthernet0/0/0
 ip address 10.0.0.14 255.255.255.252
 negotiation auto
 ipv6 address FE80::5 link-local
 ipv6 address 2001:DB8:ACAD:4::2/64
 ipv6 ospf 10 area 0
!
interface GigabitEthernet0/0/1
 ip address 10.0.0.17 255.255.255.252
 negotiation auto
 ipv6 address FE80::5 link-local
 ipv6 address 2001:DB8:ACAD:5::1/64
 ipv6 ospf 10 area 0
!
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 5.5.5.5
 passive-interface Loopback0
 network 10.0.0.12 0.0.0.3 area 0
 network 10.0.0.16 0.0.0.3 area 0
 network 192.168.4.0 0.0.0.255 area 0
!
ip forward-protocol nd
ip http server
ip http authentication local
ip http secure-server
ip tftp source-interface GigabitEthernet0
```

```
!
ipv6 router ospf 10
 router-id 5.5.5.5
 passive-interface Loopback0
!
control-plane
!
line con 0
 transport input none
 stopbits 1
line aux 0
 stopbits 1
line vty 0 4
 login
!
end
```

```
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, 7 subnets, 2 masks
O E2     10.0.0.0/30
           [110/100000] via 10.0.0.13, 00:47:08, GigabitEthernet0/0/0
O E2     10.0.0.4/30
           [110/100000] via 10.0.0.13, 00:47:08, GigabitEthernet0/0/0
O        10.0.0.8/30 [110/2] via 10.0.0.13, 01:06:03, GigabitEthernet0/0/0
C        10.0.0.12/30 is directly connected, GigabitEthernet0/0/0
L        10.0.0.14/32 is directly connected, GigabitEthernet0/0/0
C        10.0.0.16/30 is directly connected, GigabitEthernet0/0/1
L        10.0.0.17/32 is directly connected, GigabitEthernet0/0/1
O E2  192.168.0.0/24
           [110/100000] via 10.0.0.13, 00:47:08, GigabitEthernet0/0/0
O E2  192.168.1.0/24
           [110/100000] via 10.0.0.13, 00:47:08, GigabitEthernet0/0/0
O E2  192.168.2.0/24
           [110/100000] via 10.0.0.13, 00:47:08, GigabitEthernet0/0/0
      192.168.3.0/32 is subnetted, 1 subnets
O        192.168.3.1 [110/2] via 10.0.0.13, 01:06:03, GigabitEthernet0/0/0
      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 10.0.0.18, 01:08:27, GigabitEthernet0/0/1
R5#    show ipv6 route
IPv6 Routing Table - default - 15 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 2001:DB8:ACAD:1::/64 [110/1000000]
     via FE80::4, GigabitEthernet0/0/0
OE2 2001:DB8:ACAD:2::/64 [110/1000000]
     via FE80::4, GigabitEthernet0/0/0
O   2001:DB8:ACAD:3::/64 [110/2]
     via FE80::4, GigabitEthernet0/0/0
C   2001:DB8:ACAD:4::/64 [0/0]
     via GigabitEthernet0/0/0, directly connected
L   2001:DB8:ACAD:4::2/128 [0/0]
     via GigabitEthernet0/0/0, receive
C   2001:DB8:ACAD:5::/64 [0/0]
     via GigabitEthernet0/0/1, directly connected
L   2001:DB8:ACAD:5::1/128 [0/0]
     via GigabitEthernet0/0/1, receive
OE2 2001:DB8:ACAD:A::/64 [110/1000000]
```

```
     via FE80::4, GigabitEthernet0/0/0
OE2 2001:DB8:ACAD:B::/64 [110/1000000]
     via FE80::4, GigabitEthernet0/0/0
OE2 2001:DB8:ACAD:C::/64 [110/1000000]
     via FE80::4, GigabitEthernet0/0/0
O   2001:DB8:ACAD:D::1/128 [110/1]
     via FE80::4, GigabitEthernet0/0/0
C   2001:DB8:ACAD:E::/64 [0/0]
     via Loopback0, directly connected
L   2001:DB8:ACAD:E::1/128 [0/0]
     via Loopback0, receive
O   2001:DB8:ACAD:F::1/128 [110/1]
     via FE80::6, GigabitEthernet0/0/1
L   FF00::/8 [0/0]
     via Null0, receive
R5#   show ip protocol
*** 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 1"
  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:
    10.0.0.12 0.0.0.3 area 0
    10.0.0.16 0.0.0.3 area 0
    192.168.4.0 0.0.0.255 area 0
  Passive Interface(s):
    Loopback0
  Routing Information Sources:
    Gateway         Distance      Last Update
    4.4.4.4              110      00:47:17
    6.6.6.6              110      01:08:37
  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 10"
  Router ID 5.5.5.5
  Number of areas: 1 normal, 0 stub, 0 nssa
  Interfaces (Area 0):
    Loopback0
    GigabitEthernet0/0/1
    GigabitEthernet0/0/0
  Redistribution:
    None
```

Router 6 Config

```
version 16.9
no service timestamps debug uptime
no service timestamps log uptime
platform qfp utilization monitor load 80
no platform punt-keepalive disable-kernel-core
!
hostname R6
!
boot-start-marker
boot system flash bootflash:isr4300-universalk9.16.09.08.SPA.bin
boot-end-marker
!
vrf definition Mgmt-intf
 !
```

```
 address-family ipv4
 exit-address-family
 !
 address-family ipv6
 exit-address-family
!
no aaa new-model
!
ip dhcp pool webuidhcp
!
login on-success log
!
subscriber templating
ipv6 unicast-routing
multilink bundle-name authenticated
!
crypto pki trustpoint TP-self-signed-3632327409
 enrollment selfsigned
 subject-name cn=IOS-Self-Signed-Certificate-3632327409
 revocation-check none
 rsakeypair TP-self-signed-3632327409
!
crypto pki certificate chain TP-self-signed-3632327409
 certificate self-signed 01
  30820330 30820218 A0030201 02020101 300D0609 2A864886 F70D0101 05050030
  31312F30 2D060355 04031326 494F532D 53656C66 2D536967 6E65642D 43657274
  69666963 6174652D 33363332 33323734 3039301E 170D3231 30393233 31383137
  35335A17 0D333030 31303130 30303030 305A3031 312F302D 06035504 03132649
  4F532D53 656C662D 5369676E 65642D43 65727469 66696361 74652D33 36333233
  32373430 39308201 22300D06 092A8648 86F70D01 01010500 0382010F 00308201
  0A028201 0100B261 9DFBA6B6 8D617464 7C90FCC7 D914F91B F0DF4ED7 9AFB8CE2
  BF1F41AC DB949268 AF8CD9BE 16EAB58A FB679418 C789105C DB05CB67 9249A66C
  B4538875 218832E8 5DA23BA9 0F7DDC35 93C41E6C 0CF872EC 1710D94A C40141C1
  20E54B85 66DF49BD 93F48563 ECB6934A 4811F2C8 468950D1 031CAB0B DF6987B7
  12B77176 24B19411 5D6BCE70 B5B590CC C87C3CA7 C55A90E3 B6EDD138 5C63C9F1
  06462C2C 254BBA4F 307D9121 1E7A867B 6DE2D1DE 0A28083B 2CFC55B8 4F40192A
  86551DA1 7281AA09 70BA719F 0810F085 897C7BF4 1EA0AC26 9977C614 C4CD4B1F
  0EA1E92F ED0F86E3 6F330E3F 618DDBEF FA156AB1 2C435CEC 42B0CB03 6C00E24D
  DE169FF2 29090203 010001A3 53305130 0F060355 1D130101 FF040530 030101FF
  301F0603 551D2304 18301680 1461F090 CFE5BD03 762D6BEA 47FA40B1 B7B50D84
  B3301D06 03551D0E 04160414 61F090CF E5BD0376 2D6BEA47 FA40B1B7 B50D84B3
  300D0609 2A864886 F70D0101 05050003 82010100 7AA1BE0B 2C741D8F 13F9D863
  11C880F0 643DE7BD D32247FD 8A2EA77A 5B8ECACA 138BDD75 BC36D296 83B3EA0B
  95C3B925 56304C8F B143BC75 EAF50D76 05BBE797 E8332934 BAA0E845 D3210A85
  451A52F8 3F76538E C575EBBC 664DC1DB 879816F1 E185EE64 074CE44B A2A144D3
  E241B1E6 3E8F5931 3381B01E CB014313 DEDC5150 10A6476B 63776933 A334B1A9
  F0223A98 176997A3 8F77DA19 86DEB18C E2016B13 692442EC 35D05474 DB4147F9
  0EF0B077 7B9B80CF 58D0F081 DDA781E5 248FF007 681FC687 5763966C DB6DF225
  5DBF2C1F 9CB22504 85D554EC 7A0F84E2 E53FFDEF 7A837C8B 1BBD531E 1B014549
  3049C732 9B1BD2A8 51C365CD E565AFF9 A7A67504
        quit
!
license udi pid ISR4321/K9 sn FLM240607Q1
no license smart enable
diagnostic bootup level minimal
!
spanning-tree mode pvst
spanning-tree extend system-id
!
redundancy
 mode none
!
interface Loopback0
 ip address 192.168.5.1 255.255.255.0
 ipv6 address FE80::6 link-local
 ipv6 address 2001:DB8:ACAD:F::1/64
 ipv6 ospf 10 area 0
!
interface GigabitEthernet0/0/0
 ip address 10.0.0.18 255.255.255.252
 negotiation auto
 ipv6 address FE80::6 link-local
 ipv6 address 2001:DB8:ACAD:5::2/64
 ipv6 ospf 10 area 0
!
interface GigabitEthernet0/0/1
 no ip address
```

```
 negotiation auto
!
interface GigabitEthernet0/1/0
 no ip address
 negotiation auto
!
interface GigabitEthernet0/1/1
 no ip address
 negotiation auto
!
interface GigabitEthernet0
 vrf forwarding Mgmt-intf
 no ip address
 shutdown
 negotiation auto
!
router ospf 1
 router-id 6.6.6.6
 passive-interface Loopback0
 network 10.0.0.16 0.0.0.3 area 0
 network 192.168.5.0 0.0.0.255 area 0
!
ip forward-protocol nd
ip http server
ip http authentication local
ip http secure-server
ip tftp source-interface GigabitEthernet0
!
ipv6 router ospf 10
 router-id 6.6.6.6
 passive-interface Loopback0
!
control-plane
!
line con 0
 transport input none
 stopbits 1
line aux 0
 stopbits 1
line vty 0 4
 login
!
end
```

```
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, 6 subnets, 2 masks
O E2     10.0.0.0/30
           [110/100000] via 10.0.0.17, 00:48:11, GigabitEthernet0/0/0
O E2     10.0.0.4/30
           [110/100000] via 10.0.0.17, 00:48:11, GigabitEthernet0/0/0
O        10.0.0.8/30 [110/3] via 10.0.0.17, 01:07:06, GigabitEthernet0/0/0
O        10.0.0.12/30 [110/2] via 10.0.0.17, 01:07:52, GigabitEthernet0/0/0
C        10.0.0.16/30 is directly connected, GigabitEthernet0/0/0
L        10.0.0.18/32 is directly connected, GigabitEthernet0/0/0
O E2  192.168.0.0/24
           [110/100000] via 10.0.0.17, 00:48:11, GigabitEthernet0/0/0
O E2  192.168.1.0/24
           [110/100000] via 10.0.0.17, 00:48:11, GigabitEthernet0/0/0
O E2  192.168.2.0/24
           [110/100000] via 10.0.0.17, 00:48:11, GigabitEthernet0/0/0
      192.168.3.0/32 is subnetted, 1 subnets
O        192.168.3.1 [110/3] via 10.0.0.17, 01:07:06, GigabitEthernet0/0/0
      192.168.4.0/32 is subnetted, 1 subnets
O        192.168.4.1 [110/2] via 10.0.0.17, 01:09:30, GigabitEthernet0/0/0
```

```
      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
R6#   show ipv6 route
IPv6 Routing Table - default - 14 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 2001:DB8:ACAD:1::/64 [110/1000000]
     via FE80::5, GigabitEthernet0/0/0
OE2 2001:DB8:ACAD:2::/64 [110/1000000]
     via FE80::5, GigabitEthernet0/0/0
O   2001:DB8:ACAD:3::/64 [110/3]
     via FE80::5, GigabitEthernet0/0/0
O   2001:DB8:ACAD:4::/64 [110/2]
     via FE80::5, GigabitEthernet0/0/0
C   2001:DB8:ACAD:5::/64 [0/0]
     via GigabitEthernet0/0/0, directly connected
L   2001:DB8:ACAD:5::2/128 [0/0]
     via GigabitEthernet0/0/0, receive
OE2 2001:DB8:ACAD:A::/64 [110/1000000]
     via FE80::5, GigabitEthernet0/0/0
OE2 2001:DB8:ACAD:B::/64 [110/1000000]
     via FE80::5, GigabitEthernet0/0/0
OE2 2001:DB8:ACAD:C::/64 [110/1000000]
     via FE80::5, GigabitEthernet0/0/0
O   2001:DB8:ACAD:D::1/128 [110/2]
     via FE80::5, GigabitEthernet0/0/0
O   2001:DB8:ACAD:E::1/128 [110/1]
     via FE80::5, GigabitEthernet0/0/0
C   2001:DB8:ACAD:F::/64 [0/0]
     via Loopback0, directly connected
L   2001:DB8:ACAD:F::1/128 [0/0]
     via Loopback0, receive
L   FF00::/8 [0/0]
     via Null0, receive
R6#              show ip protocol
*** 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 1"
  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:
    10.0.0.16 0.0.0.3 area 0
    192.168.5.0 0.0.0.255 area 0
  Passive Interface(s):
    Loopback0
  Routing Information Sources:
    Gateway         Distance      Last Update
    4.4.4.4              110      00:48:18
    5.5.5.5              110      01:07:59
  Distance: (default is 110)

R6# show ipv6 protocol
IPv6 Routing Protocol is "connected"
IPv6 Routing Protocol is "application"
IPv6 Routing Protocol is "ND"
IPv6 Routing Protocol is "ospf 10"
  Router ID 6.6.6.6
  Number of areas: 1 normal, 0 stub, 0 nssa
```

```
  Interfaces (Area 0):
    Loopback0
    GigabitEthernet0/0/0
  Redistribution:
    None
```

Problems and Troubleshooting:

The OSPF and EIGRP routing was configured without any problems. The main issues I had was configuring BGP and the redistribution between BGP and the IGPs. First, BGP routes were not being put into the routing table. Second, BGP was not redistributing EIGRP or OSPF routes across the link. Third, BGP was not redistributing directly connected routes of the routers running BGP.

BGP Routes not visible:

After configuring the IP addressing schemes and enabling OSPF and EIGRP instances, I configured BGP on R3 and R4 using the router bgp asn command and assigned a router-id. I also specified the BGP peers and their remote-as and redistributed either ospf or eigrp in the address-families depending on which router I was on. When I entered the show ip route, I did not see any BGP routes. After researching online, I realized I had to use the neighbor IPV4/IPV6 address activate in order for BGP to start sharing routes. After configuring this, I was able to see BGP routes in the autonomous system I was in and the directly connected routes of the BGP router.

This meant that the routes past the BGP peer were still not visible and redistribution had not worked across the link. It appears you have to redistribute BGP in the EIGRP and OSPF instances as well so the routes across the entire network are visible and routable. I entered the redistribute bgp 100 metric 100000 for OSPF and redistribute bgp 200 metric 10000 1 255 1 1500 for EIGRP. After entering those commands, BGP routes propagated the routing table. However, I still was not able to see two directly connected Loopback addresses on the BGP peers. After consulting Cisco's website, I discovered that a redistribute connected command was also needed to redistribute the directly connected routes and not just the network routes. After this, all BGP routes and interfaces seemed to be routable. When I started pinging, I discovered one final issue. The Loopback interface on R6 was not reachable nor was it in the routing table. When I checked the interface, I realized that I had accidentally entered in the wrong subnet for the interface so after I changed it all routers and networks. were reachable.

Conclusion:

Routing protocols are designed to solve certain problems. The problem of managing and exchanging huge volume of routes within and between autonomous systems is solved by BGP. The use of BGP as the main routing protocol for the Internet shows its scalability, performance and reliability. BGP can allow for both efficient routing and redistribution of IGPs. In our next lab, we will configure IBGP instead of just EBGP and learn how interior BGP works and how it differs from EBGP.