

BGP SETUP

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CISCO

CCNP LAB REPORT

Purpose

This lab provides instructions for setting up three distinct routing protocols connected by the Border Gateway Protocol (BGP). Specifically, we will cover the commands and steps required to set up the Open Shortest Path First (OSPF), Enhanced Interior Gateway Routing Protocol (EIGRP), and Intermediate System-to-Intermediate System (IS-IS) routing protocols over IPv4 and IPv6, then cover the commands necessary to connect the three using BGP.

Background Information

In the lab, we will introduce the setups for three new routing protocols which provide alternatives to the OSPF protocol we covered in the previous report. Although OSPF can theoretically run by itself on a large network in one process, there are multiple advantages and functions offered by other protocols in addition to OSPF's features. Prior to discussing the setup steps of EIGRP, IS-IS, and BGP, we will first discuss these advantages and functions they provide in depth.

EIGRP is a CISCO proprietary protocol exclusive to CISCO brand routers with a fast rate of convergence for low network traffic. EIGRP is a distance-vector protocol, meaning the routers running EIGRP will mutually share their routing tables to measure the distance between them and find the best possible router. However, unlike other such protocols, EIGRP routers will send hello packets to discover neighbors and check the adjacent status of the connections like OSPF using triggered updates. Whereas protocols such as OSPF send periodic updates every few minutes, EIGRP only sends the packets when there is a change. Due to the uses of these hello packets in this low impact manner, EIGRP also has a low impact on the traffic on a network.

EIGRP uses the Diffusing Update Algorithm (DUAL) to compute the paths and prevent routing loops. With the algorithm, EIGRP ensures speedy convergence, usually in less than 200 milliseconds, at low cost to efficiency. Another advantage offered by EIGRP would be its easy configuration, with one command enough to activate a process and another command to set up each network. Finally, OSPF offers advanced features as part of its advantages such as encryption, with iBGP offered over WAN.

IS-IS is a 1992 routing protocol using link-state interior routing to support IP and IPv6 routing. IS-IS operates by constructing a link-state database which allows routers to visualize the map and topology of the network. To construct the path to target, IS-IS runs the Dijkstra algorithm to construct a shortest path to destination in just over linear time. For this reason, IS-IS offers stability and extensive scalability for companies who need a reliable and large network running in the same autonomous system. Specifically, the two-level hierarchy (relying solely on layers 1 and 2) of the IS-IS system allows for expansion, the large capacity of its link state database, and efficiency with its message sending allows the network to expand with minimal impact to efficiency. When comparing IS-IS and OSPF on similar size network, the IS-IS

protocol nearly always demands less CPU use than other link-state routing protocols like OSPF because it depends on layers 1 and 2 rather than IP.

Though the setup of IS-IS requires a few more commands than more modern routing protocols like OSPF or EIGRP, IS-IS offers additional advantages beyond its low impact and scalability. Despite its age, IS-IS can evolve rapidly to keep up with changes in the world of networking. For example, after the release of IPv6, IS-IS quickly implemented IS-ISv3 to support IPv6 routing over IS-IS. Due to the structure in which IS-IS was built, these developments are quickly developed. Other advantages of IS-IS include its fault tolerance for IP configuration errors of addressing changes. Neither of these issues impact IS-IS as the protocol runs on Layer 2.

To connect distinct autonomous systems running routing protocols into a large network, we may use protocols like BGP. For industrial internet service providers who provide access for companies to internet, they must allow each firm to independently make decisions about the network protocols they run for themselves for convenience and security purposes. Similarly, large companies may subdivide their networks into multiple autonomous systems running different protocols for fault tolerance, to meet the different demands of different departments, or for security purposes. When these firms want these distinct systems to connect, they use the BGP protocol.

BGP's purpose is to connect different networks running possibly different networking protocols together (e.g. connecting an OSPF-routed network to one running IS-IS). By redistributing the paths that the other routing protocols find into BGP and redistributing the BGP routes into other protocols, all the routes will be disseminated throughout the network. BGP advertises the networks it finds and the path of which autonomous systems it takes to reach it. In particular, whereas normal routing protocols may treat each router as nodes, BGP will treat the autonomous systems as nodes on the network topology map.

With its functions, BGP allows companies to scale and compartmentalize their networks. BGP is designed to handle thousands of routes because it is meant to contain routes across an entire connected network. In fact, the global Internet uses BGP in its backbone to route packets between any two devices connected to the internet.

Lab Summary

In the lab, we will construct a network with six routers connected one-by-one in a line. We label the routers R1, R2, ..., R6 from left to right. We will set up OSPF and OSPFv3 between routers R1 and R2 so that they can form connections over IPv4 and IPv6, then set up EIGRP and EIGRPv6 on routers R3 and R4, set up IS-IS on IPv4 and IPv6 on routers R5 and R6.

We assign BGP Autonomous System Numbers (ASN) 65001, 65002, and 65003 to the routers running OSPF, EIGRP, and IS-IS respectively. Afterwards, we will redistribute each autonomous system's routes into BGP along with all the router's directly connected routes, then redistribute

the BGP routes back into each autonomous system. This way, all the routers in the network can reach each other.

Lab Commands

The new commands introduced in this lab are as follows.

EIGRP Setup

To activate EIGRP on IPv4 and IPv6 respectively, we use the commands,

```
router eigrp [process-id]
ipv6 router eigrp 1
```

After the prior command is entered, we can add a connected network to the EIGRP process running on the route with the command,

```
network [ip-address] [wildcard-mask]
```

IS-IS Setup

To activate an IS-IS process and assign the net address, use the following two commands. It is mandatory to assign an IS-IS net address.

```
router isis [process-id]
net [net-id]
```

Now, to activate IS-IS on the interface, we use the commands,

```
ip router isis [process-id]
ipv6 router isis [process-id]
```

BGP Setup

To activate BGP on a router, we must specify its ASN (autonomous system number). A group of routers running the same routing protocol must have the same routing ID. For example, Routers R1 and R2 both run OSPF, so they both have ASN 65001.

```
router bgp [autonomous-system-number]
```

We now establish the addresses of an adjacent router from a different network with the following commands for IPv4 and IPv6 respectively. We use the IP address and ASN of the neighboring router.

```
neighbor [neighbor-ipv4-address] remote-as [neighbor-ASN]
neighbor [neighbor-ipv6-address] remote-as [neighbor-ASN]
```

To activate these neighbor connections, we use the following commands for IPv4 and IPv6 respectively.

```
address-family ipv4
neighbor [neighbor-ipv4-address] activate
```

```
address-family ipv6
neighbor [neighbor-ipv6-address] activate
```

To redistribute IPv4 connected routes, OSPF routes, EIGRP routes, and IS-IS routes into BGP, we use the following commands in order.

```
address-family ipv4
redistribute connected
redistribute ospf [ospf-process-id]
redistribute eigrp [eigrp-process-id]
redistribute isis [is-is-process-id] level-2
```

To redistribute IPv6 connected routes, OSPF routes, EIGRP routes, and IS-IS routes into BGP, we enter the IPv6 address families and type the same commands.

```
address-family ipv6
redistribute connected
redistribute ospf [ospf-process-id]
redistribute eigrp [eigrp-process-id]
redistribute isis [is-is-process-id] level-2
```

To redistribute the BGP routes back into each autonomous system's routing protocol, we use the following commands for OSPF, EIGRP, and IS-IS respectively.

For OSPF on IPv4, the usual metric in the command below to use is 20.

```
router ospf [ospf-process-id]
redistribute bgp [autonomous-system-number] metric [metric] subnets
```

For OSPF on IPv6, the commands are as follows.

```
router ospfv3 [ospf-process-id]
address-family ipv6 unicast
redistribute bgp [autonomous-system-number]
```

To redistribute BGP back into EIGRP on IPv4 and IPv6 with default settings,

```
router eigrp [eigrp-process-id]
redistribute bgp [autonomous-system-number] metric 10000 10 255 1 1500

ipv6 router eigrp [eigrp-process-id]
```

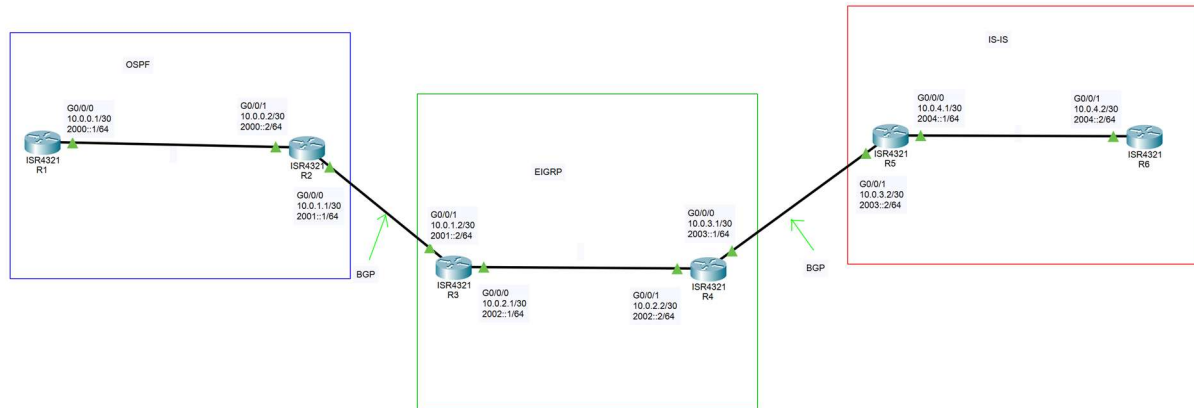
```
redistribute bgp [autonomous-system-number] metric 10000 10 255 1 1500
```

To redistribute BGP back into IS-IS,

```
router isis [isis-process-id]
redistribute bgp [autonomous-system-number]
address-family ipv6
redistribute bgp [autonomous-system-number]
```

Network Diagram with IPs

The routers are pairwise connected by straight-through copper ethernet cables.



Configuration

R1 Configuration

```
version 16.9
service timestamps debug datetime msec
service timestamps log datetime msec
platform qfp utilization monitor load 80
platform punt-keepalive disable-kernel-core
hostname 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
login on-success log
subscriber templating
ipv6 unicast-routing
multilink bundle-name authenticated
crypto pki trustpoint TP-self-signed-1312775118
enrollment selfsigned
subject-name cn=IOS-Self-Signed-Certificate-1312775118
revocation-check none
rsa-keypair TP-self-signed-1312775118
crypto pki certificate chain TP-self-signed-1312775118
certificate self-signed 01
30820330 30820218 A0030201 02020101 300D0609 2A864886 F70D0101 05050030
31312F30 2D060355 04031326 494F532D 53656C66 2D536967 6E65642D 43657274
```

69666963 6174652D 31333132 37373531 3138301E 170D3235 31303231 32313131
30305A17 0D333030 31303130 30303030 305A3031 312F302D 06035504 03132649
4F532D53 656C662D 5369676E 65642D43 65727469 66696361 74652D31 33313237
37353131 38308201 22300D06 092A8648 86F70D01 01010500 0382010F 00308201
0A028201 0100D4B1 D7A3DC2F E27EF074 B587997A 83369AED CD79523B 82BA5406
38BD3496 4CF25EE6 D91C1654 75468799 666A8597 1E4F8964 A748494D 735C6C1E
BB4A16D1 B6D888D5 5C52272A 40566AC7 62A6DA19 669B0D3D 1B11464A E8278B62
D6769B4E E9F5BBBD 6121395F E51171BC 77D057AD 86790553 ED159B1C 00C86DDE
AF2F216A CD423DA6 B586317D C9F1FB6B C2556532 812EA4EA 9E7B3157 E7F8F382
ED9E0C2A C6271512 7847D4F7 5CF3B0FA AEFA0B83 5DA5ED40 A85053F1 726F9332
574B7BB2 EAF61AD4 28D4DB6E 377D3ABA 3D1A57C6 1A65056B 10A4C782 28E436F3
C9D51BCE 19E21790 8935E455 C3CC2453 8DD749AC 56BC9677 AF5A8D99 79AD36B3
2466CC70 CDDD0203 010001A3 53305130 0F060355 1D130101 FF040530 030101FF
301F0603 551D2304 18301680 14BBBD78A 4AE0C35F 3A897DD1 1F4813F6 BDA9BF97
69301D06 03551D0E 04160414 BBD78A4A E0C35F3A 897DD11F 4813F6BD A9BF9769
300D0609 2A864886 F70D0101 05050003 82010100 83C5DE8B 4BC2A099 35EFB4FE
E422C870 982DB3AB D0ED38B7 D9EE39AD DB434C0D EFC7F42B AD9654B9 AC159F0C
4ACBC304 BFF777CB 1254EA07 A7B1571D BC5FA157 E6965FC2 E6647C32 507A65B0
A18A38B9 EAFD66DC 5F80C712 7DB482CA CBF3D0BC 4D70C00C 70734728 0E558741
9CC8F237 88883062 8A5855B9 46CABB14 DC9D5943 16185957 59AA7995 292BF06D
F59F3B16 A1C6405C C1C8977C 0319678A A9F941FB CD49C402 2D92519C 763E2157
0C474196 897D2249 61FD9326 CA1EF958 A300FEFD F37E0624 D882222E 5D039C1A
4BF29D8C DDADB75E C663CC84 F8D9D801 13C362AA 11FD8D86 D5E13BAC A303E2F1
EC11E342 251DDBD5 DBF49119 41EEEB34 9DD32A09

quit

license udi pid ISR4321/K9 sn FD021060Z52

no license smart enable

diagnostic bootup level minimal

spanning-tree extend system-id

redundancy

mode none

interface GigabitEthernet0/0/0

ip address 10.0.0.1 255.255.255.252

ip ospf 1 area 0

negotiation auto

ipv6 address 2000::1/64

ipv6 ospf 1 area 0

interface GigabitEthernet0/0/1

no ip address

shutdown

negotiation auto

interface Serial0/1/0

interface Serial0/1/1

interface Service-Engine0/2/0

no ip address

interface GigabitEthernet0

vrf forwarding Mgmt-intf

no ip address

shutdown

negotiation auto

```
router ospfv3 1
address-family ipv6 unicast
exit-address-family
router ospf 1
network 10.0.0.0 0.0.0.3 area 0
ip forward-protocol nd
ip http server
ip http authentication local
ip http secure-server
ip tftp source-interface GigabitEthernet0
control-plane
line con 0
transport input none
stopbits 1
line aux 0
stopbits 1
line vty 0 4
login
end
```

R2 Configuration

```
version 16.9
service timestamps debug datetime msec
service timestamps log datetime msec
platform qfp utilization monitor load 80
platform punt-keepalive disable-kernel-core
hostname 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
login on-success log
subscriber templating
ipv6 unicast-routing
multilink bundle-name authenticated
crypto pki trustpoint TP-self-signed-3485044676
enrollment selfsigned
subject-name cn=IOS-Self-Signed-Certificate-3485044676
revocation-check none
rsa-keypair TP-self-signed-3485044676
crypto pki certificate chain TP-self-signed-3485044676
certificate self-signed 01
30820330 30820218 A0030201 02020101 300D0609 2A864886 F70D0101 05050030
```

31312F30 2D060355 04031326 494F532D 53656C66 2D536967 6E65642D 43657274
69666963 6174652D 33343835 30343436 3736301E 170D3235 31303231 32303430
35395A17 0D333030 31303130 30303030 305A3031 312F302D 06035504 03132649
4F532D53 656C662D 5369676E 65642D43 65727469 66696361 74652D33 34383530
34343637 36308201 22300D06 092A8648 86F70D01 01010500 0382010F 00308201
0A028201 0100A019 C5282366 5109831F C41240D8 45ED4109 2FC96A66 1122F5DA
5290219E 3530ABD9 56BDBCEC E7ED26E0 0F8681CC 60193943 67866666 3FFD7A48
AA9458E7 0D2A2B46 8A669636 6CC5FDE6 E4E23E3F 4A8C33D5 6AA31F93 4B80815D
E3787197 1F2067C0 78227A64 E100B0FA BB216C78 70492AF6 49737298 649EFE15
14628A16 45B08F84 F3001973 73D9E4CE C7F344B2 C8063741 21971B42 4DF1DEBC
A12B7B01 79BA4B58 0D7F7AD8 9744D3AB EF91360A 13033546 602866F3 6FCCEF08
F61CA61E 7198098F C2754B84 F02F8592 AD883DC7 DF428CAE A4B94C77 700DCAC6
425AEF01 74BF0992 48841455 DB19FD9B 7BDF07D 31B2A941 F16988E8 5F79DCBB
D37D9E9E E64F0203 010001A3 53305130 0F060355 1D130101 FF040530 030101FF
301F0603 551D2304 18301680 1433EC78 623F817D D3AD51CB AFAAF316 EC14C48C
3B301D06 03551D0E 04160414 33EC7862 3F817DD3 AD51CBAF AAF316EC 14C48C3B
300D0609 2A864886 F70D0101 05050003 82010100 6B6EA990 BDA2EB7C 950E7487
73BD78D4 BECEBDFB D9667F85 3C458662 A70EDB75 69B9909F E8047E95 8D0A23FE
35BB0A44 856E28EC 6037AFA1 8BFF5E9B BB3A90AF 57DAF744 247D82C1 C5F5C9AB
B8F753C5 017A7FAA FAC136DA 6F7B1BB5 832AED52 B844FF21 0C5D2F5A 3701F507
609F0D0C FA67DB11 6D34A9BD 81079AA3 705CFF4E DE0DE728 1309C684 9914E68A
92847A0D F69FED85 71B6FC94 83634053 1033A3A9 EDA51C48 1834E173 80969353
ED81310E 82A074A7 602025C0 6745DD8E 1CB1BF8A 5564F31B 97C03235 D7AEB213
B36CF8F8 F959BDDD 0B0C8B30 01A2C8A9 05BF9D7F F029C37B 59A9EBBC 8BD248E4
DAF8E5D3 FF0753F0 63DA46F2 FB23A26E 41820034

quit

license udi pid ISR4321/K9 sn FD021082HVD

no license smart enable

diagnostic bootup level minimal

spanning-tree extend system-id

redundancy

mode none

interface GigabitEthernet0/0/0

ip address 10.0.1.1 255.255.255.252

ip ospf 1 area 0

negotiation auto

ipv6 address 2001::1/64

ipv6 ospf 1 area 0

interface GigabitEthernet0/0/1

ip address 10.0.0.2 255.255.255.252

ip ospf 1 area 0

negotiation auto

ipv6 address 2000::2/64

ipv6 ospf 1 area 0

interface Serial0/1/0

interface Serial0/1/1

interface Service-Engine0/2/0

no ip address

interface GigabitEthernet0

vrf forwarding Mgmt-intf

```
no ip address
shutdown
negotiation auto
router ospfv3 1
address-family ipv6 unicast
redistribute bgp 65001
exit-address-family
router ospf 1
redistribute bgp 65001 metric 20 subnets
network 10.0.0.0 0.0.0.3 area 0
network 10.0.1.0 0.0.0.3 area 0
router bgp 65001
bgp log-neighbor-changes
neighbor 10.0.1.2 remote-as 65002
neighbor 2001::2 remote-as 65002
address-family ipv4
redistribute connected
redistribute ospf 1
neighbor 10.0.1.2 activate
no neighbor 2001::2 activate
exit-address-family
address-family ipv6
redistribute connected
redistribute ospf 1
neighbor 2001::2 activate
exit-address-family
ip forward-protocol nd
ip http server
ip http authentication local
ip http secure-server
ip tftp source-interface GigabitEthernet0
control-plane
line con 0
transport input none
stopbits 1
line aux 0
stopbits 1
line vty 0 4
login
end
```

R3 Configuration

```
version 16.9
service timestamps debug datetime msec
service timestamps log datetime msec
platform qfp utilization monitor load 80
platform punt-keepalive disable-kernel-core
hostname 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
login on-success log
subscriber templating
ipv6 unicast-routing
multilink bundle-name authenticated
crypto pki trustpoint TP-self-signed-2857297660
enrollment selfsigned
subject-name cn=IOS-Self-Signed-Certificate-2857297660
revocation-check none
rsa-keypair TP-self-signed-2857297660
crypto pki certificate chain TP-self-signed-2857297660
certificate self-signed 01
30820330 30820218 A0030201 02020101 300D0609 2A864886 F70D0101 05050030
31312F30 2D060355 04031326 494F532D 53656C66 2D536967 6E65642D 43657274
69666963 6174652D 32383537 32393736 3630301E 170D3235 31303231 32303537
34395A17 0D333030 31303130 30303030 305A3031 312F302D 06035504 03132649
4F532D53 656C662D 5369676E 65642D43 65727469 66696361 74652D32 38353732
39373636 30308201 22300D06 092A8648 86F70D01 01010500 0382010F 00308201
0A028201 0100C1F6 F9104A55 950AD339 871C4FE3 C0414AA6 EABBCEFE1 E60B0DC2
15FE008C 2D439B79 B5E7D91B 02BE2B09 F8D1E26E FBC64955 A8B0D62F E1344E5F
92C71184 C57B1065 4664C070 9B4C0BB5 16B0D82D BC849701 D2563DBC E66D53FC
2376E50D 7A8184F5 A6B9E911 4F1582A6 85BC680E FD269097 F01A080E 0FB27787
358E83EA C17982D0 E34B3901 AA475401 5FDAEB43 147F0FC0 E3C2E524 F027FDE2
CF1A3250 3CD22484 3848C9DF 7F8ED807 F6C2312D 1CE72A7B A41A1DE4 E06CCDAD
A1FB240D 5BEA17F3 C42E61C2 35760DF7 AF6D884F 93B7C2E1 11AB0F8B 266534C9
4E6EF2AC 703B9BE9 4CC1AFC1 F50AC3CE AB95B773 AE7B27B4 6E570E9C F8543E56
85223BAE B0870203 010001A3 53305130 0F060355 1D130101 FF040530 030101FF
301F0603 551D2304 18301680 14F93A0D 3C1E0241 3B639008 BD48CE84 C0667C42
FA301D06 03551D0E 04160414 F93A0D3C 1E02413B 639008BD 48CE84C0 667C42FA
300D0609 2A864886 F70D0101 05050003 82010100 8DD1D5C3 C20DFA39 D11E7687
AFC0E942 8CF56D03 D60916DD 9FC371A0 94865AE9 6CA17638 0D6C8BA4 C334491B
9E75771E BA6B3A71 27AB508E 595BD12C 9321D05B 7BB8BB51 434D6828 15777B5B
A0D2A495 E81860B2 ACF352EF E90F9466 061C83FE 16271AB8 5C90A4CB 5FDC0A81
AE52A7F5 D24422E0 6DD17716 78B48FE8 250E3C7B 9B3E2073 1C818316 2F4994C1
B47764D7 94746029 0034916A E7420017 4C8D35F5 9E651E0B 68305068 C8425BDD
21DA1B3D C7EE073A 22E9C9ED ECF0B84C C0856C66 A5B86532 24B0EC46 A94CB0A2
9F15FFC3 3D765BDC DBAB0A86 67E59A63 00583187 1B15CFD1 A6D2CD0E 2C510CD1
3FE835F3 A509BE76 622333B7 26821FAE 20C92352
quit
license udi pid ISR4321/K9 sn FD021500FNQ
no license smart enable
diagnostic bootup level minimal
spanning-tree extend system-id
```

```
redundancy
mode none
interface GigabitEthernet0/0/0
ip address 10.0.2.1 255.255.255.252
negotiation auto
ipv6 address 2002::1/64
ipv6 eigrp 1
interface GigabitEthernet0/0/1
ip address 10.0.1.2 255.255.255.252
negotiation auto
ipv6 address 2001::2/64
ipv6 eigrp 1
interface Service-Engine0/2/0
no ip address
shutdown
interface GigabitEthernet0
vrf forwarding Mgmt-intf
no ip address
shutdown
negotiation auto
router eigrp 1
network 10.0.1.0 0.0.0.3
network 10.0.2.0 0.0.0.3
redistribute bgp 65002 metric 10000 10 255 1 1500
router bgp 65002
bgp log-neighbor-changes
neighbor 10.0.1.1 remote-as 65001
neighbor 2001::1 remote-as 65001
address-family ipv4
redistribute connected
redistribute eigrp 1
neighbor 10.0.1.1 activate
no neighbor 2001::1 activate
exit-address-family
address-family ipv6
redistribute connected
redistribute eigrp 1
neighbor 2001::1 activate
exit-address-family
ip forward-protocol nd
ip http server
ip http authentication local
ip http secure-server
ip tftp source-interface GigabitEthernet0
ipv6 router eigrp 1
redistribute bgp 65002 metric 10000 10 255 1 1500
control-plane
line con 0
transport input none
stopbits 1
```

```
line aux 0
stopbits 1
line vty 0 4
login
end
```

R4 Configuration

```
version 16.9
service timestamps debug datetime msec
service timestamps log datetime msec
platform qfp utilization monitor load 80
platform punt-keepalive disable-kernel-core
hostname 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
login on-success log
subscriber templating
ipv6 unicast-routing
multilink bundle-name authenticated
crypto pki trustpoint TP-self-signed-1192009516
enrollment selfsigned
subject-name cn=IOS-Self-Signed-Certificate-1192009516
revocation-check none
rsa keypair TP-self-signed-1192009516
crypto pki certificate chain TP-self-signed-1192009516
certificate self-signed 01
30820330 30820218 A0030201 02020101 300D0609 2A864886 F70D0101 05050030
31312F30 2D060355 04031326 494F532D 53656C66 2D536967 6E65642D 43657274
69666963 6174652D 31313932 30303935 3136301E 170D3235 31303231 32303532
34335A17 0D333030 31303130 30303030 305A3031 312F302D 06035504 03132649
4F532D53 656C662D 5369676E 65642D43 65727469 66696361 74652D31 31393230
30393531 36308201 22300D06 092A8648 86F70D01 01010500 0382010F 00308201
0A028201 0100C458 92764E28 D8414087 87B8CDDF D57EDE25 D8C57D2E 92E3A710
D751760F 1D211C0D 1168B169 C25CB2C8 EB5B4C66 2D5F02ED 8F41318F 7A78F134
43492F4F 9C5AF08C 165770FD BB7C4914 EDCB14F1 83FBDFD2 AEF3893 CB730EFF
1FE667E5 7780DA1A 8990044B 39CF1CB8 E146BAD0 D1955FC8 4ADCA043 27A1029F
62BADEA3 5588C0F9 676E7F7C 3DC19037 F2F61934 8FB4388C 1440AD47 C10D0CA3
D70F9EC6 AB785A0F FA7CC487 A5F09D78 7106173A 3FEFCF14 EBC79BF9 6F415FA8
8E8E3F85 0BC4F7E7 080517CF D20E0EE8 DE6F0542 A34E24CE 68F6486A 17F99D5D
CFC29E03 7D6C34B4 12B3B653 D5BF4C89 542209E5 46E12B99 CA5E9373 531D3E7D
0D419A87 2F2B0203 010001A3 53305130 0F060355 1D130101 FF040530 030101FF
301F0603 551D2304 18301680 149CF3F2 88C1EDC5 269EE45C 27D26E75 A971F40D
```

20301D06 03551D0E 04160414 9CF3F288 C1EDC526 9EE45C27 D26E75A9 71F40D20
300D0609 2A864886 F70D0101 05050003 82010100 1E7D38A1 2D0D8BD7 9B48CF22
E08946A9 71BCE943 6C669A89 8FADF4B6 915CF374 94329422 043B17D3 3E98BDD1
662FF905 1CC002B7 5B0A657C E49B9271 95DA548B EB8F80B2 67B6EA4A 38911020
E30D886D 957501DC 4ACE34E7 93E1FF48 52672F68 933C6826 155B8567 E81553DF
2E7F254C 2A3075DF B4498150 46736748 B97CE7F0 99E67098 02483F06 E2077925
BE2CC318 341EE6B2 710305CE 715041A4 C0318136 92275ADD E3A55FC8 F637FFBC
B9C5DBB1 E291F0A2 43990B40 0C39457A 159AFD93 CE6139EF D2CD0B20 0DB0460B
589CFF24 FFC907F8 9A529EC7 12006951 EF0939FB ACC850BD 270FF6B3 F034DE0E
C463C049 4D307AAB 8159EBD4 3CE1CF05 E7B68108

quit

license udi pid ISR4321/K9 sn FD021482DVS

no license smart enable

diagnostic bootup level minimal

spanning-tree extend system-id

redundancy

mode none

interface GigabitEthernet0/0/0

ip address 10.0.3.1 255.255.255.252

negotiation auto

ipv6 address 2003::1/64

ipv6 eigrp 1

interface GigabitEthernet0/0/1

ip address 10.0.2.2 255.255.255.252

negotiation auto

ipv6 address 2002::2/64

ipv6 eigrp 1

interface GigabitEthernet0

vrf forwarding Mgmt-intf

no ip address

shutdown

negotiation auto

router eigrp 1

network 10.0.2.0 0.0.0.3

network 10.0.3.0 0.0.0.3

redistribute bgp 65002 metric 10000 10 255 1 1500

router bgp 65002

bgp log-neighbor-changes

neighbor 10.0.3.2 remote-as 65003

neighbor 2003::2 remote-as 65003

address-family ipv4

redistribute connected

redistribute eigrp 1

neighbor 10.0.3.2 activate

no neighbor 2003::2 activate

exit-address-family

address-family ipv6

redistribute connected

redistribute eigrp 1

neighbor 2003::2 activate

```
exit-address-family
ip forward-protocol nd
ip http server
ip http authentication local
ip http secure-server
ip tftp source-interface GigabitEthernet0
ipv6 router eigrp 1
redistribute bgp 65002 metric 10000 10 255 1 1500
control-plane
line con 0
transport input none
stopbits 1
line aux 0
stopbits 1
line vty 0 4
login
end
```

R5 Configuration

```
version 16.9
service timestamps debug datetime msec
service timestamps log datetime msec
platform qfp utilization monitor load 80
platform punt-keepalive disable-kernel-core
hostname 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-3875574019
enrollment selfsigned
subject-name cn=IOS-Self-Signed-Certificate-3875574019
revocation-check none
rsa-keypair TP-self-signed-3875574019
crypto pki certificate chain TP-self-signed-3875574019
certificate self-signed 01
30820330 30820218 A0030201 02020101 300D0609 2A864886 F70D0101 05050030
31312F30 2D060355 04031326 494F532D 53656C66 2D536967 6E65642D 43657274
69666963 6174652D 33383735 35373430 3139301E 170D3235 31303231 32303433
32305A17 0D333030 31303130 30303030 305A3031 312F302D 06035504 03132649
```

```
4F532D53 656C662D 5369676E 65642D43 65727469 66696361 74652D33 38373535
37343031 39308201 22300D06 092A8648 86F70D01 01010500 0382010F 00308201
0A028201 0100C16B 5A4C0210 7A46598D 0B16BE05 48FE15F8 27AEF7E6 662B7635
DE886E1B FACB3CA4 32051A8B A89A4F47 65516481 6F93131C 6B034577 B8DC8542
7BAA2AC8 2BCD3BD2 F4FD315E C1ED43F0 E2C6C93D 5DA98E82 BBF978A6 91BC81A6
F4AEC7BA 63744B10 B76F8121 2D9DB70A F71ED5E6 C3CF8008 3CCF68AC F1B87012
D7DD765C 6BF9883C CB79006B 82522116 78179B6D 4F609C20 F05B8D60 5558DC1E
656F0E60 5BCDD495 9E1932E4 5B81064C 7B346924 79CA732F A30D0A8F 555BD08B
37F40488 33077686 13F2223C 6C2BC115 C63434A0 FF5962F7 7BA56BD7 73895599
35FCB5B1 45328A49 93F15A29 85DF0F65 00B94140 891C1E09 A55581A1 25C26188
C6097122 3AFF0203 010001A3 53305130 0F060355 1D130101 FF040530 030101FF
301F0603 551D2304 18301680 14320EE5 01E27D35 FBA2F429 C18DFF95 A7F1FD97
2C301D06 03551D0E 04160414 320EE501 E27D35FB A2F429C1 8DFF95A7 F1FD972C
300D0609 2A864886 F70D0101 05050003 82010100 06D44928 D326E18F 330A5028
32522110 CB467707 BC76BB31 1E10CB70 A00D6256 9F4C55BF 63543F2E 8C12CE26
00B4E376 74F5B312 17DF48CE 5821E984 1AC3D3B5 688965C2 040D0EE6 6F1CB23A
EF7F81BF 01183F59 7AD9E133 93F054C2 A0F37E7D A3B464E8 91E94DB5 803DB90C
AD84E0FA D9892B95 310F35EA 07D3143A F9DF9298 975221F4 ECB684BE 0E517DA5
283D23A2 4B82D1E4 26C19FD5 9CE720E5 0F9518FC 6625E2F3 E5B14DDC 8FC23516
E1329DC0 8EB49B68 8CA662AD 23E202D0 9FBD7549 CB431D7A 683E2FE5 24845C95
847C895C 8B35C1B9 8C82ED41 9C449DD6 0A25E87F D7633C6E 6059BA5E 7064FA7A
FEA657B8 20340C08 0EB0618E DEA117DC 4A94B6A5
```

quit

```
license udi pid ISR4321/K9 sn FLM2407014D
```

```
no license smart enable
```

```
diagnostic bootup level minimal
```

```
spanning-tree extend system-id
```

```
redundancy
```

```
mode none
```

```
interface GigabitEthernet0/0/0
```

```
ip address 10.0.4.1 255.255.255.252
```

```
ip router isis 1
```

```
negotiation auto
```

```
ipv6 address 2004::1/64
```

```
ipv6 router isis 1
```

```
interface GigabitEthernet0/0/1
```

```
ip address 10.0.3.2 255.255.255.252
```

```
ip router isis 1
```

```
negotiation auto
```

```
ipv6 address 2003::2/64
```

```
ipv6 router isis 1
```

```
interface GigabitEthernet0/2/0
```

```
no ip address
```

```
shutdown
```

```
negotiation auto
```

```
interface GigabitEthernet0/2/1
```

```
no ip address
```

```
shutdown
```

```
negotiation auto
```

```
interface GigabitEthernet0
```

```
vrf forwarding Mgmt-intf
no ip address
shutdown
negotiation auto
router isis 1
net 01.0000.0000.0000.0005.00
is-type level-2-only
metric-style narrow
redistribute bgp 65003
address-family ipv6
redistribute bgp 65003
exit-address-family
router isis 5
metric-style narrow
router bgp 65003
bgp log-neighbor-changes
neighbor 10.0.3.1 remote-as 65002
neighbor 2003::1 remote-as 65002
address-family ipv4
redistribute connected
redistribute isis 1 level-2
neighbor 10.0.3.1 activate
no neighbor 2003::1 activate
exit-address-family
address-family ipv6
redistribute connected
redistribute isis 1 level-2
neighbor 2003::1 activate
exit-address-family
ip forward-protocol nd
ip http server
ip http authentication local
ip http secure-server
ip tftp source-interface GigabitEthernet0
control-plane
line con 0
transport input none
stopbits 1
line aux 0
stopbits 1
line vty 0 4
login
end
```

R6 Configuration

```
version 16.9
service timestamps debug datetime msec
service timestamps log datetime msec
```

```
platform qfp utilization monitor load 80
platform punt-keepalive disable-kernel-core
hostname 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
login on-success log
subscriber templating
ipv6 unicast-routing
multilink bundle-name authenticated
crypto pki trustpoint TP-self-signed-3696827413
enrollment selfsigned
subject-name cn=IOS-Self-Signed-Certificate-3696827413
revocation-check none
rsa-keypair TP-self-signed-3696827413
crypto pki certificate chain TP-self-signed-3696827413
certificate self-signed 01
30820330 30820218 A0030201 02020101 300D0609 2A864886 F70D0101 05050030
31312F30 2D060355 04031326 494F532D 53656C66 2D536967 6E65642D 43657274
69666963 6174652D 33363936 38323734 3133301E 170D3235 31303231 32303539
35345A17 0D333030 31303130 30303030 305A3031 312F302D 06035504 03132649
4F532D53 656C662D 5369676E 65642D43 65727469 66696361 74652D33 36393638
32373431 33308201 22300D06 092A8648 86F70D01 01010500 0382010F 00308201
0A028201 01009AED 642ACD2A 6214E358 BDADD38E D7F5B7DC D73FD629 F1A5527E
696A4D46 9D8EB826 710C0F34 B033635E 83D555D5 F62E9153 2FD0DFEE 018081FA
51468E56 F8AA5EC5 4DF3E65D A2360C54 9A831C3B FA6FAEB3 BF0D09DA C08B9B7E
5EA981B9 A31CECFE 1D5F3944 03973DE2 EFB869B6 D38BC850 9CF69EC4 813868C0
EB954108 BC984B29 2874C218 5D8683FC 73EEC338 525BB537 858F4860 26336164
B0F75A12 2C34CEF2 47EAD5C1 9949E5C4 16C90B0F 10BD77E4 E6448A79 CD24F8D8
8C382FE2 424385FF 1C6A5FE1 A94F6432 3ABE7856 FBBEFCBA 3ECE02D8 E66F54C1
F9FF5B70 1DD422EA 0B03DE39 901F3783 43BF4D2B 64AD757B 4C06A435 6BAF349D
24624A45 50310203 010001A3 53305130 0F060355 1D130101 FF040530 030101FF
301F0603 551D2304 18301680 14928EFF 7D8E13ED B7C473AD 207F3F35 4CFC2A56
5E301D06 03551D0E 04160414 928EFF7D 8E13EDB7 C473AD20 7F3F354C FC2A565E
300D0609 2A864886 F70D0101 05050003 82010100 8DC099A2 3974C2D7 0E94ABBF
B5119782 DF0B056F F83AEC97 673E909C 335726C6 FBE4037A B70D4156 1242A92D
B3BF1F89 4CC1B524 49FCB299 675CCDF0 B56655A6 65F6B19D E3FB9408 430D0E20
9AEFB6A5 00025995 087C03DC 4E85BB4A D243271D 95F72F18 2A23225A CA77DEC4
32C93702 A5DCD5E1 49AC91E3 1AD46DCF 1BF5E55B B565CA30 D3276D92 708277E4
E4A78EDC 916FDD8C D2521803 DB31AD42 AF42FCBF 589D686D 24AF348C 65E41B03
302B68BB 832EC0AC 8A350C39 1412DF50 CA427908 E8FC8DBA D54D595A 1EC3AAD1
4A5CBA4B 7A62A61A 2E8F3DEC B3F092BD 4343799C 21234A24 643D453B CF62CD38
B7A14FE6 67452C9F 3DA0666E 1ECCC2CB 8FEB7D7D
quit
license udi pid ISR4321/K9 sn FLM240608PH
```

```
no license smart enable
diagnostic bootup level minimal
spanning-tree extend system-id
redundancy
mode none
interface GigabitEthernet0/0/0
no ip address
shutdown
negotiation auto
interface GigabitEthernet0/0/1
ip address 10.0.4.2 255.255.255.252
ip router isis 1
negotiation auto
ipv6 address 2004::2/64
ipv6 router isis 1
interface GigabitEthernet0/2/0
no ip address
shutdown
negotiation auto
interface GigabitEthernet0/2/1
no ip address
shutdown
negotiation auto
interface GigabitEthernet0
vrf forwarding Mgmt-intf
no ip address
shutdown
negotiation auto
router isis 1
net 01.0000.0000.0000.0006.00
is-type level-2-only
metric-style narrow
ip forward-protocol nd
ip http server
ip http authentication local
ip http secure-server
ip tftp source-interface GigabitEthernet0
control-plane
line con 0
transport input none
stopbits 1
line aux 0
stopbits 1
line vty 0 4
login
end
```

Routing Tables

R1 Routing Table

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, GigabitEthernet0/0/0

L 10.0.0.1/32 is directly connected, GigabitEthernet0/0/0

O 10.0.1.0/30 [110/2] via 10.0.0.2, 01:18:24,

GigabitEthernet0/0/0

O E2 10.0.2.0/30 [110/20] via 10.0.0.2, 00:53:47,

GigabitEthernet0/0/0

O E2 10.0.3.0/30 [110/20] via 10.0.0.2, 00:53:47,

GigabitEthernet0/0/0

O E2 10.0.4.0/30 [110/20] via 10.0.0.2, 00:53:16,

GigabitEthernet0/0/0

R1#show ipv6 route

IPv6 Routing Table - default - 7 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 2000::/64 [0/0]

via GigabitEthernet0/0/0, directly connected

L 2000::1/128 [0/0]

via GigabitEthernet0/0/0, receive

```

O   2001::/64 [110/2]
    via FE80::2C1:B1FF:FEB3:8C01, GigabitEthernet0/0/0
OE2 2002::/64 [110/1]
    via FE80::2C1:B1FF:FEB3:8C01, GigabitEthernet0/0/0
OE2 2003::/64 [110/1]
    via FE80::2C1:B1FF:FEB3:8C01, GigabitEthernet0/0/0
OE2 2004::/64 [110/1]
    via FE80::2C1:B1FF:FEB3:8C01, GigabitEthernet0/0/0
L   FF00::/8 [0/0]
    via Null0, receive

```

R2 Routing Table

```
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, GigabitEthernet0/0/1
```

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

```
C    10.0.1.0/30 is directly connected, GigabitEthernet0/0/0
```

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

```
B    10.0.2.0/30 [20/0] via 10.0.1.2, 00:54:47
```

```
B    10.0.3.0/30 [20/3072] via 10.0.1.2, 00:54:47
```

```
B    10.0.4.0/30 [20/258816] via 10.0.1.2, 00:54:16
```

```
R2#show ipv6 route
```

```
IPv6 Routing Table - default - 8 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 2000::/64 [0/0]
 via GigabitEthernet0/0/1, directly connected
 L 2000::2/128 [0/0]
 via GigabitEthernet0/0/1, receive
 C 2001::/64 [0/0]
 via GigabitEthernet0/0/0, directly connected
 L 2001::1/128 [0/0]
 via GigabitEthernet0/0/0, receive
 B 2002::/64 [20/0]
 via FE80::521C:B0FF:FE63:37A1, GigabitEthernet0/0/0
 B 2003::/64 [20/3072]
 via FE80::521C:B0FF:FE63:37A1, GigabitEthernet0/0/0
 B 2004::/64 [20/258816]
 via FE80::521C:B0FF:FE63:37A1, GigabitEthernet0/0/0
 L FF00::/8 [0/0]
 via Null0, receive

R3 Routing Table

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
B    10.0.0.0/30 [20/0] via 10.0.1.1, 01:19:49
C    10.0.1.0/30 is directly connected, GigabitEthernet0/0/1
L    10.0.1.2/32 is directly connected, GigabitEthernet0/0/1
C    10.0.2.0/30 is directly connected, GigabitEthernet0/0/0
L    10.0.2.1/32 is directly connected, GigabitEthernet0/0/0
D    10.0.3.0/30 [90/3072] via 10.0.2.2, 00:55:22,
GigabitEthernet0/0/0
D EX 10.0.4.0/30 [170/258816] via 10.0.2.2, 00:55:12,
GigabitEthernet0/0/0

```

```
R3#show ipv6 route
```

```
IPv6 Routing Table - default - 8 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    2000::/64 [20/0]
     via FE80::2C1:B1FF:FEB3:8C00, GigabitEthernet0/0/1
C    2001::/64 [0/0]
     via GigabitEthernet0/0/1, directly connected
L    2001::2/128 [0/0]
     via GigabitEthernet0/0/1, receive
C    2002::/64 [0/0]
     via GigabitEthernet0/0/0, directly connected
L    2002::1/128 [0/0]
     via GigabitEthernet0/0/0, receive
D    2003::/64 [90/3072]
     via FE80::267E:12FF:FE4D:E7B1, GigabitEthernet0/0/0
EX   2004::/64 [170/258816]
     via FE80::267E:12FF:FE4D:E7B1, GigabitEthernet0/0/0
L    FF00::/8 [0/0]
     via Null0, receive

```

R4 Routing Table

```
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
D EX    10.0.0.0/30 [170/258816] via 10.0.2.1, 00:55:31,
GigabitEthernet0/0/1
D      10.0.1.0/30 [90/3072] via 10.0.2.1, 00:55:31,
GigabitEthernet0/0/1
C      10.0.2.0/30 is directly connected, GigabitEthernet0/0/1
L      10.0.2.2/32 is directly connected, GigabitEthernet0/0/1
C      10.0.3.0/30 is directly connected, GigabitEthernet0/0/0
L      10.0.3.1/32 is directly connected, GigabitEthernet0/0/0
B      10.0.4.0/30 [20/0] via 10.0.3.2, 00:55:04
  
```

R4#show ipv6 route

IPv6 Routing Table - default - 8 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

```

EX 2000::/64 [170/258816]
    via FE80::521C:B0FF:FE63:37A0, GigabitEthernet0/0/1
D 2001::/64 [90/3072]
    via FE80::521C:B0FF:FE63:37A0, GigabitEthernet0/0/1
C 2002::/64 [0/0]
    via GigabitEthernet0/0/1, directly connected
L 2002::2/128 [0/0]
    via GigabitEthernet0/0/1, receive
C 2003::/64 [0/0]
  
```

```

    via GigabitEthernet0/0/0, directly connected
L   2003::1/128 [0/0]
    via GigabitEthernet0/0/0, receive
B   2004::/64 [20/0]
    via FE80::CE7F:76FF:FE6A:A621, GigabitEthernet0/0/0
L   FF00::/8 [0/0]
    via Null0, receive

```

R5 Routing Table

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

```

B   10.0.0.0/30 [20/258816] via 10.0.3.1, 00:54:29
B   10.0.1.0/30 [20/3072] via 10.0.3.1, 00:54:29
B   10.0.2.0/30 [20/0] via 10.0.3.1, 00:54:29
C   10.0.3.0/30 is directly connected, GigabitEthernet0/0/1
L   10.0.3.2/32 is directly connected, GigabitEthernet0/0/1
C   10.0.4.0/30 is directly connected, GigabitEthernet0/0/0
L   10.0.4.1/32 is directly connected, GigabitEthernet0/0/0

```

R5#show ipv6 route

IPv6 Routing Table - default - 8 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 2000::/64 [20/258816]
 via FE80::267E:12FF:FE4D:E7B0, GigabitEthernet0/0/1
 B 2001::/64 [20/3072]
 via FE80::267E:12FF:FE4D:E7B0, GigabitEthernet0/0/1
 B 2002::/64 [20/0]
 via FE80::267E:12FF:FE4D:E7B0, GigabitEthernet0/0/1
 C 2003::/64 [0/0]
 via GigabitEthernet0/0/1, directly connected
 L 2003::2/128 [0/0]
 via GigabitEthernet0/0/1, receive
 C 2004::/64 [0/0]
 via GigabitEthernet0/0/0, directly connected
 L 2004::1/128 [0/0]
 via GigabitEthernet0/0/0, receive
 L FF00::/8 [0/0]
 via Null0, receive

R6 Routing Table

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
 i L2 10.0.0.0/30 [115/10] via 10.0.4.1, 00:53:36,
 GigabitEthernet0/0/1

```

i L2    10.0.1.0/30 [115/10] via 10.0.4.1, 00:53:36,
GigabitEthernet0/0/1
i L2    10.0.2.0/30 [115/10] via 10.0.4.1, 00:53:36,
GigabitEthernet0/0/1
i L2    10.0.3.0/30 [115/20] via 10.0.4.1, 00:53:46,
GigabitEthernet0/0/1
C       10.0.4.0/30 is directly connected, GigabitEthernet0/0/1
L       10.0.4.2/32 is directly connected, GigabitEthernet0/0/1

```

R6#show ipv6 route

IPv6 Routing Table - default - 7 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

```

I2  2000::/64 [115/10]
    via FE80::CE7F:76FF:FE6A:A620, GigabitEthernet0/0/1
I2  2001::/64 [115/10]
    via FE80::CE7F:76FF:FE6A:A620, GigabitEthernet0/0/1
I2  2002::/64 [115/10]
    via FE80::CE7F:76FF:FE6A:A620, GigabitEthernet0/0/1
I2  2003::/64 [115/20]
    via FE80::CE7F:76FF:FE6A:A620, GigabitEthernet0/0/1
C   2004::/64 [0/0]
    via GigabitEthernet0/0/1, directly connected
L   2004::2/128 [0/0]
    via GigabitEthernet0/0/1, receive
L   FF00::/8 [0/0]
    via Null0, receive

```

Problems

Through the lab, we ran into multiple issues during setup, and they are documented below. For convenience, we denote “Router RX’s port which connects to Router RY” as Port RX_{RY} . For example, port $R2_{R3}$ is the port on Router 2 which is connected to Router 3.

During our initial setup of BGP, we assigned Routers R2, R3, R4, and R5 with Autonomous System numbers of 65001, 65002, 65003, and 65004 respectively. On Routers R3 and R4, the routers would display an “ASN mismatch” warning message. We soon discovered that, because R3 and R4 were both connected by the same EIGRP process, we needed to match their

Autonomous System Numbers. After correcting the ASN of R4, R5 to 65002 and 65003 respectively, the error messages disappeared.

After resetting BGP, we ran into another connectivity issue between Router 2 and Router 4. After opening the routing table, we discovered that Router 2 has a route to the IP address of port $R4_{R5}$ but not ports $R4_{R3}$ or $R3_{R4}$. However, on Router 3's routing table there were directly connected routes to the IP Addresses of $R3_{R4}$ and $R4_{R3}$ and an EIGRP route to $R4_{R5}$. Although R3 and R4 are part of the same EIGRP network, the routes between them are considered directly connected routes, and were not distributed into BGP when we ran `redistribute eigrp 1`. To fix this issue, we added the `redistribute connected` command which redistributed the connected routes of each router into BGP. The connection between R2 and R4 was formed.

After the above error was fixed, we found that all pings could work except for the ping between R1 and R6 in IPv6. Realizing that we had likely made a configuration mistake on one of the routers, we viewed the IPv6 routing tables of every router between R1 to R6. However, none of the routes seemed to be missing. We eventually realized that the error was in fact on R6. Although the ICMPv6 was successfully received by R6, R6 did not have an IPv6 route to send it back to R1. The error was that we neglected to add a command on R5 redistributing the BGP routes into IS-IS on IPv6. After the missing command was added, we were done.

Conclusion

During the setup of the BGP, OSPF, EIGRP, and IS-IS in the lab, we experienced an assortment of issues which took hours to fix. However, we practiced our debugging skills and worked through the errors with the assistance of textbooks, internet, and peer feedback. More importantly, we practiced the commands used to set up two new routing protocols each with their own advantages and the BGP protocol which links everything together. Through practicing the setup in both IPv4 and IPv6, we have become more versatile in our networking abilities for connecting router networks.

Signoff Page