CCNP Lab 3

The purpose of this lab was to learn and understand more Routing Protocols, as well as how they can interact with each other. The previous lab was to set up multi-area OSPF on 6 routers. This time, the concept that I am taught here is setting up more than just OSPF. This time, I must set up 3 different routing protocols (OSPF, EIGRP, and BGP) and link them together. Multi-area OSPF was relatively easy—just change a few area numbers in a notepad file. However, because I am using different routing protocols, I have to first learn how to set up said routing protocols, then link them together using a special command.

Some background on this lab. I already talked about OSPF twice, so we will skip to the other routing protocols. **E**nhanced **I**nterior **G**ateway **R**outing **P**rotocol is a Cisco-proprietary protocol that works similarly to OSPF. **B**order **G**ateway **P**rotocol is an open standard routing protocol that allows routers to communicate their routes with each other in very large networks While OSPF and EIGRP use layer 3, BGP uses layer 4, specifically, TCP. EIGRP and BGP have advantages over OSPF. EIGRP converges faster and sends more frequent updates. However, since EIGRP is cisco-proprietary, you can’t just use it for all routers. BGP is more flexible and more scalable than OSPF and EIGRP, making it a great backbone protocol. This means that if you want to set up a very large network, you should have BGP as the backbone, and EIGRP for smaller subnetworks.

EIGRP has some advantages and disadvantages compared to OSPF. The biggest advantage is that EIGRP is faster than OSPF because it uses a different algorithm, called the **D**iffusing **U**pdate **Al**gorithm. DUAL allows EIGRP to update its topology than OSPF, decreasing the convergence time. Also, because EIGRP is cisco-proprietary, Cisco decided that its administrative distance is 90, which is lower than OSPF’s 110. However, EIGRP is a cisco-proprietary protocol. This means that if you have a router from a different company, like Juniper, you can’t use EIGRP—Juniper routers don’t understand such a protocol, so you must use OSPF. Overall though, both protocols work well for making a network of many sizes, and if you need multiple “regions,” you can use a different AD for EIGRP, like how you can use different areas for OSPF, making both protocols very powerful.

BGP is a very different routing protocol than OSPF or EIGRP. BGP is often used as a backbone for extremely large networks. BGP has multiple advantages over EIGRP and OSPF. First of all, the protocol is open standard, so you can use it for any size network. Second, this protocol works in layer 4 (specifically TCP) instead of layer 3 (IP). This is because BGP needs to be able to control the networks layer for it to work. BGP is often the best protocol for external networks. External BGP, or eBGP, is when two different autonomous system numbers connect together with a command that I will mention later. This is because BGP is generally a stable protocol and allows alternate paths if one goes down. This is why the default AD of eBGP is 20. However, BGP has its drawbacks as well. It is vulnerable to losing packets, which it can't detect, and you can flood the system can be overloaded with a DDoS attack. Finally, someone can claim they are the intended AS, giving them control of the traffic for a little while.

In summary, I set up single-area OSPF on 3 routers, BGP on two routers, and EIGRP on 3 routers, with 6 routers used. I then linked OSPF, BGP, and EIGRP together using a specific command that makes multi-protocol possible.

I already talked about configuring OSPF, so I’ll skip to EIGRP. Configuring EIGRP is very similar to OSPF. To enter the router configuration, you type in global configuration:

ip router eigrp <AS number>

Or if you are on IPv6,

ipv6 router eigrp <AS number>

This AS number is the equivalent of an area number for OSPF. Once you are in the router configuration, you type in each router

network <network> <wildcard mask>

Which enables EIGRP for that network. Unlike OSPF, you don’t have to type out an area number. The **A**utonomous **S**ystem number is the “area.” This also means you don’t have to type an “ip eigrp <AS number>” in the interface configuration mode. Meanwhile, configuring EIGRP for IPv6 is almost the exact same as OSPF, but you replace OSPF with EIGRP and you don’t have an area number in the interface configuration mode. Also, making a passive interface in EIGRP is the same as OSPF.

BGP, however, has a more interesting configuration. To set it up, you first type:

router bgp <AS>

On the routers you want. A key thing to note is that the AS numbers **must be different** for the different routers. Once you are in the BGP router config, you type

address-family ipv4

This is because unlike OSPF and EIGRP, BGP only has one router configuration mode, and you don’t have to do a “ipv6 router bgp <AS>.” Instead, from BGP router config, you type:

address-family ipv6

And that allows you to configure IPv6. Anyway, in the IPv4 address family, you type:

neighbor <IP address> remote-as <AS>

Note that the AS number there must be the other router’s AS number. If you want to set up a network, you type in the IPv4 address family:

network <network address> mask <mask>

Which enables BGP for that network. In the IPv6 address family, the configuration is

neighbor <IP address> remote-as <AS>

neighbor <IP address> activate

In that order. This makes the router recognize the other router’s IP and AS, then activates it to make it work.

Now, the most important command to know: the redistribute command. These routing protocols can’t talk with each other normally, ie. OSPF and BGP, by default, can’t interact with each other. If you want them to communicate between their protocols, you need to type into each router configuration:

redistribute <protocol> <ID>

That ID depends on what protocol you use. If you use OSPF, that ID is the process ID. For EIGRP or BGP, that ID is the AS number. There are some caveats, though. For example, to redistribute from EIGRP to BGP, you must add a metric, which looks like this:

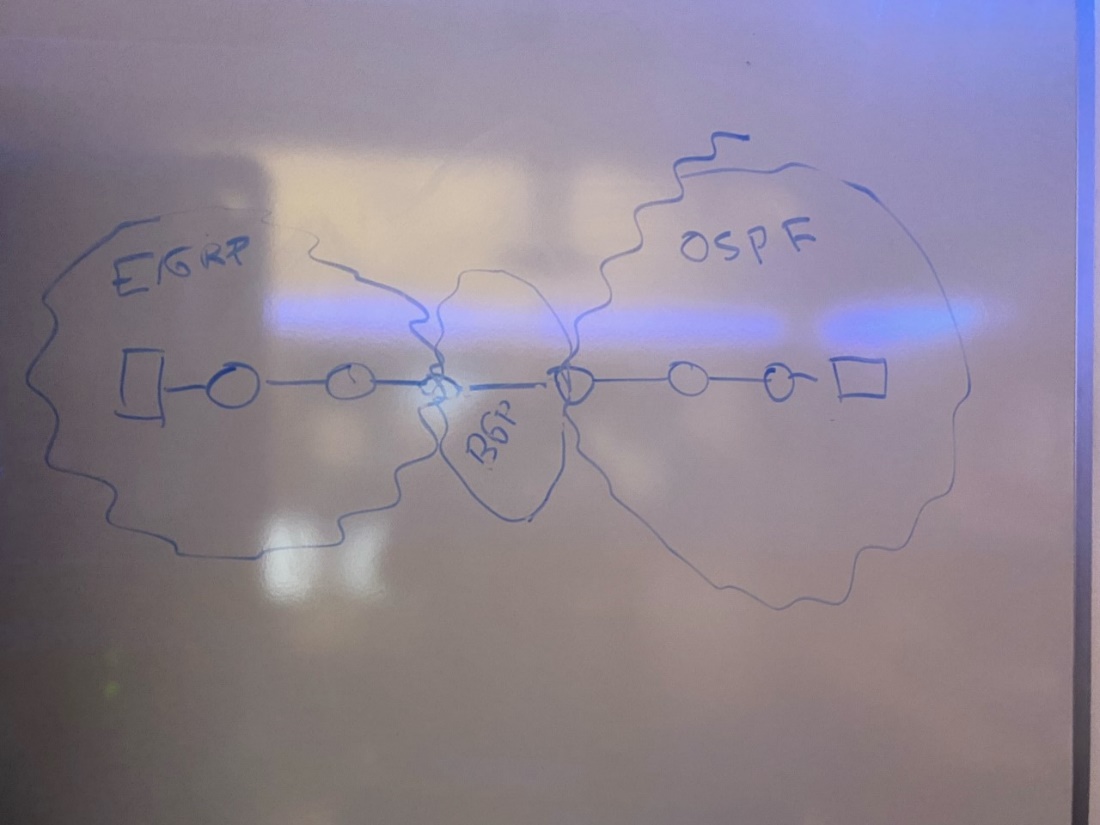
redistribute bgp <AS> metric <metric #>

This is because BGP and EIGRP use different metrics, so you have to define one metric that they both can use. On the other hand, BGP and OSPF use metrics that they can understand, so you don’t have to use the metric command there. The same is true in IPv6. However, in IPv6, these routing protocols can’t redistribute their directly connected routes (even if they are in the redistributed network), so you must type into router configuration:

redistribute connected

To make it work. Also, in OSPF, you have to use “ipv6 router ospf” rather than “router ospfv3” to redistribute routes in IPv6, because for some reason the router doesn’t recognize the redistribute command with “router ospfv3,” and I don’t know why.

My network diagram was conveniently drawn out for me to use. The diagram shows where to put the routing protocols and this is what it looks like:



Each rectangle is an end device, and each circle is a router.

Here are my 6 router configurations along with the pings and traceroutes from the PCs. This will show you that the routers are working properly. First are the running configurations:

Router 1:

R1#show run

Building configuration...

Current configuration : 1713 bytes

! Last configuration change at 20:48:07 UTC Thu Oct 6 2022

version 15.5

service timestamps debug datetime msec

service timestamps log datetime msec

no platform punt-keepalive disable-kernel-core

hostname R1

boot-start-marker

boot-end-marker

vrf definition Mgmt-intf

address-family ipv4

exit-address-family

address-family ipv6

exit-address-family

no aaa new-model

ipv6 unicast-routing

subscriber templating

multilink bundle-name authenticated

license udi pid ISR4321/K9 sn FDO214421CF

spanning-tree extend system-id

redundancy

mode none

vlan internal allocation policy ascending

interface GigabitEthernet0/0/0

ip address 10.0.1.1 255.255.255.0

ip ospf 1 area 0

negotiation auto

ipv6 address FE80::1 link-local

ipv6 address 2001:1::1/64

ipv6 ospf 1 area 0

interface GigabitEthernet0/0/1

ip address 10.0.0.1 255.255.255.0

ip ospf 1 area 0

negotiation auto

ipv6 address FE80::1 link-local

ipv6 address 2001::1/64

ipv6 ospf 1 area 0

interface Serial0/1/0

no ip address

interface Serial0/1/1

no ip address

interface GigabitEthernet0

vrf forwarding Mgmt-intf

no ip address

negotiation auto

interface Vlan1

no ip address

router ospfv3 1

router-id 1.1.1.1

address-family ipv6 unicast

passive-interface GigabitEthernet0/0/1

exit-address-family

router ospf 1

passive-interface GigabitEthernet0/0/1

network 10.0.0.0 0.0.0.255 area 0

network 10.0.1.0 0.0.0.255 area 0

ip forward-protocol nd

no ip http server

no ip http secure-server

ip tftp source-interface GigabitEthernet0

control-plane

line con 0

stopbits 1

line aux 0

stopbits 1

line vty 0 4

login

end

Router 2:

R2#show run

Building configuration...

Current configuration : 1634 bytes

! Last configuration change at 21:01:56 UTC Thu Oct 6 2022

version 15.5

service timestamps debug datetime msec

service timestamps log datetime msec

no platform punt-keepalive disable-kernel-core

hostname R2

boot-start-marker

boot-end-marker

vrf definition Mgmt-intf

address-family ipv4

exit-address-family

address-family ipv6

exit-address-family

no aaa new-model

ipv6 unicast-routing

subscriber templating

multilink bundle-name authenticated

license udi pid ISR4321/K9 sn FDO211216BL

spanning-tree extend system-id

redundancy

mode none

vlan internal allocation policy ascending

interface GigabitEthernet0/0/0

ip address 10.0.2.1 255.255.255.0

ip ospf 1 area 0

negotiation auto

ipv6 address FE80::1 link-local

ipv6 address 2001:2::1/64

ipv6 ospf 1 area 0

interface GigabitEthernet0/0/1

ip address 10.0.1.2 255.255.255.0

ip ospf 1 area 0

negotiation auto

ipv6 address FE80::2 link-local

ipv6 address 2001:1::2/64

ipv6 ospf 1 area 0

interface Serial0/1/0

no ip address

interface Serial0/1/1

no ip address

interface GigabitEthernet0

vrf forwarding Mgmt-intf

no ip address

negotiation auto

interface Vlan1

no ip address

router ospfv3 1

router-id 2.2.2.2

address-family ipv6 unicast

exit-address-family

router ospf 1

network 10.0.1.0 0.0.0.255 area 0

network 10.0.2.0 0.0.0.255 area 0

ip forward-protocol nd

no ip http server

no ip http secure-server

ip tftp source-interface GigabitEthernet0

control-plane

line con 0

stopbits 1

line aux 0

stopbits 1

line vty 0 4

login

end

Router 3:

R3#show run

Building configuration...

Current configuration : 2018 bytes

! Last configuration change at 20:54:52 UTC Thu Oct 6 2022

version 15.5

service timestamps debug datetime msec

service timestamps log datetime msec

no platform punt-keepalive disable-kernel-core

hostname R3

boot-start-marker

boot-end-marker

vrf definition Mgmt-intf

address-family ipv4

exit-address-family

address-family ipv6

exit-address-family

no aaa new-model

ipv6 unicast-routing

subscriber templating

vtp domain cisco

vtp mode transparent

multilink bundle-name authenticated

license udi pid ISR4321/K9 sn FDO214420G7

spanning-tree extend system-id

redundancy

mode none

vlan internal allocation policy ascending

vlan 10,20

interface GigabitEthernet0/0/0

ip address 10.0.3.1 255.255.255.0

negotiation auto

ipv6 address FE80::1 link-local

ipv6 address 2001:3::1/64

interface GigabitEthernet0/0/1

ip address 10.0.2.2 255.255.255.0

ip ospf 1 area 0

negotiation auto

ipv6 address FE80::2 link-local

ipv6 address 2001:2::2/64

ipv6 ospf 1 area 0

interface Serial0/1/0

interface Serial0/1/1

interface GigabitEthernet0

vrf forwarding Mgmt-intf

no ip address

shutdown

negotiation auto

interface Vlan1

no ip address

shutdown

router ospf 1

redistribute bgp 1 subnets

network 10.0.2.0 0.0.0.255 area 0

router bgp 1

bgp log-neighbor-changes

neighbor 10.0.3.2 remote-as 2

neighbor 2001:3::2 remote-as 2

address-family ipv4

network 10.0.3.0 mask 255.255.255.0

redistribute ospf 1

neighbor 10.0.3.2 activate

no neighbor 2001:3::2 activate

exit-address-family

address-family ipv6

redistribute connected

redistribute ospf 1

neighbor 2001:3::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 ospf 1

router-id 3.3.3.3

redistribute connected

redistribute bgp 1

control-plane

line con 0

stopbits 1

line aux 0

stopbits 1

line vty 0 4

login

end

Router 4:

R4#show run

Building configuration...

Current configuration : 2170 bytes

! Last configuration change at 21:06:59 UTC Thu Oct 6 2022

version 15.5

service timestamps debug datetime msec

service timestamps log datetime msec

no platform punt-keepalive disable-kernel-core

hostname R4

boot-start-marker

boot-end-marker

vrf definition Mgmt-intf

address-family ipv4

exit-address-family

address-family ipv6

exit-address-family

no aaa new-model

ipv6 unicast-routing

subscriber templating

vtp domain cisco

vtp mode transparent

multilink bundle-name authenticated

license udi pid ISR4321/K9 sn FDO21442B21

spanning-tree extend system-id

redundancy

mode none

vlan internal allocation policy ascending

vlan 10,20

interface GigabitEthernet0/0/0

ip address 10.0.4.1 255.255.255.0

negotiation auto

ipv6 address FE80::1 link-local

ipv6 address 2001:4::1/64

ipv6 eigrp 1

interface GigabitEthernet0/0/1

ip address 10.0.3.2 255.255.255.0

negotiation auto

ipv6 address FE80::2 link-local

ipv6 address 2001:3::2/64

interface Serial0/1/0

interface Serial0/1/1

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

interface Vlan1

no ip address

shutdown

router eigrp 1

network 10.0.4.0 0.0.0.255

redistribute bgp 2 metric 1000 1 255 255 1500

router bgp 2

bgp log-neighbor-changes

neighbor 10.0.3.1 remote-as 1

neighbor 2001:3::1 remote-as 1

address-family ipv4

network 10.0.3.0 mask 255.255.255.0

redistribute eigrp 1

neighbor 10.0.3.1 activate

no neighbor 2001:3::1 activate

exit-address-family

address-family ipv6

redistribute connected

redistribute eigrp 1

neighbor 2001:3::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 eigrp 1

eigrp router-id 4.4.4.4

redistribute bgp 2

redistribute connected

control-plane

line con 0

stopbits 1

line aux 0

stopbits 1

line vty 0 4

login

end

Router 5:

R5#show run

Building configuration...

Current configuration : 3897 bytes

! Last configuration change at 20:50:31 UTC Thu Oct 6 2022

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-2270144787

enrollment selfsigned

subject-name cn=IOS-Self-Signed-Certificate-2270144787

revocation-check none

rsakeypair TP-self-signed-2270144787

crypto pki certificate chain TP-self-signed-2270144787

certificate self-signed 01

30820330 30820218 A0030201 02020101 300D0609 2A864886 F70D0101 05050030

31312F30 2D060355 04031326 494F532D 53656C66 2D536967 6E65642D 43657274

69666963 6174652D 32323730 31343437 3837301E 170D3232 31303036 32303439

33315A17 0D333030 31303130 30303030 305A3031 312F302D 06035504 03132649

4F532D53 656C662D 5369676E 65642D43 65727469 66696361 74652D32 32373031

34343738 37308201 22300D06 092A8648 86F70D01 01010500 0382010F 00308201

0A028201 0100CC78 773AED14 BB09D2C8 18C82D3F D868F214 190245A2 68975E9F

7FD6AAA7 4CD0BC2A 7DFC2D23 D45C92AD 2F597D59 1FA8B70D FA85EA6F 33D4C83F

5BF91FD9 3511AA68 6D0B2E2F 03245584 50BB26D1 77B35895 AE7660A2 4DD712FB

0AF5325D CF9F3B5C 46CEB70C BA2A0C32 FD9AEDB1 1020E93C 5013E0BC 4699980F

B6523635 29C7112F C5B2FCED 6915FE06 9FC21193 31B5B3A0 31D3DB75 470FD0D3

2B90F72A 85C2EA5C 817CDFC1 E18D6364 C48ED542 B4262CC3 C1E8BEDC BDE772D9

2DA3F6C5 9E17B3BB 777807E6 67E68AE0 6E31DCC6 028159EA 535F67E1 73B44312

A74907E9 3C7212E0 06F772D0 65F45826 2FBC1D8D 871D49CB F44546C6 01633690

83234EEF 7F950203 010001A3 53305130 0F060355 1D130101 FF040530 030101FF

301F0603 551D2304 18301680 14E08014 36FE6595 A9AA9CFF 487B9FD7 EA10B3BC

DD301D06 03551D0E 04160414 E0801436 FE6595A9 AA9CFF48 7B9FD7EA 10B3BCDD

300D0609 2A864886 F70D0101 05050003 82010100 51EB61F4 E0214435 9CE33DC8

CFAD543D 6B4D9B25 E211EBBE 6FD83C35 F9904382 3B691344 9771CDC9 1FF6BB09

C67391B3 B5DF617F 9EA9295A FF42F2B7 6D3161CF 5C9DAB5A 93E32A2E 9884EC73

0B36B4C4 3817BEB7 CEB66835 F0C14A61 5CB0CE33 7AC9C352 353EF889 E7AA178C

1C11D5B4 41B9E1E3 901FC195 761CEA81 2E4EB423 CE5D0D28 8A9CFFF6 AE445BBF

117F1257 C6DC4A62 A3517FA1 8643D6F3 96F12A41 C5A55873 E1D2C970 D70575DE

158DD02F A1193B5A 55DECB05 8EB99EC3 44029E1C F5386CBC 44F02AD5 FEEE6E17

D5BE810F EBD77614 71CDBAEA 63AAED1F 2BAA7007 C3ECF41B 917390E3 98975216

FF786E40 19B3C9BC BE37F38B A42419DA 88BCF364

quit

license udi pid ISR4321/K9 sn FLM24060912

no license smart enable

diagnostic bootup level minimal

spanning-tree extend system-id

redundancy

mode none

interface GigabitEthernet0/0/0

ip address 10.0.5.1 255.255.255.0

negotiation auto

ipv6 address FE80::1 link-local

ipv6 address 2001:5::1/64

ipv6 eigrp 1

interface GigabitEthernet0/0/1

ip address 10.0.4.2 255.255.255.0

negotiation auto

ipv6 address FE80::2 link-local

ipv6 address 2001:4::2/64

ipv6 eigrp 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 eigrp 1

network 10.0.4.0 0.0.0.255

network 10.0.5.0 0.0.0.255

ip forward-protocol nd

ip http server

ip http authentication local

ip http secure-server

ip tftp source-interface GigabitEthernet0

ipv6 router eigrp 1

eigrp router-id 5.5.5.5

control-plane

line con 0

transport input none

stopbits 1

line aux 0

stopbits 1

line vty 0 4

login

end

Router 6:

R6#show run

Building configuration...

Current configuration : 3977 bytes

! Last configuration change at 20:55:43 UTC Thu Oct 6 2022

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-4144679456

enrollment selfsigned

subject-name cn=IOS-Self-Signed-Certificate-4144679456

revocation-check none

rsakeypair TP-self-signed-4144679456

crypto pki certificate chain TP-self-signed-4144679456

certificate self-signed 01

30820330 30820218 A0030201 02020101 300D0609 2A864886 F70D0101 05050030

31312F30 2D060355 04031326 494F532D 53656C66 2D536967 6E65642D 43657274

69666963 6174652D 34313434 36373934 3536301E 170D3232 31303036 32303534

33315A17 0D333030 31303130 30303030 305A3031 312F302D 06035504 03132649

4F532D53 656C662D 5369676E 65642D43 65727469 66696361 74652D34 31343436

37393435 36308201 22300D06 092A8648 86F70D01 01010500 0382010F 00308201

0A028201 0100E28B 6EC570E0 BBAEF158 5B5A9ABC D15E289D 53E05D64 421A06B0

A79C4CF9 08AB3DC9 193B92CF 3165EABA 66C8FF74 82BD224F 5CDB1203 635C2716

E4A01858 E45A7652 D3D53299 EC4809E6 047A811F 4CABA5EE D305F2E9 DB93740F

21511D2F B1E15BF5 2A7CFEEA 5DF057D2 566E9609 595DD2C4 EBA246AA E838F1B8

D32FC4DB 28903EE3 964ABBC5 28310633 42BEFBC1 B54AD876 A048D563 4EEAE59F

31A022BC 8A91C355 A7115924 2040C4C8 519B6858 9B1A51FC 8445952C A272AFFE

F088B04B D43C77C6 9C7AD4FE 521413CC 20D4BE49 8D1346A0 C81590FB 81D217E9

8152D3C2 C4EA5AD2 45ADD108 E2578864 1F08E45D BDBF237B 053DD11E 2B127D34

C66E66BA 6F6F0203 010001A3 53305130 0F060355 1D130101 FF040530 030101FF

301F0603 551D2304 18301680 14CC91D3 D730BD7E BF1F1544 AD7EEAA3 03C9ACFC

3E301D06 03551D0E 04160414 CC91D3D7 30BD7EBF 1F1544AD 7EEAA303 C9ACFC3E

300D0609 2A864886 F70D0101 05050003 82010100 B2CCF087 181B5DD8 3D5C9FEB

CB3BE567 A978A257 0ED004A7 CBE014F4 5E3F2604 3CEC0F3D 4CEA02CB ABDD1C13

E32EDB0C B86F4070 8BF5DB6B 634CA3FD A2088A23 EB36EE23 4454DFE0 22D390C2

DED82CCC C9351907 4FEB4640 4DA3BBAE C0E1E3A5 2B70A14C 48B5AD58 BEEC6019

C51A5345 DE79669D 0A1F1F53 815FC77F 8BFB4AB5 B1ADB343 ABACB351 5890F281

5AB98715 69C36746 208F4A54 1470FB7A D5717469 B8DB952C 0041EB80 B96A0538

8B774619 A8AB271D 7F7EC809 A5B30CAB FDE1EFE4 7E8597F6 F5996576 1EE7738B

02B6B252 077AF0E7 7C9C74AA 84B0F26B 7D57176B 9226F98C 34912C3E 03B2856E

C32240F1 CDD4AA4A A8786460 52E3F3A9 C49B260B

quit

license udi pid ISR4321/K9 sn FLM2408005M

no license smart enable

diagnostic bootup level minimal

spanning-tree extend system-id

redundancy

mode none

interface GigabitEthernet0/0/0

ip address 10.0.6.1 255.255.255.0

negotiation auto

ipv6 address FE80::1 link-local

ipv6 address 2001:6::1/64

ipv6 eigrp 1

interface GigabitEthernet0/0/1

ip address 10.0.5.2 255.255.255.0

negotiation auto

ipv6 address FE80::2 link-local

ipv6 address 2001:5::2/64

ipv6 eigrp 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 eigrp 1

network 10.0.5.0 0.0.0.255

network 10.0.6.0 0.0.0.255

passive-interface GigabitEthernet0/0/0

ip forward-protocol nd

ip http server

ip http authentication local

ip http secure-server

ip tftp source-interface GigabitEthernet0

ipv6 router eigrp 1

passive-interface GigabitEthernet0/0/0

eigrp router-id 6.6.6.6

control-plane

line con 0

transport input none

stopbits 1

line aux 0

stopbits 1

line vty 0 4

login

end

Those are the 6 router configurations. Now here are the IP and IPv6 routes for each router:

Router 1:

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, 8 subnets, 2 masks

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

L 10.0.0.1/32 is directly connected, GigabitEthernet0/0/1

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

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

O 10.0.2.0/24 [110/2] via 10.0.1.2, 00:21:45, GigabitEthernet0/0/0

O E2 10.0.3.0/24 [110/1] via 10.0.1.2, 00:21:35, GigabitEthernet0/0/0

O E2 10.0.4.0/24 [110/1] via 10.0.1.2, 00:21:30, GigabitEthernet0/0/0

O E2 10.0.5.0/24 [110/1] via 10.0.1.2, 00:21:30, GigabitEthernet0/0/0

R1#show ipv6 route

IPv6 Routing Table - default - 9 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::/64 [0/0]

via GigabitEthernet0/0/1, directly connected

L 2001::1/128 [0/0]

via GigabitEthernet0/0/1, receive

C 2001:1::/64 [0/0]

via GigabitEthernet0/0/0, directly connected

L 2001:1::1/128 [0/0]

via GigabitEthernet0/0/0, receive

O 2001:2::/64 [110/2]

via FE80::2, GigabitEthernet0/0/0

OE2 2001:3::/64 [110/20]

via FE80::2, GigabitEthernet0/0/0

OE2 2001:4::/64 [110/1]

via FE80::2, GigabitEthernet0/0/0

OE2 2001:5::/64 [110/1]

via FE80::2, GigabitEthernet0/0/0

L FF00::/8 [0/0]

via Null0, receive

R1#

Router 2:

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, 9 subnets, 2 masks

O 10.0.0.0/24 [110/2] via 10.0.1.1, 00:25:36, GigabitEthernet0/0/1

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

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

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

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

O E2 10.0.3.0/24 [110/1] via 10.0.2.2, 00:25:12, GigabitEthernet0/0/0

O E2 10.0.4.0/24 [110/1] via 10.0.2.2, 00:24:57, GigabitEthernet0/0/0

O E2 10.0.5.0/24 [110/1] via 10.0.2.2, 00:24:57, GigabitEthernet0/0/0

O E2 10.0.6.0/24 [110/1] via 10.0.2.2, 00:00:07, GigabitEthernet0/0/0

R2#show ipv6 route

IPv6 Routing Table - default - 10 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

O 2001::/64 [110/2]

via FE80::1, GigabitEthernet0/0/1

C 2001:1::/64 [0/0]

via GigabitEthernet0/0/1, directly connected

L 2001:1::2/128 [0/0]

via GigabitEthernet0/0/1, receive

C 2001:2::/64 [0/0]

via GigabitEthernet0/0/0, directly connected

L 2001:2::1/128 [0/0]

via GigabitEthernet0/0/0, receive

OE2 2001:3::/64 [110/20]

via FE80::2, GigabitEthernet0/0/0

OE2 2001:4::/64 [110/1]

via FE80::2, GigabitEthernet0/0/0

OE2 2001:5::/64 [110/1]

via FE80::2, GigabitEthernet0/0/0

OE2 2001:6::/64 [110/1]

via FE80::2, GigabitEthernet0/0/0

L FF00::/8 [0/0]

via Null0, receive

R2#

Router 3:

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, 9 subnets, 2 masks

O 10.0.0.0/24 [110/3] via 10.0.2.1, 00:26:06, GigabitEthernet0/0/1

O 10.0.1.0/24 [110/2] via 10.0.2.1, 00:26:06, GigabitEthernet0/0/1

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

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

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

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

B 10.0.4.0/24 [20/0] via 10.0.3.2, 00:25:51

B 10.0.5.0/24 [20/3072] via 10.0.3.2, 00:25:51

B 10.0.6.0/24 [20/3328] via 10.0.3.2, 00:00:30

R3#show ipv6 route

IPv6 Routing Table - default - 10 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

O 2001::/64 [110/3]

via FE80::1, GigabitEthernet0/0/1

O 2001:1::/64 [110/2]

via FE80::1, GigabitEthernet0/0/1

C 2001:2::/64 [0/0]

via GigabitEthernet0/0/1, directly connected

L 2001:2::2/128 [0/0]

via GigabitEthernet0/0/1, receive

C 2001:3::/64 [0/0]

via GigabitEthernet0/0/0, directly connected

L 2001:3::1/128 [0/0]

via GigabitEthernet0/0/0, receive

B 2001:4::/64 [20/0]

via FE80::2, GigabitEthernet0/0/0

B 2001:5::/64 [20/3072]

via FE80::2, GigabitEthernet0/0/0

B 2001:6::/64 [20/3328]

via FE80::2, GigabitEthernet0/0/0

L FF00::/8 [0/0]

via Null0, receive

R3#

Router 4:

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, 9 subnets, 2 masks

B 10.0.0.0/24 [20/3] via 10.0.3.1, 00:26:39

B 10.0.1.0/24 [20/2] via 10.0.3.1, 00:26:39

B 10.0.2.0/24 [20/0] via 10.0.3.1, 00:26:39

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

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

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

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

D 10.0.5.0/24 [90/3072] via 10.0.4.2, 00:27:06, GigabitEthernet0/0/0

D 10.0.6.0/24 [90/3328] via 10.0.4.2, 00:01:04, GigabitEthernet0/0/0

R4#show ipv6 route

IPv6 Routing Table - default - 10 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::/64 [20/3]

via FE80::1, GigabitEthernet0/0/1

B 2001:1::/64 [20/2]

via FE80::1, GigabitEthernet0/0/1

B 2001:2::/64 [20/0]

via FE80::1, GigabitEthernet0/0/1

C 2001:3::/64 [0/0]

via GigabitEthernet0/0/1, directly connected

L 2001:3::2/128 [0/0]

via GigabitEthernet0/0/1, receive

C 2001:4::/64 [0/0]

via GigabitEthernet0/0/0, directly connected

L 2001:4::1/128 [0/0]

via GigabitEthernet0/0/0, receive

D 2001:5::/64 [90/3072]

via FE80::2, GigabitEthernet0/0/0

D 2001:6::/64 [90/3328]

via FE80::2, GigabitEthernet0/0/0

L FF00::/8 [0/0]

via Null0, receive

R4#

Router 5:

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, 9 subnets, 2 masks

D EX 10.0.0.0/24 [170/2560512] via 10.0.4.1, 00:33:35, GigabitEthernet0/0/1

D EX 10.0.1.0/24 [170/2560512] via 10.0.4.1, 00:33:35, GigabitEthernet0/0/1

D EX 10.0.2.0/24 [170/2560512] via 10.0.4.1, 00:33:35, GigabitEthernet0/0/1

D EX 10.0.3.0/24 [170/2560512] via 10.0.4.1, 00:34:13, GigabitEthernet0/0/1

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

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

C 10.0.5.0/24 is directly connected, GigabitEthernet0/0/0

L 10.0.5.1/32 is directly connected, GigabitEthernet0/0/0

D 10.0.6.0/24 [90/3072] via 10.0.5.2, 00:08:00, GigabitEthernet0/0/0

R5#show ipv6 route

IPv6 Routing Table - default - 10 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 2001::/64 [170/2560512]

via FE80::1, GigabitEthernet0/0/1

EX 2001:1::/64 [170/2560512]

via FE80::1, GigabitEthernet0/0/1

EX 2001:2::/64 [170/2560512]

via FE80::1, GigabitEthernet0/0/1

EX 2001:3::/64 [170/3072]

via FE80::1, GigabitEthernet0/0/1

C 2001:4::/64 [0/0]

via GigabitEthernet0/0/1, directly connected

L 2001:4::2/128 [0/0]

via GigabitEthernet0/0/1, receive

C 2001:5::/64 [0/0]

via GigabitEthernet0/0/0, directly connected

L 2001:5::1/128 [0/0]

via GigabitEthernet0/0/0, receive

D 2001:6::/64 [90/3072]

via FE80::2, GigabitEthernet0/0/0

L FF00::/8 [0/0]

via Null0, receive

R5#

Router 6:

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, 9 subnets, 2 masks

D EX 10.0.0.0/24 [170/2560768] via 10.0.5.1, 00:34:58, GigabitEthernet0/0/1

D EX 10.0.1.0/24 [170/2560768] via 10.0.5.1, 00:34:58, GigabitEthernet0/0/1

D EX 10.0.2.0/24 [170/2560768] via 10.0.5.1, 00:34:58, GigabitEthernet0/0/1

D EX 10.0.3.0/24 [170/2560768] via 10.0.5.1, 00:35:18, GigabitEthernet0/0/1

D 10.0.4.0/24 [90/3072] via 10.0.5.1, 00:35:18, GigabitEthernet0/0/1

C 10.0.5.0/24 is directly connected, GigabitEthernet0/0/1

L 10.0.5.2/32 is directly connected, GigabitEthernet0/0/1

C 10.0.6.0/24 is directly connected, GigabitEthernet0/0/0

L 10.0.6.1/32 is directly connected, GigabitEthernet0/0/0

R6#show ipv6 route

IPv6 Routing Table - default - 10 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 2001::/64 [170/2560768]

via FE80::1, GigabitEthernet0/0/1

EX 2001:1::/64 [170/2560768]

via FE80::1, GigabitEthernet0/0/1

EX 2001:2::/64 [170/2560768]

via FE80::1, GigabitEthernet0/0/1

EX 2001:3::/64 [170/3328]

via FE80::1, GigabitEthernet0/0/1

D 2001:4::/64 [90/3072]

via FE80::1, GigabitEthernet0/0/1

C 2001:5::/64 [0/0]

via GigabitEthernet0/0/1, directly connected

L 2001:5::2/128 [0/0]

via GigabitEthernet0/0/1, receive

C 2001:6::/64 [0/0]

via GigabitEthernet0/0/0, directly connected

L 2001:6::1/128 [0/0]

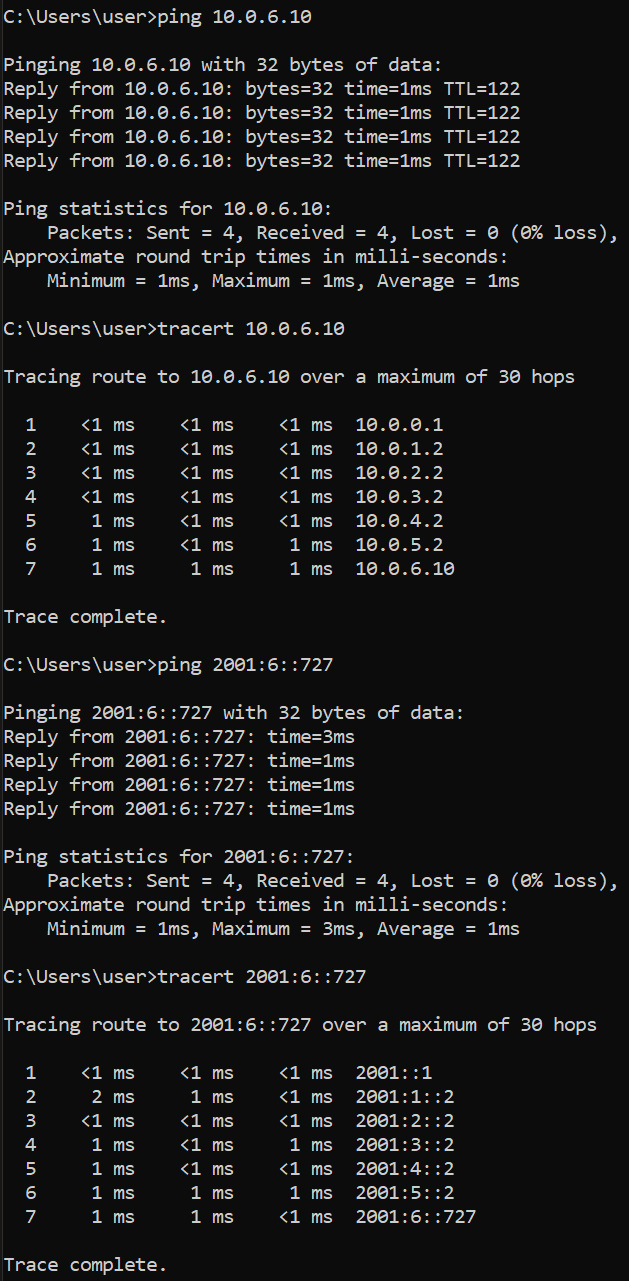
via GigabitEthernet0/0/0, receive

L FF00::/8 [0/0]

via Null0, receive

R6#

And finally, here are the pings and traceroutes of one PC to the other, showing the routes work:



While doing this lab, I ran into several issues. The first thing is while trying to set up BGP for IPv6, I needed to figure out why I couldn’t properly get it working. This is when I learned the address-family command, which allowed me to get BGP for IPv6 running. The second thing is that even though I could redistribute OSPF and BGP just fine, I struggled to link BGP and EIGRP together. This is because I didn’t use the metric argument, simply because I didn’t think it was necessary. This left me stuck for several days until I tried using the metric command, and then it suddenly worked. Unfortunately, I had an incident that forced me to reset my hard drive, which resulted in 3-5 days of work down the drain. I managed to fix it in just a couple days and got the routing protocols running again. Then, while setting up IPv6, I noticed that using “router ospfv3” couldn’t recognize the redistribute command, so I switched to “ipv6 router ospf” on R3. I then ran into the same metric problem with BGP and EIGRP, which took another day just to realize that I had to use metric on IPv6 as well as IPv4. Finally, after fixing all of that, I realized that the routers R3 and R4 for whatever reason couldn’t redistribute their directly connected routes (but only for IPv6), so I added “redistribute connected” to account for that.

In conclusion, I was tasked with setting up 3 routing protocols, OSPF, BGP, and EIGRP, and link them together such that a device on either end of the network could communicate with the other. While doing this lab, some of the complications I had to deal with included a BGP and EIGRP metric mismatch, BGP for IPv6 working awkwardly, and having to restart due to resetting my hard drive. Overall, I learned about how different routing protocols could interact with each other, why you would want to use some routing protocols over others, and how powerful these protocols are when they work together.