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Configuring OSPFv3

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Purpose

The purpose of this lab was to set up a multi-area OSPFv3 network across five Cisco catalyst 4321 routers. Three of the routers are in area 0, and two are in area 1. We had to figure out how to configure OSPFv3 with our general knowledge on OSPFv2, allowing IPv6 connectivity across all the networks.

Background Information

Routing

Routing is a significant process in networking as it allows hosts on different IP networks to connect to each other. *Open Shortest Path First* (OSPF) is a routing protocol simplifying the process of creating routes by using algorithms to figure out the directions automatically. OSPF excels in interior networks, which are smaller in scale, but would crash in large networks with hundreds of routes. In networking, routes are ultimately just *directions* for packets.

There are two options when dealing with traffic on a network; you can configure *static routes*, or you can set up a *routing protocol*. I like to think of static routes as absolute directions drawn onto a map, set in stone and unchangeable. The map can’t be altered unless it is manually redrawn. If you were to follow the map, you might find some of the routes to be outdated.

It would be nice if routes were adaptable, if they could update based on the fastest paths available. This is the difference between *static routing* and *routing protocols*. Routing protocols update their routing directions automatically based on information sent from neighbors. This is the magic of routing protocols: automatic updates and directions – like google maps – for packets. Routes are stored in a database on the router, known as a *routing table*.

Routing tables

Like a signpost at a fork in the road, routers contain directions for different destinations. These directions are stored in RAM memory on the router, which means that they are temporary; RAM memory can be accessed much faster than hard drives or SSDs but is not saved after the device shuts down. Let’s look at an example of a packet arriving at a router.

A packet arrives at a router. This router has three interfaces: north, south, and east. The packet arrived on the east interface, so it either must turn north or south, assuming one of these paths lead to the destination. Luckily, there are directions in the router: *10.0.0.0/24* out interface *north*; *172.16.0.0/24* out interface *south*. The packet has a destination address of *10.0.0.3*, which matches up with the *north* interface. The router sends the packet out the north interface. Routes are either generated statically, by the admin, or automatically by routing protocols such as OSPF, BGP, etc.

Here is an example of a routing table:

|  |
| --- |
| Gateway of last resort is not set  10.0.0.0/8 is variably subnetted, 11 subnets, 2 masks  O IA 10.10.10.0/30 [110/128] via 10.10.10.5, 01:03:27, Serial0/1/1  C 10.10.10.4/30 is directly connected, Serial0/1/1  L 10.10.10.6/32 is directly connected, Serial0/1/1  C 10.10.10.8/30 is directly connected, Serial0/1/0  L 10.10.10.9/32 is directly connected, Serial0/1/0  O IA 10.10.10.12/30 [110/128] via 10.10.10.10, 01:03:27, Serial0/1/0  C 10.10.10.16/30 is directly connected, Serial0/2/0  L 10.10.10.17/32 is directly connected, Serial0/2/0  O IA 10.10.10.20/30 [110/128] via 10.10.10.18, 01:03:27, Serial0/2/0  O IA 10.10.10.24/30 [110/192] via 10.10.10.18, 01:03:27, Serial0/2/0  O E2 10.10.10.28/30 [110/100] via 10.10.10.18, 01:03:27, Serial0/2/0 |

Ignoring the letters on the left (the origin of the route), we can see a range of addresses and the corresponding interface leading towards them. For example, *10.10.10.0/30* addresses direct out the *Serial0/1/1* interface. “Via *ip*”, is also commonly seen as a direction, indicating that a packet should be sent to the specified neighboring router. Sometimes there is a combination of directions: both *interface* and *neighboring ips*.

OSPF

Since we’ve defined routing and routing tables, I can go into more detail on how OSPF functions. Each router is like a junction for packets; packets usually have multiple roads they can turn down to reach further junctions, ultimately ending at their destination. Every router running OSPF will communicate with neighbor OSPF routers to relay statuses and updates about new routes and preferred paths. By sharing information to neighbor OSPF routers, information can spread through an OSPF network regardless of hop counts between routers. The packets OSPF broadcasts to relay information are known as *Link-State Advertisements* (LSAs). To see more on LSAs, check out *LSA Background Information*.

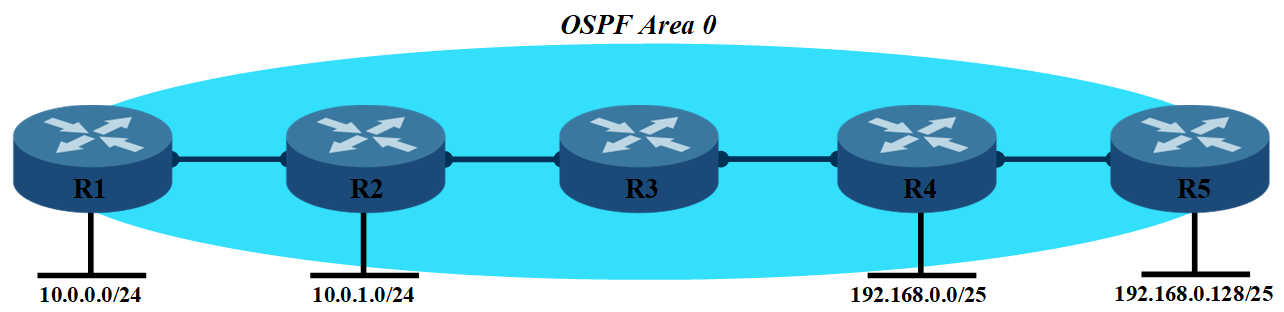
OSPF configured routers rely on *cost* to commute the shortest path through a network. While you can set the cost manually, OSPF will automatically determine the cost value per interface based on a *reference bandwidth* – usually the bandwidth of the fastest interface in your network – and *interface bandwidth***,** the bandwidth of the interface being assessed.

There are two OSPF protocols that can be configured on a router: OSPFv2 and OSPFv3, the main difference being *OSPFv2* routes *IPv4* and *OSPFv3* routes *IPv6*. OSPFv3 has nine *Link-State Advertisements*. LSAs are used to communicate different states and information of an OSPF router, such as a neighbor’s local topology, to build the *routing table*. Although there are other routing protocols such as RIP or EIGRP, OSPF is massively adopted in large enterprise networks because of its many benefits: route redundancy, the ability to run on most routers, classless routing, and loop-free topologies.

Multi-area OSPF

OSPF routers communicate to each other using LSA packets, but this communication comes at a cost: bandwidth. When OSPF runs across a large network, LSA packets consume more bandwidth, as there are more routers that send updates. If the network has low-bandwidth interfaces, LSA traffic could hinder the performance. But what if we could limit the amount of LSA traffic on a network?

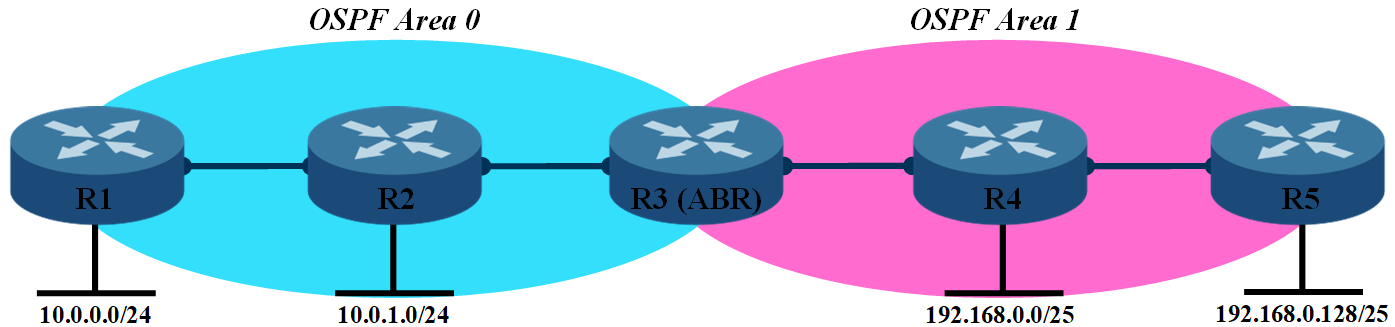
*Multi-area OSPF* is the process of dividing routers into multiple groups, known as *areas*, to reduce the size of LSA packets that need to be sent. Routes need to be specific and abundant for each network advertised within a local area. However, routers in a local area only need a broad definition of networks in external areas. Therefore, LSA packets across areas transmit summarizations by compressing multiple lines of routes into a single subnet. Let’s compare a single-area OSPF network to a multi-area OSPF network.



In this topology, each router needs a specific route for every network in the area. LSA packets would be abundant in this area for each network OSPF is advertising. There would be no summarizations. A routing table on R2 may look something like the following:

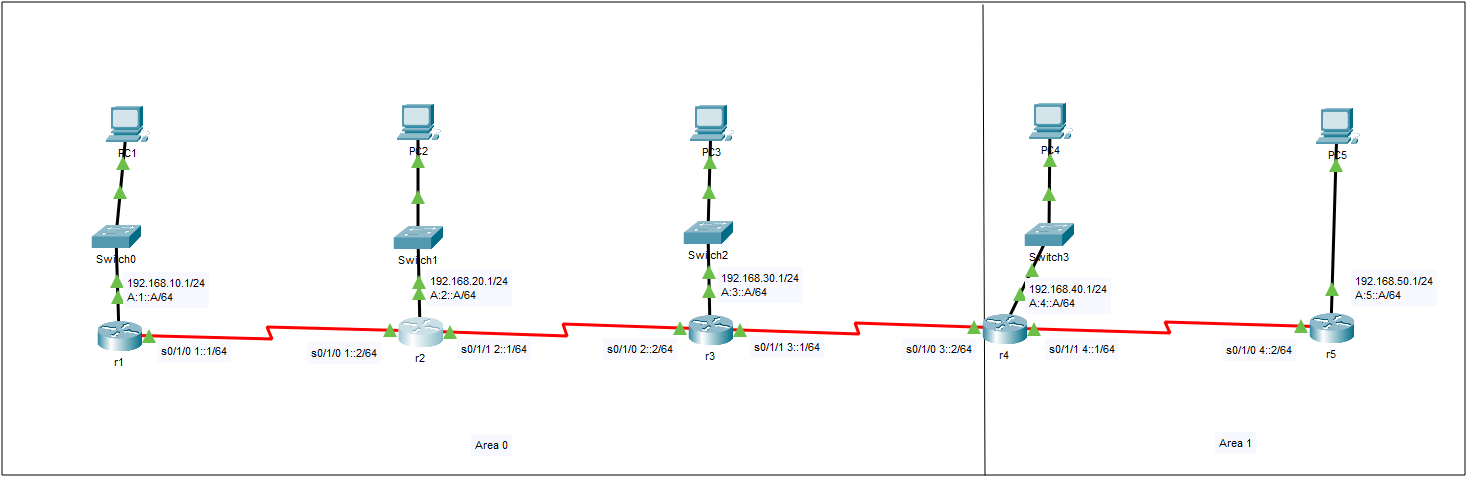
* *10.0.0.0/24 out interface GigabitEthernet0*
* *192.168.0.0/25 out interface GigabitEthernet1*
* *192.168.0.128/25 out interface GigabitEthernet1*

Now let’s divide this network into two areas.



Now that there are multiple areas, we can summarize networks for each area. Instead of routers four and five having routes to the *10.0.0.0/24* and *10.0.1.0/24* networks, they can share a singular, summarized route, *10.0.0.0/23*, that points towards the ASBR. When a packet enters the destination area, more precise routes will direct it to the destined network. An LSA packet to *area 0* from *area 1* might be distributing the following network, *192.168.0.0/24*, only consisting of one prefix. Compared to LSAs containing all the specific routes, *route summarization* helps reduce LSA packet sizes. Now, the routing table on R2 may look something like the following:

* *10.0.0.0/24 out interface GigabitEthernet0*
* *192.168.0.0/24 out interface GigabitEthernet1*

Network Diagram

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **PC** | | | | **IPv4 address** | | **IPv6 address** | | |
| 1 | | | | 192.168.10.10/24 | | A:1::1/64 | | |
| 2 | | | | 192.168.20.20/24 | | A:2::1/64 | | |
| 3 | | | | 192.168.30.30/24 | | A:3::1/64 | | |
| 4 | | | | 192.168.40.40/24 | | A:4::1/64 | | |
| 5 | | | | 192.168.50.50/24 | | A:5::1/64 | | |
| **Router** | **Interface** | **IPv4 Address** | | **IPv6 Global Address** | | **IPv6 Link-Local Address** |
| 1 | |  | | --- | | G0/0/0 | | S0/1/0 | | |  | | --- | | 192.168.10.1/24 | | 10.10.10.1/30 | | | |  | | --- | | A:1::A/64 | | 1::1 | | | |  | | --- | | FE80::1 | | FE80::1 | |
| 2 | |  | | --- | | G0/0/0 | | S0/1/0 | | S0/1/1 | | |  | | --- | | 192.168.20.1/24 | | 10.10.10.2/30 | | 10.10.10.5/30 | | | |  | | --- | | A:2::A/64 | | 1::2 | | 2::1 | | | |  | | --- | | FE80::1 | | FE80::2 | | FE80::1 | |
| 3 | |  | | --- | | G0/0/0 | | S0/1/0 | | S0/1/1 | | |  | | --- | | 192.168.30.1/24 | | 10.10.10.6/30 | | 10.10.10.9/30 | | | |  | | --- | | A:3::A/64 | | 2::2 | | 3::1 | | | |  | | --- | | FE80::1 | | FE80::2 | | FE80::1 | |
| 4 | |  | | --- | | G0/0/0 | | S0/1/0 | | S0/1/1 | | |  | | --- | | 192.168.40.1/24 | | 10.10.10.10/30 | | 10.10.10.13/30 | | | |  | | --- | | A:4::A/64 | | 3::2 | | 4::1 | | | |  | | --- | | FE80::1 | | FE80::2 | | FE80::1 | |
| 5 | |  | | --- | | G0/0/0 | | S0/1/0 | | |  | | --- | | 192.168.50.1/24 | | 10.10.10.14/30 | | | |  | | --- | | A:5::A/64 | | 4::2 | | | |  | | --- | | FE80::1 | | FE80::2 | |

Summary

In this lab, I set up multi-area OSPF networks routing both IPv4 and IPv6 traffic across five Cisco catalyst 4321 routers. I began by constructing a topology and then building an IP scheme. After allocating all my IPv4 and IPv6 addresses to their corresponding PC’s and routers, I tested connectivity. Pings from PCs could reach their default gateways, but nothing past that. Time to form some routes with OSPF. I configured each active interface on every router, advertising OSPF networks in the correct areas. OSPFv3 is similar in configuration to OSPFv2, except OSPFv3 is advertised in *interface configuration mode* and OSPFv2 is advertised using network statements in *router configuration mode*. Once OSPF adjacencies had formed, routes were automatically distributed, and pings could reach anywhere in the network.

Lab Commands

|  |  |
| --- | --- |
| **Command** | A statement necessary for a configuration to work, denoted in bold |
| **[*Argument*]** | An argument necessary for a command to function, denoted in bold italics. |
| *Optional-Statement*  *<Optional Argument>* | An optional argument or statement, not necessary for a command to function, denoted in italics |

Router(config)# **interface [*interface*] [*id*]**

* Enables configuration on a specific interface

// OSPF

Router(config)# **router ospf [*process id*]**

* Enables the OSPF routing protocol and enters OSPF router configuration mode

*Generally, OSPF process ids should be the same, though OSPF should still form adjacencies with different process ids. Each OSPF process retains a different routing table; depending on the configuration, process ID could determine what routes are redistributed. A router can run multiple OSPF processes but will contain a separate OSPF database per process.*

Router(config-router)# **router-id** **[*router* *id*]**

* Uniquely determines an OSPF router within a domain

*Router ids are automatically determined by the highest loopback interface if they are not manually defined. Router ids can play a part in DR/BDR elections.*

Router(config-router)# **network [*network address*] [*wildcard mask*] area [*area number*]**

* Advertises the specified subnet to neighbor routers

// OSPFv3

Router(config)# **ipv6** **router ospf [*process id*]**

* Enables the OSPF routing protocol and enters OSPF router configuration mode

*Generally, OSPF process ids should be the same, though OSPF should still form adjacencies with different process ids. Each OSPF process retains a different routing table; depending on the configuration, process ID could determine what routes are redistributed. A router can run multiple OSPF processes but will contain a separate OSPF database per process.*

Router(config-rtr)# **router-id** **[*router* *id*]**

* Uniquely determines an OSPF router within a domain

*Router ids are automatically determined by the highest loopback interface if they are not manually defined. Router ids can play a part in DR/BDR elections.*

Router(config-if)# **ipv6 ospf [*process id*] area [*number*]**

* Advertises an IPv6 OSPFv3 network in a local interface

*Written in interface configuration mode. Generally, OSPF process ids should be the same, though OSPF should still form adjacencies with different process ids.*

// Show Commands

Router# **show [*ipv4/ipv6*] ospf database**

* Displays the routing database

Router# **show [*ipv4/ipv6*] ospf neighbor**

* Displays information about adjacent routers configured with OSPF

Router# **show [*ipv4/ipv6*] ospf interface**

* Displays information about each interface configured with OSPF

Configurations

Router 1

**r1#show run**

no service timestamps log datetime msec

no service timestamps debug datetime msec

no service password-encryption

hostname r1

no ip cef

ipv6 unicast-routing

no ipv6 cef

spanning-tree mode pvst

interface GigabitEthernet0/0/0

ip address 192.168.10.1 255.255.255.0

duplex auto

speed auto

ipv6 address FE80::1 link-local

ipv6 address A:1::A/64

ipv6 ospf 10 area 0

interface GigabitEthernet0/0/1

no ip address

duplex auto

speed auto

shutdown

interface Serial0/1/0

ip address 10.10.10.1 255.255.255.252

ipv6 address FE80::1 link-local

ipv6 address 1::1/64

ipv6 ospf 10 area 0

interface Serial0/1/1

no ip address

clock rate 2000000

shutdown

interface Vlan1

no ip address

shutdown

router ospf 10

router-id 1.1.1.1

log-adjacency-changes

network 192.168.10.0 0.0.0.255 area 0

network 10.10.10.0 0.0.0.3 area 0

ipv6 router ospf 10

log-adjacency-changes

ip classless

ip flow-export version 9

no cdp run

line con 0

line aux 0

line vty 0 4

login

end

**r1#show ipv6 route**

IPv6 Routing Table - 12 entries

Codes: C - Connected, L - Local, S - Static, R - RIP, B - BGP

U - Per-user Static route, M - MIPv6

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

O - OSPF intra, OI - OSPF inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2

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

D - EIGRP, EX - EIGRP external

C 1::/64 [0/0]

via Serial0/1/0, directly connected

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

via Serial0/1/0, receive

O 2::/64 [110/128]

via FE80::2, Serial0/1/0

O 3::/64 [110/192]

via FE80::2, Serial0/1/0

OI 4::/64 [110/256]

via FE80::2, Serial0/1/0

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

via GigabitEthernet0/0/0, directly connected

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

via GigabitEthernet0/0/0, receive

O A:2::/64 [110/65]

via FE80::2, Serial0/1/0

O A:3::/64 [110/129]

via FE80::2, Serial0/1/0

OI A:4::/64 [110/193]

via FE80::2, Serial0/1/0

OI A:5::/64 [110/257]

via FE80::2, Serial0/1/0

L FF00::/8 [0/0]

via Null0, receive

**r1#show ipv6 ospf int**

GigabitEthernet0/0/0 is up, line protocol is up

Link Local Address FE80::1, Interface ID 1

Area 0, Process ID 10, Instance ID 0, Router ID 192.168.10.1

Network Type BROADCAST, Cost: 1

Transmit Delay is 1 sec, State DR, Priority 1

Designated Router (ID) 192.168.10.1, local address FE80::1

No backup designated router on this network

Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5

Hello due in 00:00:08

Index 1/1, flood queue length 0

Next 0x0(0)/0x0(0)

Last flood scan length is 1, maximum is 1

Last flood scan time is 0 msec, maximum is 0 msec

Neighbor Count is 0, Adjacent neighbor count is 0

Suppress hello for 0 neighbor(s)

Serial0/1/0 is up, line protocol is up

Link Local Address FE80::1, Interface ID 3

Area 0, Process ID 10, Instance ID 0, Router ID 192.168.10.1

Network Type POINT-TO-POINT, Cost: 64

Transmit Delay is 1 sec, State POINT-TO-POINT,

Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5

Hello due in 00:00:08

Index 2/2, flood queue length 0

Next 0x0(0)/0x0(0)

Last flood scan length is 1, maximum is 1

Last flood scan time is 0 msec, maximum is 0 msec

Neighbor Count is 1 , Adjacent neighbor count is 1

Adjacent with neighbor 192.168.20.1

Suppress hello for 0 neighbor(s)

**r1#show ipv6 ospf neighbor**

Neighbor ID Pri State Dead Time Interface ID Interface

192.168.20.1 0 FULL/ - 00:00:31 3 Serial0/1/0

**r1#show ipv6 ospf database**

OSPF Router with ID (192.168.10.1) (Process ID 10)

Router Link States (Area 0)

ADV Router Age Seq# Fragment ID Link count Bits

192.168.10.1 765 0x80000003 0 1

192.168.20.1 766 0x80000004 0 2

192.168.40.1 765 0x80000003 0 1 B

192.168.30.1 764 0x80000004 0 2

Inter Area Prefix Link States (Area 0)

ADV Router Age Seq# Metric Prefix

192.168.40.1 761 0x80000004 1 A:4::/64

192.168.40.1 761 0x80000005 64 4::/64

192.168.40.1 752 0x80000006 65 A:5::/64

Link (Type-8) Link States (Area 0)

ADV Router Age Seq# Link ID Interface

192.168.10.1 774 0x80000004 1 Gi0/0/0

192.168.10.1 766 0x80000005 3 Se0/1/0

192.168.20.1 766 0x80000008 3 Se0/1/0

Intra Area Prefix Link States (Area 0)

ADV Router Age Seq# Link ID Ref-lstype Ref-LSID

192.168.10.1 774 0x80000003 2 0x2001 0

192.168.40.1 775 0x80000002 2 0x2001 0

192.168.30.1 767 0x80000004 2 0x2001 0

192.168.20.1 767 0x80000004 2 0x2001 0

Router 2

**r2#show run**

no service timestamps log datetime msec

no service timestamps debug datetime msec

no service password-encryption

hostname r2

no ip cef

ipv6 unicast-routing

no ipv6 cef

spanning-tree mode pvst

interface GigabitEthernet0/0/0

ip address 192.168.20.1 255.255.255.0

duplex auto

speed auto

ipv6 address FE80::1 link-local

ipv6 address A:2::A/64

ipv6 ospf 10 area 0

interface GigabitEthernet0/0/1

no ip address

duplex auto

speed auto

shutdown

interface Serial0/1/0

ip address 10.10.10.2 255.255.255.252

ipv6 address FE80::2 link-local

ipv6 address 1::2/64

ipv6 ospf 10 area 0

clock rate 2000000

interface Serial0/1/1

ip address 10.10.10.5 255.255.255.252

ipv6 address FE80::1 link-local

ipv6 address 2::1/64

ipv6 ospf 10 area 0

interface Vlan1

no ip address

shutdown

router ospf 10

router-id 2.2.2.2

log-adjacency-changes

network 192.168.20.0 0.0.0.255 area 0

network 10.10.10.0 0.0.0.3 area 0

network 10.10.10.4 0.0.0.3 area 0

ipv6 router ospf 10

log-adjacency-changes

ip classless

ip flow-export version 9

no cdp run

line con 0

line aux 0

line vty 0 4

login

end

**r2#show ipv6 route**

IPv6 Routing Table - 13 entries

Codes: C - Connected, L - Local, S - Static, R - RIP, B - BGP

U - Per-user Static route, M - MIPv6

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

O - OSPF intra, OI - OSPF inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2

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

D - EIGRP, EX - EIGRP external

C 1::/64 [0/0]

via Serial0/1/0, directly connected

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

via Serial0/1/0, receive

C 2::/64 [0/0]

via Serial0/1/1, directly connected

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

via Serial0/1/1, receive

O 3::/64 [110/128]

via FE80::2, Serial0/1/1

OI 4::/64 [110/192]

via FE80::2, Serial0/1/1

O A:1::/64 [110/65]

via FE80::1, Serial0/1/0

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

via GigabitEthernet0/0/0, directly connected

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

via GigabitEthernet0/0/0, receive

O A:3::/64 [110/65]

via FE80::2, Serial0/1/1

OI A:4::/64 [110/129]

via FE80::2, Serial0/1/1

OI A:5::/64 [110/193]

via FE80::2, Serial0/1/1

L FF00::/8 [0/0]

via Null0, receive

**r2#show ipv6 ospf interface**

GigabitEthernet0/0/0 is up, line protocol is up

Link Local Address FE80::1, Interface ID 1

Area 0, Process ID 10, Instance ID 0, Router ID 192.168.20.1

Network Type BROADCAST, Cost: 1

Transmit Delay is 1 sec, State DR, Priority 1

Designated Router (ID) 192.168.20.1, local address FE80::1

No backup designated router on this network

Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5

Hello due in 00:00:02

Index 1/1, flood queue length 0

Next 0x0(0)/0x0(0)

Last flood scan length is 1, maximum is 1

Last flood scan time is 0 msec, maximum is 0 msec

Neighbor Count is 0, Adjacent neighbor count is 0

Suppress hello for 0 neighbor(s)

Serial0/1/1 is up, line protocol is up

Link Local Address FE80::1, Interface ID 4

Area 0, Process ID 10, Instance ID 0, Router ID 192.168.20.1

Network Type POINT-TO-POINT, Cost: 64

Transmit Delay is 1 sec, State POINT-TO-POINT,

Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5

Hello due in 00:00:02

Index 2/2, flood queue length 0

Next 0x0(0)/0x0(0)

Last flood scan length is 1, maximum is 1

Last flood scan time is 0 msec, maximum is 0 msec

Neighbor Count is 1 , Adjacent neighbor count is 1

Adjacent with neighbor 192.168.30.1

Suppress hello for 0 neighbor(s)

Serial0/1/0 is up, line protocol is up

Link Local Address FE80::2, Interface ID 3

Area 0, Process ID 10, Instance ID 0, Router ID 192.168.20.1

Network Type POINT-TO-POINT, Cost: 64

Transmit Delay is 1 sec, State POINT-TO-POINT,

Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5

Hello due in 00:00:01

Index 3/3, flood queue length 0

Next 0x0(0)/0x0(0)

Last flood scan length is 1, maximum is 1

Last flood scan time is 0 msec, maximum is 0 msec

Neighbor Count is 1 , Adjacent neighbor count is 1

Adjacent with neighbor 192.168.10.1

Suppress hello for 0 neighbor(s)

**r2#show ipv6 ospf neighbor**

Neighbor ID Pri State Dead Time Interface ID Interface

192.168.10.1 0 FULL/ - 00:00:35 3 Serial0/1/0

192.168.30.1 0 FULL/ - 00:00:33 3 Serial0/1/1

**r2#show ipv6 ospf database**

OSPF Router with ID (192.168.20.1) (Process ID 10)

Router Link States (Area 0)

ADV Router Age Seq# Fragment ID Link count Bits

192.168.20.1 836 0x80000004 0 2

192.168.10.1 836 0x80000003 0 1

192.168.40.1 836 0x80000003 0 1 B

192.168.30.1 835 0x80000004 0 2

Inter Area Prefix Link States (Area 0)

ADV Router Age Seq# Metric Prefix

192.168.40.1 832 0x80000004 1 A:4::/64

192.168.40.1 832 0x80000005 64 4::/64

192.168.40.1 822 0x80000006 65 A:5::/64

Link (Type-8) Link States (Area 0)

ADV Router Age Seq# Link ID Interface

192.168.20.1 845 0x80000006 1 Gi0/0/0

192.168.20.1 838 0x80000007 4 Se0/1/1

192.168.20.1 836 0x80000008 3 Se0/1/0

192.168.10.1 837 0x80000005 3 Se0/1/0

192.168.30.1 836 0x80000007 3 Se0/1/1

Intra Area Prefix Link States (Area 0)

ADV Router Age Seq# Link ID Ref-lstype Ref-LSID

192.168.20.1 837 0x80000004 2 0x2001 0

192.168.40.1 846 0x80000002 2 0x2001 0

192.168.10.1 845 0x80000003 2 0x2001 0

192.168.30.1 838 0x80000004 2 0x2001 0

Router 3

**r3#show run**

no service timestamps log datetime msec

no service timestamps debug datetime msec

no service password-encryption

hostname r3

no ip cef

ipv6 unicast-routing

no ipv6 cef

spanning-tree mode pvst

interface GigabitEthernet0/0/0

ip address 192.168.30.1 255.255.255.0

duplex auto

speed auto

ipv6 address FE80::1 link-local

ipv6 address A:3::A/64

ipv6 ospf 10 area 0

interface GigabitEthernet0/0/1

no ip address

duplex auto

speed auto

shutdown

interface Serial0/1/0

ip address 10.10.10.6 255.255.255.252

ipv6 address FE80::2 link-local

ipv6 address 2::2/64

ipv6 ospf 10 area 0

clock rate 2000000

interface Serial0/1/1

ip address 10.10.10.9 255.255.255.252

ipv6 address FE80::1 link-local

ipv6 address 3::1/64

ipv6 ospf 10 area 0

interface Vlan1

no ip address

shutdown

router ospf 10

router-id 3.3.3.3

log-adjacency-changes

network 192.168.30.0 0.0.0.255 area 0

network 10.10.10.4 0.0.0.3 area 0

network 10.10.10.8 0.0.0.3 area 0

ipv6 router ospf 10

log-adjacency-changes

ip classless

ip flow-export version 9

no cdp run

line con 0

line aux 0

line vty 0 4

login

end

**r3#show ipv6 route**

IPv6 Routing Table - 13 entries

Codes: C - Connected, L - Local, S - Static, R - RIP, B - BGP

U - Per-user Static route, M - MIPv6

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

O - OSPF intra, OI - OSPF inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2

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

D - EIGRP, EX - EIGRP external

O 1::/64 [110/128]

via FE80::1, Serial0/1/0

C 2::/64 [0/0]

via Serial0/1/0, directly connected

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

via Serial0/1/0, receive

C 3::/64 [0/0]

via Serial0/1/1, directly connected

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

via Serial0/1/1, receive

OI 4::/64 [110/128]

via FE80::2, Serial0/1/1

O A:1::/64 [110/129]

via FE80::1, Serial0/1/0

O A:2::/64 [110/65]

via FE80::1, Serial0/1/0

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

via GigabitEthernet0/0/0, directly connected

L A:3::A/128 [0/0]

via GigabitEthernet0/0/0, receive

OI A:4::/64 [110/65]

via FE80::2, Serial0/1/1

OI A:5::/64 [110/129]

via FE80::2, Serial0/1/1

L FF00::/8 [0/0]

via Null0, receive

**r3#show ipv6 ospf interface**

GigabitEthernet0/0/0 is up, line protocol is up

Link Local Address FE80::1, Interface ID 1

Area 0, Process ID 10, Instance ID 0, Router ID 192.168.30.1

Network Type BROADCAST, Cost: 1

Transmit Delay is 1 sec, State DR, Priority 1

Designated Router (ID) 192.168.30.1, local address FE80::1

No backup designated router on this network

Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5

Hello due in 00:00:04

Index 1/1, flood queue length 0

Next 0x0(0)/0x0(0)

Last flood scan length is 1, maximum is 1

Last flood scan time is 0 msec, maximum is 0 msec

Neighbor Count is 0, Adjacent neighbor count is 0

Suppress hello for 0 neighbor(s)

Serial0/1/1 is up, line protocol is up

Link Local Address FE80::1, Interface ID 4

Area 0, Process ID 10, Instance ID 0, Router ID 192.168.30.1

Network Type POINT-TO-POINT, Cost: 64

Transmit Delay is 1 sec, State POINT-TO-POINT,

Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5

Hello due in 00:00:00

Index 2/2, flood queue length 0

Next 0x0(0)/0x0(0)

Last flood scan length is 1, maximum is 1

Last flood scan time is 0 msec, maximum is 0 msec

Neighbor Count is 1 , Adjacent neighbor count is 1

Adjacent with neighbor 192.168.40.1

Suppress hello for 0 neighbor(s)

Serial0/1/0 is up, line protocol is up

Link Local Address FE80::2, Interface ID 3

Area 0, Process ID 10, Instance ID 0, Router ID 192.168.30.1

Network Type POINT-TO-POINT, Cost: 64

Transmit Delay is 1 sec, State POINT-TO-POINT,

Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5

Hello due in 00:00:02

Index 3/3, flood queue length 0

Next 0x0(0)/0x0(0)

Last flood scan length is 1, maximum is 1

Last flood scan time is 0 msec, maximum is 0 msec

Neighbor Count is 1 , Adjacent neighbor count is 1

Adjacent with neighbor 192.168.20.1

Suppress hello for 0 neighbor(s)

**r3#show ipv6 ospf neighbor**

Neighbor ID Pri State Dead Time Interface ID Interface

192.168.20.1 0 FULL/ - 00:00:38 4 Serial0/1/0

192.168.40.1 0 FULL/ - 00:00:38 3 Serial0/1/1

**r3#show ipv6 ospf database**

OSPF Router with ID (192.168.30.1) (Process ID 10)

Router Link States (Area 0)

ADV Router Age Seq# Fragment ID Link count Bits

192.168.30.1 889 0x80000004 0 2

192.168.20.1 891 0x80000004 0 2

192.168.10.1 891 0x80000003 0 1

192.168.40.1 891 0x80000003 0 1 B

Inter Area Prefix Link States (Area 0)

ADV Router Age Seq# Metric Prefix

192.168.40.1 887 0x80000004 1 A:4::/64

192.168.40.1 886 0x80000005 64 4::/64

192.168.40.1 876 0x80000006 65 A:5::/64

Link (Type-8) Link States (Area 0)

ADV Router Age Seq# Link ID Interface

192.168.30.1 899 0x80000006 1 Gi0/0/0

192.168.30.1 890 0x80000007 3 Se0/1/0

192.168.30.1 890 0x80000008 4 Se0/1/1

192.168.40.1 896 0x80000003 3 Se0/1/1

192.168.20.1 893 0x80000007 4 Se0/1/0

Intra Area Prefix Link States (Area 0)

ADV Router Age Seq# Link ID Ref-lstype Ref-LSID

192.168.30.1 892 0x80000004 2 0x2001 0

192.168.40.1 900 0x80000002 2 0x2001 0

192.168.10.1 900 0x80000003 2 0x2001 0

192.168.20.1 892 0x80000004 2 0x2001 0

Router 4

**r4#show run**

no service timestamps log datetime msec

no service timestamps debug datetime msec

no service password-encryption

hostname r4

no ip cef

ipv6 unicast-routing

no ipv6 cef

spanning-tree mode pvst

interface GigabitEthernet0/0/0

ip address 192.168.40.1 255.255.255.0

ip ospf 10 area 1

duplex auto

speed auto

ipv6 address FE80::1 link-local

ipv6 address A:4::A/64

ipv6 ospf 10 area 1

interface GigabitEthernet0/0/1

no ip address

duplex auto

speed auto

shutdown

interface Serial0/1/0

ip address 10.10.10.10 255.255.255.252

ip ospf 10 area 0

ipv6 address FE80::2 link-local

ipv6 address 3::2/64

ipv6 ospf 10 area 0

clock rate 2000000

interface Serial0/1/1

ip address 10.10.10.13 255.255.255.252

ip ospf 10 area 1

ipv6 address FE80::1 link-local

ipv6 address 4::1/64

ipv6 ospf 10 area 1

interface Vlan1

no ip address

shutdown

router ospf 10

router-id 4.4.4.4

log-adjacency-changes

ipv6 router ospf 10

log-adjacency-changes

ip classless

ip flow-export version 9

line con 0

line aux 0

line vty 0 4

login

end

**r4#show ipv6 route**

IPv6 Routing Table - 13 entries

Codes: C - Connected, L - Local, S - Static, R - RIP, B - BGP

U - Per-user Static route, M - MIPv6

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

O - OSPF intra, OI - OSPF inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2

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

D - EIGRP, EX - EIGRP external

O 1::/64 [110/192]

via FE80::1, Serial0/1/0

O 2::/64 [110/128]

via FE80::1, Serial0/1/0

C 3::/64 [0/0]

via Serial0/1/0, directly connected

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

via Serial0/1/0, receive

C 4::/64 [0/0]

via Serial0/1/1, directly connected

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

via Serial0/1/1, receive

O A:1::/64 [110/193]

via FE80::1, Serial0/1/0

O A:2::/64 [110/129]

via FE80::1, Serial0/1/0

O A:3::/64 [110/65]

via FE80::1, Serial0/1/0

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

via GigabitEthernet0/0/0, directly connected

L A:4::A/128 [0/0]

via GigabitEthernet0/0/0, receive

O A:5::/64 [110/65]

via FE80::2, Serial0/1/1

L FF00::/8 [0/0]

via Null0, receive

**r4#show ipv6 ospf interface**

GigabitEthernet0/0/0 is up, line protocol is up

Link Local Address FE80::1, Interface ID 1

Area 1, Process ID 10, Instance ID 0, Router ID 192.168.40.1

Network Type BROADCAST, Cost: 1

Transmit Delay is 1 sec, State DR, Priority 1

Designated Router (ID) 192.168.40.1, local address FE80::1

No backup designated router on this network

Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5

Hello due in 00:00:06

Index 1/1, flood queue length 0

Next 0x0(0)/0x0(0)

Last flood scan length is 1, maximum is 1

Last flood scan time is 0 msec, maximum is 0 msec

Neighbor Count is 0, Adjacent neighbor count is 0

Suppress hello for 0 neighbor(s)

Serial0/1/1 is up, line protocol is up

Link Local Address FE80::1, Interface ID 4

Area 1, Process ID 10, Instance ID 0, Router ID 192.168.40.1

Network Type POINT-TO-POINT, Cost: 64

Transmit Delay is 1 sec, State POINT-TO-POINT,

Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5

Hello due in 00:00:06

Index 2/2, flood queue length 0

Next 0x0(0)/0x0(0)

Last flood scan length is 1, maximum is 1

Last flood scan time is 0 msec, maximum is 0 msec

Neighbor Count is 1 , Adjacent neighbor count is 1

Adjacent with neighbor 192.168.50.1

Suppress hello for 0 neighbor(s)

Serial0/1/0 is up, line protocol is up

Link Local Address FE80::2, Interface ID 3

Area 0, Process ID 10, Instance ID 0, Router ID 192.168.40.1

Network Type POINT-TO-POINT, Cost: 64

Transmit Delay is 1 sec, State POINT-TO-POINT,

Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5

Hello due in 00:00:06

Index 3/3, flood queue length 0

Next 0x0(0)/0x0(0)

Last flood scan length is 1, maximum is 1

Last flood scan time is 0 msec, maximum is 0 msec

Neighbor Count is 1 , Adjacent neighbor count is 1

Adjacent with neighbor 192.168.30.1

Suppress hello for 0 neighbor(s)

**r4#show ipv6 ospf neighbor**

Neighbor ID Pri State Dead Time Interface ID Interface

192.168.50.1 0 FULL/ - 00:00:37 3 Serial0/1/1

192.168.30.1 0 FULL/ - 00:00:36 4 Serial0/1/0

**r4#show ipv6 ospf database**

OSPF Router with ID (192.168.40.1) (Process ID 10)

Router Link States (Area 1)

ADV Router Age Seq# Fragment ID Link count Bits

192.168.40.1 961 0x80000003 0 1 B

192.168.50.1 960 0x80000003 0 1

Inter Area Prefix Link States (Area 1)

ADV Router Age Seq# Metric Prefix

192.168.40.1 966 0x80000007 64 3::/64

192.168.40.1 946 0x80000008 129 A:2::/64

192.168.40.1 946 0x80000009 192 1::/64

192.168.40.1 946 0x8000000a 65 A:3::/64

192.168.40.1 946 0x8000000b 128 2::/64

192.168.40.1 946 0x8000000c 193 A:1::/64

Link (Type-8) Link States (Area 1)

ADV Router Age Seq# Link ID Interface

192.168.40.1 970 0x80000004 1 Gi0/0/0

192.168.40.1 964 0x80000005 4 Se0/1/1

192.168.50.1 961 0x80000005 3 Se0/1/1

Intra Area Prefix Link States (Area 1)

ADV Router Age Seq# Link ID Ref-lstype Ref-LSID

192.168.40.1 970 0x80000003 2 0x2001 0

192.168.50.1 964 0x80000003 2 0x2001 0

OSPF Router with ID (192.168.40.1) (Process ID 10)

Router Link States (Area 0)

ADV Router Age Seq# Fragment ID Link count Bits

192.168.40.1 960 0x80000003 0 1 B

192.168.20.1 961 0x80000004 0 2

192.168.10.1 960 0x80000003 0 1

192.168.30.1 959 0x80000004 0 2

Inter Area Prefix Link States (Area 0)

ADV Router Age Seq# Metric Prefix

192.168.40.1 956 0x80000004 1 A:4::/64

192.168.40.1 956 0x80000005 64 4::/64

192.168.40.1 946 0x80000006 65 A:5::/64

Link (Type-8) Link States (Area 0)

ADV Router Age Seq# Link ID Interface

192.168.40.1 965 0x80000003 3 Se0/1/0

192.168.30.1 960 0x80000008 4 Se0/1/0

Intra Area Prefix Link States (Area 0)

ADV Router Age Seq# Link ID Ref-lstype Ref-LSID

192.168.40.1 970 0x80000002 2 0x2001 0

192.168.10.1 969 0x80000003 2 0x2001 0

192.168.30.1 962 0x80000004 2 0x2001 0

192.168.20.1 962 0x80000004 2 0x2001 0

Router 5

**r5#show run**

no service timestamps log datetime msec

no service timestamps debug datetime msec

no service password-encryption

hostname r5

no ip cef

ipv6 unicast-routing

no ipv6 cef

spanning-tree mode pvst

interface GigabitEthernet0/0/0

ip address 192.168.50.1 255.255.255.0

ip ospf 10 area 1

duplex auto

speed auto

ipv6 address FE80::1 link-local

ipv6 address A:5::A/64

ipv6 ospf 10 area 1

interface GigabitEthernet0/0/1

no ip address

duplex auto

speed auto

shutdown

interface Serial0/1/0

ip address 10.10.10.14 255.255.255.252

ip ospf 10 area 1

ipv6 address FE80::2 link-local

ipv6 address 4::2/64

ipv6 ospf 10 area 1

clock rate 2000000

interface Serial0/1/1

no ip address

clock rate 2000000

shutdown

interface Vlan1

no ip address

shutdown

router ospf 10

router-id 5.5.5.5

log-adjacency-changes

ipv6 router ospf 10

log-adjacency-changes

ip classless

ip flow-export version 9

line con 0

line aux 0

line vty 0 4

login

end

**r5#show ipv6 route**

IPv6 Routing Table - 12 entries

Codes: C - Connected, L - Local, S - Static, R - RIP, B - BGP

U - Per-user Static route, M - MIPv6

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

O - OSPF intra, OI - OSPF inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2

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

D - EIGRP, EX - EIGRP external

OI 1::/64 [110/256]

via FE80::1, Serial0/1/0

OI 2::/64 [110/192]

via FE80::1, Serial0/1/0

OI 3::/64 [110/128]

via FE80::1, Serial0/1/0

C 4::/64 [0/0]

via Serial0/1/0, directly connected

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

via Serial0/1/0, receive

OI A:1::/64 [110/257]

via FE80::1, Serial0/1/0

OI A:2::/64 [110/193]

via FE80::1, Serial0/1/0

OI A:3::/64 [110/129]

via FE80::1, Serial0/1/0

O A:4::/64 [110/65]

via FE80::1, Serial0/1/0

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

via GigabitEthernet0/0/0, directly connected

L A:5::A/128 [0/0]

via GigabitEthernet0/0/0, receive

L FF00::/8 [0/0]

via Null0, receive

**r5#show ipv6 ospf interface**

GigabitEthernet0/0/0 is up, line protocol is up

Link Local Address FE80::1, Interface ID 1

Area 1, Process ID 10, Instance ID 0, Router ID 192.168.50.1

Network Type BROADCAST, Cost: 1

Transmit Delay is 1 sec, State DR, Priority 1

Designated Router (ID) 192.168.50.1, local address FE80::1

No backup designated router on this network

Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5

Hello due in 00:00:00

Index 1/1, flood queue length 0

Next 0x0(0)/0x0(0)

Last flood scan length is 1, maximum is 1

Last flood scan time is 0 msec, maximum is 0 msec

Neighbor Count is 0, Adjacent neighbor count is 0

Suppress hello for 0 neighbor(s)

Serial0/1/0 is up, line protocol is up

Link Local Address FE80::2, Interface ID 3

Area 1, Process ID 10, Instance ID 0, Router ID 192.168.50.1

Network Type POINT-TO-POINT, Cost: 64

Transmit Delay is 1 sec, State POINT-TO-POINT,

Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5

Hello due in 00:00:07

Index 2/2, flood queue length 0

Next 0x0(0)/0x0(0)

Last flood scan length is 1, maximum is 1

Last flood scan time is 0 msec, maximum is 0 msec

Neighbor Count is 1 , Adjacent neighbor count is 1

Adjacent with neighbor 192.168.40.1

Suppress hello for 0 neighbor(s)

**r5#show ipv6 ospf neighbor**

Neighbor ID Pri State Dead Time Interface ID Interface

192.168.40.1 0 FULL/ - 00:00:35 4 Serial0/1/0

**r5#show ipv6 ospf database**

OSPF Router with ID (192.168.50.1) (Process ID 10)

Router Link States (Area 1)

ADV Router Age Seq# Fragment ID Link count Bits

192.168.50.1 1020 0x80000003 0 1

192.168.40.1 1022 0x80000003 0 1 B

Inter Area Prefix Link States (Area 1)

ADV Router Age Seq# Metric Prefix

192.168.40.1 1027 0x80000007 64 3::/64

192.168.40.1 1006 0x80000008 129 A:2::/64

192.168.40.1 1006 0x80000009 192 1::/64

192.168.40.1 1006 0x8000000a 65 A:3::/64

192.168.40.1 1006 0x8000000b 128 2::/64

192.168.40.1 1006 0x8000000c 193 A:1::/64

Link (Type-8) Link States (Area 1)

ADV Router Age Seq# Link ID Interface

192.168.50.1 1030 0x80000004 1 Gi0/0/0

192.168.50.1 1021 0x80000005 3 Se0/1/0

192.168.40.1 1024 0x80000005 4 Se0/1/0

Intra Area Prefix Link States (Area 1)

ADV Router Age Seq# Link ID Ref-lstype Ref-LSID

192.168.50.1 1024 0x80000003 2 0x2001 0

192.168.40.1 1030 0x80000003 2 0x2001 0

Problems

This lab was very similar to the single-area IPv4 OSPF lab which I had completed previously, so I didn’t run into much trouble. However, I ran into an interesting problem where no device could reach router five from area 0.

First, I tested if I could ping to router five from router one. I could reach its neighbor, router four, but could not reach beyond to router five. Since there were routes to all the networks except the one on router five, I concluded that this was likely an issue on router five’s serial interface – the interface bridging router four to router five. To troubleshoot the interface, I went into router five and double checked the IP addresses and the OSPFv3 configuration.

After many show commands, I noticed router five’s OSPFv3 process ID didn’t match the other routers. The process ID on router five was 1, whereas all the other routers had a process ID of 10. This was a typo I had made, but my research indicated that process ID didn’t have to match for OSPF to function. This isn’t totally wrong; however, with further investigation, I realized each process retains a different routing table. While connectivity had been established, it was understandable how routes could have messed up. I decided to wipe router 5 clean and start over, correcting the process IDs, which solved the problem.

Conclusion

In this lab, I set up multi-area OSPFv2 and OSPFv3 networks in CISCO packet tracer. Though it was just a simulation, I think I could take this knowledge and configure OSPFv3 on a physical catalyst 4321 router. Being able to configure an IGP is important for networks with multiple subnets and can be used alongside more complicated protocols like iBGP. An insight I took from this lab was to narrow down a problem before pasting in unnecessary commands found online.