Multi-Area OSPF

CCNP LAB 2

Jason Liu

CCNP – Mr. Mason, Mr. Hansen

Period 6, 7, 8

*Lab 2: Multi-Area OSPF*

**Purpose**

The objective of the lab was to understand and configure basic OSPFv3 practices for multiple areas of OSPF addressing. Both IPv4 and IPV6 are configured for best practice.

**Background Information**

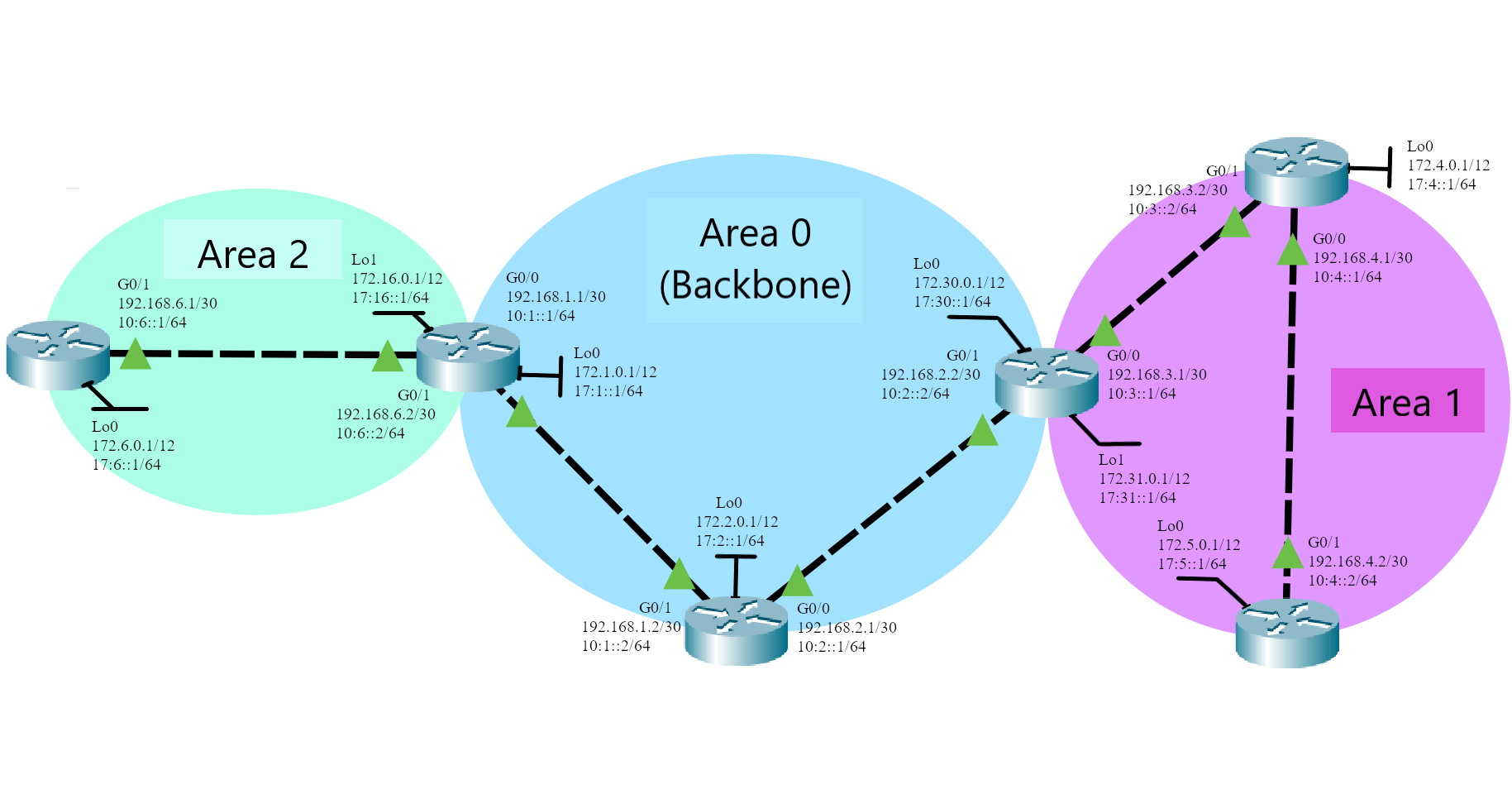
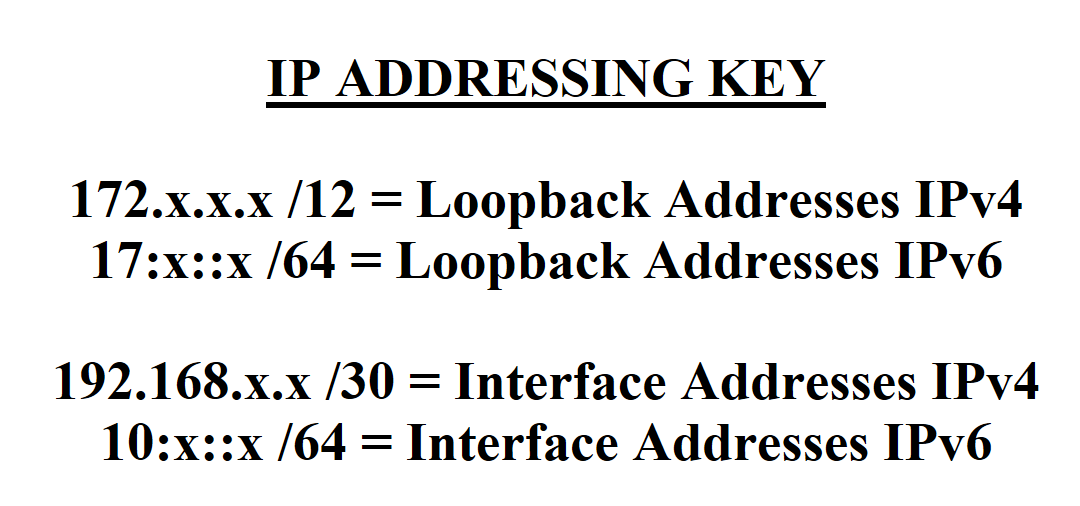
OSPFv3 is a link-state routing protocol for IPv6 networks. It can run at the same time as the OSPFv2 protocol. Similar to it’s IPv4 counterpart, OSPFv3 calculates the shortest path via comparing the total costs of each route. They function in very similar ways, except in the way they are configured. OSPFv3 must be enabled through the specific interfaces, while OSPFv2 for IPv4 can be enabled through activating OSPF for the entire network subnet.

The purpose of areas in OSPF is to divide the topology into smaller groups of networks. These administratively separated areas share identical topology databases but only within each respective area. Thus, this reduces total overhead routing traffic, including link-state advertisements (LSAs). Note that pings and routing tables still trace throughout the entire network. There is a special area known as the Backbone Area, in which it distributes routing information across all the areas. It is often named Area 0. All other Area Border Routers should have either a physical or virtual route connected to the Backbone Area.

Area Border Routers (ABR) are routers that see and are a part of multiple areas. They have certain OSPF enabled interfaces that are a part of one area, and others that are of another. In this topology, Routers 1 and 3 act as border routers where they can each see into two different areas. Very similar to it, Autonomous System Border Routers (ASBRs) also act as a border, but it is used for its connection to external, non-OSPF domains. These routing devices can exchange routing information with other protocols and is beneficial in connecting large system of networks and managing the variety of protocols.

**Lab Summary**

Six routers were split among 3 areas for this lab. The routers are once again connected in one long line. Each one was connected via Gigabit Ethernet ports with cross-over cables, each router to the next in order of the line (see Network Diagram). A loopback interface was added on each router to simulate Local Area Networks (LANs). Area zero contains R1-R3. Area 1 uses border router R3 and connects R4 and R5. Area 2 uses border router 1 and connects to R6. IPv6 OSPF was enabled on all interfaces, and IPv4 OSPF was configured via network and wildcard masks. On the interfaces, the “ipv6 ospf network” command was configured to point-to-point networks, as the routers were each directly connected to the other. Adjustment to hello and dead intervals were made on all interfaces, changed from 10 and 40 seconds, to 15 and 60 seconds, respectively.



**Table of IP’s**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **G0/0/1** | **G0/0/0** | **Loopback Interfaces** | **OSPF Router ID**  **Both OSPFv3 and v2** |
| **Router 6** | **192.168.6.1**  **10:6::1** | **--** | **Lo0: 172.6.0.1**  **17:6::1** | **6.6.6.6** |
| **Router 1 (ABR)** | **192.168.6.2**  **10:6::2** | **192.168.1.1**  **10:1::1** | **Lo1: 172.16.0.1 and 17:16::1 (Area 2)**  **Lo0: 172.1.0.1 and 17:1::1 (Area 0)** | **1.1.1.1** |
| **Router 2** | **192.168.1.2**  **10:1::2** | **192.168.2.1**  **10:2::1** | **Lo0: 172.2.0.1**  **17:2::1** | **2.2.2.2** |
| **Router 3 (ABR)** | **192.168.2.2**  **10:2::2** | **192.168.3.1**  **10:3::1** | **Lo1: 172.30.0.1 and 17:30::1 (Area 0)**  **Lo0: 172.31.0.1 and 17:31::1 (Area 1)** | **3.3.3.3** |
| **Router 4** | **192.168.3.2**  **10:3::2** | **192.168.4.1**  **10:4::1** | **Lo0: 172.4.0.1**  **17:4::1** | **4.4.4.4** |
| **Router 5** | **192.168.4.2**  **10:4::2** | -- | **Lo0: 172.5.0.1**  **17:5::1** | **5.5.5.5** |

**Lab Commands**

Most commands were common network fundamentals. Key commands to this lab include:

**router ospfv3 [*process-id]*** *–* Enables OSPFv3 routing protocol on the router and enters the router configuration mode. Process-id of 10 was used for both OSPfv2 and v3.

**ipv6 ospf [*process-id]* area [*area-id]*** – Enables said interface to be advertised to the OSPF database. In other words, enables OSPF for IPv6.

**show ipv6 route {ospf} –** Displays the IPv6 routing table. {Specifically ospf discovered routes.}

**show ipv6 ospf –** Displays basic ospfv3 information.

**show ipv6 ospf interface [*interface]* –** Displays OSPF related information configured on the interface.

**show ipv6 ospf database –** Displays data from OSPFv3 database.

**show ospfv3 10 ipv6 border-routers –** Displays Area Border Router(s) in the area.

**ipv6 ospf hello-interval [*time interval]* –** Changes the hello time interval of the interface. Dead intervals automatically change to 4 times the hello interval.

**Configurations**

Show Running-Configurations:

**R1 (ABR)**

R1#show run

shutdown

negotiation auto

interface Vlan1

no ip address

shutdown

**router ospfv3 10**

**router-id 1.1.1.1**

**address-family ipv6 unicast**

**exit-address-family**

**router ospf 10**

**router-id 1.1.1.1**

**network 172.1.0.0 0.0.15.255 area 0**

**network 172.16.0.0 0.0.15.255 area 2**

**network 192.168.1.0 0.0.0.3 area 0**

**network 192.168.6.0 0.0.0.3 area 2**

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

Building configuration...

Current configuration : 2188 bytes

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 FDO21482HZX

spanning-tree extend system-id

redundancy

mode none

vlan internal allocation policy ascending

**interface Loopback0**

**ip address 172.1.0.1 255.255.240.0**

**ipv6 address 17:1::1/64**

**ipv6 enable**

**ipv6 ospf 10 area 0**

**ipv6 ospf network point-to-point**

**interface Loopback1**

**ip address 172.16.0.1 255.255.240.0**

**ipv6 address 17:16::1/64**

**ipv6 enable**

**ipv6 ospf 10 area 2**

**ipv6 ospf network point-to-point**

**interface GigabitEthernet0/0/0**

**ip address 192.168.1.1 255.255.255.252**

**ip ospf hello-interval 15**

**negotiation auto**

**ipv6 address 10:1::1/64**

**ipv6 enable**

**ipv6 ospf 10 area 0**

**ipv6 ospf network point-to-point**

**ipv6 ospf hello-interval 15**

**interface GigabitEthernet0/0/1**

**ip address 192.168.6.2 255.255.255.252**

**ip ospf hello-interval 15**

**negotiation auto**

**ipv6 address 10:6::2/64**

**ipv6 enable**

**ipv6 ospf 10 area 2**

**ipv6 ospf network point-to-point**

**ipv6 ospf hello-interval 15**

interface Serial0/1/0

no ip address

shutdown

interface Serial0/1/1

no ip address

shutdown

interface GigabitEthernet0

vrf forwarding Mgmt-intf

no ip address

**R2**

R2#show run

**router-id 2.2.2.2**

**network 172.2.0.0 0.0.15.255 area 0**

**network 192.168.1.0 0.0.0.3 area 0**

**network 192.168.2.0 0.0.0.3 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

Building configuration...

Current configuration : 1997 bytes

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 FDO21482DWJ

spanning-tree extend system-id

redundancy

mode none

vlan internal allocation policy ascending

**interface Loopback0**

**ip address 172.2.0.1 255.255.240.0**

**ipv6 address 17:2::1/64**

**ipv6 enable**

**ipv6 ospf 10 area 0**

**ipv6 ospf network point-to-point**

**interface GigabitEthernet0/0/0**

**ip address 192.168.2.1 255.255.255.252**

**ip ospf hello-interval 15**

**negotiation auto**

**ipv6 address 10:2::1/64**

**ipv6 enable**

**ipv6 ospf 10 area 0**

**ipv6 ospf network point-to-point**

**ipv6 ospf hello-interval 15**

**interface GigabitEthernet0/0/1**

**ip address 192.168.1.2 255.255.255.252**

**ip ospf hello-interval 15**

**negotiation auto**

**ipv6 address 10:1::2/64**

**ipv6 enable**

**ipv6 ospf 10 area 0**

**ipv6 ospf network point-to-point**

**ipv6 ospf hello-interval 15**

interface Serial0/1/0

no ip address

shutdown

interface Serial0/1/1

no ip address

shutdown

interface GigabitEthernet0

vrf forwarding Mgmt-intf

no ip address

shutdown

negotiation auto

interface Vlan1

no ip address

shutdown

**router ospfv3 10**

**router-id 2.2.2.2**

**address-family ipv6 unicast**

**exit-address-family**

**router ospf 10**

**R3 (ABR)**

R3#show run

**router ospfv3 10**

**router-id 3.3.3.3**

address-family ipv6 unicast

exit-address-family

**router ospf 10**

**router-id 3.3.3.3**

**network 172.30.0.0 0.0.15.255 area 0**

**network 172.31.0.0 0.0.15.255 area 1**

**network 192.168.2.0 0.0.0.3 area 0**

**network 192.168.3.0 0.0.0.3 area 1**

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

Building configuration...

Current configuration : 2192 bytes

version 15.5

service timestamps debug datetime msec

service timestamps log datetime msec

no platform punt-keepalive disable-kernel-core

hostname R3

boot-start-marker

boot-end-marker

vrf definition Mgmt-intf

address-family ipv4

exit-address-family

address-family ipv6

exit-address-family

no aaa new-model

**ipv6 unicast-routing**

subscriber templating

multilink bundle-name authenticated

license udi pid ISR4321/K9 sn FDO214420HW

spanning-tree extend system-id

redundancy

mode none

vlan internal allocation policy ascending

**interface Loopback0**

**ip address 172.30.0.1 255.255.240.0**

**ipv6 address 17:30::1/64**

**ipv6 enable**

**ipv6 ospf 10 area 0**

**ipv6 ospf network point-to-point**

**interface Loopback1**

**ip address 172.31.0.1 255.255.240.0**

**ipv6 address 172:31::1/64**

**ipv6 enable**

**ipv6 ospf 10 area 1**

**ipv6 ospf network point-to-point**

**interface GigabitEthernet0/0/0**

**ip address 192.168.3.1 255.255.255.252**

**ip ospf hello-interval 15**

**negotiation auto**

**ipv6 address 10:3::1/64**

**ipv6 enable**

**ipv6 ospf 10 area 1**

**ipv6 ospf network point-to-point**

**ipv6 ospf hello-interval 15**

**interface GigabitEthernet0/0/1**

**ip address 192.168.2.2 255.255.255.252**

**ip ospf hello-interval 15**

**negotiation auto**

**ipv6 address 10:2::2/64**

**ipv6 enable**

**ipv6 ospf 10 area 0**

**ipv6 ospf network point-to-point**

**ipv6 ospf hello-interval 15**

interface Serial0/1/0

no ip address

shutdown

interface Serial0/1/1

no ip address

shutdown

interface GigabitEthernet0

vrf forwarding Mgmt-intf

no ip address

shutdown

negotiation auto

interface Vlan1

no ip address

shutdown

**R4**

R4#show run

**router-id 4.4.4.4**

**network 172.4.0.0 0.0.15.255 area 1**

**network 192.168.3.0 0.0.0.3 area 1**

**network 192.168.4.0 0.0.0.3 area 1**

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

Building configuration...

Current configuration : 1997 bytes

version 15.5

service timestamps debug datetime msec

service timestamps log datetime msec

no platform punt-keepalive disable-kernel-core

hostname R4

boot-start-marker

boot-end-marker

vrf definition Mgmt-intf

address-family ipv4

exit-address-family

address-family ipv6

exit-address-family

no aaa new-model

**ipv6 unicast-routing**

subscriber templating

multilink bundle-name authenticated

license udi pid ISR4321/K9 sn FDO214421D1

spanning-tree extend system-id

redundancy

mode none

vlan internal allocation policy ascending

**interface Loopback0**

**ip address 172.4.0.1 255.255.240.0**

**ipv6 address 17:4::1/64**

**ipv6 enable**

**ipv6 ospf 10 area 1**

**ipv6 ospf network point-to-point**

**interface GigabitEthernet0/0/0**

**ip address 192.168.4.1 255.255.255.252**

**ip ospf hello-interval 15**

**negotiation auto**

**ipv6 address 10:4::1/64**

**ipv6 enable**

**ipv6 ospf 10 area 1**

**ipv6 ospf network point-to-point**

**ipv6 ospf hello-interval 15**

**interface GigabitEthernet0/0/1**

**ip address 192.168.3.2 255.255.255.252**

**ip ospf hello-interval 15**

**negotiation auto**

**ipv6 address 10:3::2/64**

**ipv6 enable**

**ipv6 ospf 10 area 1**

**ipv6 ospf network point-to-point**

**ipv6 ospf hello-interval 15**

interface Serial0/1/0

no ip address

shutdown

interface Serial0/1/1

no ip address

shutdown

interface GigabitEthernet0

vrf forwarding Mgmt-intf

no ip address

shutdown

negotiation auto

interface Vlan1

no ip address

shutdown

**router ospfv3 10**

**router-id 4.4.4.4**

**address-family ipv6 unicast**

**exit-address-family**

**router ospf 10**

**R5**

R5#show run

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

Building configuration...

Current configuration : 4170 bytes

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

**ipv6 unicast-routing**

subscriber templating

multilink bundle-name authenticated

license udi pid ISR4321/K9 sn FLM240608PJ

spanning-tree extend system-id

redundancy

mode none

**interface Loopback0**

**ip address 172.5.0.1 255.255.240.0**

**ipv6 address 17:5::1/64**

**ipv6 enable**

**ipv6 ospf 10 area 1**

**ipv6 ospf network point-to-point**

interface GigabitEthernet0/0/0

no ip address

ip ospf hello-interval 15

shutdown

negotiation auto

ipv6 ospf hello-interval 15

**interface GigabitEthernet0/0/1**

**ip address 192.168.4.2 255.255.255.252**

**ip ospf hello-interval 15**

**negotiation auto**

**ipv6 address 10:4::2/64**

**ipv6 enable**

**ipv6 ospf 10 area 1**

**ipv6 ospf network point-to-point**

**ipv6 ospf hello-interval 15**

interface GigabitEthernet0/1/0

no ip address

shutdown

negotiation auto

interface GigabitEthernet0/1/1

no ip address

shutdown

negotiation auto

interface GigabitEthernet0

vrf forwarding Mgmt-intf

no ip address

shutdown

negotiation auto

**router ospfv3 10**

**router-id 5.5.5.5**

address-family ipv6 unicast

exit-address-family

**router ospf 10**

**router-id 5.5.5.5**

**network 172.5.0.0 0.0.15.255 area 1**

**network 192.168.4.0 0.0.0.3 area 1**

ip forward-protocol nd

ip http server

**R6**

R6#show run

ip tftp source-interface GigabitEthernet0

control-plane

line con 0

stopbits 1

line aux 0

stopbits 1

line vty 0 4

login

end

Building configuration...

Current configuration : 1797 bytes

version 15.5

service timestamps debug datetime msec

service timestamps log datetime msec

no platform punt-keepalive disable-kernel-core

hostname R6

boot-start-marker

boot-end-marker

vrf definition Mgmt-intf

address-family ipv4

exit-address-family

address-family ipv6

exit-address-family

no aaa new-model

**ipv6 unicast-routing**

subscriber templating

multilink bundle-name authenticated

license udi pid ISR4321/K9 sn FDO21491LXF

spanning-tree extend system-id

redundancy

mode none

vlan internal allocation policy ascending

**interface Loopback0**

**ip address 172.6.0.1 255.255.240.0**

**ipv6 address 17:6::1/64**

**ipv6 enable**

**ipv6 ospf 10 area 2**

**ipv6 ospf network point-to-point**

interface GigabitEthernet0/0/0

no ip address

shutdown

negotiation auto

**interface GigabitEthernet0/0/1**

**ip address 192.168.6.1 255.255.255.252**

**ip ospf hello-interval 15**

**negotiation auto**

**ipv6 address 10:6::1/64**

**ipv6 enable**

**ipv6 ospf 10 area 2**

**ipv6 ospf network point-to-point**

**ipv6 ospf hello-interval 15**

interface Serial0/1/0

no ip address

shutdown

interface Serial0/1/1

no ip address

shutdown

interface GigabitEthernet0

vrf forwarding Mgmt-intf

no ip address

shutdown

negotiation auto

interface Vlan1

no ip address

shutdown

**router ospfv3 10**

**router-id 6.6.6.6**

address-family ipv6 unicast

exit-address-family

**router ospf 10**

**router-id 6.6.6.6**

**network 172.6.0.0 0.0.15.255 area 2**

**network 192.168.6.0 0.0.0.3 area 2**

ip forward-protocol nd

no ip http server

no ip http secure-server

Show IP Routes:

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

**R1**

172.1.0.0/16 is variably subnetted, 2 subnets, 2 masks

C 172.1.0.0/20 is directly connected, Loopback0

L 172.1.0.1/32 is directly connected, Loopback0

172.2.0.0/32 is subnetted, 1 subnets

O 172.2.0.1 [110/2] via 192.168.1.2, 00:50:23, GigabitEthernet0/0/0

172.4.0.0/32 is subnetted, 1 subnets

O IA 172.4.0.1 [110/4] via 192.168.1.2, 00:50:23, GigabitEthernet0/0/0

172.5.0.0/32 is subnetted, 1 subnets

O IA 172.5.0.1 [110/5] via 192.168.1.2, 00:50:19, GigabitEthernet0/0/0

172.6.0.0/32 is subnetted, 1 subnets

O 172.6.0.1 [110/2] via 192.168.6.1, 00:03:55, GigabitEthernet0/0/1

172.16.0.0/16 is variably subnetted, 2 subnets, 2 masks

C 172.16.0.0/20 is directly connected, Loopback1

L 172.16.0.1/32 is directly connected, Loopback1

172.30.0.0/32 is subnetted, 1 subnets

O 172.30.0.1 [110/3] via 192.168.1.2, 00:50:23, GigabitEthernet0/0/0

172.31.0.0/32 is subnetted, 1 subnets

O IA 172.31.0.1 [110/3] via 192.168.1.2, 00:50:23, GigabitEthernet0/0/0

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

C 192.168.1.0/30 is directly connected, GigabitEthernet0/0/0

L 192.168.1.1/32 is directly connected, GigabitEthernet0/0/0

192.168.2.0/30 is subnetted, 1 subnets

O 192.168.2.0 [110/2] via 192.168.1.2, 00:50:23, GigabitEthernet0/0/0

192.168.3.0/30 is subnetted, 1 subnets

O IA 192.168.3.0 [110/3] via 192.168.1.2, 00:50:23, GigabitEthernet0/0/0

192.168.4.0/30 is subnetted, 1 subnets

O IA 192.168.4.0 [110/4] via 192.168.1.2, 00:50:23, GigabitEthernet0/0/0

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

C 192.168.6.0/30 is directly connected, GigabitEthernet0/0/1

L 192.168.6.2/32 is directly connected, GigabitEthernet0/0/1

**R2**

172.1.0.0/32 is subnetted, 1 subnets

O 172.1.0.1 [110/2] via 192.168.1.1, 00:58:55, GigabitEthernet0/0/1

172.2.0.0/16 is variably subnetted, 2 subnets, 2 masks

C 172.2.0.0/20 is directly connected, Loopback0

L 172.2.0.1/32 is directly connected, Loopback0

172.4.0.0/32 is subnetted, 1 subnets

O IA 172.4.0.1 [110/3] via 192.168.2.2, 01:10:01, GigabitEthernet0/0/0

172.5.0.0/32 is subnetted, 1 subnets

O IA 172.5.0.1 [110/4] via 192.168.2.2, 00:58:45, GigabitEthernet0/0/0

172.6.0.0/32 is subnetted, 1 subnets

O IA 172.6.0.1 [110/3] via 192.168.1.1, 00:12:21, GigabitEthernet0/0/1

172.16.0.0/32 is subnetted, 1 subnets

O IA 172.16.0.1 [110/2] via 192.168.1.1, 00:58:55, GigabitEthernet0/0/1

172.30.0.0/32 is subnetted, 1 subnets

O 172.30.0.1 [110/2] via 192.168.2.2, 01:12:19, GigabitEthernet0/0/0

172.31.0.0/32 is subnetted, 1 subnets

O IA 172.31.0.1 [110/2] via 192.168.2.2, 01:12:19, GigabitEthernet0/0/0

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

C 192.168.1.0/30 is directly connected, GigabitEthernet0/0/1

L 192.168.1.2/32 is directly connected, GigabitEthernet0/0/1

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

C 192.168.2.0/30 is directly connected, GigabitEthernet0/0/0

L 192.168.2.1/32 is directly connected, GigabitEthernet0/0/0

192.168.3.0/30 is subnetted, 1 subnets

O IA 192.168.3.0 [110/2] via 192.168.2.2, 01:10:50, GigabitEthernet0/0/0

192.168.4.0/30 is subnetted, 1 subnets

O IA 192.168.4.0 [110/3] via 192.168.2.2, 01:00:46, GigabitEthernet0/0/0

192.168.6.0/30 is subnetted, 1 subnets

O IA 192.168.6.0 [110/2] via 192.168.1.1, 00:13:25, GigabitEthernet0/0/1

**R3**

172.1.0.0/32 is subnetted, 1 subnets

O 172.1.0.1 [110/3] via 192.168.2.1, 01:02:24, GigabitEthernet0/0/1

172.2.0.0/32 is subnetted, 1 subnets

O 172.2.0.1 [110/2] via 192.168.2.1, 01:15:58, GigabitEthernet0/0/1

172.4.0.0/32 is subnetted, 1 subnets

O 172.4.0.1 [110/2] via 192.168.3.2, 01:13:40, GigabitEthernet0/0/0

172.5.0.0/32 is subnetted, 1 subnets

O 172.5.0.1 [110/3] via 192.168.3.2, 01:02:24, GigabitEthernet0/0/0

172.6.0.0/32 is subnetted, 1 subnets

O IA 172.6.0.1 [110/4] via 192.168.2.1, 00:16:00, GigabitEthernet0/0/1

172.16.0.0/32 is subnetted, 1 subnets

O IA 172.16.0.1 [110/3] via 192.168.2.1, 01:02:24, GigabitEthernet0/0/1

172.30.0.0/16 is variably subnetted, 2 subnets, 2 masks

C 172.30.0.0/20 is directly connected, Loopback0

L 172.30.0.1/32 is directly connected, Loopback0

172.31.0.0/16 is variably subnetted, 2 subnets, 2 masks

C 172.31.0.0/20 is directly connected, Loopback1

L 172.31.0.1/32 is directly connected, Loopback1

192.168.1.0/30 is subnetted, 1 subnets

O 192.168.1.0 [110/2] via 192.168.2.1, 01:13:30, GigabitEthernet0/0/1

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

C 192.168.2.0/30 is directly connected, GigabitEthernet0/0/1

L 192.168.2.2/32 is directly connected, GigabitEthernet0/0/1

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

C 192.168.3.0/30 is directly connected, GigabitEthernet0/0/0

L 192.168.3.1/32 is directly connected, GigabitEthernet0/0/0

192.168.4.0/30 is subnetted, 1 subnets

O 192.168.4.0 [110/2] via 192.168.3.2, 01:02:34, GigabitEthernet0/0/0

192.168.6.0/30 is subnetted, 1 subnets

O IA 192.168.6.0 [110/3] via 192.168.2.1, 00:17:04, GigabitEthernet0/0/1

**R4**

172.1.0.0/32 is subnetted, 1 subnets

O IA 172.1.0.1 [110/4] via 192.168.3.1, 01:04:42, GigabitEthernet0/0/1

172.2.0.0/32 is subnetted, 1 subnets

O IA 172.2.0.1 [110/3] via 192.168.3.1, 01:15:58, GigabitEthernet0/0/1

172.4.0.0/16 is variably subnetted, 2 subnets, 2 masks

C 172.4.0.0/20 is directly connected, Loopback0

L 172.4.0.1/32 is directly connected, Loopback0

172.5.0.0/32 is subnetted, 1 subnets

O 172.5.0.1 [110/2] via 192.168.4.2, 01:04:51, GigabitEthernet0/0/0

172.6.0.0/32 is subnetted, 1 subnets

O IA 172.6.0.1 [110/5] via 192.168.3.1, 00:18:18, GigabitEthernet0/0/1

172.16.0.0/32 is subnetted, 1 subnets

O IA 172.16.0.1 [110/4] via 192.168.3.1, 01:04:42, GigabitEthernet0/0/1

172.30.0.0/32 is subnetted, 1 subnets

O IA 172.30.0.1 [110/2] via 192.168.3.1, 01:15:58, GigabitEthernet0/0/1

172.31.0.0/32 is subnetted, 1 subnets

O 172.31.0.1 [110/2] via 192.168.3.1, 01:15:58, GigabitEthernet0/0/1

192.168.1.0/30 is subnetted, 1 subnets

O IA 192.168.1.0 [110/3] via 192.168.3.1, 01:15:48, GigabitEthernet0/0/1

192.168.2.0/30 is subnetted, 1 subnets

O IA 192.168.2.0 [110/2] via 192.168.3.1, 01:15:58, GigabitEthernet0/0/1

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

C 192.168.3.0/30 is directly connected, GigabitEthernet0/0/1

L 192.168.3.2/32 is directly connected, GigabitEthernet0/0/1

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

C 192.168.4.0/30 is directly connected, GigabitEthernet0/0/0

L 192.168.4.1/32 is directly connected, GigabitEthernet0/0/0

192.168.6.0/30 is subnetted, 1 subnets

O IA 192.168.6.0 [110/4] via 192.168.3.1, 00:19:22, GigabitEthernet0/0/1

**R5**

172.1.0.0/32 is subnetted, 1 subnets

O IA 172.1.0.1 [110/5] via 192.168.4.1, 00:59:02, GigabitEthernet0/0/1

172.2.0.0/32 is subnetted, 1 subnets

O IA 172.2.0.1 [110/4] via 192.168.4.1, 00:59:15, GigabitEthernet0/0/1

172.4.0.0/32 is subnetted, 1 subnets

O 172.4.0.1 [110/2] via 192.168.4.1, 00:59:15, GigabitEthernet0/0/1

172.5.0.0/16 is variably subnetted, 2 subnets, 2 masks

C 172.5.0.0/20 is directly connected, Loopback0

L 172.5.0.1/32 is directly connected, Loopback0

172.6.0.0/32 is subnetted, 1 subnets

O IA 172.6.0.1 [110/6] via 192.168.4.1, 00:12:38, GigabitEthernet0/0/1

172.16.0.0/32 is subnetted, 1 subnets

O IA 172.16.0.1 [110/5] via 192.168.4.1, 00:59:02, GigabitEthernet0/0/1

172.30.0.0/32 is subnetted, 1 subnets

O IA 172.30.0.1 [110/3] via 192.168.4.1, 00:59:15, GigabitEthernet0/0/1

172.31.0.0/32 is subnetted, 1 subnets

O 172.31.0.1 [110/3] via 192.168.4.1, 00:59:15, GigabitEthernet0/0/1

192.168.1.0/30 is subnetted, 1 subnets

O IA 192.168.1.0 [110/4] via 192.168.4.1, 00:59:15, GigabitEthernet0/0/1

192.168.2.0/30 is subnetted, 1 subnets

O IA 192.168.2.0 [110/3] via 192.168.4.1, 00:59:15, GigabitEthernet0/0/1

192.168.3.0/30 is subnetted, 1 subnets

O 192.168.3.0 [110/2] via 192.168.4.1, 00:59:15, GigabitEthernet0/0/1

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

C 192.168.4.0/30 is directly connected, GigabitEthernet0/0/1

L 192.168.4.2/32 is directly connected, GigabitEthernet0/0/1

192.168.6.0/30 is subnetted, 1 subnets

O IA 192.168.6.0 [110/5] via 192.168.4.1, 00:13:42, GigabitEthernet0/0/1

**R6**

172.1.0.0/32 is subnetted, 1 subnets

O IA 172.1.0.1 [110/2] via 192.168.6.2, 00:03:37, GigabitEthernet0/0/1

172.2.0.0/32 is subnetted, 1 subnets

O IA 172.2.0.1 [110/3] via 192.168.6.2, 00:03:37, GigabitEthernet0/0/1

172.4.0.0/32 is subnetted, 1 subnets

O IA 172.4.0.1 [110/5] via 192.168.6.2, 00:03:37, GigabitEthernet0/0/1

172.5.0.0/32 is subnetted, 1 subnets

O IA 172.5.0.1 [110/6] via 192.168.6.2, 00:03:37, GigabitEthernet0/0/1

172.6.0.0/16 is variably subnetted, 2 subnets, 2 masks

C 172.6.0.0/20 is directly connected, Loopback0

L 172.6.0.1/32 is directly connected, Loopback0

172.16.0.0/32 is subnetted, 1 subnets

O 172.16.0.1 [110/2] via 192.168.6.2, 00:03:37, GigabitEthernet0/0/1

172.30.0.0/32 is subnetted, 1 subnets

O IA 172.30.0.1 [110/4] via 192.168.6.2, 00:03:37, GigabitEthernet0/0/1

172.31.0.0/32 is subnetted, 1 subnets

O IA 172.31.0.1 [110/4] via 192.168.6.2, 00:03:37, GigabitEthernet0/0/1

192.168.1.0/30 is subnetted, 1 subnets

O IA 192.168.1.0 [110/2] via 192.168.6.2, 00:03:37, GigabitEthernet0/0/1

192.168.2.0/30 is subnetted, 1 subnets

O IA 192.168.2.0 [110/3] via 192.168.6.2, 00:03:37, GigabitEthernet0/0/1

192.168.3.0/30 is subnetted, 1 subnets

O IA 192.168.3.0 [110/4] via 192.168.6.2, 00:03:37, GigabitEthernet0/0/1

192.168.4.0/30 is subnetted, 1 subnets

O IA 192.168.4.0 [110/5] via 192.168.6.2, 00:03:37, GigabitEthernet0/0/1

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

C 192.168.6.0/30 is directly connected, GigabitEthernet0/0/1

L 192.168.6.1/32 is directly connected, GigabitEthernet0/0/1

Show IPv6 Routes:

IPv6 Routing Table - default - 16 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

**R1**

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

via GigabitEthernet0/0/0, directly connected

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

via GigabitEthernet0/0/0, receive

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

via FE80::267E:12FF:FE4D:F771, GigabitEthernet0/0/0

OI 10:3::/64 [110/3]

via FE80::267E:12FF:FE4D:F771, GigabitEthernet0/0/0

OI 10:4::/64 [110/4]

via FE80::267E:12FF:FE4D:F771, GigabitEthernet0/0/0

C 10:6::/64 [0/0]

via GigabitEthernet0/0/1, directly connected

L 10:6::2/128 [0/0]

via GigabitEthernet0/0/1, receive

C 17:1::/64 [0/0]

via Loopback0, directly connected

L 17:1::1/128 [0/0]

via Loopback0, receive

O 17:2::/64 [110/2]

via FE80::267E:12FF:FE4D:F771, GigabitEthernet0/0/0

OI 17:4::/64 [110/4]

via FE80::267E:12FF:FE4D:F771, GigabitEthernet0/0/0

OI 17:5::/64 [110/5]

via FE80::267E:12FF:FE4D:F771, GigabitEthernet0/0/0

O 17:6::/64 [110/2]

via FE80::521C:B0FF:FE42:E971, GigabitEthernet0/0/1

C 17:16::/64 [0/0]

via Loopback1, directly connected

L 17:16::1/128 [0/0]

via Loopback1, receive

O 17:30::/64 [110/3]

via FE80::267E:12FF:FE4D:F771, GigabitEthernet0/0/0

OI 172:31::/64 [110/3]

via FE80::267E:12FF:FE4D:F771, GigabitEthernet0/0/0

L FF00::/8 [0/0]

via Null0, receive

**R2**

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

via GigabitEthernet0/0/1, directly connected

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

via GigabitEthernet0/0/1, receive

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

via GigabitEthernet0/0/0, directly connected

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

via GigabitEthernet0/0/0, receive

OI 10:3::/64 [110/2]

via FE80::227:90FF:FED5:FAD1, GigabitEthernet0/0/0

OI 10:4::/64 [110/3]

via FE80::227:90FF:FED5:FAD1, GigabitEthernet0/0/0

OI 10:6::/64 [110/2]

via FE80::267E:12FF:FE4D:F6E0, GigabitEthernet0/0/1

O 17:1::/64 [110/2]

via FE80::267E:12FF:FE4D:F6E0, GigabitEthernet0/0/1

C 17:2::/64 [0/0]

via Loopback0, directly connected

L 17:2::1/128 [0/0]

via Loopback0, receive

OI 17:4::/64 [110/3]

via FE80::227:90FF:FED5:FAD1, GigabitEthernet0/0/0

OI 17:5::/64 [110/4]

via FE80::227:90FF:FED5:FAD1, GigabitEthernet0/0/0

OI 17:6::/64 [110/3]

via FE80::267E:12FF:FE4D:F6E0, GigabitEthernet0/0/1

OI 17:16::/64 [110/2]

via FE80::267E:12FF:FE4D:F6E0, GigabitEthernet0/0/1

O 17:30::/64 [110/2]

via FE80::227:90FF:FED5:FAD1, GigabitEthernet0/0/0

OI 172:31::/64 [110/2]

via FE80::227:90FF:FED5:FAD1, GigabitEthernet0/0/0

L FF00::/8 [0/0]

via Null0, receive

**R3**

O 10:1::/64 [110/2]

via FE80::267E:12FF:FE4D:F770, GigabitEthernet0/0/1

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

via GigabitEthernet0/0/1, directly connected

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

via GigabitEthernet0/0/1, receive

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

via GigabitEthernet0/0/0, directly connected

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

via GigabitEthernet0/0/0, receive

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

via FE80::B6A8:B9FF:FE01:B991, GigabitEthernet0/0/0

OI 10:6::/64 [110/3]

via FE80::267E:12FF:FE4D:F770, GigabitEthernet0/0/1

O 17:1::/64 [110/3]

via FE80::267E:12FF:FE4D:F770, GigabitEthernet0/0/1

O 17:2::/64 [110/2]

via FE80::267E:12FF:FE4D:F770, GigabitEthernet0/0/1

O 17:4::/64 [110/2]

via FE80::B6A8:B9FF:FE01:B991, GigabitEthernet0/0/0

O 17:5::/64 [110/3]

via FE80::B6A8:B9FF:FE01:B991, GigabitEthernet0/0/0

OI 17:6::/64 [110/4]

via FE80::267E:12FF:FE4D:F770, GigabitEthernet0/0/1

OI 17:16::/64 [110/3]

via FE80::267E:12FF:FE4D:F770, GigabitEthernet0/0/1

C 17:30::/64 [0/0]

via Loopback0, directly connected

L 17:30::1/128 [0/0]

via Loopback0, receive

C 172:31::/64 [0/0]

via Loopback1, directly connected

L 172:31::1/128 [0/0]

via Loopback1, receive

L FF00::/8 [0/0]

via Null0, receive

**R4**

OI 10:1::/64 [110/3]

via FE80::227:90FF:FED5:FAD0, GigabitEthernet0/0/1

OI 10:2::/64 [110/2]

via FE80::227:90FF:FED5:FAD0, GigabitEthernet0/0/1

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

via GigabitEthernet0/0/1, directly connected

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

via GigabitEthernet0/0/1, receive

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

via GigabitEthernet0/0/0, directly connected

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

via GigabitEthernet0/0/0, receive

OI 10:6::/64 [110/4]

via FE80::227:90FF:FED5:FAD0, GigabitEthernet0/0/1

OI 17:1::/64 [110/4]

via FE80::227:90FF:FED5:FAD0, GigabitEthernet0/0/1

OI 17:2::/64 [110/3]

via FE80::227:90FF:FED5:FAD0, GigabitEthernet0/0/1

C 17:4::/64 [0/0]

via Loopback0, directly connected

L 17:4::1/128 [0/0]

via Loopback0, receive

O 17:5::/64 [110/2]

via FE80::CE7F:76FF:FECE:9BF1, GigabitEthernet0/0/0

OI 17:6::/64 [110/5]

via FE80::227:90FF:FED5:FAD0, GigabitEthernet0/0/1

OI 17:16::/64 [110/4]

via FE80::227:90FF:FED5:FAD0, GigabitEthernet0/0/1

OI 17:30::/64 [110/2]

via FE80::227:90FF:FED5:FAD0, GigabitEthernet0/0/1

O 172:31::/64 [110/2]

via FE80::227:90FF:FED5:FAD0, GigabitEthernet0/0/1

L FF00::/8 [0/0]

via Null0, receive

**R5**

OI 10:1::/64 [110/4]

via FE80::B6A8:B9FF:FE01:B990, GigabitEthernet0/0/1

OI 10:2::/64 [110/3]

via FE80::B6A8:B9FF:FE01:B990, GigabitEthernet0/0/1

O 10:3::/64 [110/2]

via FE80::B6A8:B9FF:FE01:B990, GigabitEthernet0/0/1

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

via GigabitEthernet0/0/1, directly connected

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

via GigabitEthernet0/0/1, receive

OI 10:6::/64 [110/5]

via FE80::B6A8:B9FF:FE01:B990, GigabitEthernet0/0/1

OI 17:1::/64 [110/5]

via FE80::B6A8:B9FF:FE01:B990, GigabitEthernet0/0/1

OI 17:2::/64 [110/4]

via FE80::B6A8:B9FF:FE01:B990, GigabitEthernet0/0/1

O 17:4::/64 [110/2]

via FE80::B6A8:B9FF:FE01:B990, GigabitEthernet0/0/1

C 17:5::/64 [0/0]

via Loopback0, directly connected

L 17:5::1/128 [0/0]

via Loopback0, receive

OI 17:6::/64 [110/6]

via FE80::B6A8:B9FF:FE01:B990, GigabitEthernet0/0/1

OI 17:16::/64 [110/5]

via FE80::B6A8:B9FF:FE01:B990, GigabitEthernet0/0/1

OI 17:30::/64 [110/3]

via FE80::B6A8:B9FF:FE01:B990, GigabitEthernet0/0/1

O 172:31::/64 [110/3]

via FE80::B6A8:B9FF:FE01:B990, GigabitEthernet0/0/1

L FF00::/8 [0/0]

via Null0, receive

**R6**

OI 10:1::/64 [110/2]

via FE80::267E:12FF:FE4D:F6E1, GigabitEthernet0/0/1

OI 10:2::/64 [110/3]

via FE80::267E:12FF:FE4D:F6E1, GigabitEthernet0/0/1

OI 10:3::/64 [110/4]

via FE80::267E:12FF:FE4D:F6E1, GigabitEthernet0/0/1

OI 10:4::/64 [110/5]

via FE80::267E:12FF:FE4D:F6E1, GigabitEthernet0/0/1

C 10:6::/64 [0/0]

via GigabitEthernet0/0/1, directly connected

L 10:6::1/128 [0/0]

via GigabitEthernet0/0/1, receive

OI 17:1::/64 [110/2]

via FE80::267E:12FF:FE4D:F6E1, GigabitEthernet0/0/1

OI 17:2::/64 [110/3]

via FE80::267E:12FF:FE4D:F6E1, GigabitEthernet0/0/1

OI 17:4::/64 [110/5]

via FE80::267E:12FF:FE4D:F6E1, GigabitEthernet0/0/1

OI 17:5::/64 [110/6]

via FE80::267E:12FF:FE4D:F6E1, GigabitEthernet0/0/1

C 17:6::/64 [0/0]

via Loopback0, directly connected

L 17:6::1/128 [0/0]

via Loopback0, receive

O 17:16::/64 [110/2]

via FE80::267E:12FF:FE4D:F6E1, GigabitEthernet0/0/1

OI 17:30::/64 [110/4]

via FE80::267E:12FF:FE4D:F6E1, GigabitEthernet0/0/1

OI 172:31::/64 [110/4]

via FE80::267E:12FF:FE4D:F6E1, GigabitEthernet0/0/1

L FF00::/8 [0/0]

via Null0, receive

Verification Commands – Pings from Edge to Edge of Topology:

**R5 Pings**

R5#ping 172.6.0.1

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 172.6.0.1, timeout is 2 seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 0/0/0 ms

R5#ping 17:6::1

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 17:6::1, timeout is 2 seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 0/0/0 ms

R5#ping 192.168.6.1

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 192.168.6.1, timeout is 2 seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 0/0/3 ms

R5#ping 10:6::1

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 10:6::1, timeout is 2 seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 0/0/1 ms

**R6 Pings**

R6#ping 172.6.0.1

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 172.6.0.1, timeout is 2 seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 0/2/5 ms

R6#ping 17:5::1

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 17:5::1, timeout is 2 seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 0/0/1 ms

R6#ping 192.168.4.2

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 192.168.4.2, timeout is 2 seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 0/0/0 ms

R6#ping 10:4::2

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 10:4::2, timeout is 2 seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 0/0/1 ms

Verification Commands – Show Commands:

**R1**

**R1#show ipv6 ospf int g0/0/0**

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

Link Local Address FE80::267E:12FF:FE4D:F6E0, Interface ID 6

Area 0, Process ID 10, Instance ID 0, Router ID 1.1.1.1

Network Type POINT\_TO\_POINT, Cost: 1

Transmit Delay is 1 sec, State POINT\_TO\_POINT

Timer intervals configured, Hello 15, Dead 60, Wait 60, Retransmit 5

Hello due in 00:00:09

Graceful restart helper support enabled

Index 1/2/3, flood queue length 0

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

Last flood scan length is 1, maximum is 4

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

Neighbor Count is 1, Adjacent neighbor count is 1

Adjacent with neighbor 2.2.2.2

Suppress hello for 0 neighbor(s)

**R1#show ipv6 ospf int g0/0/1**

GigabitEthernet0/0/1 is up, line protocol is up

Link Local Address FE80::267E:12FF:FE4D:F6E1, Interface ID 7

Area 2, Process ID 10, Instance ID 0, Router ID 1.1.1.1

Network Type POINT\_TO\_POINT, Cost: 1

Transmit Delay is 1 sec, State POINT\_TO\_POINT

Timer intervals configured, Hello 15, Dead 60, Wait 60, Retransmit 5

Hello due in 00:00:10

Graceful restart helper support enabled

Index 1/2/4, flood queue length 0

Next 0x0(0)/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 6.6.6.6

Suppress hello for 0 neighbor(s)

**R1#show ipv6 ospf**

Routing Process "ospfv3 10" with ID 1.1.1.1

Supports NSSA (compatible with RFC 3101)

Supports Database Exchange Summary List Optimization (RFC 5243)

Event-log enabled, Maximum number of events: 1000, Mode: cyclic

It is an area border router

Router is not originating router-LSAs with maximum metric

Initial SPF schedule delay 5000 msecs

Minimum hold time between two consecutive SPFs 10000 msecs

Maximum wait time between two consecutive SPFs 10000 msecs

Minimum LSA interval 5 secs

Minimum LSA arrival 1000 msecs

LSA group pacing timer 240 secs

Interface flood pacing timer 33 msecs

Retransmission pacing timer 66 msecs

Retransmission limit dc 24 non-dc 24

EXCHANGE/LOADING adjacency limit: initial 300, process maximum 300

Number of external LSA 0. Checksum Sum 0x000000

Number of areas in this router is 2. 2 normal 0 stub 0 nssa

Graceful restart helper support enabled

Reference bandwidth unit is 100 mbps

RFC1583 compatibility enabled

Area BACKBONE(0)

Number of interfaces in this area is 2

SPF algorithm executed 7 times

Number of LSA 17. Checksum Sum 0x077153

Number of DCbitless LSA 0

Number of indication LSA 0

Number of DoNotAge LSA 0

Flood list length 0

Area 2

Number of interfaces in this area is 2

SPF algorithm executed 6 times

Number of LSA 17. Checksum Sum 0x09794E

Number of DCbitless LSA 0

Number of indication LSA 0

Number of DoNotAge LSA 0

Flood list length 0

**R1#show ospfv3 10 ipv6 border-routers**

OSPFv3 10 address-family ipv6 (router-id 1.1.1.1)

Codes: i - Intra-area route, I - Inter-area route

i 3.3.3.3 [2] via FE80::267E:12FF:FE4D:F771, GigabitEthernet0/0/0, ABR, Area 0, SPF 8

**R2**

**R2#show ipv6 ospf int g0/0/0**

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

Link Local Address FE80::267E:12FF:FE4D:F770, Interface ID 6

Area 0, Process ID 10, Instance ID 0, Router ID 2.2.2.2

Network Type POINT\_TO\_POINT, Cost: 1

Transmit Delay is 1 sec, State POINT\_TO\_POINT

Timer intervals configured, Hello 15, Dead 60, Wait 60, Retransmit 5

Hello due in 00:00:03

Graceful restart helper support enabled

Index 1/2/2, flood queue length 0

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

Last flood scan length is 2, maximum is 3

Last flood scan time is 0 msec, maximum is 1 msec

Neighbor Count is 1, Adjacent neighbor count is 1

Adjacent with neighbor 3.3.3.3

Suppress hello for 0 neighbor(s)

**R2#show ipv6 ospf int g0/0/1**

GigabitEthernet0/0/1 is up, line protocol is up

Link Local Address FE80::267E:12FF:FE4D:F771, Interface ID 7

Area 0, Process ID 10, Instance ID 0, Router ID 2.2.2.2

Network Type POINT\_TO\_POINT, Cost: 1

Transmit Delay is 1 sec, State POINT\_TO\_POINT

Timer intervals configured, Hello 15, Dead 60, Wait 60, Retransmit 5

Hello due in 00:00:02

Graceful restart helper support enabled

Index 1/3/3, flood queue length 0

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

Last flood scan length is 2, maximum is 4

Last flood scan time is 0 msec, maximum is 1 msec

Neighbor Count is 1, Adjacent neighbor count is 1

Adjacent with neighbor 1.1.1.1

Suppress hello for 0 neighbor(s)

**R2#show ipv6 ospf**

Routing Process "ospfv3 10" with ID 2.2.2.2

Supports NSSA (compatible with RFC 3101)

Supports Database Exchange Summary List Optimization (RFC 5243)

Event-log enabled, Maximum number of events: 1000, Mode: cyclic

Router is not originating router-LSAs with maximum metric

Initial SPF schedule delay 5000 msecs

Minimum hold time between two consecutive SPFs 10000 msecs

Maximum wait time between two consecutive SPFs 10000 msecs

Minimum LSA interval 5 secs

Minimum LSA arrival 1000 msecs

LSA group pacing timer 240 secs

Interface flood pacing timer 33 msecs

Retransmission pacing timer 66 msecs

Retransmission limit dc 24 non-dc 24

EXCHANGE/LOADING adjacency limit: initial 300, process maximum 300

Number of external LSA 0. Checksum Sum 0x000000

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

Graceful restart helper support enabled

Reference bandwidth unit is 100 mbps

RFC1583 compatibility enabled

Area BACKBONE(0)

Number of interfaces in this area is 3

SPF algorithm executed 7 times

Number of LSA 19. Checksum Sum 0x080C98

Number of DCbitless LSA 0

Number of indication LSA 0

Number of DoNotAge LSA 0

Flood list length 0

**R2#show ospfv3 10 ipv6 border-routers**

OSPFv3 10 address-family ipv6 (router-id 2.2.2.2)

Codes: i - Intra-area route, I - Inter-area route

i 1.1.1.1 [1] via FE80::267E:12FF:FE4D:F6E0, GigabitEthernet0/0/1, ABR, Area 0, SPF 10

i 3.3.3.3 [1] via FE80::227:90FF:FED5:FAD1, GigabitEthernet0/0/0, ABR, Area 0, SPF 10

**R3**

**R3#show ipv6 ospf int g0/0/0**

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

Link Local Address FE80::227:90FF:FED5:FAD0, Interface ID 6

Area 1, Process ID 10, Instance ID 0, Router ID 3.3.3.3

Network Type POINT\_TO\_POINT, Cost: 1

Transmit Delay is 1 sec, State POINT\_TO\_POINT

Timer intervals configured, Hello 15, Dead 60, Wait 60, Retransmit 5

Hello due in 00:00:01

Graceful restart helper support enabled

Index 1/2/3, flood queue length 0

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

Last flood scan length is 5, maximum is 5

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

Neighbor Count is 1, Adjacent neighbor count is 1

Adjacent with neighbor 4.4.4.4

Suppress hello for 0 neighbor(s)

**R3#show ipv6 ospf int g0/0/1**

GigabitEthernet0/0/1 is up, line protocol is up

Link Local Address FE80::227:90FF:FED5:FAD1, Interface ID 7

Area 0, Process ID 10, Instance ID 0, Router ID 3.3.3.3

Network Type POINT\_TO\_POINT, Cost: 1

Transmit Delay is 1 sec, State POINT\_TO\_POINT

Timer intervals configured, Hello 15, Dead 60, Wait 60, Retransmit 5

Hello due in 00:00:06

Graceful restart helper support enabled

Index 1/2/4, flood queue length 0

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

Last flood scan length is 5, maximum is 5

Last flood scan time is 0 msec, maximum is 1 msec

Neighbor Count is 1, Adjacent neighbor count is 1

Adjacent with neighbor 2.2.2.2

Suppress hello for 0 neighbor(s)

**R3#show ipv6 ospf**

Routing Process "ospfv3 10" with ID 3.3.3.3

Supports NSSA (compatible with RFC 3101)

Supports Database Exchange Summary List Optimization (RFC 5243)

Event-log enabled, Maximum number of events: 1000, Mode: cyclic

It is an area border router

Router is not originating router-LSAs with maximum metric

Initial SPF schedule delay 5000 msecs

Minimum hold time between two consecutive SPFs 10000 msecs

Maximum wait time between two consecutive SPFs 10000 msecs

Minimum LSA interval 5 secs

Minimum LSA arrival 1000 msecs

LSA group pacing timer 240 secs

Interface flood pacing timer 33 msecs

Retransmission pacing timer 66 msecs

Retransmission limit dc 24 non-dc 24

EXCHANGE/LOADING adjacency limit: initial 300, process maximum 300

Number of external LSA 0. Checksum Sum 0x000000

Number of areas in this router is 2. 2 normal 0 stub 0 nssa

Graceful restart helper support enabled

Reference bandwidth unit is 100 mbps

RFC1583 compatibility enabled

Area BACKBONE(0)

Number of interfaces in this area is 2

SPF algorithm executed 8 times

Number of LSA 17. Checksum Sum 0x074E2C

Number of DCbitless LSA 0

Number of indication LSA 0

Number of DoNotAge LSA 0

Flood list length 0

Area 1

Number of interfaces in this area is 2

SPF algorithm executed 7 times

Number of LSA 17. Checksum Sum 0x0B9CAC

Number of DCbitless LSA 0

Number of indication LSA 0

Number of DoNotAge LSA 0

Flood list length 0

**R3#show ospfv3 10 ipv6 border-routers**

OSPFv3 10 address-family ipv6 (router-id 3.3.3.3)

Codes: i - Intra-area route, I - Inter-area route

i 1.1.1.1 [2] via FE80::267E:12FF:FE4D:F770, GigabitEthernet0/0/1, ABR, Area 0, SPF 11

**R4**

**R4#show ipv6 ospf interface g0/0/0**

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

Link Local Address FE80::B6A8:B9FF:FE01:B990, Interface ID 6

Area 1, Process ID 10, Instance ID 0, Router ID 4.4.4.4

Network Type POINT\_TO\_POINT, Cost: 1

Transmit Delay is 1 sec, State POINT\_TO\_POINT

Timer intervals configured, Hello 15, Dead 60, Wait 60, Retransmit 5

Hello due in 00:00:00

Graceful restart helper support enabled

Index 1/2/2, flood queue length 0

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

Last flood scan length is 4, maximum is 5

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

Neighbor Count is 1, Adjacent neighbor count is 1

Adjacent with neighbor 5.5.5.5

Suppress hello for 0 neighbor(s)

**R4#show ipv6 ospf interface g0/0/1**

GigabitEthernet0/0/1 is up, line protocol is up

Link Local Address FE80::B6A8:B9FF:FE01:B991, Interface ID 7

Area 1, Process ID 10, Instance ID 0, Router ID 4.4.4.4

Network Type POINT\_TO\_POINT, Cost: 1

Transmit Delay is 1 sec, State POINT\_TO\_POINT

Timer intervals configured, Hello 15, Dead 60, Wait 60, Retransmit 5

Hello due in 00:00:05

Graceful restart helper support enabled

Index 1/3/3, flood queue length 0

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

Last flood scan length is 2, maximum is 2

Last flood scan time is 0 msec, maximum is 1 msec

Neighbor Count is 1, Adjacent neighbor count is 1

Adjacent with neighbor 3.3.3.3

Suppress hello for 0 neighbor(s)

**R4#show ipv6 ospf**

Routing Process "ospfv3 10" with ID 4.4.4.4

Supports NSSA (compatible with RFC 3101)

Supports Database Exchange Summary List Optimization (RFC 5243)

Event-log enabled, Maximum number of events: 1000, Mode: cyclic

Router is not originating router-LSAs with maximum metric

Initial SPF schedule delay 5000 msecs

Minimum hold time between two consecutive SPFs 10000 msecs

Maximum wait time between two consecutive SPFs 10000 msecs

Minimum LSA interval 5 secs

Minimum LSA arrival 1000 msecs

LSA group pacing timer 240 secs

Interface flood pacing timer 33 msecs

Retransmission pacing timer 66 msecs

Retransmission limit dc 24 non-dc 24

EXCHANGE/LOADING adjacency limit: initial 300, process maximum 300

Number of external LSA 0. Checksum Sum 0x000000

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

Graceful restart helper support enabled

Reference bandwidth unit is 100 mbps

RFC1583 compatibility enabled

Area 1

Number of interfaces in this area is 3

SPF algorithm executed 5 times

Number of LSA 19. Checksum Sum 0x0C4429

Number of DCbitless LSA 0

Number of indication LSA 0

Number of DoNotAge LSA 0

Flood list length 0

**R4#show ospfv3 10 ipv6 border-routers**

OSPFv3 10 address-family ipv6 (router-id 4.4.4.4)

Codes: i - Intra-area route, I - Inter-area route

i 3.3.3.3 [1] via FE80::227:90FF:FED5:FAD0, GigabitEthernet0/0/1, ABR, Area 1, SPF 7

**R5**

**R5#show ipv6 ospf interface g0/0/1**

GigabitEthernet0/0/1 is up, line protocol is up

Link Local Address FE80::CE7F:76FF:FECE:9BF1, Interface ID 7

Area 1, Process ID 10, Instance ID 0, Router ID 5.5.5.5

Network Type POINT\_TO\_POINT, Cost: 1

Transmit Delay is 1 sec, State POINT\_TO\_POINT

Timer intervals configured, Hello 15, Dead 60, Wait 60, Retransmit 5

Hello due in 00:00:07

Graceful restart helper support enabled

Index 1/2/2, flood queue length 0

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

Last flood scan length is 3, maximum is 3

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

Neighbor Count is 1, Adjacent neighbor count is 1

Adjacent with neighbor 4.4.4.4

Suppress hello for 0 neighbor(s)

**R5#show ipv6 ospf**

Routing Process "ospfv3 10" with ID 5.5.5.5

Supports NSSA (compatible with RFC 3101)

Supports Database Exchange Summary List Optimization (RFC 5243)

Event-log enabled, Maximum number of events: 1000, Mode: cyclic

Router is not originating router-LSAs with maximum metric

Initial SPF schedule delay 50 msecs

Minimum hold time between two consecutive SPFs 200 msecs

Maximum wait time between two consecutive SPFs 5000 msecs

Initial LSA throttle delay 50 msecs

Minimum hold time for LSA throttle 200 msecs

Maximum wait time for LSA throttle 5000 msecs

Minimum LSA arrival 100 msecs

LSA group pacing timer 240 secs

Interface flood pacing timer 33 msecs

Retransmission pacing timer 66 msecs

Retransmission limit dc 24 non-dc 24

EXCHANGE/LOADING adjacency limit: initial 300, process maximum 300

Number of external LSA 0. Checksum Sum 0x000000

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

Graceful restart helper support enabled

Reference bandwidth unit is 100 mbps

RFC1583 compatibility enabled

Area 1

Number of interfaces in this area is 2

SPF algorithm executed 11 times

Number of LSA 17. Checksum Sum 0x0B72C7

Number of DCbitless LSA 0

Number of indication LSA 0

Number of DoNotAge LSA 0

Flood list length 0

**R5#show ospfv3 10 ipv6 border-routers**

OSPFv3 10 address-family ipv6 (router-id 5.5.5.5)

Codes: i - Intra-area route, I - Inter-area route

i 3.3.3.3 [2] via FE80::B6A8:B9FF:FE01:B990, GigabitEthernet0/0/1, ABR, Area 1, SPF 14

**R6**

**R6#show ipv6 ospf interface g0/0/1**

GigabitEthernet0/0/1 is up, line protocol is up

Link Local Address FE80::521C:B0FF:FE42:E971, Interface ID 7

Area 2, Process ID 10, Instance ID 0, Router ID 6.6.6.6

Network Type POINT\_TO\_POINT, Cost: 1

Transmit Delay is 1 sec, State POINT\_TO\_POINT

Timer intervals configured, Hello 15, Dead 60, Wait 60, Retransmit 5

Hello due in 00:00:02

Graceful restart helper support enabled

Index 1/2/2, flood queue length 0

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

Last flood scan length is 2, maximum is 2

Last flood scan time is 1 msec, maximum is 1 msec

Neighbor Count is 1, Adjacent neighbor count is 1

Adjacent with neighbor 1.1.1.1

Suppress hello for 0 neighbor(s)

**R6#show ipv6 ospf**

Routing Process "ospfv3 10" with ID 6.6.6.6

Supports NSSA (compatible with RFC 3101)

Supports Database Exchange Summary List Optimization (RFC 5243)

Event-log enabled, Maximum number of events: 1000, Mode: cyclic

Router is not originating router-LSAs with maximum metric

Initial SPF schedule delay 5000 msecs

Minimum hold time between two consecutive SPFs 10000 msecs

Maximum wait time between two consecutive SPFs 10000 msecs

Minimum LSA interval 5 secs

Minimum LSA arrival 1000 msecs

LSA group pacing timer 240 secs

Interface flood pacing timer 33 msecs

Retransmission pacing timer 66 msecs

Retransmission limit dc 24 non-dc 24

EXCHANGE/LOADING adjacency limit: initial 300, process maximum 300

Number of external LSA 0. Checksum Sum 0x000000

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

Graceful restart helper support enabled

Reference bandwidth unit is 100 mbps

RFC1583 compatibility enabled

Area 2

Number of interfaces in this area is 2

SPF algorithm executed 2 times

Number of LSA 17. Checksum Sum 0x0929BA

Number of DCbitless LSA 0

Number of indication LSA 0

Number of DoNotAge LSA 0

Flood list length 0

**R6#show ospfv3 10 ipv6 border-routers**

OSPFv3 10 address-family ipv6 (router-id 6.6.6.6)

Codes: i - Intra-area route, I - Inter-area route

i 1.1.1.1 [1] via FE80::267E:12FF:FE4D:F6E1, GigabitEthernet0/0/1, ABR, Area 2, SPF 2

**Problems**

This was the first lab in which I worked with a partner. His name was Aidan Garner. We had to learn to communicate clearly to make efficient use of sharing the same rack of routers. Many drawings and notes were taken in the process of working together.

Albeit, we still had communication and dependency errors. For example, the naming of the topology and IP networks were inconsistent, seen in the naming of the ABRs’ loopback interfaces. Also, R6 was unevenly added onto the bus topology. However, having a partner increased configuration speed and consistency.

In terms of the network, the first problem arose when entering the router configuration mode. Both commands, “IPv6 router [*process-id*]” and “router ospfv3 [*process-id*]” seem to enter IPv6 router configuration mode, but after some research we decided to use the ospfv3 command for best practice. We learned there were no disadvantages to this command, and it also paralleled the ospfv2 router configuration command for visual organization.

Another problem occurred during the adjustments to the hello/dead interval timers. We did not know that inconsistent timers in a network would cause link-state relationships to shut down. This was resolved by changing the timers on every physical interface of the routers to match 15 and 60 second hello and dead intervals, respectively.

**Conclusion**

As the first lab to intertwine IPv4 and IPv6 addressing, this lab reinforced the importance of organized labelling and topology drafts to minimize improvisation and errors throughout the configuration process. This problem was emphasized by the necessity of fluent communication with my partner. That is something I will definitely focus on and improve on in future labs. OSPFv3 with multiple areas was a educational challenge that helped me learn a lot about the aspects of OSPF.