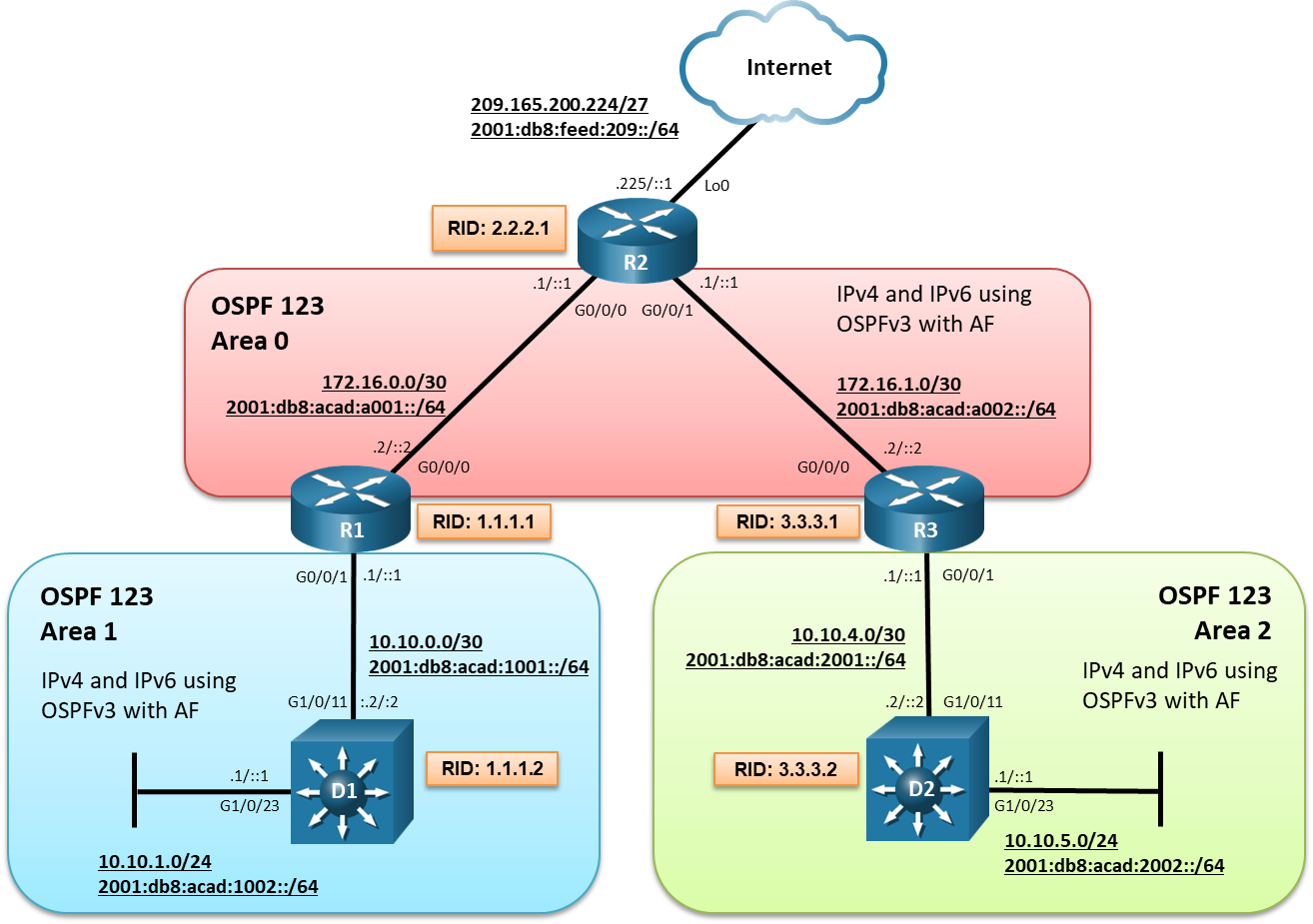
Lab - Implement Multiarea OSPFv3

# Topology



# Addressing Table

| Device | Interface | IPv4 Address | IPv6 Address | IPv6 Link-Local |
| --- | --- | --- | --- | --- |
| R1 | G0/0/0 | 172.16.0.2/30 | 2001:db8:acad:a001::2/64 | fe80::1:2 |
| R1 | G0/0/1 | 10.10.0.1/30 | 2001:db8:acad:1001::1/64 | fe80::1:1 |
| R2 | Lo0 | 209.165.200.225/27 | 2001:db8:feed:209::1/64 | fe80::2:3 |
| R2 | G0/0/0 | 172.16.0.1/30 | 2001:db8:acad:a001::1/64 | fe80::2:1 |
| R2 | G0/0/1 | 172.16.1.1/30 | 2001:db8:acad:a002::1/64 | fe80::2:2 |
| R3 | G0/0/0 | 172.16.1.2/30 | 2001:db8:acad:a002::2/64 | fe80::3:2 |
| R3 | G0/0/1 | 10.10.4.1/30 | 2001:db8:acad:2001::1/64 | fe80::3:1 |
| D1 | G1/0/11 | 10.10.0.2/30 | 2001:db8:acad:1001::2/64 | fe80::d1:2 |
| D1 | G1/0/23 | 10.10.1.0/24 | 2001:db8:acad:1002::1/64 | fe80::d1:1 |
| D2 | G1/0/11 | 10.10.4.2/30 | 2001:db8:acad:2001::2/64 | fe80::d2:2 |
| D2 | G1/0/23 | 10.10.5.1/24 | 2001:db8:acad:2002::1/64 | fe80::d2:1 |

# Objectives

Part 1: Build the Topology and Configure Basic Device Settings and IP Addressing

Part 2: Configure Traditional OSPFv3 for IPv6 on D1

Part 3: Configure OSPFv3 for Address Families (AF) IPv4 and AF IPv6

Part 4: Verify OSPFv3 AF

Part 5: Tune OSPFv3 AF

# Background / Scenario

In this lab, you will configure the network with multiarea OSPFv3 routing using the AF feature for both IPv4 and IPv6 in OSPF areas 0, 1 and 2. This lab was specifically designed to use three routers and two Layer 3 switches that support OSPFv3 using AF.

It should be noted that OSPFv3 runs on top of IPv6 and uses IPv6 link local addresses for OSPFv3 control packets. Therefore, it is required that IPv6 be enabled on an OSPFv3 link, although the link may not be participating in any IPv6 AFs. Additionally, OSPFv3 AF for IPv4 unicast is not backwards compatible with OSPFv2.

**Note**: The routers used with CCNP hands-on labs are Cisco 4221 with Cisco IOS XE Release 16.9.4 (universalk9 image). Other routers and Cisco IOS versions can be used. Depending on the model and Cisco IOS version, the commands available and the output produced might vary from what is shown in the labs.

**Note**: The switches used with CCNP hands-on labs are Cisco Catalyst 3650s with Cisco IOS XE Release 16.9.4 (universalk9 image). Other switches and Cisco IOS versions can be used. Depending on the model and Cisco IOS version, the commands available and output produced might vary from what is shown in the labs.

**Note**: Ensure that the routers and switches have been erased and have no startup configurations. If you are unsure contact your instructor.

# Required Resources

* 3 Routers (Cisco 4221 with Cisco IOS XE Release 16.9.4 universal image or comparable)
* 2 Switches (Cisco 3650 with Cisco IOS XE Release 16.9.4 universal image or comparable)
* Console cables to configure the Cisco IOS devices via the console ports
* Ethernet cables as shown in the topology

# Instructions

## Build the Network and Configure Basic Device Settings and Interface Addressing

In Part 1, you will set up the network topology and configure basic settings and interface addressing on routers and switches.

### Cable the network as shown in the topology.

Attach the devices as shown in the topology diagram, and cable as necessary.

### Configure basic settings for each router.

* + - 1. Console into each device, enter global configuration mode, and apply the basic settings and interface addressing using the following startup configurations for each device.

Open configuration window

Router R1

hostname R1

no ip domain lookup

line con 0

logging sync

exec-time 0 0

exit

interface g0/0/0

ip add 172.16.0.2 255.255.255.252

ipv6 add 2001:db8:acad:a001::2/64

ipv6 add fe80::1:2 link-local

no shut

exit

interface GigabitEthernet0/0/1

ipv6 add 2001:db8:acad:1001::1/64

ipv6 add fe80::1:1 link-local

no shut

exit

Router R2

hostname R2

no ip domain lookup

line con 0

logging sync

exec-time 0 0

exit

interface g0/0/0

ip add 172.16.0.1 255.255.255.252

ipv6 add 2001:db8:acad:a001::1/64

ipv6 add fe80::2:1 link-local

no shut

exit

interface GigabitEthernet0/0/1

ip address 172.16.1.1 255.255.255.252

ipv6 add 2001:db8:acad:a002::1/64

ipv6 add fe80::2:2 link-local

no shut

exit

int lo0

ip add 209.165.200.225 255.255.255.224

ipv6 add 2001:db8:feed:209::1/64

ipv6 add fe80::2:3 link-local

exit

Router R3

hostname R3

no ip domain lookup

line con 0

logging sync

exec-time 0 0

exit

interface g0/0/0

ip add 172.16.1.2 255.255.255.252

ipv6 add 2001:db8:acad:a002::2/64

ipv6 add fe80::3:2 link-local

no shut

exit

interface GigabitEthernet0/0/1

ip address 10.10.4.1 255.255.255.252

ipv6 add 2001:db8:acad:2001::1/64

ipv6 add fe80::3:1 link-local

no shut

exit

Switch D1

hostname D1

no ip domain lookup

line con 0

exec-timeout 0 0

logging synchronous

exit

interface g1/0/11

no switchport

ipv6 add 2001:db8:acad:1001::2/64

ipv6 add fe80::d1:2 link-local

no shutdown

exit

interface g1/0/23

no switchport

ipv6 add 2001:db8:acad:1002::1/64

ipv6 add fe80::d1:1 link-local

no shutdown

exit

Switch D2

host D2

no ip domain lookup

line con 0

logging sync

exec-time 0 0

exit

interface gi1/0/11

no switchport

ip address 10.10.4.2 255.255.255.252

ipv6 add 2001:db8:acad:2001::2/64

ipv6 add fe80::d2:2 link-local

no shut

exit

interface gi1/0/23

no switchport

ip address 10.10.5.1 255.255.255.0

ipv6 add 2001:db8:acad:2002::1/64

ipv6 add fe80::d2:1 link-local

no shut

exit

* + - 1. Save the running configuration to startup-config.

Close configuration window

## Configure Traditional OSPFv3 for IPv6 on D1

### Configure traditional OSPFv3 on D1.

Traditional OSPFv3 implements OSPF routing for IPv6. In this part of the lab, you will configure traditional OSPFv3 for routing IPv6 on D1, which is in the IPv6-only area.

* + - 1. OSPFv3 messages are sourced from the router’s IPv6 link-local address. Earlier in this lab, IPv6 GUA and link-local addresses were statically configured on each router’s interface. The link-local addresses were statically configured to make these addresses more recognizable than being automatically created using EUI-64. Issue the **show ipv6 interface brief** command to verify the GUA and link-local addresses on the router’s interfaces.

Open configuration window

D1# **show ipv6 interface brief**

<output omitted>

GigabitEthernet1/0/11 [up/up]

FE80::D1:2

2001:DB8:ACAD:1001::2

<output omitted>

GigabitEthernet1/0/23 [up/up]

FE80::D1:1

2001:DB8:ACAD:1002::1

<output omitted>

* + - 1. IPv6 routing is disabled by default. Enable IPv6 routing using the **ipv6 unicast-routing** command in global configuration mode.

D1(config)# **ipv6 unicast-routing**

* + - 1. Most Cisco IOS versions have IPv6 CEF enabled by default when IPv6 routing is enabled. Use the **show ipv6 cef** command to verify whether IPv6 CEF is enabled. If you need to enable IPv6 CEF, use the **ipv6 cef** command. If IPv6 CEF is disabled you will see the an IOS message similar to “%IPv6 CEF not running".

D1# **show ipv6 cef**

::/0

no route

::/127

discard

2001:DB8:ACAD:1001::/64

attached to GigabitEthernet1/0/11

2001:DB8:ACAD:1001::2/128

receive for GigabitEthernet1/0/11

2001:DB8:ACAD:1002::/64

attached to GigabitEthernet1/0/23

2001:DB8:ACAD:1002::1/128

receive for GigabitEthernet1/0/23

FE80::/10

receive for Null0

FF00::/8

multicast

FF02::/16

receive

* + - 1. Configure the OSPFv3 process on D1. Similar to OSPFv2, the process ID does not have to match other routers to form neighbor adjacencies, although that is considered best practice. Configure the 32-bit OSPFv3 router ID on each router. Enable OSPFv3 directly on the interfaces using the interface **ipv6** **ospf** *pid* **area** *area* command**.**

D1(config)# **ipv6 unicast-routing**

D1(config)# **ipv6 router ospf 123**

D1(config-rtr)# **router-id 1.1.1.2**

D1(config-rtr)# **exit**

D1(config)# **interface g1/0/11**

D1(config-if)# **ipv6 ospf 123 area 1**

D1(config-if)# **exit**

D1(config)# **interface g1/0/23**

D1(config-if)# **ipv6 ospf 123 area 1**

D1(config-if)# **exit**

* + - 1. The **show ipv6 ospf** command can be used to verify the OSPF router ID. If the OSPFv3 router ID is uses a 32-bit value other than the one specified by the **router-id** command, you can reset the router ID by using the **clear ipv6 ospf** *pid* **process** command and re-verify using the command **show ipv6 ospf**.

D1# **show ipv6 ospf**

Routing Process "ospfv3 123" with ID 1.1.1.2

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 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 5 times

Number of LSA 12. Checksum Sum 0x0486C1

Number of DCbitless LSA 0

Number of indication LSA 0

Number of DoNotAge LSA 0

Flood list length 0

* + - 1. The **show ipv6 protocols** command can be used to verify general OSPFv3 information such as areas and enabled interfaces.

D1# **show ipv6 protocols**

IPv6 Routing Protocol is "connected"

IPv6 Routing Protocol is "ND"

IPv6 Routing Protocol is "ospf 123"

Router ID 1.1.1.2

Number of areas: 1 normal, 0 stub, 0 nssa

Interfaces (Area 1):

GigabitEthernet1/0/23

GigabitEthernet1/0/11

Redistribution:

None

Close configuration window

## Configure OSPFv3 for AF IPv4 and AF IPv6

OSPFv3 with the address family (AF) unifies OSPF configuration for both IPv4 and IPv6. Each OSPFv3 AF is a single process, so you may have two processes per interface, but only one process per AF. OSPFv3 messages are sent over IPv6 which requires that IPv6 routing is enabled and that the interface has a link-local IPv6 address. This is the requirement even if only the IPv4 AF is configured.

In this section you will configure OSPFv3 with AF for the IPv4 and IPv6 address families on R1, R2, R3, D1 and D2.

### Configure OSPFv3 with AF on R1.

* + - 1. After enabling IPv6 unicast routing, configure OSPFv3 with AF on R1 using the **router ospfv3** *pid* command. Use the **?** to see the address families available.

Open configuration window

R1(config)# **ipv6 unicast-routing**

R1(config)# **router ospfv3 123**

R1(config-router)# **address-family ?**

ipv4 Address family

ipv6 Address family

* + - 1. Next, specify the AF for IPv4 and use the **?** to see the available options.

R1(config-router)# **address-family ipv4 ?**

unicast Address Family modifier

vrf Specify parameters for a VPN Routing/Forwarding instance

<cr>

* + - 1. Enter the AF for IPv4 unicast using the command **address-family ipv4 unicast**. Use the **?** to examine the options in AF configuration mode. Some of the more common configuration commands are highlighted. Use the **router-id** command to configure the router ID for the IPv4 AF.

R1(config-router)# **address-family ipv4 unicast**

R1(config-router-af)# **?**

Router Address Family configuration commands:

adjacency Control adjacency formation

area OSPF area parameters

authentication Authentication parameters

auto-cost Calculate OSPF interface cost according to bandwidth

auto-cost-determination Calculate OSPF interface cost according to bandwidth

bfd BFD configuration commands

compatible Compatibility list

default Set a command to its defaults

default-information Control distribution of default information

default-metric Set metric of redistributed routes

discard-route Enable or disable discard-route installation

distance Define an administrative distance

distribute-list Filter networks in routing updates

event-log Event Logging

exit-address-family Exit from Address Family configuration mode

graceful-restart Graceful-restart options

help Description of the interactive help system

ignore Do not complain about specific event

interface-id Source of the interface ID

limit Limit a specific OSPF feature

local-rib-criteria Enable or disable usage of local RIB as route

criteria

log-adjacency-changes Log changes in adjacency state

manet Specify MANET OSPF parameters

max-lsa Maximum number of non self-generated LSAs to accept

max-metric Set maximum metric

maximum-paths Forward packets over multiple paths

mpls MPLS Traffic Engineering configs

no Negate a command or set its defaults

passive-interface Suppress routing updates on an interface

prefix-suppression Enable prefix suppression

process-min-time Percentage of quantum to be used before releasing

CPU

queue-depth Hello/Router process queue depth

redistribute Redistribute information from another routing

protocol

router-id router-id for this OSPF process

shutdown Shutdown the router process

snmp Modify snmp parameters

statistics Enable or disable OSPF statistics options

summary-address Configure IP address summaries

summary-prefix Configure IP address summaries

timers Adjust routing timers

R1(config-router-af)#

R1(config-router-af)# **router-id 1.1.1.1**

* + - 1. Exit the IPv4 AF configuration mode and enter the AF IPv6 configuration mode. The **exit-address-family** (or a shorter version of **exit**) command is used exit address family configuration mode. Issue the **address-family ipv6 unicast** command to enter the IPv6 AF. For the IPv6 AF, use the **router-id** command to configure the router ID. It isn’t necessary to configure a different router ID for IPv6 AF but it is a valid option. The **exit** command is used to return to global configuration mode.

R1(config-router-af)# **exit-address-family**

R1(config-router)# **address-family ipv6 unicast**

R1(config-router-af)# **router-id 1.1.1.1**

R1(config-router-af)# **exit-address-family**

R1(config-router)# **exit**

* + - 1. OSPFv3 is enabled directly on the interfaces for both IPv4 and IPv6 AFs using the **ospfv3** *pid* [ **ipv4** | **ipv6** ] **area** *area-id* interface command. Use this command to enable OSPFv3 on both of R1’s interfaces.

R1(config)# **interface g0/0/0**

R1(config-if)# **ospfv3 123 ipv4 area 0**

R1(config-if)# **ospfv3 123 ipv6 area 0**

R1(config-if)# **exit**

R1(config)# **interface g0/0/1**

R1(config-if)# **ospfv3 123 ipv4 area 1**

R1(config-if)# **ospfv3 123 ipv6 area 1**

Close configuration window

### Configure OSPFv3 with AF IPv4 and AF IPv6 on R2.

Enable IPv6 unicast routing and configure the OSPFv3 with AF for both IPv4 and IPv6 on R2, similar to the configuration for R1.

Open configuration window

R2(config)# **ipv6 unicast-routing**

R2(config)# **router ospfv3 123**

R2(config-router)# **address-family ipv4 unicast**

R2(config-router-af)# **router-id 2.2.2.1**

R2(config-router-af)# **exit-address-family**

R2(config-router)# **address-family ipv6 unicast**

R2(config-router-af)# **router-id 2.2.2.1**

R2(config-router-af)# **exit-address-family**

R2(config-router)# **exit**

R2(config)# **interface g0/0/0**

R2(config-if)# **ospfv3 123 ipv4 area 0**

R2(config-if)# **ospfv3 123 ipv6 area 0**

R2(config-if)# **exit**

R2(config)# **interface g0/0/1**

R2(config-if)# **ospfv3 123 ipv4 area 0**

R2(config-if)# **ospfv3 123 ipv6 area 0**

Close configuration window

### Configure OSPFv3 with IPv4 AF and IPv6 AF on R3.

Enable IPv6 unicast routing and configure the OSPFv3 with AF for both IPv4 and IPv6 on R3, similar to the configurations for R1 and R2. On R3, set the router ID for both IPv4 AF and IPv6 AF with a single command as shown.

Open configuration window

R3(config)# **ipv6 unicast-routing**

R3(config)# **router ospfv3 123**

R3(config-router)# **router-id 3.3.3.1**

R3(config-router)# **address-family ipv4 unicast**

R3(config-router-af)# **exit-address-family**

R3(config-router)# **address-family ipv6 unicast**

R3(config-router-af)# **exit-address-family**

R3(config-router)# **exit**

R3(config)# **interface g0/0/0**

R3(config-if)# **ospfv3 123 ipv4 area 0**

R3(config-if)# **ospfv3 123 ipv6 area 0**

R3(config-if)# **exit**

R3(config)# **interface g0/0/1**

R3(config-if)# **ospfv3 123 ipv4 area 2**

R3(config-if)# **ospfv3 123 ipv6 area 2**

Close configuration window

### Configure OSPFv3 with AF on D2.

* + - 1. Enter the following command to enable routing for IPv4. (This may not be required on depending on model and IOS.)

Open configuration window

D2(config)# **ip routing**

* + - 1. Enter the following command to enable routing for IPv6. (This may not be required on depending on model and IOS.)

D2(config)# **ipv6 unicast-routing**

**Note**: By default, the 3650 supports IPv6 interface configuration.

* + - 1. Configure the OSPFv3 with AF for both IPv4 and IPv6 on D2, similar to the configurations for R1, R2 and R3.

D2(config)# **router ospfv3 123**

D2(config-router)# **address-family ipv4 unicast**

D2(config-router-af)# **router-id 3.3.3.2**

D2(config-router-af)# **exit-address-family**

D2(config-router)# **address-family ipv6 unicast**

D2(config-router-af)# **router-id 3.3.3.2**

D2(config-router-af)# **exit-address-family**

D2(config-router)# **exit**

D2(config)# **interface g1/0/11**

D2(config-if)# **ospfv3 123 ipv4 area 2**

D2(config-if)# **ospfv3 123 ipv6 area 2**

D2(config-if)# **exit**

D2(config)# **interface g 1/0/23**

D2(config-if)# **ospfv3 123 ipv4 area 2**

D2(config-if)# **ospfv3 123 ipv6 area 2**

Close configuration window

## Verify OSPFv3

The commands to verify traditional OSPFv3 and OSPFv3 with AF may differ. This is because OSPFv3 with AF commands include information for both IPv4 and IPv6 address families, whereas traditional OSPFv3 is for IPv6 only.

### Verifying neighbor adjacencies.

* + - 1. Use the **show ipv6 ospf neighbor** command on D1 to display OSPFv3 neighbors. This is a command used for routers configured with traditional OSPFv3. The equivalent command for OSPFv2 would be **show ip ospf neighbor**.

Open configuration window

D1# **show ipv6 ospf neighbor**

OSPFv3 Router with ID (1.1.1.2) (Process ID 123)

Neighbor ID Pri State Dead Time Interface ID Interface

1.1.1.1 1 FULL/DR 00:00:39 6 GigabitEthernet1/0/11

* + - 1. This same command on a router running OSPFv3 with AF would generate similar output. For example, on R1 issue the same **show ipv6 ospf neighbor** command. Notice the output is only OSPFv3 for the IPv6 AF.

R1# **show ipv6 ospf neighbor**

OSPFv3 Router with ID (1.1.1.1) (Process ID 123)

Neighbor ID Pri State Dead Time Interface ID Interface

2.2.2.1 1 FULL/BDR 00:00:31 5 GigabitEthernet0/0/0

1.1.1.2 1 FULL/BDR 00:00:38 471 GigabitEthernet0/0/1

* + - 1. Now, issue the **show ospfv3 neighbor** command on R1. This is a command used for routers configured for OSPFv3 with AF. Notice the output includes neighbors for both IPv4 and IPv6 address families.

R1# **show ospfv3 neighbor**

OSPFv3 123 address-family ipv4 (router-id 1.1.1.1)

Neighbor ID Pri State Dead Time Interface ID Interface

2.2.2.1 1 FULL/BDR 00:00:38 5 GigabitEthernet0/0/0

OSPFv3 123 address-family ipv6 (router-id 1.1.1.1)

Neighbor ID Pri State Dead Time Interface ID Interface

2.2.2.1 1 FULL/BDR 00:00:32 5 GigabitEthernet0/0/0

1.1.1.2 1 FULL/BDR 00:00:30 471 GigabitEthernet0/0/1

Traditional OSPFv3 commands are similar to those for OSPFv2, except **ipv6** is used as an argument instead of **ip**, for example **show ip ospf neighbor** and **show ipv6 ospf neighbor**. OSPFv3 with AF uses the argument ospfv3 which includes both OSPF for IPv4 and IPv6 AFs. For example, **show ospfv3 neighbor**.

Traditional OSPFv3 commands can be used when a router is configured for OSPFv3 with AF, but the OSPFv3 AF router will only show OSPF for IPv6 AF information. OSPFv3 with AF commands cannot be used on routers configured with traditional OSPFv3.

To summarize the **show** command arguments:

* OSPFv2: Use **show ip ospf** (IPv4 only)
* Traditional OSPFv3: Use **show** **ipv6 ospf** (IPv6 only)
* OSPFv3 with AF: Use **show ospfv3** (IPv4 and IPv6 AF) or **show ipv6 ospf** (IPv6 only)

#### Question:

Why does the **show ipv6 ospf neighbor** command only display OSPFv3 neighbors in the IPv6 AF?

Type your answers here.

Close configuration window

### Examining the IP routing tables.

* + - 1. Use the **show ipv6 route ospf** command on D1 to display OSPFv3 routing entries in the IPv6 routing table.

Open configuration window

D1# **show ipv6 route ospf**

IPv6 Routing Table - default - 9 entries

Codes: C - Connected, L - Local, S - Static, U - Per-user Static route

B - BGP, R - RIP, H - NHRP, 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, RL - RPL, O - OSPF Intra, OI - OSPF Inter

OE1 - OSPF ext 1, OE2 - OSPF ext 2, ON1 - OSPF NSSA ext 1

ON2 - OSPF NSSA ext 2, la - LISP alt, lr - LISP site-registrations

ld - LISP dyn-eid, lA - LISP away, le - LISP extranet-policy

OI 2001:DB8:ACAD:2001::/64 [110/4]

via FE80::1:1, GigabitEthernet1/0/11

OI 2001:DB8:ACAD:2002::/64 [110/5]

via FE80::1:1, GigabitEthernet1/0/11

OI 2001:DB8:ACAD:A001::/64 [110/2]

via FE80::1:1, GigabitEthernet1/0/11

OI 2001:DB8:ACAD:A002::/64 [110/3]

via FE80::1:1, GigabitEthernet1/0/11

#### Question:

Display the routes using the **show ip route ospf**. Why are there no routes displayed using this command?

Type your answers here.

* + - 1. Understanding the difference between commands associated with OSPFv2 and OSPFv3 can seem challenging at times. The **show ip route ospfv3** command is used to view OSPFv3 routes in the IPv4 routing table. The **show ipv6 route ospf** command is used to view OSPFv3 routes in the IPv6 routing table. The **show ipv6 route ospf** command is the same command used with traditional OSPFv3 for IPv6.

R1# **show ip route ospf**

R1# **show ip route ospfv3**

Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP

D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area

N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2

E1 - OSPF external type 1, E2 - OSPF external type 2

i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2

ia - IS-IS inter area, \* - candidate default, U - per-user static route

o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP

a - application route

+ - replicated route, % - next hop override, p - overrides from PfR

Gateway of last resort is not set

10.0.0.0/8 is variably subnetted, 4 subnets, 3 masks

O IA 10.10.4.0/30 [110/3] via 172.16.0.1, 00:17:34, GigabitEthernet0/0/0

O IA 10.10.5.0/24 [110/4] via 172.16.0.1, 00:17:34, GigabitEthernet0/0/0

172.16.0.0/16 is variably subnetted, 3 subnets, 2 masks

O 172.16.1.0/30 [110/2] via 172.16.0.1, 00:17:34, GigabitEthernet0/0/0

R1# s**how ipv6 route ospfv3**

^

% Invalid input detected at '^' marker.

R1# **show ipv6 route ospf**

IPv6 Routing Table - default - 9 entries

Codes: C - Connected, L - Local, S - Static, U - Per-user Static route

B - BGP, R - RIP, H - NHRP, 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, RL - RPL, O - OSPF Intra, OI - OSPF Inter

OE1 - OSPF ext 1, OE2 - OSPF ext 2, ON1 - OSPF NSSA ext 1

ON2 - OSPF NSSA ext 2, a - Application

O 2001:DB8:ACAD:1002::/64 [110/2]

via FE80::D1:2, GigabitEthernet0/0/1

OI 2001:DB8:ACAD:2001::/64 [110/3]

via FE80::2:1, GigabitEthernet0/0/0

OI 2001:DB8:ACAD:2002::/64 [110/4]

via FE80::2:1, GigabitEthernet0/0/0

O 2001:DB8:ACAD:A002::/64 [110/2]

via FE80::2:1, GigabitEthernet0/0/0

#### Question:

Why doesn’t the **show ip route ospf** command display any routes on R1?

Type your answers here.

Close configuration window

### Examining the OSPF LSDB.

* + - 1. D1 is running traditional OSPFv3. The **show ipv6 ospf database** command is used to display a summary of the OSPFv3 LSDB.

Open configuration window

D1# **show ipv6 ospf database**

OSPFv3 Router with ID (1.1.1.2) (Process ID 123)

Router Link States (Area 1)

ADV Router Age Seq# Fragment ID Link count Bits

1.1.1.1 1096 0x80000009 0 1 B

1.1.1.2 1110 0x80000005 0 1 None

Net Link States (Area 1)

ADV Router Age Seq# Link ID Rtr count

1.1.1.1 1152 0x80000001 6 2

Inter Area Prefix Link States (Area 1)

ADV Router Age Seq# Prefix

1.1.1.1 1096 0x80000003 2001:DB8:ACAD:A001::/64

1.1.1.1 1096 0x80000003 2001:DB8:ACAD:A002::/64

1.1.1.1 833 0x80000005 2001:DB8:ACAD:2001::/64

1.1.1.1 1497 0x80000002 2001:DB8:ACAD:2002::/64

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

ADV Router Age Seq# Link ID Interface

1.1.1.2 1150 0x80000001 39 Gi1/0/23

1.1.1.1 1096 0x80000006 6 Gi1/0/11

1.1.1.2 1151 0x80000001 38 Gi1/0/11

Intra Area Prefix Link States (Area 1)

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

1.1.1.1 1152 0x80000001 6144 0x2002 6

1.1.1.2 1150 0x80000003 0 0x2001 0

* + - 1. R1 is running OSPFv3 with AF. The **show ospfv3 database** command is used to display a summary of the OSPFv3 LSDB for both the IPv4 and IPv6 AFs.

R1# **show ospfv3 database**

OSPFv3 123 address-family ipv4 (router-id 1.1.1.1)

Router Link States (Area 0)

ADV Router Age Seq# Fragment ID Link count Bits

1.1.1.1 532 0x80000005 0 1 None

2.2.2.1 508 0x80000008 0 2 None

3.3.3.1 507 0x80000006 0 1 B

Net Link States (Area 0)

ADV Router Age Seq# Link ID Rtr count

2.2.2.1 539 0x80000001 5 2

3.3.3.1 512 0x80000001 5 2

Inter Area Prefix Link States (Area 0)

ADV Router Age Seq# Prefix

3.3.3.1 553 0x80000001 10.10.4.0/30

3.3.3.1 513 0x80000001 10.10.5.0/24

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

ADV Router Age Seq# Link ID Interface

1.1.1.1 579 0x80000001 5 Gi0/0/0

2.2.2.1 579 0x80000001 5 Gi0/0/0

Intra Area Prefix Link States (Area 0)

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

2.2.2.1 539 0x80000001 5120 0x2002 5

3.3.3.1 512 0x80000001 5120 0x2002 5

Router Link States (Area 1)

ADV Router Age Seq# Fragment ID Link count Bits

1.1.1.1 602 0x80000001 0 0 None

OSPFv3 123 address-family ipv6 (router-id 1.1.1.1)

Router Link States (Area 0)

ADV Router Age Seq# Fragment ID Link count Bits

1.1.1.1 530 0x80000005 0 1 B

2.2.2.1 508 0x80000009 0 2 None

3.3.3.1 508 0x80000006 0 1 B

Net Link States (Area 0)

ADV Router Age Seq# Link ID Rtr count

2.2.2.1 539 0x80000001 5 2

3.3.3.1 511 0x80000001 5 2

Inter Area Prefix Link States (Area 0)

ADV Router Age Seq# Prefix

1.1.1.1 579 0x80000001 2001:DB8:ACAD:1001::/64

1.1.1.1 559 0x80000001 2001:DB8:ACAD:1002::/64

3.3.3.1 551 0x80000001 2001:DB8:ACAD:2001::/64

3.3.3.1 512 0x80000001 2001:DB8:ACAD:2002::/64

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

ADV Router Age Seq# Link ID Interface

1.1.1.1 578 0x80000002 5 Gi0/0/0

2.2.2.1 578 0x80000002 5 Gi0/0/0

Intra Area Prefix Link States (Area 0)

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

2.2.2.1 539 0x80000001 5120 0x2002 5

3.3.3.1 511 0x80000001 5120 0x2002 5

Router Link States (Area 1)

ADV Router Age Seq# Fragment ID Link count Bits

1.1.1.1 553 0x80000006 0 1 B

1.1.1.2 552 0x80000025 0 1 None

Net Link States (Area 1)

ADV Router Age Seq# Link ID Rtr count

1.1.1.2 560 0x80000001 38 2

Inter Area Prefix Link States (Area 1)

ADV Router Age Seq# Prefix

1.1.1.1 578 0x80000001 2001:DB8:ACAD:A001::/64

1.1.1.1 538 0x80000001 2001:DB8:ACAD:A002::/64

1.1.1.1 506 0x80000001 2001:DB8:ACAD:2002::/64

1.1.1.1 506 0x80000001 2001:DB8:ACAD:2001::/64

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

ADV Router Age Seq# Link ID Interface

1.1.1.1 559 0x8000000C 6 Gi0/0/1

1.1.1.2 598 0x80000002 38 Gi0/0/1

Intra Area Prefix Link States (Area 1)

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

1.1.1.2 481 0x80000016 0 0x2001 0

1.1.1.2 560 0x80000001 38912 0x2002 38

#### Question:

What would the **show ipv6 route database** command display on R1, if anything?

Type your answers here.

Close configuration window

## Tune OSPFv3

### Configuring a passive interface.

* + - 1. To configure a passive interface in traditional OSPFv3, use the **passive-interface** command in OSPFv3 router mode.

Open configuration window

D1(config)# **ipv6 router ospf 123**

D1(config-rtr)# **passive-interface g1/0/23**

* + - 1. To configure a passive interface in OSPFv3 with AF, you can use the **passive-interface** command in OSPFv3 router mode to configure the passive interface for both IPv4 and IPv6 AFs.

D2(config)# **router ospfv3 123**

D2(config-router)# **passive-interface g1/0/23**

* + - 1. As an alternative, you can use the **passive-interface** command within AF configuration mode to configure the passive interface for a specific AFs.

D2(config-router)# **no passive-interface g1/0/23**

D2(config-router)# **address-family ipv4 unicast**

D2(config-router-af)# **passive-interface g1/0/23**

D2(config-router-af)# **exit-address-family**

D2(config-router)# **address-family ipv6 unicast**

D2(config-router-af)# **passive-interface g1/0/23**

D2(config-router-af)# **exit-address-family**

Close configuration window

### Configuring summarization.

* + - 1. The **area** *area* **range** *ipv6-summary-address* command is used to summarize prefixes from one are into another. The *area* is the area from which the prefixes are summarized.

Open configuration window

R1(config)# **router ospfv3 123**

R1(config-router)# **address-family ipv6 unicast**

R1(config-router-af)# **area 1 range 2001:db8:acad:1000::/52**

R3(config)# **router ospfv3 123**

R3(config-router)# **address-family ipv6 unicast**

R3(config-router-af)# **area 2 range 2001:db8:acad:2000::/52**

* + - 1. Notice that R2 is now receiving the summarized prefixes.

R2# **show ipv6 route ospf**

<output omitted>

OI 2001:DB8:ACAD:1000::/52 [110/3]

via FE80::1:2, GigabitEthernet0/0/0

OI 2001:DB8:ACAD:2000::/52 [110/3]

via FE80::3:2, GigabitEthernet0/0/1

#### Question:

Why is prefix summarization considered desirable? How does it stabilize routing?

Type your answers here.

Close configuration window

### Modifying the network type.

* + - 1. OSPFv3 supports the same network types as OSPFv2. Notice that the Ethernet interfaces between R2 and R1, and R2 and R3, elect a DR and a BDR. This is because Ethernet is a multiaccess network. However, these are point-to-point links and there is no need for a DR or BDR.

Open configuration window

R2# **show ospfv3 interface brief**

Interface PID Area AF Cost State Nbrs F/C

Gi0/0/1 123 0 ipv4 1 BDR 1/1

Gi0/0/0 123 0 ipv4 1 DR 1/1

Gi0/0/1 123 0 ipv6 1 BDR 1/1

Gi0/0/0 123 0 ipv6 1 DR 1/1

* + - 1. These connections can be changed to point-to-point using the **ospfv3 network point-to-point** interface command. This command needs to be configured one both sides of the point to point interface.

R2(config)# **interface g0/0/1**

R2(config-if**)# ospfv3 network point-to-point**

R2(config-if)# **exit**

R2(config)# **interface g0/0/0**

R2(config-if)# **ospfv3 network point-to-point**

R1(config)# **interface g0/0/0**

R1(config-if)# **ospfv3 network point-to-point**

R3(config)# **interface g0/0/0**

R3(config-if**)# ospfv3 network point-to-point**

* + - 1. Notice that the links have now change to P2P.

R2# **show ospfv3 interface brief**

Interface PID Area AF Cost State Nbrs F/C

Gi0/0/1 123 0 ipv4 1 P2P 1/1

Gi0/0/0 123 0 ipv4 1 P2P 1/1

Gi0/0/1 123 0 ipv6 1 P2P 1/1

Gi0/0/0 123 0 ipv6 1 P2P 1/1

#### Question:

What is the effect on the state of the interface when changing a broadcast network to point-to-point?

Type your answers here.

Close configuration window

### Advertising a default route.

* + - 1. Similar to OSPFv2, an ASBR in OSPFv3 advertises using the **default-information** command. Configure a static default route for IPv4 and IPv6 on R2.

**Note**: Without a default route in the routing table, OSPF would require the **default-information originate always** command to advertise a default route.

Open configuration window

R2(config)# **ipv6 route ::/0 lo0**

R2(config)# **ip route 0.0.0.0 0.0.0.0 lo0**

R2(config)# **router ospfv3 123**

R2(config-router)# **address-family ipv6 unicast**

R2(config-router-af)# **default-information originate**

R2(config-router-af)# **exit**

R2(config-router)# **address-family ipv4 unicast**

R2(config-router-af)# **default-information originate**

R2(config-router-af)# **exit**

* + - 1. Verify D1 is receiving an IPv6 default route via OSPFv3.

D1# **show ipv6 route ospf**

<output omitted>

OE2 ::/0 [110/1], tag 123

via FE80::1:1, GigabitEthernet1/0/11

OI 2001:DB8:ACAD:2000::/52 [110/5]

via FE80::1:1, GigabitEthernet1/0/11

OI 2001:DB8:ACAD:A001::/64 [110/2]

via FE80::1:1, GigabitEthernet1/0/11

OI 2001:DB8:ACAD:A002::/64 [110/3]

via FE80::1:1, GigabitEthernet1/0/11

* + - 1. Verify D2 is receiving an IPv4 default route via OSPFv3.

D2# **show ip route ospfv3**

<output omitted>

Gateway of last resort is 10.10.4.1 to network 0.0.0.0

O\*E2 0.0.0.0/0 [110/1] via 10.10.4.1, 00:01:13, GigabitEthernet1/0/11

172.16.0.0/30 is subnetted, 2 subnets

O IA 172.16.0.0 [110/3] via 10.10.4.1, 00:02:55, GigabitEthernet1/0/11

O IA 172.16.1.0 [110/2] via 10.10.4.1, 00:20:22, GigabitEthernet1/0/11

Close configuration window

**Router Interface Summary Table**

| **Router Model** | **Ethernet Interface #1** | **Ethernet Interface #2** | **Serial Interface #1** | **Serial Interface #2** |
| --- | --- | --- | --- | --- |
| 1800 | Fast Ethernet 0/0 (F0/0) | Fast Ethernet 0/1 (F0/1) | Serial 0/0/0 (S0/0/0) | Serial 0/0/1 (S0/0/1) |
| 1900 | Gigabit Ethernet 0/0 (G0/0) | Gigabit Ethernet 0/1 (G0/1) | Serial 0/0/0 (S0/0/0) | Serial 0/0/1 (S0/0/1) |
| 2801 | Fast Ethernet 0/0 (F0/0) | Fast Ethernet 0/1 (F0/1) | Serial 0/1/0 (S0/1/0) | Serial 0/1/1 (S0/1/1) |
| 2811 | Fast Ethernet 0/0 (F0/0) | Fast Ethernet 0/1 (F0/1) | Serial 0/0/0 (S0/0/0) | Serial 0/0/1 (S0/0/1) |
| 2900 | Gigabit Ethernet 0/0 (G0/0) | Gigabit Ethernet 0/1 (G0/1) | Serial 0/0/0 (S0/0/0) | Serial 0/0/1 (S0/0/1) |
| 4221 | Gigabit Ethernet 0/0/0 (G0/0/0) | Gigabit Ethernet 0/0/1 (G0/0/1) | Serial 0/1/0 (S0/1/0) | Serial 0/1/1 (S0/1/1) |
| 4300 | Gigabit Ethernet 0/0/0 (G0/0/0) | Gigabit Ethernet 0/0/1 (G0/0/1) | Serial 0/1/0 (S0/1/0) | Serial 0/1/1 (S0/1/1) |

**Note**: To find out how the router is configured, look at the interfaces to identify the type of router and how many interfaces the router has. There is no way to effectively list all the combinations of configurations for each router class. This table includes identifiers for the possible combinations of Ethernet and Serial interfaces in the device. The table does not include any other type of interface, even though a specific router may contain one. An example of this might be an ISDN BRI interface. The string in parenthesis is the legal abbreviation that can be used in Cisco IOS commands to represent the interface.

End of document