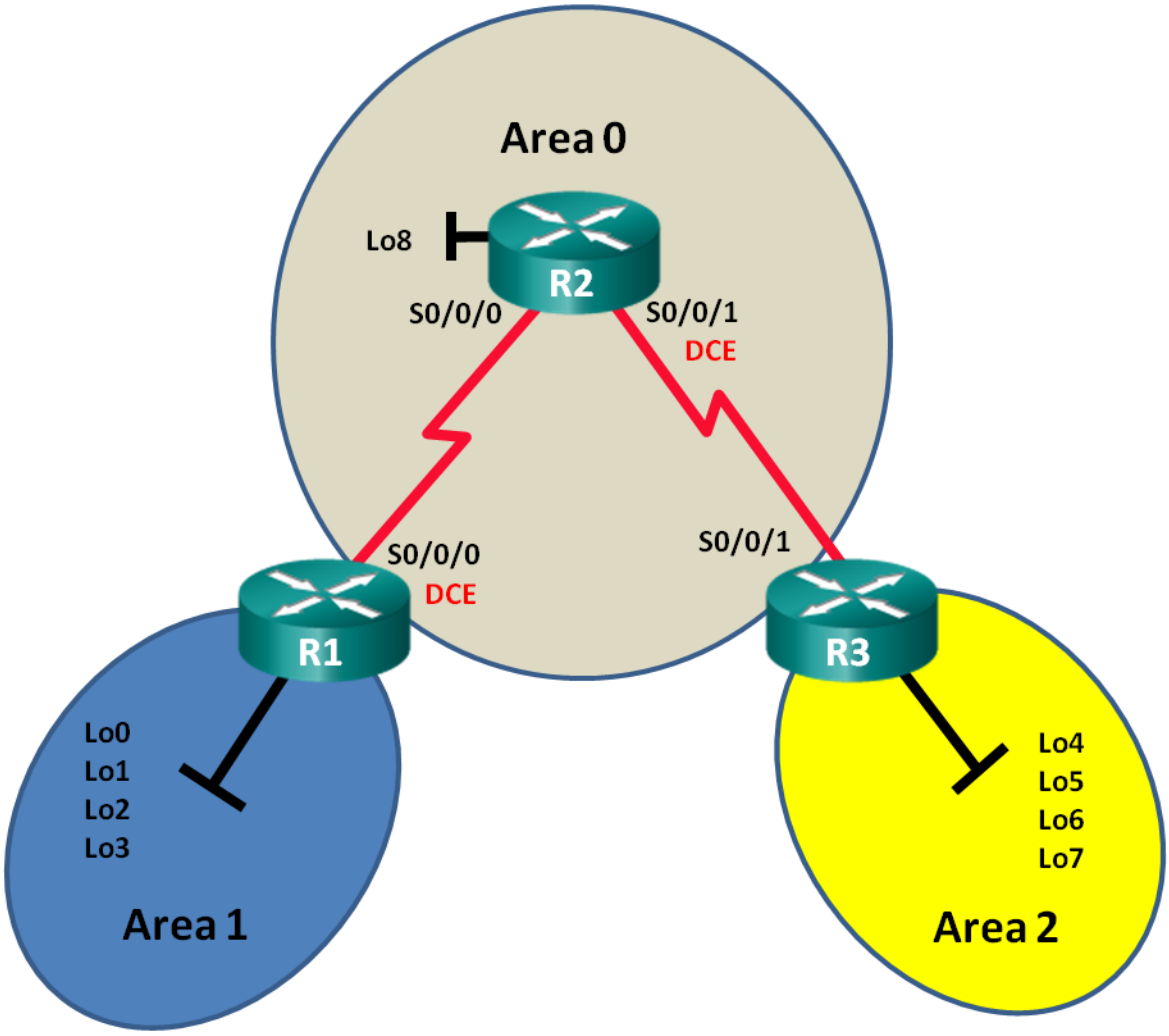
Lab - Configuring Multiarea OSPFv3

Topology



Addressing Table

Device	Interface	IPv6 Address	Default Gateway
R1	S0/0/0 (DCE)	2001:DB8:ACAD:12::1/64 FE80::1 link-local	N/A
	Lo0	2001:DB8:ACAD::1/64	N/A
	Lo1	2001:DB8:ACAD:1::1/64	N/A
	Lo2	2001:DB8:ACAD:2::1/64	N/A
	Lo3	2001:DB8:ACAD:3::1/64	N/A
R2	S0/0/0	2001:DB8:ACAD:12::2/64 FE80::2 link-local	N/A
	S0/0/1 (DCE)	2001:DB8:ACAD:23::2/64 FE80::2 link-local	N/A
	Lo8	2001:DB8:ACAD:8::1/64	N/A
R3	S0/0/1	2001:DB8:ACAD:23::3/64 FE80::3 link-local	N/A
	Lo4	2001:DB8:ACAD:4::1/64	N/A
	Lo5	2001:DB8:ACAD:5::1/64	N/A
	Lo6	2001:DB8:ACAD:6::1/64	N/A
	Lo7	2001:DB8:ACAD:7::1/64	N/A

Objectives

Part 1: Build the Network and Configure Basic Device Settings

Part 2: Configure Multiarea OSPFv3 Routing

Part 3: Configure Interarea Route Summarization

Background / Scenario

Using multiarea OSPFv3 in large IPv6 network deployments can reduce router processing by creating smaller routing tables and requiring less memory overhead. In multiarea OSPFv3, all areas are connected to the backbone area (area 0) through area border routers (ABRs).

In this lab, you will implement OSPFv3 routing for multiple areas and configure interarea route summarizations on the Area Border Routers (ABRs). You will also use a number of **show** commands to display and verify OSPFv3 routing information. This lab uses loopback addresses to simulate networks in multiple OSPFv3 areas.

Note: The routers used with CCNA hands-on labs are Cisco 1941 Integrated Services Routers (ISRs) with Cisco IOS Release 15.2(4)M3 (universalk9 image). Other routers 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. Refer to the Router Interface Summary Table at this end of this lab for the correct interface identifiers.

Note: Make sure that the routers have been erased and have no startup configurations. If you are unsure, contact your instructor.

Required Resources

- 3 Routers (Cisco 1941 with Cisco IOS Release 15.2(4)M3 universal image or comparable)
- 3 PCs (Windows 7, Vista, or XP with terminal emulation program, such as Tera Term)
- Console cables to configure the Cisco IOS devices via the console ports
- Serial cables as shown in the topology

Part 1: Build the Network and Configure Basic Device Settings

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

Step 1: Cable the network as shown in the topology.

Step 2: Initialize and reload the routers as necessary.

Step 3: Configure basic settings for each router.

a. Disable DNS lookup.

b. Configure device name as shown in the topology.

c. Assign **class** as the privileged EXEC password.

d. Assign **cisco** as the vty password.

e. Configure a MOTD banner to warn users that unauthorized access is prohibited.

f. Configure **logging synchronous** for the console line.

g. Encrypt plain text passwords.

h. Configure the IPv6 unicast and link-local addresses listed in the Addressing Table for all interfaces.

i. Enable IPv6 unicast routing on each router.

j. Copy the running configuration to the startup configuration.

Step 4: Test connectivity.

The routers should be able to ping one another. The routers are unable to ping distant loopbacks until OSPFv3 routing is configured. Verify and troubleshoot if necessary.

Part 2: Configure Multiarea OSPFv3 Routing

In Part 2, you will configure OSPFv3 routing on all routers to separate the network domain into three distinct areas, and then verify that routing tables are updated correctly.

Step 1: Assign router IDs.

a. On R1, issue the **ipv6 router ospf** command to start an OSPFv3 process on the router.

```
R1(config)# ipv6 router ospf 1
```

Note: The OSPF process ID is kept locally and has no meaning to other routers on the network.

b. Assign the OSPFv3 router ID **1.1.1.1** to R1.

```
R1(config-rtr)# router-id 1.1.1.1
```

c. Assign a router ID of **2.2.2.2** to R2 and a router ID of **3.3.3.3** to R3.

d. Issue the **show ipv6 ospf** command to verify the router IDs on all routers.

```
R2# show ipv6 ospf
 Routing Process "ospfv3 1" with ID 2.2.2.2
 Event-log enabled, Maximum number of events: 1000, Mode: cyclic
 Router is not originating router-LSAs with maximum metric
 <output omitted>
```

Step 2: Configure multiarea OSPFv3.

a. Issue the **ipv6 ospf 1 area** *area-id* command for each interface on R1 that is to participate in OSPFv3 routing. The loopback interfaces are assigned to area 1 and the serial interface is assigned to area 0. You will change the network type on the loopback interfaces to ensure that the correct subnet is advertised.

```
R1(config)# interface lo0
R1(config-if)# ipv6 ospf 1 area 1
R1(config-if)# ipv6 ospf network point-to-point
R1(config-if)# interface lo1
R1(config-if)# ipv6 ospf 1 area 1
R1(config-if)# ipv6 ospf network point-to-point
R1(config-if)# interface lo2
R1(config-if)# ipv6 ospf 1 area 1
R1(config-if)# ipv6 ospf network point-to-point
R1(config-if)# interface lo3
R1(config-if)# ipv6 ospf 1 area 1
R1(config-if)# ipv6 ospf network point-to-point
R1(config-if)# interface s0/0/0
R1(config-if)# ipv6 ospf 1 area 0
```

b. Use the **show ipv6 protocols** command to verify multiarea OSPFv3 status.

```
R1# show ipv6 protocols
IPv6 Routing Protocol is "connected"
IPv6 Routing Protocol is "ND"
IPv6 Routing Protocol is "ospf 1"
  Router ID 1.1.1.1
  Area border router
  Number of areas: 2 normal, 0 stub, 0 nssa
  Interfaces (Area 0):
    Serial0/0/0
  Interfaces (Area 1):
    Loopback0
    Loopback1
    Loopback2
    Loopback3
  Redistribution:
    None
```

c. Assign all interfaces on R2 to participate in OSPFv3 area 0. For the loopback interface, change the network type to point-to point. Write the commands used in the space below.

int s0/0/0
ipv6 ospf 1 area 0
int s0/0/1
ipv6 ospf 1 area 0
int lo8
ipv6 ospf 1 area 0
ipv6 ospf network point-to-point

d. Use the **show ipv6 ospf interface brief** command to view OSPFv3 enabled interfaces.

```
R2# show ipv6 ospf interface brief
Interface    PID   Area            Intf ID    Cost  State Nbrs F/C
Lo8          1     0               13         1     P2P   0/0
Se0/0/1      1     0               7          64    P2P   1/1
Se0/0/0      1     0               6          64    P2P   1/1
```

e. Assign the loopback interfaces on R3 to participate in OSPFv3 area 2 and change the network type to point-to-point. Assign the serial interface to participate in OSPFv3 area 0. Write the commands used in the space below.

int lo4
ipv6 ospf 1 area 2
ipv6 ospf network point-to-point
...
int lo7
ipv6 ospf 1 area 2
ipv6 ospf network point-to-point
int s0/0/1
ipv6 ospf 1 area 0

f. Use the **show ipv6 ospf** command to verify configurations.

```
R3# show ipv6 ospf
 Routing Process "ospfv3 1" with ID 3.3.3.3
 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
 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 1
       SPF algorithm executed 2 times
       Number of LSA 16. Checksum Sum 0x0929F8
       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 4
       SPF algorithm executed 2 times
       Number of LSA 13. Checksum Sum 0x048E3C
       Number of DCbitless LSA 0
       Number of indication LSA 0
       Number of DoNotAge LSA 0
       Flood list length 0
```

Step 3: Verify OSPFv3 neighbors and routing information.

a. Issue the **show ipv6 ospf neighbor** command on all routers to verify that each router is listing the correct routers as neighbors.

```
R1# show ipv6 ospf neighbor

            OSPFv3 Router with ID (1.1.1.1) (Process ID 1)

Neighbor ID     Pri   State           Dead Time   Interface ID    Interface
2.2.2.2           0   FULL/  -        00:00:39    6               Serial0/0/0
```

b. Issue the **show ipv6 route ospf** command on all routers to verify that each router has learned routes to all networks in the Addressing Table.

```
R1# show ipv6 route ospf
IPv6 Routing Table - default - 16 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, O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1
       OE2 - OSPF ext 2, ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
OI  2001:DB8:ACAD:4::/64 [110/129]
     via FE80::2, Serial0/0/0
OI  2001:DB8:ACAD:5::/64 [110/129]
     via FE80::2, Serial0/0/0
OI  2001:DB8:ACAD:6::/64 [110/129]
     via FE80::2, Serial0/0/0
OI  2001:DB8:ACAD:7::/64 [110/129]
     via FE80::2, Serial0/0/0
O   2001:DB8:ACAD:8::/64 [110/65]
     via FE80::2, Serial0/0/0
```

```
O   2001:DB8:ACAD:23::/64 [110/128]
     via FE80::2, Serial0/0/0
```

What is the significance of an OI route?

interarea route dat aangeleerd wordt door een ospf neighbour in een andere area

c. Issue the **show ipv6 ospf database** command on all routers.

```
R1# show ipv6 ospf database

            OSPFv3 Router with ID (1.1.1.1) (Process ID 1)

                Router Link States (Area 0)

ADV Router       Age         Seq#        Fragment ID  Link count  Bits
 1.1.1.1         908         0x80000001  0            1           B
 2.2.2.2         898         0x80000003  0            2           None
 3.3.3.3         899         0x80000001  0            1           B

                Inter Area Prefix Link States (Area 0)

ADV Router       Age         Seq#        Prefix
 1.1.1.1         907         0x80000001  2001:DB8:ACAD::/62
 3.3.3.3         898         0x80000001  2001:DB8:ACAD:4::/62

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

ADV Router       Age         Seq#        Link ID    Interface
 1.1.1.1         908         0x80000001  6          Se0/0/0
 2.2.2.2         909         0x80000002  6          Se0/0/0

                Intra Area Prefix Link States (Area 0)

ADV Router       Age         Seq#        Link ID    Ref-lstype  Ref-LSID
 1.1.1.1         908         0x80000001  0          0x2001      0
 2.2.2.2         898         0x80000003  0          0x2001      0
 3.3.3.3         899         0x80000001  0          0x2001      0

                Router Link States (Area 1)

ADV Router       Age         Seq#        Fragment ID  Link count  Bits
 1.1.1.1         908         0x80000001  0            0           B

                Inter Area Prefix Link States (Area 1)

ADV Router       Age         Seq#        Prefix
 1.1.1.1         907         0x80000001  2001:DB8:ACAD:12::/64
 1.1.1.1         907         0x80000001  2001:DB8:ACAD:8::/64
 1.1.1.1         888         0x80000001  2001:DB8:ACAD:23::/64
 1.1.1.1         888         0x80000001  2001:DB8:ACAD:4::/62
```

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

ADV Router       Age         Seq#        Link ID    Interface
 1.1.1.1         908         0x80000001  13         Lo0
 1.1.1.1         908         0x80000001  14         Lo1
 1.1.1.1         908         0x80000001  15         Lo2
 1.1.1.1         908         0x80000001  16         Lo3

               Intra Area Prefix Link States (Area 1)

ADV Router       Age         Seq#        Link ID    Ref-lstype  Ref-LSID
 1.1.1.1         908         0x80000001  0          0x2001      0
```

How many link state databases are found on R1?

How many link state databases are found on R2?

How many link state databases are found on R3?

Part 3: Configure Interarea Route Summarization

In Part 3, you will manually configure interarea route summarization on the ABRs.

Step 1: Summarize networks on R1.

a. List the network addresses for the loopback interfaces and identify the hextet section where the addresses differ.

2001:DB8:ACAD:0000::1/64

2001:DB8:ACAD:0001::1/64

2001:DB8:ACAD:0002::1/64

2001:DB8:ACAD:0003::1/64

b. Convert the differing section from hex to binary.

2001:DB8:ACAD: 0000 0000 0000 0000::1/64

2001:DB8:ACAD: 0000 0000 0000 0001::1/64

2001:DB8:ACAD: 0000 0000 0000 0010::1/64

2001:DB8:ACAD: 0000 0000 0000 0011::1/64

c. Count the number of leftmost matching bits to determine the prefix for the summary route.

2001:DB8:ACAD: 0000 0000 0000 0000::1/64

2001:DB8:ACAD: 0000 0000 0000 0001::1/64

2001:DB8:ACAD: 0000 0000 0000 0010::1/64

2001:DB8:ACAD: 0000 0000 0000 0011::1/64

How many bits match? 62

d. Copy the matching bits and then add zero bits to determine the summarized network address.

2001:DB8:ACAD: 0000 0000 0000 0000::0

e. Convert the binary section back to hex.

2001:DB8:ACAD::

f. Append the prefix of the summary route (result of Step 1c).

2001:DB8:ACAD::/62

Step 2: Configure interarea route summarization on R1.

a. To manually configure interarea route summarization on R1, use the **area** *area-id* **range** *address mask* command.

```
R1(config)# ipv6 router ospf 1
R1(config-rtr)# area 1 range 2001:DB8:ACAD::/62
```

b. View the OSPFv3 routes on R3.

```
R3# show ipv6 route ospf
IPv6 Routing Table - default - 14 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, O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1
       OE2 - OSPF ext 2, ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
OI  2001:DB8:ACAD::/62 [110/129]
     via FE80::2, Serial0/0/1
O   2001:DB8:ACAD:8::/64 [110/65]
     via FE80::2, Serial0/0/1
O   2001:DB8:ACAD:12::/64 [110/128]
     via FE80::2, Serial0/0/1
```

Compare this output to the output from Part 2, Step 3b. How are the networks in area 1 now expressed in the routing table on R3?

Area 1 range 2001:db8:acad:4::/62

c. View the OSPFv3 routes on R1.

```
R1# show ipv6 route ospf
IPv6 Routing Table - default - 18 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, O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1
       OE2 - OSPF ext 2, ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
O   2001:DB8:ACAD::/62 [110/1]
     via Null0, directly connected
OI  2001:DB8:ACAD:4::/64 [110/129]
     via FE80::2, Serial0/0/0
OI  2001:DB8:ACAD:5::/64 [110/129]
     via FE80::2, Serial0/0/0
OI  2001:DB8:ACAD:6::/64 [110/129]
     via FE80::2, Serial0/0/0
```

```
OI   2001:DB8:ACAD:7::/64 [110/129]
      via FE80::2, Serial0/0/0
O    2001:DB8:ACAD:8::/64 [110/65]
      via FE80::2, Serial0/0/0
O    2001:DB8:ACAD:23::/64 [110/128]
      via FE80::2, Serial0/0/0
```

Compare this output to the output from Part 2, Step 3b. How are the summarized networks expressed in the routing table on R1?

2001:db8:acad::/62

Step 3: Summarize networks and configure interarea route summarization on R3.

a. Summarize the loopback interfaces on R3.

1) List the network addresses and identify the hextet section where the addresses differ.
2) Convert the differing section from hex to binary.
3) Count the number of left-most matching bits to determine the prefix for the summary route.
4) Copy the matching bits and then add zero bits to determine the summarized network address.
5) Convert the binary section back to hex.
6) Append the prefix of the summary route.

Write the summary address in the space provided.

2001:db8:acas:4::/62

b. Manually configure interarea route summarization on R3. Write the commands in the space provided.

area 1 range 2001:db8:acad:4::/62

c. Verify that area 2 routes are summarized on R1. What command was used?

show ipv6 route ospf

d. Record the routing table entry on R1 for the summarized route advertised from R3.

2001:db8:acad:4::/62

Reflection

1. Why would multiarea OSPFv3 be used?

kan efficienter zijn voor zeer grote netwerken

2. What is the benefit of configuring interarea route summarization?

kleine routing tables en dus betere performance

Router Interface Summary Table

Router Interface Summary				
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)

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.