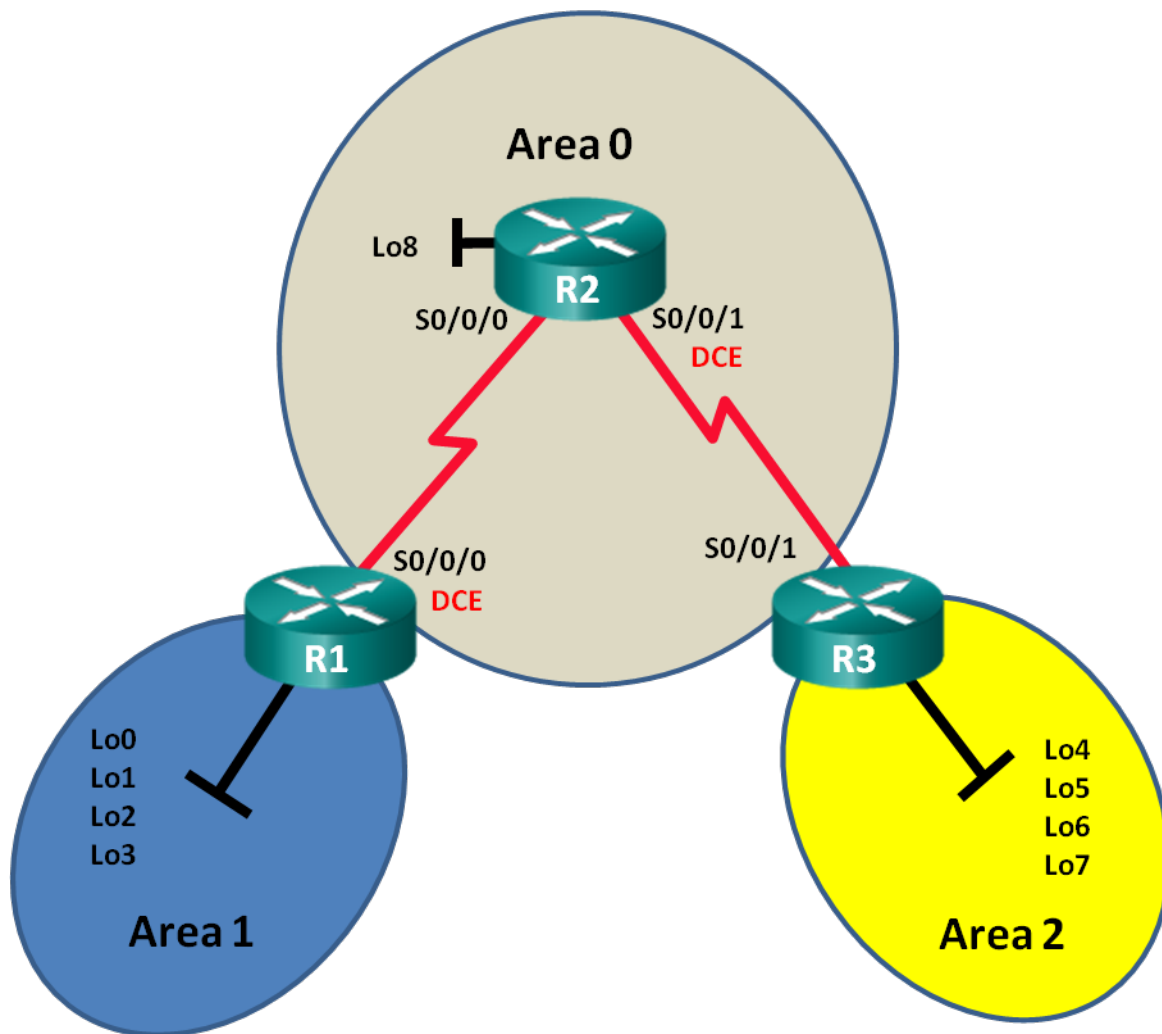


Lab - Configuring Multi-area OSPFv3 (Instructor Version)

Instructor Note: Red font color or gray highlights indicate text that appears in the instructor copy only.

Topology



Addressing Table

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

Objectives

Part 1: Build the Network and Configure Basic Device Settings

Part 2: Configure Multi-area OSPFv3 Routing

Background / Scenario

Using multi-area OSPFv3 in large IPv6 network deployments can reduce router processing cycles by creating smaller routing tables and requiring less memory overhead. In multi-area 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. 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.

Instructor Note: Refer to the Instructor Lab Manual for the procedures to initialize and reload devices.

Required Resources

- 3 Routers (Cisco 1941 with Cisco IOS Release 15.2(4)M3 universal image or comparable)
- 3 PCs (Windows 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.

- Disable DNS lookup.
- Configure device name as shown in the topology.
- Assign **class** as the privileged EXEC password.
- Assign **cisco** as the vty password.
- Configure a MOTD banner to warn users that unauthorized access is prohibited.
- Configure **logging synchronous** for the console line.
- Encrypt plaintext passwords.
- Configure the IPv6 unicast and link-local addresses listed in the Addressing Table for all interfaces.
- Enable IPv6 unicast routing on each router.
- 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 Multi-area 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.

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

```
R1(config-rtr)# router-id 1.1.1.1
```
- Start an OSPFv3 process on R2 and R3 and 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 multi-area 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 multi-area 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.
-

```
R2(config)# interface lo8
R2(config-if)# ipv6 ospf 1 area 0
R2(config-if)# ipv6 ospf network point-to-point
R2(config-if)# interface s0/0/0
R2(config-if)# ipv6 ospf 1 area 0
R2(config-if)# interface s0/0/1
R2(config-if)# ipv6 ospf 1 area 0
```

- 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.

```
R3(config)# interface lo4
R3(config-if)# ipv6 ospf 1 area 2
R3(config-if)# ipv6 ospf network point-to-point
R3(config-if)# interface lo5
R3(config-if)# ipv6 ospf 1 area 2
R3(config-if)# ipv6 ospf network point-to-point
R3(config-if)# interface lo6
R3(config-if)# ipv6 ospf 1 area 2
R3(config-if)# ipv6 ospf network point-to-point
R3(config-if)# interface lo7
R3(config-if)# ipv6 ospf 1 area 2
R3(config-if)# ipv6 ospf network point-to-point
```

```
R3(config-if)# interface s0/0/1
R3(config-if)# 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 msec
Minimum hold time between two consecutive SPF's 10000 msec
Maximum wait time between two consecutive SPF's 10000 msec
Minimum LSA interval 5 sec
Minimum LSA arrival 1000 msec
LSA group pacing timer 240 sec
Interface flood pacing timer 33 msec
Retransmission pacing timer 66 msec
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 does OI stand for? How was the OI route learned?

An OI route is an OSPF interarea route, which was learned from an OSPF neighbor participating in another 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
------------	-----	------	---------	-----------

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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? ____ **2**

How many link state databases are found on R2? ____ **1**

How many link state databases are found on R3? ____ **2**

Reflection

1. Why would multi-area OSPFv3 be used?

Answers will vary. Multi-area OSPFv3 can be used in large network domains to improve the efficiency of the routing process, decrease the size of routing tables, and decrease router CPU/memory processing requirements.

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.

Device Configs - Final

Router R1

```
R1# show run
Building configuration...

Current configuration : 2078 bytes
!
version 15.2
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R1
!
boot-start-marker
boot-end-marker
!
enable secret 4 06YFDUHH6lwAE/kLkDq9BGholQM5EnRtoyr8cHAUg.2
!
no aaa new-model
!
no ip domain lookup
ip cef
ipv6 unicast-routing
```

```
ipv6 cef
!
multilink bundle-name authenticated
!
redundancy
!
interface Loopback0
 no ip address
 ipv6 address 2001:DB8:ACAD::1/64
 ipv6 ospf 1 area 1
 ipv6 ospf network point-to-point
!
interface Loopback1
 no ip address
 ipv6 address 2001:DB8:ACAD:1::1/64
 ipv6 ospf 1 area 1
 ipv6 ospf network point-to-point
!
interface Loopback2
 no ip address
 ipv6 address 2001:DB8:ACAD:2::1/64
 ipv6 ospf 1 area 1
 ipv6 ospf network point-to-point
!
interface Loopback3
 no ip address
 ipv6 address 2001:DB8:ACAD:3::1/64
 ipv6 ospf 1 area 1
 ipv6 ospf network point-to-point
!
interface Embedded-Service-Engine0/0
 no ip address
 shutdown
!
interface GigabitEthernet0/0
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface GigabitEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/0/0
 no ip address
 ipv6 address FE80::1 link-local
```

```
ipv6 address 2001:DB8:ACAD:12::1/64
ipv6 ospf 1 area 0
clock rate 2000000
!
interface Serial0/0/1
no ip address
shutdown
!
ip forward-protocol nd
!
no ip http server
no ip http secure-server
!
ipv6 router ospf 1
router-id 1.1.1.1
!
control-plane
!
banner motd ^CUnauthorized access is strictly prohibited.^C
!
line con 0
password cisco
logging synchronous
login
line aux 0
line 2
no activation-character
no exec
transport preferred none
transport input all
transport output pad telnet rlogin lapb-ta mop udptn v120 ssh
stopbits 1
line vty 0 4
password cisco
login
transport input none
!
scheduler allocate 20000 1000
!
end
```

Router R2

```
R2# show run
Building configuration...

Current configuration : 1809 bytes
!
version 15.2
service timestamps debug datetime msec
```

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```
service timestamps log datetime msec
no service password-encryption
!
hostname R2
!
boot-start-marker
boot-end-marker
!
enable secret 4 06YFDUHH61wAE/kLkDq9BGho1QM5EnRtoyr8cHAUg.2
!
no aaa new-model
!
no ip domain lookup
ip cef
ipv6 unicast-routing
ipv6 cef
!
multilink bundle-name authenticated
!
redundancy
!
interface Loopback8
  no ip address
  ipv6 address 2001:DB8:ACAD:8::1/64
  ipv6 ospf 1 area 0
  ipv6 ospf network point-to-point
!
interface Embedded-Service-Engine0/0
  no ip address
  shutdown
!
interface GigabitEthernet0/0
  no ip address
  shutdown
  duplex auto
  speed auto
!
interface GigabitEthernet0/1
  no ip address
  shutdown
  duplex auto
  speed auto
!
interface Serial0/0/0
  no ip address
  ipv6 address FE80::2 link-local
  ipv6 address 2001:DB8:ACAD:12::2/64
  ipv6 ospf 1 area 0
!
```

```
interface Serial0/0/1
no ip address
ipv6 address FE80::2 link-local
ipv6 address 2001:DB8:ACAD:23::2/64
ipv6 ospf 1 area 0
clock rate 2000000
!
ip forward-protocol nd
!
no ip http server
no ip http secure-server
!
ipv6 router ospf 1
router-id 2.2.2.2
!
control-plane
!
banner motd ^CUnauthorized access is strictly prohibited.^C
!
line con 0
password cisco
logging synchronous
login
line aux 0
line 2
no activation-character
no exec
transport preferred none
transport input all
transport output pad telnet rlogin lapb-ta mop udptn v120 ssh
stopbits 1
line vty 0 4
password cisco
login
transport input none
!
scheduler allocate 20000 1000
!
end
```

Router R3

```
R3# show run
Building configuration...

Current configuration : 2142 bytes
!
version 15.2
service timestamps debug datetime msec
service timestamps log datetime msec
```

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```
no service password-encryption
!
hostname R3
!
boot-start-marker
boot-end-marker
!
enable secret 4 06YFDUHH6lwAE/kLkDq9BGholQM5EnRtoyr8cHAUg.2
!
no aaa new-model
memory-size iomem 15
!
no ip domain lookup
ip cef
ipv6 unicast-routing
ipv6 cef
!
multilink bundle-name authenticated!
!
redundancy
!
interface Loopback4
 no ip address
 ipv6 address 2001:DB8:ACAD:4::1/64
 ipv6 ospf 1 area 2
 ipv6 ospf network point-to-point
!
interface Loopback5
 no ip address
 ipv6 address 2001:DB8:ACAD:5::1/64
 ipv6 ospf 1 area 2
 ipv6 ospf network point-to-point
!
interface Loopback6
 no ip address
 ipv6 address 2001:DB8:ACAD:6::1/64
 ipv6 ospf 1 area 2
 ipv6 ospf network point-to-point
!
interface Loopback7
 no ip address
 ipv6 address 2001:DB8:ACAD:7::1/64
 ipv6 ospf 1 area 2
 ipv6 ospf network point-to-point
!
interface Embedded-Service-Engine0/0
 no ip address
 shutdown
!
```

```
interface GigabitEthernet0/0
  no ip address
  shutdown
  duplex auto
  speed auto
!
interface GigabitEthernet0/1
  no ip address
  shutdown
  duplex auto
  speed auto
!
interface Serial0/0/0
  no ip address
  shutdown
  clock rate 2000000
!
interface Serial0/0/1
  no ip address
  ipv6 address FE80::3 link-local
  ipv6 address 2001:DB8:ACAD:23::3/64
  ipv6 ospf 1 area 0
!
ip forward-protocol nd
!
no ip http server
no ip http secure-server
!
ipv6 router ospf 1
  router-id 3.3.3.3
!
control-plane
!
banner motd ^CUnauthorized access is strictly prohibited.^C
!
line con 0
  password cisco
  logging synchronous
  login
line aux 0
line 2
  no activation-character
  no exec
  transport preferred none
  transport input all
  transport output pad telnet rlogin lapb-ta mop udptn v120 ssh
  stopbits 1
line vty 0 4
  password cisco
```

Lab - Configuring Multi-area OSPFv3

```
login
transport input none
!
scheduler allocate 20000 1000
!
end
```