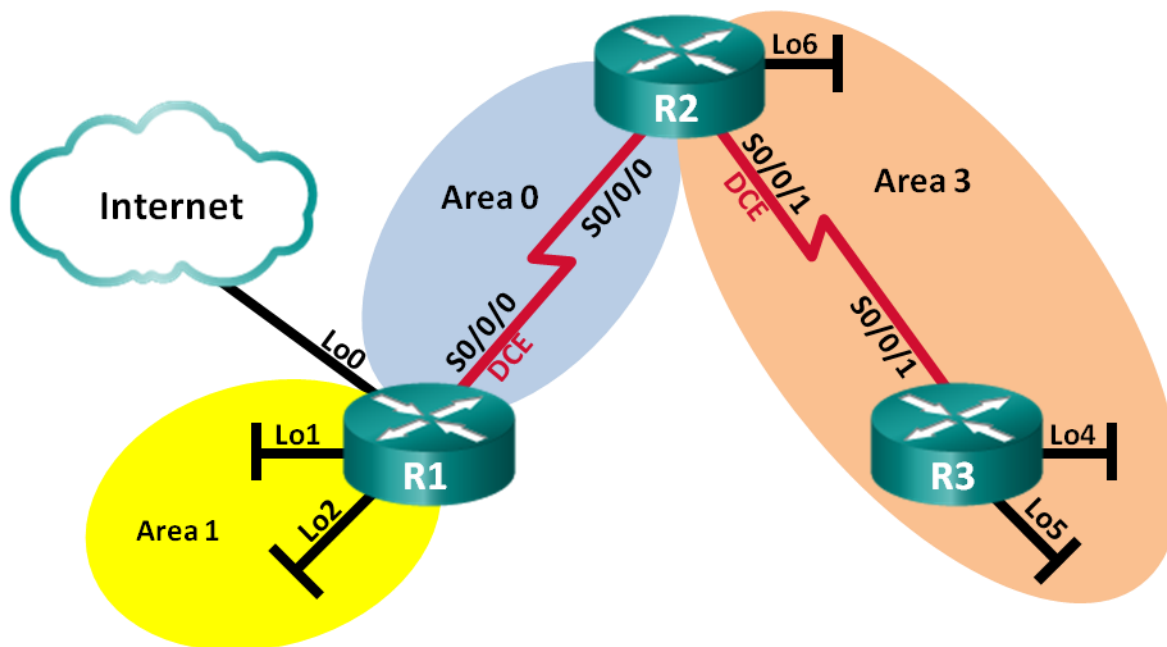


Lab – Troubleshooting Multiarea OSPFv2 and OSPFv3 (Instructor Version)

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

Topology



Addressing Table

| Device | Interface | IP Address |
|--------|--------------|---|
| R1 | Lo0 | 209.165.200.225/30 |
| | Lo1 | 192.168.1.1/24 2001:DB8:ACAD:1::1/64 FE80::1 link-local |
| | Lo2 | 192.168.2.1/24 2001:DB8:ACAD:2::1/64 FE80::1 link-local |
| | S0/0/0 (DCE) | 192.168.12.1/30 2001:DB8:ACAD:12::1/64 FE80::1 link-local |
| R2 | S0/0/0 | 192.168.12.2/30 2001:DB8:ACAD:12::2/64 FE80::2 link-local |
| | S0/0/1 (DCE) | 192.168.23.2/30 2001:DB8:ACAD:23::2/64 FE80::2 link-local |
| | Lo6 | 192.168.6.1/24 2001:DB8:ACAD:6::1/64 FE80::2 link-local |
| R3 | Lo4 | 192.168.4.1/24 2001:DB8:ACAD:4::1/64 FE80::3 link-local |
| | Lo5 | 192.168.5.1/24 2001:DB8:ACAD:5::1/64 FE80::3 link-local |
| | S0/0/1 | 192.168.23.1/30 2001:DB8:ACAD:23::1/64 FE80::3 link-local |

Objectives

Part 1: Build the Network and Load Device Configurations

Part 2: Troubleshoot Layer 3 Connectivity

Part 3: Troubleshoot OSPFv2

Part 4: Troubleshoot OSPFv3

Background / Scenario

Open Shortest Path First (OSPF) is an open-standard link-state routing protocol for IP networks. OSPFv2 is defined for IPv4 networks, while OSPFv3 is defined for IPv6 networks. OSPFv2 and OSPFv3 are completely isolated routing protocols, meaning changes in OSPFv2 do not affect OSPFv3 routing, and vice versa.

In this lab, a multiarea OSPF network running OSPFv2 and OSPFv3 is experiencing problems. You have been assigned to find the problems with the network and correct them.

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 the 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)
- 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 Load Device Configurations

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

Step 2: Load router configuration files.

Load the following configurations into the appropriate router. All routers have the same passwords. The enable password is **class**, and the line password is **cisco**.

Router R1 Configuration:

```
enable
conf t
hostname R1
enable secret class
ipv6 unicast-routing
no ip domain lookup
interface Loopback0
 ip address 209.165.200.225 255.255.255.252
interface Loopback1
 ip address 192.168.1.1 255.255.255.0
 ipv6 address 2001:DB80:ACAD:1::1/64
! ipv6 address 2001:DB8:ACAD:1::1/64
! ipv6 ospf 1 area 1
 ipv6 ospf network point-to-point
interface Loopback2
 ip address 192.168.2.1 255.255.255.0
```

```
ipv6 address 2001:DB8:ACAD:2::1/64
ipv6 ospf 1 area 1
ipv6 ospf network point-to-point
interface Serial0/0/0
ip address 192.168.21.1 255.255.255.252
!ip address 192.168.12.1 255.255.255.252
ipv6 address FE80::1 link-local
ipv6 address 2001:DB8:ACAD:12::1/64
ipv6 ospf 1 area 0
clock rate 128000
shutdown
!no shutdown
router ospf 1
router-id 1.1.1.1
passive-interface Loopback1
passive-interface Loopback2
!network 192.168.1.0 0.0.0.255 area 1
network 192.168.2.0 0.0.0.255 area 1
network 192.168.12.0 0.0.0.3 area 0
default-information originate
ipv6 router ospf 1
! router-id 1.1.1.1
area 1 range 2001:DB8:ACAD::/61
! area 1 range 2001:DB8:ACAD::/62
ip route 0.0.0.0 0.0.0.0 Loopback0
banner motd @
    Unauthorized Access is Prohibited! @
line con 0
password cisco
logging synchronous
login
line vty 0 4
password cisco
logging synchronous
login
transport input all
end
```

Router R2 Configuration:

```
enable
conf t
hostname R2
ipv6 unicast-routing
no ip domain lookup
enable secret class
interface Loopback6
```

```
ip address 192.168.6.1 255.255.255.0
ipv6 address 2001:DB8:CAD:6::1/64
! ipv6 address 2001:DB8:ACAD:6::1/64
! ipv6 ospf 1 area 3
interface Serial0/0/0
ip address 192.168.12.2 255.255.255.252
ipv6 address FE80::2 link-local
ipv6 address 2001:DB8:ACAD:12::2/64
ipv6 ospf 1 area 0
no shutdown
interface Serial0/0/1
ip address 192.168.23.2 255.255.255.252
ipv6 address FE80::2 link-local
ipv6 address 2001:DB8:ACAD:23::2/64
ipv6 ospf 1 area 3
clock rate 128000
no shutdown
router ospf 1
router-id 2.2.2.2
passive-interface Loopback6
network 192.168.6.0 0.0.0.255 area 3
network 192.168.12.0 0.0.0.3 area 0
network 192.168.23.0 0.0.0.3 area 3
ipv6 router ospf 1
router-id 2.2.2.2
banner motd @
    Unauthorized Access is Prohibited! @
line con 0
password cisco
logging synchronous
login
line vty 0 4
password cisco
logging synchronous
login
transport input all
end
```

Router R3 Configuration:

```
enable
conf t
hostname R3
no ip domain lookup
ipv6 unicast-routing
enable secret class
interface Loopback4
```

```
ip address 192.168.4.1 255.255.255.0
ipv6 address 2001:DB8:ACAD:4::1/64
ipv6 ospf 1 area 3
interface Loopback5
ip address 192.168.5.1 255.255.255.0
ipv6 address 2001:DB8:ACAD:5::1/64
ipv6 ospf 1 area 3
interface Serial0/0/1
ip address 192.168.23.1 255.255.255.252
ipv6 address FE80::3 link-local
ipv6 address 2001:DB8:ACAD:23::1/64
ipv6 ospf 1 area 3
no shutdown
router ospf 1
router-id 3.3.3.3
passive-interface Loopback4
passive-interface Loopback5
network 192.168.4.0 0.0.0.255 area 3
network 192.168.5.0 0.0.0.255 area 3
! network 192.168.23.0 0.0.0.3 area 3
ipv6 router ospf 1
router-id 3.3.3.3
banner motd @
    Unauthorized Access is Prohibited! @
line con 0
password cisco
logging synchronous
login
line vty 0 4
password cisco
logging synchronous
login
transport input all
end
```

Step 3: Save your configuration.

Part 2: Troubleshoot Layer 3 Connectivity

In Part 2, you will verify that Layer 3 connectivity is established on all interfaces. You will need to test both IPv4 and IPv6 connectivity for all device interfaces.

Step 1: Verify the interfaces listed in the Addressing Table are active and configured with correct IP address information.

- a. Issue the **show ip interface brief** command on all three routers to verify that the interfaces are in an up/up state.

R1# **show ip interface brief**

| Interface | IP-Address | OK? | Method | Status | Protocol |
|----------------------------|-----------------|-----|--------|-----------------------|----------|
| Embedded-Service-Engine0/0 | unassigned | YES | unset | administratively down | down |
| GigabitEthernet0/0 | unassigned | YES | unset | administratively down | down |
| GigabitEthernet0/1 | unassigned | YES | unset | administratively down | down |
| Serial0/0/0 | 192.168.21.1 | YES | manual | administratively down | down |
| Serial0/0/1 | unassigned | YES | unset | administratively down | down |
| Loopback0 | 209.165.200.225 | YES | manual | up | up |
| Loopback1 | 192.168.1.1 | YES | manual | up | up |
| Loopback2 | 192.168.2.1 | YES | manual | up | up |

R2# **show ip interface brief**

| Interface | IP-Address | OK? | Method | Status | Protocol |
|----------------------------|--------------|-----|--------|-----------------------|----------|
| Embedded-Service-Engine0/0 | unassigned | YES | unset | administratively down | down |
| GigabitEthernet0/0 | unassigned | YES | unset | administratively down | down |
| GigabitEthernet0/1 | unassigned | YES | unset | administratively down | down |
| Serial0/0/0 | 192.168.12.2 | YES | manual | down | down |
| Serial0/0/1 | 192.168.23.2 | YES | SLARP | up | up |
| Loopback6 | 192.168.6.1 | YES | manual | up | up |

R3# **show ip interface brief**

| Interface | IP-Address | OK? | Method | Status | Protocol |
|----------------------------|--------------|-----|--------|-----------------------|----------|
| Embedded-Service-Engine0/0 | unassigned | YES | unset | administratively down | down |
| GigabitEthernet0/0 | unassigned | YES | unset | administratively down | down |
| GigabitEthernet0/1 | unassigned | YES | unset | administratively down | down |
| Serial0/0/0 | unassigned | YES | unset | administratively down | down |
| Serial0/0/1 | 192.168.23.1 | YES | manual | up | up |
| Loopback4 | 192.168.4.1 | YES | manual | up | up |
| Loopback5 | 192.168.5.1 | YES | manual | up | up |

- b. Issue the **show run | section interface** command to view all the commands related to interfaces.

R1:

R1# **show run | section interface**

```
interface Loopback0
 ip address 209.165.200.225 255.255.255.252
interface Loopback1
 ip address 192.168.1.1 255.255.255.0
 ipv6 address 2001:DB80:ACAD:1::1/64
 ipv6 ospf 1 area 0
 ipv6 ospf network point-to-point
interface Loopback2
 ip address 192.168.2.1 255.255.255.0
 ipv6 address 2001:DB8:ACAD:2::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
ip address 192.168.21.1 255.255.255.252
shutdown
ipv6 address FE80::1 link-local
ipv6 address 2001:DB8:ACAD:12::1/64
ipv6 ospf 1 area 1
clock rate 128000
interface Serial0/0/1
no ip address
shutdown
passive-interface Loopback1
passive-interface Loopback2
```

R2:

```
R2# show run | section interface
interface Loopback6
ip address 192.168.6.1 255.255.255.0
ipv6 address 2001:DB8:CAD:6::1/64
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
ip address 192.168.12.2 255.255.255.252
ipv6 address FE80::2 link-local
ipv6 address 2001:DB8:ACAD:12::2/64
```



```
ipv6 ospf 1 area 0
interface Serial0/0/1
ip address 192.168.23.2 255.255.255.252
ipv6 address FE80::2 link-local
ipv6 address 2001:DB8:ACAD:23::2/64
ipv6 ospf 1 area 3
clock rate 128000
passive-interface Loopback6
```

R3:

```
R3# show run | section interface
interface Loopback4
ip address 192.168.4.1 255.255.255.0
ipv6 address 2001:DB8:ACAD:4::1/64
ipv6 ospf 1 area 3
interface Loopback5
ip address 192.168.5.1 255.255.255.0
ipv6 address 2001:DB8:ACAD:5::1/64
ipv6 ospf 1 area 3
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
ip address 192.168.23.1 255.255.255.252
ipv6 address FE80::3 link-local
ipv6 address 2001:DB8:ACAD:23::1/64
ipv6 ospf 1 area 3
passive-interface Loopback4
passive-interface Loopback5
```

- c. Resolve all problems found. Record the commands used to correct the configuration.

```
R1(config)# interface s0/0/0
R1(config-if)# ip address 192.168.12.1 255.255.255.252
R1(config-if)# no shutdown
R1(config-if)# interface lo1
R1(config-if)# no ipv6 address 2001:DB80:ACAD:1::1/64
R1(config-if)# ipv6 address 2001:db8:acad:1::1/64
R1(config-if)# end

R2(config)# interface lo6
R2(config-if)# no ipv6 address 2001:DB8:CAD:6::1/64
R2(config-if)# ipv6 address 2001:db8:acad:6::1/64
R2(config-if)# end
```

R3: No L3 connectivity issues

- d. Using the **ping** command, verify that IPv4 and IPv6 connectivity has been established on all directly connected router interfaces. If problems still exist, continue troubleshooting Layer 3 issues.

Part 3: Troubleshoot OSPFv2

Note: LAN (loopback) interfaces should not advertise OSPF routing information, but routes to these networks should be contained in the routing tables.

Step 1: Test IPv4 end-to-end connectivity.

From each router, ping all interfaces on the other routers. Record your results below as IPv4 OSPFv2 connectivity problems do exist.

```
R1 to R2: All pings were successful.
R1 to R3: All pings failed.
R2 to R1: All pings were successful.
R2 to R3: Pings to the Loopback 4 and 5 failed.
R3 to R1: All pings failed.
R3 to R2: Pings to the Loopback 6 and Serial 0/0/0 failed.
```

Step 2: Verify that all interfaces are assigned to the proper OSPFv2 areas on R1.

- a. Issue the **show ip protocols** command to verify that OSPF is running and that all networks are being advertised in the correct areas. Verify that the router ID is set correctly, as well for OSPF.

```
R1# show ip protocols
*** IP Routing is NSF aware ***

Routing Protocol is "ospf 1"
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Router ID 1.1.1.1
  It is an area border and autonomous system boundary router
  Redistributing External Routes from,
  Number of areas in this router is 2. 2 normal 0 stub 0 nssa
  Maximum path: 4
  Routing for Networks:
    192.168.2.0 0.0.0.255 area 1
    192.168.12.0 0.0.0.3 area 0
  Passive Interface(s):
    Loopback1
    Loopback2
  Routing Information Sources:
    Gateway         Distance      Last Update
    2.2.2.2          110          00:10:43
  Distance: (default is 110)
```

- b. If required, make the necessary changes needed to the configuration on R1 based on the output from the **show ip protocols** command. Record the commands used to correct the configuration.

```
R1(config)# router ospf 1
R1(config-router)# network 192.168.1.0 0.0.0.255 area 1
R1(config-router)# end
```

- c. If required, re-issue the **show ip protocols** command to verify that your changes had the desired effect.
- d. Issue the **show ip ospf interface brief** command to verify that the serial interface and loopback interfaces 1 and 2 are listed as OSPF networks assigned to their respective areas.

```
R1# show ip ospf interface brief

Interface    PID   Area      IP Address/Mask    Cost   State  Nbrs  F/C
Se0/0/0      1     0         192.168.12.1/30    64     P2P    1/1
Lo2          1     1         192.168.2.1/24     1      LOOP   0/0
Lo1          1     1         192.168.1.1/24     1      LOOP   0/0
```

- e. Resolve any problems discovered on R1 for OSPFv2.

Instructor Note: All problems were resolved for OSPFv2 on R1.

Step 3: Verify that all interfaces are assigned to the proper OSPFv2 areas on R2.

- a. Issue the **show ip protocols** command to verify that OSPF is running and that all networks are being advertised in their proper respective areas. Verify that the router ID is also set correctly.

```
R2# show ip protocols
*** IP Routing is NSF aware ***
```

```
Routing Protocol is "ospf 1"
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Router ID 2.2.2.2
  It is an area border router
  Number of areas in this router is 2. 2 normal 0 stub 0 nssa
  Maximum path: 4
  Routing for Networks:
    192.168.6.0 0.0.0.255 area 3
    192.168.12.0 0.0.0.3 area 0
    192.168.23.0 0.0.0.3 area 3
  Passive Interface(s):
    Loopback6
  Routing Information Sources:
    Gateway         Distance      Last Update
    1.1.1.1          110          00:09:33
  Distance: (default is 110)
```

- b. If required, make any necessary changes to the configuration on R2 based on the output from the **show ip protocols** command. Record the commands used to correct the configuration.

No changes are necessary on R2 for OSPFv2.

Instructor Note: No changes are necessary on R2 for OSPFv2.

- c. If required, re-issue the **show ip protocols** command to verify that your changes had the desired effect.
- d. Issue the **show ip ospf interface brief** command to verify that all interfaces are listed as OSPF networks assigned to their proper respective areas.

R2# **show ip ospf interface brief**

| Interface | PID | Area | IP Address/Mask | Cost | State | Nbrs | F/C |
|-----------|-----|------|-----------------|------|-------|------|-----|
| Se0/0/0 | 1 | 0 | 192.168.12.2/30 | 64 | P2P | 1/1 | |
| Lo6 | 1 | 3 | 192.168.6.1/24 | 1 | LOOP | 0/0 | |
| Se0/0/1 | 1 | 3 | 192.168.23.2/30 | 64 | P2P | 0/0 | |

- e. Resolve any problems discovered on R2 for OSPFv2.

Instructor Note: All problems were resolved for OSPFv2 on R2.

Step 4: Verify that all interfaces are assigned to the proper OSPFv2 areas on R3.

- a. Issue the **show ip protocols** command to verify that OSPF is running and that all networks are being advertised in their respective areas. Verify that the router ID is also set correctly.

R3# **show ip protocols**

```
*** IP Routing is NSF aware ***
```

```
Routing Protocol is "ospf 1"
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
```

```

Router ID 3.3.3.3
Number of areas in this router is 1. 1 normal 0 stub 0 nssa
Maximum path: 4
Routing for Networks:
  192.168.4.0 0.0.0.255 area 3
  192.168.5.0 0.0.0.255 area 3
Passive Interface(s):
  Loopback4
  Loopback5
Routing Information Sources:
  Gateway          Distance      Last Update
Distance: (default is 110)

```

- b. If required, make the necessary changes to the configuration on R3 based on the output from the **show ip protocols** command. Record the commands used to correct the configuration.

```

R3(config)# router ospf 1
R3(config-router)# network 192.168.23.0 0.0.0.3 area 3
R3(config-router)# end

```

- c. If required, re-issue the **show ip protocols** command to verify that your changes had the desired effect.
- d. Issue the **show ip ospf interface brief** command to verify that all interfaces are listed as OSPF networks assigned to their proper areas.

```

R3# show ip ospf interface brief

```

| Interface | PID | Area | IP Address/Mask | Cost | State | Nbrs | F/C |
|-----------|-----|------|-----------------|------|-------|------|-----|
| Lo4 | 1 | 3 | 192.168.4.1/24 | 1 | LOOP | 0/0 | |
| Lo5 | 1 | 3 | 192.168.5.1/24 | 1 | LOOP | 0/0 | |
| Se0/0/1 | 1 | 3 | 192.168.23.1/30 | 64 | P2P | 1/1 | |

- e. Resolve any problems discovered on R3 for OSPFv2.

Instructor Note: All problems were resolved for OSPFv2 on R3.

Step 5: Verify OSPFv2 neighbor information.

Issue the **show ip ospf neighbor** command to verify that each router has all OSPFv2 neighbors listed.

```

R1# show ip ospf neighbor

```

| Neighbor ID | Pri | State | Dead Time | Address | Interface |
|-------------|-----|---------|-----------|--------------|-------------|
| 2.2.2.2 | 0 | FULL/ - | 00:00:39 | 192.168.12.2 | Serial0/0/0 |

```

R2# show ip ospf neighbor

```

| Neighbor ID | Pri | State | Dead Time | Address | Interface |
|-------------|-----|---------|-----------|--------------|-------------|
| 1.1.1.1 | 0 | FULL/ - | 00:00:31 | 192.168.12.1 | Serial0/0/0 |
| 3.3.3.3 | 0 | FULL/ - | 00:00:39 | 192.168.23.1 | Serial0/0/1 |

```

R3# show ip ospf neighbor

```

| Neighbor ID | Pri | State | Dead Time | Address | Interface |
|-------------|-----|---------|-----------|--------------|-------------|
| 2.2.2.2 | 0 | FULL/ - | 00:00:39 | 192.168.23.2 | Serial0/0/1 |

Step 6: Verify OSPFv2 routing information.

- Issue the **show ip route ospf** command to verify that each router has all OSPFv2 routes in their respective routing tables.

R1# **show ip route ospf**

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
+ - replicated route, % - next hop override

Gateway of last resort is 0.0.0.0 to network 0.0.0.0

```
192.168.4.0/32 is subnetted, 1 subnets
O IA    192.168.4.1 [110/129] via 192.168.12.2, 00:16:10, Serial0/0/0
192.168.5.0/32 is subnetted, 1 subnets
O IA    192.168.5.1 [110/129] via 192.168.12.2, 00:16:10, Serial0/0/0
192.168.6.0/32 is subnetted, 1 subnets
O IA    192.168.6.1 [110/65] via 192.168.12.2, 00:56:07, Serial0/0/0
192.168.23.0/30 is subnetted, 1 subnets
O IA    192.168.23.0 [110/128] via 192.168.12.2, 00:56:07, Serial0/0/0
```

R2# **show ip route ospf**

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
+ - replicated route, % - next hop override

Gateway of last resort is 192.168.12.1 to network 0.0.0.0

```
O*E2  0.0.0.0/0 [110/1] via 192.168.12.1, 00:57:11, Serial0/0/0
192.168.1.0/32 is subnetted, 1 subnets
O IA    192.168.1.1 [110/65] via 192.168.12.1, 00:39:50, Serial0/0/0
192.168.2.0/32 is subnetted, 1 subnets
O IA    192.168.2.1 [110/65] via 192.168.12.1, 00:57:10, Serial0/0/0
192.168.4.0/32 is subnetted, 1 subnets
O       192.168.4.1 [110/65] via 192.168.23.1, 00:17:13, Serial0/0/1
192.168.5.0/32 is subnetted, 1 subnets
O       192.168.5.1 [110/65] via 192.168.23.1, 00:17:13, Serial0/0/1
```

R3# **show ip route ospf**

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
+ - replicated route, % - next hop override

Gateway of last resort is 192.168.23.1 to network 0.0.0.0

```
O*E2 0.0.0.0/0 [110/1] via 192.168.23.1, 00:18:06, Serial0/0/1
      192.168.1.0/32 is subnetted, 1 subnets
O IA   192.168.1.1 [110/129] via 192.168.23.2, 00:18:06, Serial0/0/1
      192.168.2.0/32 is subnetted, 1 subnets
O IA   192.168.2.1 [110/129] via 192.168.23.2, 00:18:06, Serial0/0/1
      192.168.6.0/32 is subnetted, 1 subnets
O      192.168.6.1 [110/65] via 192.168.23.2, 00:18:06, Serial0/0/1
      192.168.12.0/30 is subnetted, 1 subnets
O IA   192.168.12.0 [110/128] via 192.168.23.2, 00:18:06, Serial0/0/1
```

- b. If any OSPFv2 routes are missing, troubleshoot and resolve the problems.

Instructor Note: All routes for OSPFv2 are in all three routing tables.

Step 7: Verify IPv4 end-to-end connectivity.

From each router, ping all interfaces on other routers. If IPv4 end-to-end connectivity does not exist, then continue troubleshooting to resolve any remaining issues.

Part 4: Troubleshoot OSPFv3

Note: LAN (loopback) interfaces should not advertise OSPFv3 routing information, but routes to these networks should be contained in the routing tables.

Step 1: Test IPv6 end-to-end connectivity.

From each router, ping all interfaces on the other routers. Record your results as IPv6 connectivity problems do exist.

R1 to R2: All pings to loopback 6 failed.

R1 to R3: All pings were successful.

R2 to R1: All pings to loopback 1 and 2 failed.

R2 to R3: All pings were successful.

R3 to R1: All pings were successful.

R3 to R2: All pings were successful.

Step 2: Verify that IPv6 unicast routing has been enabled on all routers.

- a. An easy way to verify that IPv6 routing has been enabled on a router is to use the **show run | section ipv6 unicast** command. By adding the pipe section to the **show run** command, the **ipv6 unicast-routing** command is displayed if IPv6 routing has been enabled.

```
R1# show run | section ipv6 unicast
ipv6 unicast-routing
```

```
R2# show run | section ipv6 unicast
ipv6 unicast-routing
```

```
R3# show run | section ipv6 unicast
ipv6 unicast-routing
```

- b. If IPv6 unicast routing is not enabled on one or more routers, enable it now. If required, record the commands used to correct the configuration.

IPv6 routing has been enabled on all routers.

Step 3: Verify that all interfaces are assigned to the proper OSPFv3 areas on R1.

- a. Issue the **show ipv6 protocols** command to verify that the router ID is correct and the expected interfaces display in their proper areas.

```
R1# show ipv6 protocols
IPv6 Routing Protocol is "connected"
IPv6 Routing Protocol is "ND"
IPv6 Routing Protocol is "ospf 1"
  Router ID 209.165.200.225
  Area border router
  Number of areas: 2 normal, 0 stub, 0 nssa
  Interfaces (Area 0):
    Serial0/0/0
  Interfaces (Area 1):
    Loopback2
  Redistribution:
    None
```

- b. If required, make any necessary changes to the configuration on R1 based on the output from the **show ipv6 protocols** command. Record the commands used to correct the configuration. It may be necessary to reset OSPF process by issuing the **clear ipv6 ospf process** command.

```
R1(config)# interface lo1
R1(config-if)# ipv6 ospf 1 area 1
R1(config-if)# ipv6 router ospf 1
R1(config-rtr)# router-id 1.1.1.1
```


- c. Re-issue the **show ipv6 protocols** command on R1 to make sure changes took effect.

```
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):
    Loopback2
    Loopback1
  Redistribution:
    None
```

- d. Enter the **show ipv6 route ospf** command on R1 to verify that the interarea route summarization is configured correctly.

```
R1# show ipv6 route ospf
IPv6 Routing Table - default - 12 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
O   2001:DB8:ACAD::/61 [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:23::/64 [110/128]
    via FE80::2, Serial0/0/0
```

- e. Which IPv6 networks are included in the interarea route summarization shown in the routing table?

```
2001:DB8:ACAD::/64 through 2001:DB8:ACAD:7::/64
```

- f. If required, make the necessary configuration changes on R1. Record the commands used to correct the configuration.

```
R1(config)# ipv6 router ospf 1
R1(config-rtr)# no area 1 range 2001:DB8:ACAD::/61
R1(config-rtr)# area 1 range 2001:DB8:ACAD::/62
```

- g. If required, re-issue the **show ipv6 route ospf** command on R1 to verify the changes.

```
R1# show ipv6 route ospf
IPv6 Routing Table - default - 11 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
O   2001:DB8:ACAD::/62 [110/1]
    via Null0, directly connected
OI  2001:DB8:ACAD:4::1/128 [110/128]
    via FE80::2, Serial0/0/0
OI  2001:DB8:ACAD:5::1/128 [110/128]
    via FE80::2, Serial0/0/0
OI  2001:DB8:ACAD:23::/64 [110/128]
    via FE80::2, Serial0/0/0
```

Step 4: Verify that all interfaces are assigned to the proper OSPFv3 areas on R2.

- Issue the **show ipv6 protocols** command and verify that the router ID is correct and that the expected interfaces are showing up under their proper areas.

```
R2# show ipv6 protocols
IPv6 Routing Protocol is "connected"
IPv6 Routing Protocol is "ND"
IPv6 Routing Protocol is "ospf 1"
  Router ID 2.2.2.2
  Area border router
  Number of areas: 2 normal, 0 stub, 0 nssa
  Interfaces (Area 0):
    Serial0/0/0
  Interfaces (Area 3):
    Serial0/0/1
  Redistribution:
    None
```

- If required, make any necessary changes to the configuration on R2 based on the output from the **show ipv6 protocols** command. Record the commands used to correct the configuration. It may be necessary to reset OSPF process by issuing the **clear ipv6 ospf process** command.

```
R2(config)# interface lo 6
R2(config-if)# ipv6 ospf 1 area 3
```

- Verify that the configuration change has the desired effect.

```
R2# show ipv6 protocols
IPv6 Routing Protocol is "connected"
IPv6 Routing Protocol is "ND"
IPv6 Routing Protocol is "ospf 1"
```

```
Router ID 2.2.2.2
Area border router
Number of areas: 2 normal, 0 stub, 0 nssa
Interfaces (Area 0):
  Serial0/0/0
Interfaces (Area 3):
  Loopback6
  Serial0/0/1
Redistribution:
  None
```

Step 5: Verify that all interfaces are assigned to the proper OSPFv3 areas on R3.

- a. Issue the **show ipv6 protocols** command to verify that the router ID is correct and the expected interfaces display under their respective areas.

```
R3# show ipv6 protocols
IPv6 Routing Protocol is "connected"
IPv6 Routing Protocol is "ND"
IPv6 Routing Protocol is "ospf 1"
  Router ID 3.3.3.3
  Number of areas: 1 normal, 0 stub, 0 nssa
  Interfaces (Area 3):
    Loopback4
    Loopback5
    Serial0/0/1
  Redistribution:
    None
```

- b. If required, make any necessary changes to the configuration on R3 based on the output from the **show ipv6 protocols** command. Record the commands used to correct the configuration. It may be necessary to reset OSPF process by issuing the **clear ipv6 ospf process** command.

There are no problems with R3.

- c. Verify that the configuration changes have the desired effect.

Step 6: Verify that all routers have correct neighbor adjacency information.

- a. Issue the **show ipv6 ospf neighbor** command to verify that adjacencies have formed between neighboring routers.

```
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/ -         00:00:37    6             Serial0/0/0

R2# show ipv6 ospf neighbor
OSPFv3 Router with ID (2.2.2.2) (Process ID 1)
```

| Neighbor ID | Pri | State | Dead Time | Interface ID | Interface |
|-------------|-----|---------|-----------|--------------|-------------|
| 1.1.1.1 | 0 | FULL/ - | 00:00:39 | 6 | Serial0/0/0 |
| 3.3.3.3 | 0 | FULL/ - | 00:00:35 | 7 | Serial0/0/1 |

R3# **show ipv6 ospf neighbor**

OSPFv3 Router with ID (3.3.3.3) (Process ID 1)

| Neighbor ID | Pri | State | Dead Time | Interface ID | Interface |
|-------------|-----|---------|-----------|--------------|-------------|
| 2.2.2.2 | 0 | FULL/ - | 00:00:34 | 7 | Serial0/0/1 |

Step 7: Verify OSPFv3 routing information.

- a. Issue the **show ipv6 route ospf** command, and verify that OSPFv3 routes exist to all networks.

R1# **show ipv6 route ospf**

IPv6 Routing Table - default - 12 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

```
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::1/128 [110/64]
    via FE80::2, Serial0/0/0
OI 2001:DB8:ACAD:23::/64 [110/128]
    via FE80::2, Serial0/0/0
```

R2# **show ipv6 route ospf**

IPv6 Routing Table - default - 10 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

```
OI 2001:DB8:ACAD::/62 [110/65]
    via FE80::1, Serial0/0/0
O 2001:DB8:ACAD:4::/64 [110/65]
    via FE80::3, Serial0/0/1
O 2001:DB8:ACAD:5::/64 [110/65]
    via FE80::3, Serial0/0/1
```

R3# **show ipv6 route ospf**

```
IPv6 Routing Table - default - 10 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:6::1/128 [110/64]
    via FE80::2, Serial0/0/1
OI  2001:DB8:ACAD:12::/64 [110/128]
    via FE80::2, Serial0/0/1
```

- b. Resolve any routing issues that still exist.

Instructor Note: All OSPFv3 routing issues should have been resolved.

Step 8: Verify IPv6 end-to-end connectivity.

From each router, ping all of the IPv6 interfaces on the other routers. If IPv6 end-to-end issues still exist, continue troubleshooting to resolve any remaining issues.

Reflection

Why not just use the **show running-config** command to resolve all issues?

Specific show commands give you the appropriate information that you need to verify settings without showing a lot of extraneous information.

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

Router R1

```
R1#sh run
Building configuration...

Current configuration : 2041 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 06YFDUHH61wAE/kLkDq9BGho1QM5EnRtoyr8cHAUg.2
!
no aaa new-model
!
!
!
```

```
!  
!  
!  
!  
no ip domain lookup  
ip cef  
ipv6 unicast-routing  
ipv6 cef  
multilink bundle-name authenticated  
  
interface Loopback0  
ip address 209.165.200.225 255.255.255.252  
!  
interface Loopback1  
ip address 192.168.1.1 255.255.255.0  
ipv6 address 2001:DB8:ACAD:1::1/64  
ipv6 ospf 1 area 1  
ipv6 ospf network point-to-point  
!  
interface Loopback2  
ip address 192.168.2.1 255.255.255.0  
ipv6 address 2001:DB8:ACAD:2::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  
ip address 192.168.12.1 255.255.255.252  
ipv6 address FE80::1 link-local  
ipv6 address 2001:DB8:ACAD:12::1/64  
ipv6 ospf 1 area 0  
clock rate 128000  
!  
interface Serial0/0/1
```

```
no ip address
shutdown
clock rate 2000000
!
router ospf 1
router-id 1.1.1.1
passive-interface Loopback1
passive-interface Loopback2
network 192.168.1.0 0.0.0.255 area 1
network 192.168.2.0 0.0.0.255 area 1
network 192.168.12.0 0.0.0.3 area 0
default-information originate
!
ip forward-protocol nd
!
no ip http server
no ip http secure-server
!
ip route 0.0.0.0 0.0.0.0 Loopback0
!
ipv6 router ospf 1
router-id 1.1.1.1
area 1 range 2001:DB8:ACAD::/62
!
!
!
!
control-plane
!
!
banner motd ^C
  Unauthorized Access is 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
logging synchronous
login
```



```
transport input all
!  
scheduler allocate 20000 1000
!  
end
```

Router R2

```
R2#sh run
Building configuration...

Current configuration : 1847 bytes
!
version 15.2
service timestamps debug datetime msec
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
!
interface Loopback6
 ip address 192.168.6.1 255.255.255.0
 ipv6 address 2001:DB8:ACAD:6::1/64
 ipv6 ospf 1 area 3
!
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
ip address 192.168.12.2 255.255.255.252
ipv6 address FE80::2 link-local
ipv6 address 2001:DB8:ACAD:12::2/64
ipv6 ospf 1 area 0
!
interface Serial0/0/1
ip address 192.168.23.2 255.255.255.252
ipv6 address FE80::2 link-local
ipv6 address 2001:DB8:ACAD:23::2/64
ipv6 ospf 1 area 3
clock rate 128000
!
router ospf 1
router-id 2.2.2.2
passive-interface Loopback6
network 192.168.6.0 0.0.0.255 area 3
network 192.168.12.0 0.0.0.3 area 0
network 192.168.23.0 0.0.0.3 area 3
!
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 ^C
  Unauthorized Access is 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
  logging synchronous
  login
  transport input all
!
scheduler allocate 20000 1000
!
end
```

Router R3

```
R3#sh run
Building configuration...

Current configuration : 1853 bytes
!
version 15.2
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R3
!
boot-start-marker
boot-end-marker
!
!
enable secret 4 06YFDUHH61wAE/kLkDq9BGho1QM5EnRtoyr8cHAUg.2
!
no aaa new-model
!
!
!
!
!
!
```

Lab – Troubleshooting Multiarea OSPFv2 and OSPFv3

```
no ip domain lookup
ip cef
ipv6 unicast-routing
ipv6 cef
multilink bundle-name authenticated
!

interface Loopback4
 ip address 192.168.4.1 255.255.255.0
 ipv6 address 2001:DB8:ACAD:4::1/64
 ipv6 ospf 1 area 3
!
interface Loopback5
 ip address 192.168.5.1 255.255.255.0
 ipv6 address 2001:DB8:ACAD:5::1/64
 ipv6 ospf 1 area 3
!
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
 ip address 192.168.23.1 255.255.255.252
 ipv6 address FE80::3 link-local
 ipv6 address 2001:DB8:ACAD:23::1/64
 ipv6 ospf 1 area 3
!
router ospf 1
 router-id 3.3.3.3
 passive-interface Loopback4
 passive-interface Loopback5
 network 192.168.4.0 0.0.0.255 area 3
```

Lab – Troubleshooting Multiarea OSPFv2 and OSPFv3

```
network 192.168.5.0 0.0.0.255 area 3
network 192.168.23.0 0.0.0.3 area 3
!
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 ^C
  Unauthorized Access is 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
logging synchronous
login
transport input all
!
scheduler allocate 20000 1000
!
end
```