

# Mike Azure

*Advanced Cisco CCNP  
Networking*

Multi-Area OSPF  
Configuration

Lab 2

**OSPF Setup**

**Lab 1**

## Purpose

The purpose of this lab was to learn how to implement multi-area OSPF.

## Background Information on Lab Concepts

OSPF (Open Shortest Path First) is a routing protocol (for IPV4 and IPV6) used to distribute traffic in a network. Notably, OSPF is a link-state protocol. This means OSPF has full awareness of the topology of its network by sending position requests (or LSA's) to each router on the network. It essentially has a picture of all the devices in the area, allowing it to find the shortest path to route traffic. The method OSPF uses to find the shortest path between links is called Dijkstra's Algorithm. Dijkstra's Algorithm is generally used to find the shortest path between two points, and it is frequently utilized in GPS apps such as Google Maps. To understand how OSPF uses Dijkstra's Algorithm, imagine you are in a large maze and must deliver envelopes to mailboxes scattered throughout the maze. While walking through the maze, you discover a mailbox, and deliver your first envelope. Eventually, after an extended period of time, you find all of the mailboxes and deliver all of your envelopes. When you are given a new set of envelopes to deliver, you enter the maze again, but this time you remember the position of the mailboxes from your last time entering the maze. Since you remember the mailbox positions, you can deliver the envelopes faster. Eventually, after multiple series of delivering the envelopes, you have learned the layout of the mailboxes and maze. Therefore, you can efficiently deliver the envelopes. OSPF works the same way. Instead of delivering envelopes to mailboxes, OSPF delivers packets to routers. Overtime, it learns the topology (or maze) of the network and finds the shortest path between routers using Dijkstra's Algorithm. By having a full picture of the network and knowing the shortest path between routers, OSPF can quickly route traffic. Single area OSPF is commonly used in small networks, while multi-area OSPF is used in larger networks (20-30 routers). The advantage of multi-area OSPF in large networks is decreased CPU usage as a result of a smaller routing table. Using the above analogy, instead of having to remember one large maze with a bunch of mailboxes, you only have to remember the locations of a few mailboxes in one area of the maze.

## Lab Summary

We first created a topology and labeled our desired areas for the OSPF configuration. We then subnetted all of the networks required in these areas. After we created a document with the config for each router in the network, we tested our configuration using packet tracer and debugged accordingly. Once the simulated multi-area OSPF configuration functioned perfectly in packet tracer, we moved to setting up the network on the CCNP lab equipment. We connected the routers according to our topology. We found our configuration did not function perfectly on the CCNP lab equipment, so we proceeded to debug. To test our setup, we pinged the loopback interfaces and IP addresses of all the routers from each router. Using this system, we were able to identify the errors and fix them. A modification we made to OSPF was changing the dead interval timer to 80 seconds on each router.

## Lab Commands

```
Router> enable
```

Turns on privileged exec mode which allows changes to be made to the router.

```
Router# config t
```

Enters the router config file and allows you to make changes to the router configuration file.

```
Router# copy run start
```

Saves the running-configuration (current config on the router, includes the edits you have made during the session, clears when the router powers off) to the startup-configuration (file that router pulls running-config from on bootup, default config)

```
Router# show ip route
```

Displays information about the various routes that are available to the router, including the protocol by which the route was acquired (OSPF, RIP, EGRIP, static, etc.)

Router# show **ip ospf**

Displays general information about all OSPF instances and roles on the router

Router# show **ip ospf interface**

Displays the OSPF status of all OSPF-enabled interfaces on the router

Router# show **ip route**

Displays information about the various routes that are available to the router, including the protocol by which the route was acquired (OSPF, RIP, EGRIP, static, etc.)

Router# show **ip ospf neighbor**

Displays the OSPF status of routers that are directly connected and OSPF-enabled

Router(config)# **interface** [*interface*] [*id*]

Enables configuration on a specific interface.

Router(config)# **router ospf** [*process id*]

Enables the OSPF routing protocol and enters router configuration mode.

It is good practice for the process ID to be the same, however isn't necessary for OSPF to form adjacencies; process ID is only locally significant. Each OSPF process retains a different routing table, so depending on the configuration, process ID could determine what routes are redistributed. A router can have multiple OSPF processes but will contain a separate OSPF database per process.

Router(config-router)# **network** [*network address*] [*wildcard mask*] area [*area number*]

Activates OSPFv2 for a specific subnet.

This command is typed after you enter router OSPF configuration mode. Routers in a particular area share a complete topological database and have route summaries of external areas.

Router(config-if)# **ip ospf dead-interval** [*interval time in seconds*]

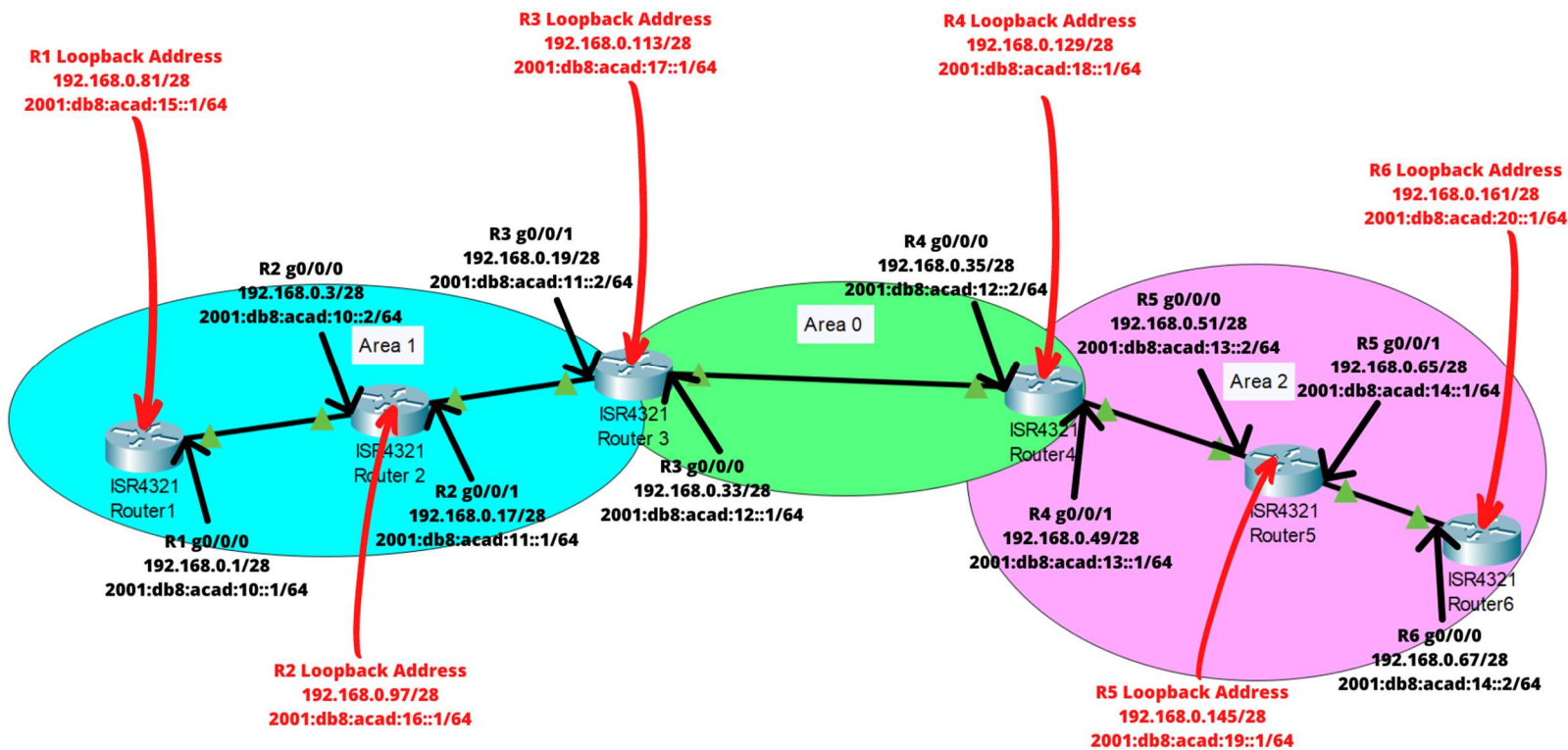
Modifies the timer value for the OSPF dead-interval. If an interface stops sending hello packets, other routers will use this timer to determine when to remove it from the SPF tree.

Router(config-if)# **ipv6 ospf** [*process id*] area [*number*]

Activates OSPFv3 under a specific interface.

This command is typed when in interface configuration mode. It is good practice for the process ID to be the same, however isn't necessary for OSPF to form adjacencies; process ID is only locally significant. Each OSPF process retains a different routing table, so depending on the configuration, process ID could determine what routes are redistributed. A router can have multiple OSPF processes but will contain a separate OSPF database per process. Routers in a particular area share a complete topological database and have route summaries of external areas.

# Network Diagram with IP's



## Configurations

### Router 1:

```
R1#show run
Building configuration...
Current configuration : 1762 bytes
Last configuration change at 18:27:00
UTC Tue Sep 28 2021
version 15.5
service timestamps debug datetime
msec
service timestamps log datetime msec
no platform punt-keepalive disable-
kernel-core
hostname R1
boot-start-marker
boot-end-marker
vrf definition Mgmt-intf
address-family ipv4
exit-address-family
address-family ipv6
exit-address-family
no aaa new-model
ipv6 unicast-routing
subscriber templating
```

```
multilink bundle-name authenticated
license udi pid ISR4321/K9 sn FDO21482
DXE
spanning-tree extend system-id
redundancy
mode none
vlan internal allocation policy
ascending
interface Loopback0
ip address 192.168.0.81
255.255.255.240
ipv6 address 2001:DB8:ACAD:15::1/64
ipv6 ospf 10 area 1
interface GigabitEthernet0/0/0
ip address 192.168.0.1
255.255.255.240
negotiation auto
ipv6 address 2001:DB8:ACAD:10::1/64
ipv6 ospf 10 area 1
interface GigabitEthernet0/0/1
no ip address
shutdown
```

```

negotiation auto
interface Serial0/1/0
no ip address
shutdown
interface Serial0/1/1
no ip address
shutdown
interface GigabitEthernet0/2/0
no ip address
shutdown
negotiation auto
interface GigabitEthernet0/2/1
no ip address
shutdown
negotiation auto
interface GigabitEthernet0
vrf forwarding Mgmt-intf
no ip address
shutdown
negotiation auto
interface Vlan1
R1#show ip route
no ip address
shutdown
router ospf 10
network 192.168.0.0 0.0.0.15 area 1
network 192.168.0.80 0.0.0.15 area 1
ip forward-protocol nd
no ip http server
no ip http secure-server
ip tftp source-interface
GigabitEthernet0
ipv6 router ospf 10
router-id 1.1.1.1
control-plane
line con 0
stopbits 1
line aux 0
stopbits 1
line vty 0 4
login
End

```

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

```

192.168.0.0/24 is variably subnetted, 13 subnets, 2 masks
C      192.168.0.0/28 is directly connected, GigabitEthernet0/0/0
L      192.168.0.1/32 is directly connected, GigabitEthernet0/0/0
O      192.168.0.16/28
        [110/2] via 192.168.0.3, 00:12:50, GigabitEthernet0/0/0
O IA   192.168.0.32/28
        [110/3] via 192.168.0.3, 00:12:50, GigabitEthernet0/0/0
O IA   192.168.0.48/28
        [110/4] via 192.168.0.3, 00:12:31, GigabitEthernet0/0/0
O IA   192.168.0.64/28
        [110/5] via 192.168.0.3, 00:12:05, GigabitEthernet0/0/0
C      192.168.0.80/28 is directly connected, Loopback0
L      192.168.0.81/32 is directly connected, Loopback0
O      192.168.0.97/32
        [110/2] via 192.168.0.3, 00:13:00, GigabitEthernet0/0/0
O      192.168.0.113/32
        [110/3] via 192.168.0.3, 00:12:50, GigabitEthernet0/0/0
O IA   192.168.0.129/32
        [110/4] via 192.168.0.3, 00:12:31, GigabitEthernet0/0/0
O IA   192.168.0.145/32
        [110/5] via 192.168.0.3, 00:12:05, GigabitEthernet0/0/0

```

```
O IA      192.168.0.161/32
          [110/6] via 192.168.0.3, 00:11:31, GigabitEthernet0/0/0
```

```
R1#show ipv6 route
```

```
IPv6 Routing Table - default - 14 entries
```

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

```
       B - BGP, R - RIP, I1 - ISIS L1, I2 - ISIS L2
```

```
       IA - ISIS interarea, IS - ISIS summary, D - EIGRP, EX - EIGRP external
```

```
       ND - ND Default, NDp - ND Prefix, DCE - Destination, NDr - Redirect
```

```
       O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
```

```
       ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2, a - Application
```

```
C  2001:DB8:ACAD:10::/64 [0/0]
    via GigabitEthernet0/0/0, directly connected
L  2001:DB8:ACAD:10::1/128 [0/0]
    via GigabitEthernet0/0/0, receive
O  2001:DB8:ACAD:11::/64 [110/2]
    via FE80::521C:B0FF:FE63:3830, GigabitEthernet0/0/0
OI 2001:DB8:ACAD:12::/64 [110/3]
    via FE80::521C:B0FF:FE63:3830, GigabitEthernet0/0/0
OI 2001:DB8:ACAD:13::/64 [110/4]
    via FE80::521C:B0FF:FE63:3830, GigabitEthernet0/0/0
OI 2001:DB8:ACAD:14::/64 [110/5]
    via FE80::521C:B0FF:FE63:3830, GigabitEthernet0/0/0
C  2001:DB8:ACAD:15::/64 [0/0]
    via Loopback0, directly connected
L  2001:DB8:ACAD:15::1/128 [0/0]
    via Loopback0, receive
O  2001:DB8:ACAD:16::1/128 [110/1]
    via FE80::521C:B0FF:FE63:3830, GigabitEthernet0/0/0
O  2001:DB8:ACAD:17::1/128 [110/2]
    via FE80::521C:B0FF:FE63:3830, GigabitEthernet0/0/0
OI 2001:DB8:ACAD:18::1/128 [110/3]
    via FE80::521C:B0FF:FE63:3830, GigabitEthernet0/0/0
OI 2001:DB8:ACAD:19::1/128 [110/4]
    via FE80::521C:B0FF:FE63:3830, GigabitEthernet0/0/0
OI 2001:DB8:ACAD:20::1/128 [110/5]
    via FE80::521C:B0FF:FE63:3830, GigabitEthernet0/0/0
L  FF00::/8 [0/0]
    via Null0, receive
```

```
R1#show ip ospf neighbor
```

Neighbor ID	Pri	State	Dead Time	Address	Interface
192.168.0.97	1	FULL/DR	00:00:39	192.168.0.3	GigabitEthernet0/0/0

```
R1#show ipv6 ospf neighbor
```

```
OSPFv3 Router with ID (1.1.1.1) (Process ID 10)
```

Neighbor ID	Pri	State	Dead Time	Interface ID	Interface
2.2.2.2	1	FULL/DR	00:00:39	6	GigabitEthernet0/0/0

```

R1#show ip ospf interface
Loopback0 is up, line protocol is up
Internet Address 192.168.0.81/28, Area 1, Attached via Network Statement
Process ID 10, Router ID 192.168.0.81, Network Type LOOPBACK, Cost: 1
Topology-MTID      Cost      Disabled      Shutdown      Topology Name
    0              1          no           no           Base
Loopback interface is treated as a stub Host
GigabitEthernet0/0/0 is up, line protocol is up
Internet Address 192.168.0.1/28, Area 1, Attached via Network Statement
Process ID 10, Router ID 192.168.0.81, Network Type BROADCAST, Cost: 1
Topology-MTID      Cost      Disabled      Shutdown      Topology Name
    0              1          no           no           Base
Transmit Delay is 1 sec, State BDR, Priority 1
Designated Router (ID) 192.168.0.97, Interface address 192.168.0.3
Backup Designated router (ID) 192.168.0.81, Interface address 192.168.0.1
Timer intervals configured, Hello 10, Dead 80, Wait 80, Retransmit 5
  oob-resync timeout 40
  Hello due in 00:00:02
Supports Link-local Signaling (LLS)
Cisco NSF helper support enabled
IETF NSF helper support enabled
Index 1/2/2, flood queue length 0
Next 0x0(0)/0x0(0)/0x0(0)
Last flood scan length is 1, maximum is 1
Last flood scan time is 0 msec, maximum is 0 msec
Neighbor Count is 1, Adjacent neighbor count is 1
  Adjacent with neighbor 192.168.0.97  (Designated Router)
Suppress hello for 0 neighbor(s)

```

```

R1#show ipv6 ospf interface
Loopback0 is up, line protocol is up
Link Local Address FE80::521C:B0FF:FE2C:5100, Interface ID 14
Area 1, Process ID 10, Instance ID 0, Router ID 1.1.1.1
Network Type LOOPBACK, Cost: 1
Loopback interface is treated as a stub Host
GigabitEthernet0/0/0 is up, line protocol is up
Link Local Address FE80::521C:B0FF:FE2C:5100, Interface ID 6
Area 1, Process ID 10, Instance ID 0, Router ID 1.1.1.1
Network Type BROADCAST, Cost: 1
Transmit Delay is 1 sec, State BDR, Priority 1
Designated Router (ID) 2.2.2.2, local address FE80::521C:B0FF:FE63:3830
Backup Designated router (ID) 1.1.1.1, local address
FE80::521C:B0FF:FE2C:5100
Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
  Hello due in 00:00:08
Graceful restart helper support enabled
Index 1/2/2, flood queue length 0
Next 0x0(0)/0x0(0)/0x0(0)
Last flood scan length is 2, maximum is 2
Last flood scan time is 0 msec, maximum is 0 msec
Neighbor Count is 1, Adjacent neighbor count is 1
  Adjacent with neighbor 2.2.2.2  (Designated Router)
Suppress hello for 0 neighbor(s)

```

## Router 2:

```
R2#show run
```

Building configuration...

Current configuration : 1986 bytes

```

Last configuration change at 18:15:00
UTC Tue Sep 28 2021
version 15.5
service timestamps debug datetime msec
service timestamps log datetime msec
no platform punt-keepalive disable-
kernel-core
hostname R2
boot-start-marker
boot-end-marker
vrf definition Mgmt-intf
address-family ipv4
exit-address-family
address-family ipv6
exit-address-family
no aaa new-model
ipv6 unicast-routing
subscriber templating
multilink bundle-name authenticated
license udi pid ISR4321/K9 sn
FDO21500G1N
spanning-tree extend system-id
redundancy
mode none
vlan internal allocation policy
ascending
interface Loopback0
ip address 192.168.0.97 255.255.255.240
ipv6 address 2001:DB8:ACAD:15::1/64
ipv6 address 2001:DB8:ACAD:16::1/64
ipv6 ospf 10 area 1
interface GigabitEthernet0/0/0
ip address 192.168.0.3 255.255.255.240
negotiation auto
ipv6 address 2001:DB8:ACAD:10::1/64
ipv6 address 2001:DB8:ACAD:10::2/64
ipv6 ospf 10 area 1
interface GigabitEthernet0/0/1
ip address 192.168.0.17 255.255.255.240
negotiation auto
ipv6 address 2001:DB8:ACAD:11::1/64
ipv6 ospf 10 area 1
interface Serial0/1/0

```

```

no ip address
shutdown
interface Serial0/1/1
no ip address
shutdown
interface GigabitEthernet0/2/0
no ip address
shutdown
negotiation auto
interface GigabitEthernet0/2/1
no ip address
shutdown
negotiation auto
interface GigabitEthernet0
vrf forwarding Mgmt-intf
no ip address
shutdown
negotiation auto
interface Vlan1
no ip address
shutdown
router ospf 10
network 192.168.0.0 0.0.0.15 area 1
network 192.168.0.16 0.0.0.15 area 1
network 192.168.0.80 0.0.0.15 area 1
network 192.168.0.96 0.0.0.15 area 1
ip forward-protocol nd
no ip http server
no ip http secure-server
ip tftp source-interface
GigabitEthernet0
ipv6 router ospf 10
router-id 2.2.2.2
control-plane
line con 0
stopbits 1
line aux 0
stopbits 1
line vty 0 4
login
End

```

R2# show ip route

```

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

```

    192.168.0.0/24 is variably subnetted, 14 subnets, 2 masks
C      192.168.0.0/28 is directly connected, GigabitEthernet0/0/0
L      192.168.0.3/32 is directly connected, GigabitEthernet0/0/0
C      192.168.0.16/28 is directly connected, GigabitEthernet0/0/1
L      192.168.0.17/32 is directly connected, GigabitEthernet0/0/1
O IA   192.168.0.32/28
        [110/2] via 192.168.0.19, 00:17:40, GigabitEthernet0/0/1
O IA   192.168.0.48/28
        [110/3] via 192.168.0.19, 00:17:21, GigabitEthernet0/0/1
O IA   192.168.0.64/28
        [110/4] via 192.168.0.19, 00:16:55, GigabitEthernet0/0/1
O      192.168.0.81/32
        [110/2] via 192.168.0.1, 00:17:50, GigabitEthernet0/0/0
C      192.168.0.96/28 is directly connected, Loopback0
L      192.168.0.97/32 is directly connected, Loopback0
O      192.168.0.113/32
        [110/2] via 192.168.0.19, 00:17:40, GigabitEthernet0/0/1
O IA   192.168.0.129/32
        [110/3] via 192.168.0.19, 00:17:21, GigabitEthernet0/0/1
O IA   192.168.0.145/32
        [110/4] via 192.168.0.19, 00:16:55, GigabitEthernet0/0/1
O IA   192.168.0.161/32
        [110/5] via 192.168.0.19, 00:16:21, GigabitEthernet0/0/1
```

R2# show ipv6 route

IPv6 Routing Table - default - 16 entries

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

B - BGP, R - RIP, I1 - ISIS L1, I2 - ISIS L2

IA - ISIS interarea, IS - ISIS summary, D - EIGRP, EX - EIGRP external

ND - ND Default, NDp - ND Prefix, DCE - Destination, NDr - Redirect

O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2

ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2, a - Application

```

C 2001:DB8:ACAD:10::/64 [0/0]
    via GigabitEthernet0/0/0, directly connected
L 2001:DB8:ACAD:10::2/128 [0/0]
    via GigabitEthernet0/0/0, receive
C 2001:DB8:ACAD:11::/64 [0/0]
    via GigabitEthernet0/0/1, directly connected
L 2001:DB8:ACAD:11::1/128 [0/0]
    via GigabitEthernet0/0/1, receive
OI 2001:DB8:ACAD:12::/64 [110/2]
    via FE80::B6A8:B9FF:FE47:9231, GigabitEthernet0/0/1
OI 2001:DB8:ACAD:13::/64 [110/3]
    via FE80::B6A8:B9FF:FE47:9231, GigabitEthernet0/0/1
OI 2001:DB8:ACAD:14::/64 [110/4]
    via FE80::B6A8:B9FF:FE47:9231, GigabitEthernet0/0/1
C 2001:DB8:ACAD:15::/64 [0/0]
    via Loopback0, directly connected
L 2001:DB8:ACAD:15::1/128 [0/0]
    via Loopback0, receive
C 2001:DB8:ACAD:16::/64 [0/0]
    via Loopback0, directly connected
L 2001:DB8:ACAD:16::1/128 [0/0]
```

```

    via Loopback0, receive
O   2001:DB8:ACAD:17::1/128 [110/1]
    via FE80::B6A8:B9FF:FE47:9231, GigabitEthernet0/0/1
OI  2001:DB8:ACAD:18::1/128 [110/2]
    via FE80::B6A8:B9FF:FE47:9231, GigabitEthernet0/0/1
OI  2001:DB8:ACAD:19::1/128 [110/3]
    via FE80::B6A8:B9FF:FE47:9231, GigabitEthernet0/0/1
OI  2001:DB8:ACAD:20::1/128 [110/4]
    via FE80::B6A8:B9FF:FE47:9231, GigabitEthernet0/0/1
L   FF00::/8 [0/0]
    via Null0, receive

```

R2#show ip ospf neighbor

Neighbor ID	Pri	State	Dead Time	Address	Interface
192.168.0.113	1	FULL/DR	00:00:37	192.168.0.19	
GigabitEthernet0/0/1					
192.168.0.81	1	FULL/BDR	00:00:32	192.168.0.1	
GigabitEthernet0/0/0					

R2#show ipv6 ospf neighbor

OSPFv3 Router with ID (2.2.2.2) (Process ID 10)

Neighbor ID	Pri	State	Dead Time	Interface ID	Interface
3.3.3.3	1	FULL/DR	00:00:38	7	
GigabitEthernet0/0/1					
1.1.1.1	1	FULL/BDR	00:00:30	6	
GigabitEthernet0/0/0					

R2#show ip ospf

```

Routing Process "ospf 10" with ID 192.168.0.97
Start time: 00:01:48.289, Time elapsed: 00:19:20.646
Supports only single TOS(TOS0) routes
Supports opaque LSA
Supports Link-local Signaling (LLS)
Supports area transit capability
Supports NSSA (compatible with RFC 3101)
Supports Database Exchange Summary List Optimization (RFC 5243)
Event-log enabled, Maximum number of events: 1000, Mode: cyclic
Router is not originating router-LSAs with maximum metric
Initial SPF schedule delay 5000 msec
Minimum hold time between two consecutive SPF's 10000 msec
Maximum wait time between two consecutive SPF's 10000 msec
Incremental-SPF disabled
Minimum LSA interval 5 secs
Minimum LSA arrival 1000 msec
LSA group pacing timer 240 secs
Interface flood pacing timer 33 msec
Retransmission pacing timer 66 msec
EXCHANGE/LOADING adjacency limit: initial 300, process maximum 300
Number of external LSA 0. Checksum Sum 0x000000
Number of opaque AS LSA 0. Checksum Sum 0x000000
Number of DCbitless external and opaque AS LSA 0
Number of DoNotAge external and opaque AS LSA 0

```

```
Number of areas in this router is 1. 1 normal 0 stub 0 nssa
Number of areas transit capable is 0
External flood list length 0
IETF NSF helper support enabled
Cisco NSF helper support enabled
Reference bandwidth unit is 100 mbps
```

Area 1

```
Number of interfaces in this area is 3 (1 loopback)
Area has no authentication
SPF algorithm last executed 00:18:04.707 ago
SPF algorithm executed 5 times
Area ranges are
Number of LSA 11. Checksum Sum 0x0637D5
Number of opaque link LSA 0. Checksum Sum 0x000000
Number of DCbitless LSA 0
Number of indication LSA 0
Number of DoNotAge LSA 0
Flood list length 0
```

R2#show ipv6 ospf

```
Routing Process "ospfv3 10" with ID 2.2.2.2
Supports NSSA (compatible with RFC 3101)
Supports Database Exchange Summary List Optimization (RFC 5243)
Event-log enabled, Maximum number of events: 1000, Mode: cyclic
Router is not originating router-LSAs with maximum metric
Initial SPF schedule delay 5000 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 secs
Minimum LSA arrival 1000 msec
LSA group pacing timer 240 secs
Interface flood pacing timer 33 msec
Retransmission pacing timer 66 msec
Retransmission limit dc 24 non-dc 24
EXCHANGE/LOADING adjacency limit: initial 300, process maximum 300
Number of external LSA 0. Checksum Sum 0x000000
Number of areas in this router is 1. 1 normal 0 stub 0 nssa
Graceful restart helper support enabled
Reference bandwidth unit is 100 mbps
RFC1583 compatibility enabled
```

Area 1

```
Number of interfaces in this area is 3
SPF algorithm executed 3 times
Number of LSA 20. Checksum Sum 0x0A8BF2
Number of DCbitless LSA 0
Number of indication LSA 0
Number of DoNotAge LSA 0
Flood list length 0
```

R2#show ip ospf interface

```
Loopback0 is up, line protocol is up
Internet Address 192.168.0.97/28, Area 1, Attached via Network Statement
Process ID 10, Router ID 192.168.0.97, Network Type LOOPBACK, Cost: 1
Topology-MTID      Cost      Disabled      Shutdown      Topology Name
    0                1          no            no            Base
```

```

Loopback interface is treated as a stub Host
GigabitEthernet0/0/1 is up, line protocol is up
Internet Address 192.168.0.17/28, Area 1, Attached via Network Statement
Process ID 10, Router ID 192.168.0.97, Network Type BROADCAST, Cost: 1
Topology-MTID      Cost      Disabled      Shutdown      Topology Name
    0              1          no            no            Base
Transmit Delay is 1 sec, State BDR, Priority 1
Designated Router (ID) 192.168.0.113, Interface address 192.168.0.19
Backup Designated router (ID) 192.168.0.97, Interface address 192.168.0.17
Timer intervals configured, Hello 10, Dead 80, Wait 80, Retransmit 5
  oob-resync timeout 40
  Hello due in 00:00:00
Supports Link-local Signaling (LLS)
Cisco NSF helper support enabled
IETF NSF helper support enabled
Index 1/3/3, flood queue length 0
Next 0x0(0)/0x0(0)/0x0(0)
Last flood scan length is 1, maximum is 1
Last flood scan time is 0 msec, maximum is 0 msec
Neighbor Count is 1, Adjacent neighbor count is 1
  Adjacent with neighbor 192.168.0.113  (Designated Router)
Suppress hello for 0 neighbor(s)
GigabitEthernet0/0/0 is up, line protocol is up
Internet Address 192.168.0.3/28, Area 1, Attached via Network Statement
Process ID 10, Router ID 192.168.0.97, Network Type BROADCAST, Cost: 1
Topology-MTID      Cost      Disabled      Shutdown      Topology Name
    0              1          no            no            Base
Transmit Delay is 1 sec, State DR, Priority 1
Designated Router (ID) 192.168.0.97, Interface address 192.168.0.3
Backup Designated router (ID) 192.168.0.81, Interface address 192.168.0.1
Timer intervals configured, Hello 10, Dead 80, Wait 80, Retransmit 5
  oob-resync timeout 40
  Hello due in 00:00:06
Supports Link-local Signaling (LLS)
Cisco NSF helper support enabled
IETF NSF helper support enabled
Index 1/2/2, flood queue length 0
Next 0x0(0)/0x0(0)/0x0(0)
Last flood scan length is 1, maximum is 2
Last flood scan time is 0 msec, maximum is 1 msec
Neighbor Count is 1, Adjacent neighbor count is 1
  Adjacent with neighbor 192.168.0.81  (Backup Designated Router)
Suppress hello for 0 neighbor(s)
R2#show ipv6 ospf interface
Loopback0 is up, line protocol is up
  Link Local Address FE80::521C:B0FF:FE63:3830, Interface ID 14
  Area 1, Process ID 10, Instance ID 0, Router ID 2.2.2.2
  Network Type LOOPBACK, Cost: 1
  Loopback interface is treated as a stub Host
GigabitEthernet0/0/1 is up, line protocol is up
  Link Local Address FE80::521C:B0FF:FE63:3831, Interface ID 7
  Area 1, Process ID 10, Instance ID 0, Router ID 2.2.2.2
  Network Type BROADCAST, Cost: 1
  Transmit Delay is 1 sec, State BDR, Priority 1
  Designated Router (ID) 3.3.3.3, local address FE80::B6A8:B9FF:FE47:9231

```

```

Backup Designated router (ID) 2.2.2.2, local address FE80::521C:B0FF:FE63:3831
Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
  Hello due in 00:00:08
Graceful restart helper support enabled
Index 1/3/3, flood queue length 0
Next 0x0(0)/0x0(0)/0x0(0)
Last flood scan length is 2, maximum is 2
Last flood scan time is 0 msec, maximum is 0 msec
Neighbor Count is 1, Adjacent neighbor count is 1
  Adjacent with neighbor 3.3.3.3 (Designated Router)
  Suppress hello for 0 neighbor(s)
GigabitEthernet0/0/0 is up, line protocol is up
  Link Local Address FE80::521C:B0FF:FE63:3830, Interface ID 6
  Area 1, Process ID 10, Instance ID 0, Router ID 2.2.2.2
  Network Type BROADCAST, Cost: 1
  Transmit Delay is 1 sec, State DR, Priority 1
  Designated Router (ID) 2.2.2.2, local address FE80::521C:B0FF:FE63:3830
  Backup Designated router (ID) 1.1.1.1, local address FE80::521C:B0FF:FE2C:5100
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    Hello due in 00:00:03
  Graceful restart helper support enabled
  Index 1/2/2, flood queue length 0
  Next 0x0(0)/0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 6
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 1.1.1.1 (Backup Designated Router)
  Suppress hello for 0 neighbor(s)

```

### Router 3:

```

R3#show run
Building configuration...
Current configuration : 1763 bytes
Last configuration change at 18:25:51
UTC Tue Sep 28 2021
version 15.5
service timestamps debug datetime msec
service timestamps log datetime msec
no platform punt-keepalive disable-
kernel-core
hostname R3
boot-start-marker
boot-end-marker
vrf definition Mgmt-intf
address-family ipv4
exit-address-family
address-family ipv6
exit-address-family
no aaa new-model
ipv6 unicast-routing
subscriber templating
multilink bundle-name authenticated
license udi pid ISR4321/K9 sn
FDO21441WDF
spanning-tree extend system-id

```

```

redundancy
mode none
vlan internal allocation policy
ascending
interface Loopback0
ip address 192.168.0.113 255.255.255.240
ipv6 address 2001:DB8:ACAD:17::1/64
ipv6 ospf 10 area 1
interface GigabitEthernet0/0/0
ip address 192.168.0.33 255.255.255.240
negotiation auto
ipv6 address 2001:DB8:ACAD:12::1/64
ipv6 ospf 10 area 0
interface GigabitEthernet0/0/1
ip address 192.168.0.19 255.255.255.240
negotiation auto
ipv6 address 2001:DB8:ACAD:11::2/64
ipv6 ospf 10 area 1
interface Serial0/1/0
no ip address
shutdown
interface Serial0/1/1
no ip address
shutdown
interface GigabitEthernet0
vrf forwarding Mgmt-intf
no ip address

```

```

shutdown
negotiation auto
interface Vlan1
no ip address
shutdown
router ospf 10
network 192.168.0.0 0.0.0.15 area 1
network 192.168.0.16 0.0.0.15 area 1
network 192.168.0.32 0.0.0.15 area 0
network 192.168.0.112 0.0.0.15 area 1
ip forward-protocol nd
no ip http server
no ip http secure-server

```

```

ip tftp source-interface
GigabitEthernet0
ipv6 router ospf 10
router-id 3.3.3.3
control-plane
line con 0
stopbits 1
line aux 0
stopbits 1
line vty 0 4
login
end

```

R3#show ip route

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

```

      192.168.0.0/24 is variably subnetted, 14 subnets, 2 masks
O       192.168.0.0/28
        [110/2] via 192.168.0.17, 00:19:22, GigabitEthernet0/0/1
C       192.168.0.16/28 is directly connected, GigabitEthernet0/0/1
L       192.168.0.19/32 is directly connected, GigabitEthernet0/0/1
C       192.168.0.32/28 is directly connected, GigabitEthernet0/0/0
L       192.168.0.33/32 is directly connected, GigabitEthernet0/0/0
O IA    192.168.0.48/28
        [110/2] via 192.168.0.35, 00:18:58, GigabitEthernet0/0/0
O IA    192.168.0.64/28
        [110/3] via 192.168.0.35, 00:18:32, GigabitEthernet0/0/0
O       192.168.0.81/32
        [110/3] via 192.168.0.17, 00:19:22, GigabitEthernet0/0/1
O       192.168.0.97/32
        [110/2] via 192.168.0.17, 00:19:22, GigabitEthernet0/0/1
C       192.168.0.112/28 is directly connected, Loopback0
L       192.168.0.113/32 is directly connected, Loopback0
O IA    192.168.0.129/32
        [110/2] via 192.168.0.35, 00:18:58, GigabitEthernet0/0/0
O IA    192.168.0.145/32
        [110/3] via 192.168.0.35, 00:18:32, GigabitEthernet0/0/0
O IA    192.168.0.161/32
        [110/4] via 192.168.0.35, 00:17:58, GigabitEthernet0/0/0

```

R3#show ipv6 route

IPv6 Routing Table - default - 15 entries

Codes: C - Connected, L - Local, S - Static, U - Per-user Static route  
B - BGP, R - RIP, I1 - ISIS L1, I2 - ISIS L2

IA - ISIS interarea, IS - ISIS summary, D - EIGRP, EX - EIGRP external  
 ND - ND Default, NDp - ND Prefix, DCE - Destination, NDr - Redirect  
 O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2  
 ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2, a - Application

```
O 2001:DB8:ACAD:10::/64 [110/2]
  via FE80::521C:B0FF:FE63:3831, GigabitEthernet0/0/1
C 2001:DB8:ACAD:11::/64 [0/0]
  via GigabitEthernet0/0/1, directly connected
L 2001:DB8:ACAD:11::2/128 [0/0]
  via GigabitEthernet0/0/1, receive
C 2001:DB8:ACAD:12::/64 [0/0]
  via GigabitEthernet0/0/0, directly connected
L 2001:DB8:ACAD:12::1/128 [0/0]
  via GigabitEthernet0/0/0, receive
OI 2001:DB8:ACAD:13::/64 [110/2]
  via FE80::CE8E:71FF:FE1E:22E0, GigabitEthernet0/0/0
OI 2001:DB8:ACAD:14::/64 [110/3]
  via FE80::CE8E:71FF:FE1E:22E0, GigabitEthernet0/0/0
O 2001:DB8:ACAD:15::1/128 [110/1]
  via FE80::521C:B0FF:FE63:3831, GigabitEthernet0/0/1
O 2001:DB8:ACAD:16::1/128 [110/1]
  via FE80::521C:B0FF:FE63:3831, GigabitEthernet0/0/1
C 2001:DB8:ACAD:17::/64 [0/0]
  via Loopback0, directly connected
L 2001:DB8:ACAD:17::1/128 [0/0]
  via Loopback0, receive
OI 2001:DB8:ACAD:18::1/128 [110/1]
  via FE80::CE8E:71FF:FE1E:22E0, GigabitEthernet0/0/0
OI 2001:DB8:ACAD:19::1/128 [110/2]
  via FE80::CE8E:71FF:FE1E:22E0, GigabitEthernet0/0/0
OI 2001:DB8:ACAD:20::1/128 [110/3]
  via FE80::CE8E:71FF:FE1E:22E0, GigabitEthernet0/0/0
L FF00::/8 [0/0]
  via Null0, receive
```

R3#show ip ospf neighbor

Neighbor ID	Pri	State	Dead Time	Address	Interface
192.168.0.129	1	FULL/DR	00:00:39	192.168.0.35	
GigabitEthernet0/0/0					
192.168.0.97	1	FULL/BDR	00:00:39	192.168.0.17	
GigabitEthernet0/0/1					

R3#show ipv6 ospf neighbor

OSPFv3 Router with ID (3.3.3.3) (Process ID 10)

Neighbor ID	Pri	State	Dead Time	Interface ID	Interface
4.4.4.4	1	FULL/DR	00:00:38	6	
GigabitEthernet0/0/0					
2.2.2.2	1	FULL/BDR	00:00:34	7	
GigabitEthernet0/0/1					

R3#show ip ospf interface

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

```

Internet Address 192.168.0.33/28, Area 0, Attached via Network Statement
Process ID 10, Router ID 192.168.0.113, Network Type BROADCAST, Cost: 1
Topology-MTID      Cost      Disabled      Shutdown      Topology Name
      0              1          no           no           Base
Transmit Delay is 1 sec, State BDR, Priority 1
Designated Router (ID) 192.168.0.129, Interface address 192.168.0.35
Backup Designated router (ID) 192.168.0.113, Interface address 192.168.0.33
Timer intervals configured, Hello 10, Dead 80, Wait 80, Retransmit 5
  oob-resync timeout 40
  Hello due in 00:00:00
Supports Link-local Signaling (LLS)
Cisco NSF helper support enabled
IETF NSF helper support enabled
Index 1/1/3, flood queue length 0
Next 0x0(0)/0x0(0)/0x0(0)
Last flood scan length is 1, maximum is 1
Last flood scan time is 0 msec, maximum is 0 msec
Neighbor Count is 1, Adjacent neighbor count is 1
  Adjacent with neighbor 192.168.0.129  (Designated Router)
Suppress hello for 0 neighbor(s)
Loopback0 is up, line protocol is up
Internet Address 192.168.0.113/28, Area 1, Attached via Network Statement
Process ID 10, Router ID 192.168.0.113, Network Type LOOPBACK, Cost: 1
Topology-MTID      Cost      Disabled      Shutdown      Topology Name
      0              1          no           no           Base
Loopback interface is treated as a stub Host
GigabitEthernet0/0/1 is up, line protocol is up
Internet Address 192.168.0.19/28, Area 1, Attached via Network Statement
Process ID 10, Router ID 192.168.0.113, Network Type BROADCAST, Cost: 1
Topology-MTID      Cost      Disabled      Shutdown      Topology Name
      0              1          no           no           Base
Transmit Delay is 1 sec, State DR, Priority 1
Designated Router (ID) 192.168.0.113, Interface address 192.168.0.19
Backup Designated router (ID) 192.168.0.97, Interface address 192.168.0.17
Timer intervals configured, Hello 10, Dead 80, Wait 80, Retransmit 5
  oob-resync timeout 40
  Hello due in 00:00:03
Supports Link-local Signaling (LLS)
Cisco NSF helper support enabled
IETF NSF helper support enabled
Index 1/2/2, flood queue length 0
Next 0x0(0)/0x0(0)/0x0(0)
Last flood scan length is 1, maximum is 3
Last flood scan time is 0 msec, maximum is 0 msec
Neighbor Count is 1, Adjacent neighbor count is 1
  Adjacent with neighbor 192.168.0.97  (Backup Designated Router)
Suppress hello for 0 neighbor(s)

R3#show ipv6 ospf interface
GigabitEthernet0/0/0 is up, line protocol is up
Link Local Address FE80::B6A8:B9FF:FE47:9230, Interface ID 6
Area 0, Process ID 10, Instance ID 0, Router ID 3.3.3.3
Network Type BROADCAST, Cost: 1
Transmit Delay is 1 sec, State BDR, Priority 1

```



```

Designated Router (ID) 4.4.4.4, local address FE80::CE8E:71FF:FE1E:22E0
Backup Designated router (ID) 3.3.3.3, local address FE80::B6A8:B9FF:FE47:9230
Timer intervals configured, Hello 10, Dead 80, Wait 80, Retransmit 5
  Hello due in 00:00:00
Graceful restart helper support enabled
Index 1/1/2, flood queue length 0
Next 0x0(0)/0x0(0)/0x0(0)
Last flood scan length is 2, maximum is 2
Last flood scan time is 0 msec, maximum is 0 msec
Neighbor Count is 1, Adjacent neighbor count is 1
  Adjacent with neighbor 4.4.4.4 (Designated Router)
  Suppress hello for 0 neighbor(s)
Loopback0 is up, line protocol is up
  Link Local Address FE80::B6A8:B9FF:FE47:9230, Interface ID 12
Area 1, Process ID 10, Instance ID 0, Router ID 3.3.3.3
Network Type LOOPBACK, Cost: 1
  Loopback interface is treated as a stub Host
GigabitEthernet0/0/1 is up, line protocol is up
  Link Local Address FE80::B6A8:B9FF:FE47:9231, Interface ID 7
Area 1, Process ID 10, Instance ID 0, Router ID 3.3.3.3
Network Type BROADCAST, Cost: 1
  Transmit Delay is 1 sec, State DR, Priority 1
  Designated Router (ID) 3.3.3.3, local address FE80::B6A8:B9FF:FE47:9231
  Backup Designated router (ID) 2.2.2.2, local address FE80::521C:B0FF:FE63:3831
  Timer intervals configured, Hello 10, Dead 80, Wait 80, Retransmit 5
    Hello due in 00:00:01
  Graceful restart helper support enabled
  Index 1/2/3, flood queue length 0
  Next 0x0(0)/0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 6
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 2.2.2.2 (Backup Designated Router)
    Suppress hello for 0 neighbor(s)

```

#### Router 4:

```

R4#show run
Building configuration...
Current configuration : 1726 bytes
  Last configuration change at 18:19:09
UTC Tue Sep 28 2021
version 15.5
service timestamps debug datetime msec
service timestamps log datetime msec
no platform punt-keepalive disable-
kernel-core
hostname R4
boot-start-marker
boot-end-marker
vrf definition Mgmt-intf
address-family ipv4
exit-address-family
address-family ipv6

```

```

exit-address-family
no aaa new-model
ipv6 unicast-routing
subscriber templating
multilink bundle-name authenticated
license udi pid ISR4321/K9 sn
FDO215009QY
spanning-tree extend system-id
redundancy
mode none
vlan internal allocation policy
ascending
interface Loopback0
ip address 192.168.0.129 255.255.255.240
ipv6 address 2001:DB8:ACAD:18::1/64
ipv6 ospf 10 area 2
interface GigabitEthernet0/0/0
ip address 192.168.0.35 255.255.255.240
negotiation auto
ipv6 address 2001:DB8:ACAD:12::2/64

```

```

ipv6 ospf 10 area 0
interface GigabitEthernet0/0/1
ip address 192.168.0.49 255.255.255.240
negotiation auto
ipv6 address 2001:DB8:ACAD:13::1/64
ipv6 ospf 10 area 2
interface Serial0/1/0
no ip address
shutdown
interface Serial0/1/1
no ip address
shutdown
interface GigabitEthernet0
vrf forwarding Mgmt-intf
no ip address
shutdown
negotiation auto
interface Vlan1
no ip address
shutdown

```

```

router ospf 10
network 192.168.0.32 0.0.0.15 area 0
network 192.168.0.48 0.0.0.15 area 2
network 192.168.0.128 0.0.0.15 area 2
ip forward-protocol nd
no ip http server
no ip http secure-server
ip tftp source-interface
GigabitEthernet0
ipv6 router ospf 10
router-id 4.4.4.4
control-plane
line con 0
stopbits 1
line aux 0
stopbits 1
line vty 0 4
login
end

```

R4#show ip route

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

```

192.168.0.0/24 is variably subnetted, 14 subnets, 2 masks
O IA    192.168.0.0/28
        [110/3] via 192.168.0.33, 00:21:13, GigabitEthernet0/0/0
O IA    192.168.0.16/28
        [110/2] via 192.168.0.33, 00:21:13, GigabitEthernet0/0/0
C       192.168.0.32/28 is directly connected, GigabitEthernet0/0/0
L       192.168.0.35/32 is directly connected, GigabitEthernet0/0/0
C       192.168.0.48/28 is directly connected, GigabitEthernet0/0/1
L       192.168.0.49/32 is directly connected, GigabitEthernet0/0/1
O       192.168.0.64/28
        [110/2] via 192.168.0.51, 00:20:22, GigabitEthernet0/0/1
O IA    192.168.0.81/32
        [110/4] via 192.168.0.33, 00:21:13, GigabitEthernet0/0/0
O IA    192.168.0.97/32
        [110/3] via 192.168.0.33, 00:21:13, GigabitEthernet0/0/0
O IA    192.168.0.113/32
        [110/2] via 192.168.0.33, 00:21:13, GigabitEthernet0/0/0
C       192.168.0.128/28 is directly connected, Loopback0
L       192.168.0.129/32 is directly connected, Loopback0
O       192.168.0.145/32
        [110/2] via 192.168.0.51, 00:20:46, GigabitEthernet0/0/1

```

```
O          192.168.0.161/32
           [110/3] via 192.168.0.51, 00:20:12, GigabitEthernet0/0/1
```

```
R4#show ipv6 route
```

```
IPv6 Routing Table - default - 15 entries
```

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

```
       B - BGP, R - RIP, I1 - ISIS L1, I2 - ISIS L2
```

```
       IA - ISIS interarea, IS - ISIS summary, D - EIGRP, EX - EIGRP external
```

```
       ND - ND Default, NDp - ND Prefix, DCE - Destination, NDr - Redirect
```

```
       O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
```

```
       ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2, a - Application
```

```
OI 2001:DB8:ACAD:10::/64 [110/3]
   via FE80::B6A8:B9FF:FE47:9230, GigabitEthernet0/0/0
OI 2001:DB8:ACAD:11::/64 [110/2]
   via FE80::B6A8:B9FF:FE47:9230, GigabitEthernet0/0/0
C  2001:DB8:ACAD:12::/64 [0/0]
   via GigabitEthernet0/0/0, directly connected
L  2001:DB8:ACAD:12::2/128 [0/0]
   via GigabitEthernet0/0/0, receive
C  2001:DB8:ACAD:13::/64 [0/0]
   via GigabitEthernet0/0/1, directly connected
L  2001:DB8:ACAD:13::1/128 [0/0]
   via GigabitEthernet0/0/1, receive
O  2001:DB8:ACAD:14::/64 [110/2]
   via FE80::B6A8:B9FF:FE47:9350, GigabitEthernet0/0/1
OI 2001:DB8:ACAD:15::1/128 [110/2]
   via FE80::B6A8:B9FF:FE47:9230, GigabitEthernet0/0/0
OI 2001:DB8:ACAD:16::1/128 [110/2]
   via FE80::B6A8:B9FF:FE47:9230, GigabitEthernet0/0/0
OI 2001:DB8:ACAD:17::1/128 [110/1]
   via FE80::B6A8:B9FF:FE47:9230, GigabitEthernet0/0/0
C  2001:DB8:ACAD:18::/64 [0/0]
   via Loopback0, directly connected
L  2001:DB8:ACAD:18::1/128 [0/0]
   via Loopback0, receive
O  2001:DB8:ACAD:19::1/128 [110/1]
   via FE80::B6A8:B9FF:FE47:9350, GigabitEthernet0/0/1
O  2001:DB8:ACAD:20::1/128 [110/2]
   via FE80::B6A8:B9FF:FE47:9350, GigabitEthernet0/0/1
L  FF00::/8 [0/0]
   via Null0, receive
```

```
R4#show ip ospf neighbor
```

Neighbor ID	Pri	State	Dead Time	Address	Interface
192.168.0.113	1	FULL/BDR	00:00:39	192.168.0.33	GigabitEthernet0/0/0
192.168.0.145	1	FULL/DR	00:00:32	192.168.0.51	GigabitEthernet0/0/1

```
R4#show ipv6 ospf neighbor
```

```
OSPFv3 Router with ID (4.4.4.4) (Process ID 10)
```

Neighbor ID	Pri	State	Dead Time	Interface ID	Interface
3.3.3.3	1	FULL/BDR	00:00:33	6	
GigabitEthernet0/0/0					
5.5.5.5	1	FULL/DR	00:00:37	6	
GigabitEthernet0/0/1					

```

R4#show ip ospf
Routing Process "ospf 10" with ID 192.168.0.129
Start time: 00:01:38.595, Time elapsed: 00:22:42.504
Supports only single TOS(TOS0) routes
Supports opaque LSA
Supports Link-local Signaling (LLS)
Supports area transit capability
Supports NSSA (compatible with RFC 3101)
Supports Database Exchange Summary List Optimization (RFC 5243)
Event-log enabled, Maximum number of events: 1000, Mode: cyclic
It is an area border router
Router is not originating router-LSAs with maximum metric
Initial SPF schedule delay 5000 msec
Minimum hold time between two consecutive SPF's 10000 msec
Maximum wait time between two consecutive SPF's 10000 msec
Incremental-SPF disabled
Minimum LSA interval 5 secs
Minimum LSA arrival 1000 msec
LSA group pacing timer 240 secs
Interface flood pacing timer 33 msec
Retransmission pacing timer 66 msec
EXCHANGE/LOADING adjacency limit: initial 300, process maximum 300
Number of external LSA 0. Checksum Sum 0x000000
Number of opaque AS LSA 0. Checksum Sum 0x000000
Number of DCbitless external and opaque AS LSA 0
Number of DoNotAge external and opaque AS LSA 0
Number of areas in this router is 2. 2 normal 0 stub 0 nssa
Number of areas transit capable is 0
External flood list length 0
IETF NSF helper support enabled
Cisco NSF helper support enabled
Reference bandwidth unit is 100 mbps
  Area BACKBONE(0)
    Number of interfaces in this area is 1
    Area has no authentication
    SPF algorithm last executed 00:21:37.390 ago
    SPF algorithm executed 4 times
    Area ranges are
    Number of LSA 13. Checksum Sum 0x05885F
    Number of opaque link LSA 0. Checksum Sum 0x000000
    Number of DCbitless LSA 0
    Number of indication LSA 0
    Number of DoNotAge LSA 0
    Flood list length 0
  Area 2
    Number of interfaces in this area is 2 (1 loopback)
    Area has no authentication

```

SPF algorithm last executed 00:20:36.966 ago  
SPF algorithm executed 7 times  
Area ranges are  
Number of LSA 11. Checksum Sum 0x04A842  
Number of opaque link LSA 0. Checksum Sum 0x000000  
Number of DCbitless LSA 0  
Number of indication LSA 0  
Number of DoNotAge LSA 0  
Flood list length 0

R4#show ipv6 ospf

Routing Process "ospfv3 10" with ID 4.4.4.4  
Supports NSSA (compatible with RFC 3101)  
Supports Database Exchange Summary List Optimization (RFC 5243)  
Event-log enabled, Maximum number of events: 1000, Mode: cyclic  
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 secs  
Minimum LSA arrival 1000 msec  
LSA group pacing timer 240 secs  
Interface flood pacing timer 33 msec  
Retransmission pacing timer 66 msec  
Retransmission limit dc 24 non-dc 24  
EXCHANGE/LOADING adjacency limit: initial 300, process maximum 300  
Number of external LSA 0. Checksum Sum 0x000000  
Number of areas in this router is 2. 2 normal 0 stub 0 nssa  
Graceful restart helper support enabled  
Reference bandwidth unit is 100 mbps  
RFC1583 compatibility enabled

Area BACKBONE(0)

Number of interfaces in this area is 1  
SPF algorithm executed 4 times  
Number of LSA 16. Checksum Sum 0x09052D  
Number of DCbitless LSA 0  
Number of indication LSA 0  
Number of DoNotAge LSA 0  
Flood list length 0

Area 2

Number of interfaces in this area is 2  
SPF algorithm executed 6 times  
Number of LSA 18. Checksum Sum 0x098A37  
Number of DCbitless LSA 0  
Number of indication LSA 0  
Number of DoNotAge LSA 0  
Flood list length 0

R4#show ip ospf interface

GigabitEthernet0/0/0 is up, line protocol is up  
Internet Address 192.168.0.35/28, Area 0, Attached via Network Statement  
Process ID 10, Router ID 192.168.0.129, Network Type BROADCAST, Cost: 1  
Topology-MTID Cost Disabled Shutdown Topology Name

```

0          1          no          no          Base
Transmit Delay is 1 sec, State DR, Priority 1
Designated Router (ID) 192.168.0.129, Interface address 192.168.0.35
Backup Designated router (ID) 192.168.0.113, Interface address 192.168.0.33
Timer intervals configured, Hello 10, Dead 80, Wait 80, Retransmit 5
  oob-resync timeout 40
  Hello due in 00:00:02
Supports Link-local Signaling (LLS)
Cisco NSF helper support enabled
IETF NSF helper support enabled
Index 1/1/2, flood queue length 0
Next 0x0(0)/0x0(0)/0x0(0)
Last flood scan length is 1, maximum is 3
Last flood scan time is 0 msec, maximum is 0 msec
Neighbor Count is 1, Adjacent neighbor count is 1
  Adjacent with neighbor 192.168.0.113 (Backup Designated Router)
Suppress hello for 0 neighbor(s)
Loopback0 is up, line protocol is up
Internet Address 192.168.0.129/28, Area 2, Attached via Network Statement
Process ID 10, Router ID 192.168.0.129, Network Type LOOPBACK, Cost: 1
Topology-MTID      Cost      Disabled      Shutdown      Topology Name
    0              1          no           no           Base
Loopback interface is treated as a stub Host
GigabitEthernet0/0/1 is up, line protocol is up
Internet Address 192.168.0.49/28, Area 2, Attached via Network Statement
Process ID 10, Router ID 192.168.0.129, Network Type BROADCAST, Cost: 1
Topology-MTID      Cost      Disabled      Shutdown      Topology Name
    0              1          no           no           Base
Transmit Delay is 1 sec, State BDR, Priority 1
Designated Router (ID) 192.168.0.145, Interface address 192.168.0.51
Backup Designated router (ID) 192.168.0.129, Interface address 192.168.0.49
Timer intervals configured, Hello 10, Dead 80, Wait 80, Retransmit 5
  oob-resync timeout 40
  Hello due in 00:00:06
Supports Link-local Signaling (LLS)
Cisco NSF helper support enabled
IETF NSF helper support enabled
Index 1/2/3, flood queue length 0
Next 0x0(0)/0x0(0)/0x0(0)
Last flood scan length is 1, maximum is 1
Last flood scan time is 0 msec, maximum is 0 msec
Neighbor Count is 1, Adjacent neighbor count is 1
  Adjacent with neighbor 192.168.0.145 (Designated Router)
Suppress hello for 0 neighbor(s)

R4#show ipv6 ospf interface
GigabitEthernet0/0/0 is up, line protocol is up
Link Local Address FE80::CE8E:71FF:FE1E:22E0, Interface ID 6
Area 0, Process ID 10, Instance ID 0, Router ID 4.4.4.4
Network Type BROADCAST, Cost: 1
Transmit Delay is 1 sec, State DR, Priority 1
Designated Router (ID) 4.4.4.4, local address FE80::CE8E:71FF:FE1E:22E0
Backup Designated router (ID) 3.3.3.3, local address FE80::B6A8:B9FF:FE47:9230
Timer intervals configured, Hello 10, Dead 80, Wait 80, Retransmit 5

```

```

    Hello due in 00:00:00
    Graceful restart helper support enabled
    Index 1/1/2, flood queue length 0
    Next 0x0(0)/0x0(0)/0x0(0)
    Last flood scan length is 1, maximum is 6
    Last flood scan time is 0 msec, maximum is 0 msec
    Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 3.3.3.3 (Backup Designated Router)
    Suppress hello for 0 neighbor(s)
Loopback0 is up, line protocol is up
    Link Local Address FE80::CE8E:71FF:FE1E:22E0, Interface ID 12
    Area 2, Process ID 10, Instance ID 0, Router ID 4.4.4.4
    Network Type LOOPBACK, Cost: 1
    Loopback interface is treated as a stub Host
GigabitEthernet0/0/1 is up, line protocol is up
    Link Local Address FE80::CE8E:71FF:FE1E:22E1, Interface ID 7
    Area 2, Process ID 10, Instance ID 0, Router ID 4.4.4.4
    Network Type BROADCAST, Cost: 1
    Transmit Delay is 1 sec, State BDR, Priority 1
    Designated Router (ID) 5.5.5.5, local address FE80::B6A8:B9FF:FE47:9350
    Backup Designated router (ID) 4.4.4.4, local address FE80::CE8E:71FF:FE1E:22E1
    Timer intervals configured, Hello 10, Dead 80, Wait 80, Retransmit 5
    Hello due in 00:00:05
    Graceful restart helper support enabled
    Index 1/2/3, flood queue length 0
    Next 0x0(0)/0x0(0)/0x0(0)
    Last flood scan length is 2, maximum is 2
    Last flood scan time is 0 msec, maximum is 0 msec
    Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 5.5.5.5 (Designated Router)
    Suppress hello for 0 neighbor(s)

```

### Router 5:

```

R5#show run
Building configuration...
Current configuration : 1726 bytes
Last configuration change at 18:26:24
UTC Tue Sep 28 2021
version 15.5
service timestamps debug datetime msec
service timestamps log datetime msec
no platform punt-keepalive disable-
kernel-core
hostname R5
boot-start-marker
boot-end-marker
vrf definition Mgmt-intf
address-family ipv4
exit-address-family
address-family ipv6
exit-address-family
no aaa new-model
ipv6 unicast-routing
subscriber templating
multilink bundle-name authenticated

license udi pid ISR4321/K9 sn
FDO214420HM
spanning-tree extend system-id
redundancy
mode none
vlan internal allocation policy
ascending
interface Loopback0
ip address 192.168.0.145 255.255.255.240
ipv6 address 2001:DB8:ACAD:19::1/64
ipv6 ospf 10 area 2
interface GigabitEthernet0/0/0
ip address 192.168.0.51 255.255.255.240
negotiation auto
ipv6 address 2001:DB8:ACAD:13::2/64
ipv6 ospf 10 area 2
interface GigabitEthernet0/0/1
ip address 192.168.0.65 255.255.255.240
negotiation auto
ipv6 address 2001:DB8:ACAD:14::1/64
ipv6 ospf 10 area 2
interface Serial0/1/0
no ip address

```

```

shutdown
interface Serial0/1/1
no ip address
shutdown
interface GigabitEthernet0
vrf forwarding Mgmt-intf
no ip address
shutdown
negotiation auto
interface Vlan1
no ip address
shutdown
router ospf 10
network 192.168.0.48 0.0.0.15 area 2
network 192.168.0.64 0.0.0.15 area 2
network 192.168.0.144 0.0.0.15 area 2

```

```

ip forward-protocol nd
no ip http server
no ip http secure-server
ip tftp source-interface
GigabitEthernet0
ipv6 router ospf 10
router-id 5.5.5.5
control-plane
line con 0
stopbits 1
line aux 0
stopbits 1
line vty 0 4
login
end

```

R5#show ip route

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

```

192.168.0.0/24 is variably subnetted, 14 subnets, 2 masks
O IA    192.168.0.0/28
        [110/4] via 192.168.0.49, 00:22:34, GigabitEthernet0/0/0
O IA    192.168.0.16/28
        [110/3] via 192.168.0.49, 00:22:34, GigabitEthernet0/0/0
O IA    192.168.0.32/28
        [110/2] via 192.168.0.49, 00:22:34, GigabitEthernet0/0/0
C       192.168.0.48/28 is directly connected, GigabitEthernet0/0/0
L       192.168.0.51/32 is directly connected, GigabitEthernet0/0/0
C       192.168.0.64/28 is directly connected, GigabitEthernet0/0/1
L       192.168.0.65/32 is directly connected, GigabitEthernet0/0/1
O IA    192.168.0.81/32
        [110/5] via 192.168.0.49, 00:22:34, GigabitEthernet0/0/0
O IA    192.168.0.97/32
        [110/4] via 192.168.0.49, 00:22:34, GigabitEthernet0/0/0
O IA    192.168.0.113/32
        [110/3] via 192.168.0.49, 00:22:34, GigabitEthernet0/0/0
O       192.168.0.129/32
        [110/2] via 192.168.0.49, 00:22:34, GigabitEthernet0/0/0
C       192.168.0.144/28 is directly connected, Loopback0
L       192.168.0.145/32 is directly connected, Loopback0
O       192.168.0.161/32
        [110/2] via 192.168.0.67, 00:22:10, GigabitEthernet0/0/1

```

R5# show ipv6 route



IPv6 Routing Table - default - 15 entries

Codes: C - Connected, L - Local, S - Static, U - Per-user Static route  
B - BGP, R - RIP, I1 - ISIS L1, I2 - ISIS L2  
IA - ISIS interarea, IS - ISIS summary, D - EIGRP, EX - EIGRP external  
ND - ND Default, NDp - ND Prefix, DCE - Destination, NDr - Redirect  
O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2  
ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2, a - Application

```
OI 2001:DB8:ACAD:10::/64 [110/4]
    via FE80::CE8E:71FF:FE1E:22E1, GigabitEthernet0/0/0
OI 2001:DB8:ACAD:11::/64 [110/3]
    via FE80::CE8E:71FF:FE1E:22E1, GigabitEthernet0/0/0
OI 2001:DB8:ACAD:12::/64 [110/2]
    via FE80::CE8E:71FF:FE1E:22E1, GigabitEthernet0/0/0
C 2001:DB8:ACAD:13::/64 [0/0]
    via GigabitEthernet0/0/0, directly connected
L 2001:DB8:ACAD:13::2/128 [0/0]
    via GigabitEthernet0/0/0, receive
C 2001:DB8:ACAD:14::/64 [0/0]
    via GigabitEthernet0/0/1, directly connected
L 2001:DB8:ACAD:14::1/128 [0/0]
    via GigabitEthernet0/0/1, receive
OI 2001:DB8:ACAD:15::1/128 [110/3]
    via FE80::CE8E:71FF:FE1E:22E1, GigabitEthernet0/0/0
OI 2001:DB8:ACAD:16::1/128 [110/3]
    via FE80::CE8E:71FF:FE1E:22E1, GigabitEthernet0/0/0
OI 2001:DB8:ACAD:17::1/128 [110/2]
    via FE80::CE8E:71FF:FE1E:22E1, GigabitEthernet0/0/0
O 2001:DB8:ACAD:18::1/128 [110/1]
    via FE80::CE8E:71FF:FE1E:22E1, GigabitEthernet0/0/0
C 2001:DB8:ACAD:19::/64 [0/0]
    via Loopback0, directly connected
L 2001:DB8:ACAD:19::1/128 [0/0]
    via Loopback0, receive
O 2001:DB8:ACAD:20::1/128 [110/1]
    via FE80::227:90FF:FED5:F800, GigabitEthernet0/0/1
L FF00::/8 [0/0]
    via Null0, receive
```

R5#show ip ospf neighbor

Neighbor ID	Pri	State	Dead Time	Address	Interface
192.168.0.161	1	FULL/DR	00:00:37	192.168.0.67	GigabitEthernet0/0/1
192.168.0.129	1	FULL/BDR	00:00:33	192.168.0.49	GigabitEthernet0/0/0

R5#show ipv6 ospf neighbor

OSPFv3 Router with ID (5.5.5.5) (Process ID 10)

Neighbor ID	Pri	State	Dead Time	Interface ID	Interface
6.6.6.6	1	FULL/DR	00:00:35	6	GigabitEthernet0/0/1
4.4.4.4	1	FULL/BDR	00:00:34	7	GigabitEthernet0/0/0

```
R5#show ip ospf
Routing Process "ospf 10" with ID 192.168.0.145
Start time: 00:01:32.891, Time elapsed: 00:23:56.832
Supports only single TOS(TOS0) routes
Supports opaque LSA
Supports Link-local Signaling (LLS)
Supports area transit capability
Supports NSSA (compatible with RFC 3101)
Supports Database Exchange Summary List Optimization (RFC 5243)
Event-log enabled, Maximum number of events: 1000, Mode: cyclic
Router is not originating router-LSAs with maximum metric
Initial SPF schedule delay 5000 msec
Minimum hold time between two consecutive SPF's 10000 msec
Maximum wait time between two consecutive SPF's 10000 msec
Incremental-SPF disabled
Minimum LSA interval 5 secs
Minimum LSA arrival 1000 msec
LSA group pacing timer 240 secs
Interface flood pacing timer 33 msec
Retransmission pacing timer 66 msec
EXCHANGE/LOADING adjacency limit: initial 300, process maximum 300
Number of external LSA 0. Checksum Sum 0x000000
Number of opaque AS LSA 0. Checksum Sum 0x000000
Number of DCbitless external and opaque AS LSA 0
Number of DoNotAge external and opaque AS LSA 0
Number of areas in this router is 1. 1 normal 0 stub 0 nssa
Number of areas transit capable is 0
External flood list length 0
IETF NSF helper support enabled
Cisco NSF helper support enabled
Reference bandwidth unit is 100 mbps
```

#### Area 2

```
Number of interfaces in this area is 3 (1 loopback)
Area has no authentication
SPF algorithm last executed 00:22:27.146 ago
SPF algorithm executed 5 times
Area ranges are
Number of LSA 11. Checksum Sum 0x04A842
Number of opaque link LSA 0. Checksum Sum 0x000000
Number of DCbitless LSA 0
Number of indication LSA 0
Number of DoNotAge LSA 0
Flood list length 0
```

```
R5#show ipv6 ospf
Routing Process "ospfv3 10" with ID 5.5.5.5
Supports NSSA (compatible with RFC 3101)
Supports Database Exchange Summary List Optimization (RFC 5243)
Event-log enabled, Maximum number of events: 1000, Mode: cyclic
Router is not originating router-LSAs with maximum metric
Initial SPF schedule delay 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 secs
Minimum LSA arrival 1000 msec
```

LSA group pacing timer 240 secs  
Interface flood pacing timer 33 msec  
Retransmission pacing timer 66 msec  
Retransmission limit dc 24 non-dc 24  
EXCHANGE/LOADING adjacency limit: initial 300, process maximum 300  
Number of external LSA 0. Checksum Sum 0x000000  
Number of areas in this router is 1. 1 normal 0 stub 0 nssa  
Graceful restart helper support enabled  
Reference bandwidth unit is 100 mbps  
RFC1583 compatibility enabled

#### Area 2

Number of interfaces in this area is 3  
SPF algorithm executed 3 times  
Number of LSA 20. Checksum Sum 0x09B7EA  
Number of DCbitless LSA 0  
Number of indication LSA 0  
Number of DoNotAge LSA 0  
Flood list length 0

#### R5#show ip ospf interface

Loopback0 is up, line protocol is up

Internet Address 192.168.0.145/28, Area 2, Attached via Network Statement

Process ID 10, Router ID 192.168.0.145, Network Type LOOPBACK, Cost: 1

Topology-MTID	Cost	Disabled	Shutdown	Topology Name
0	1	no	no	Base

Loopback interface is treated as a stub Host

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

Internet Address 192.168.0.65/28, Area 2, Attached via Network Statement

Process ID 10, Router ID 192.168.0.145, Network Type BROADCAST, Cost: 1

Topology-MTID	Cost	Disabled	Shutdown	Topology Name
0	1	no	no	Base

Transmit Delay is 1 sec, State BDR, Priority 1

Designated Router (ID) 192.168.0.161, Interface address 192.168.0.67

Backup Designated router (ID) 192.168.0.145, Interface address 192.168.0.65

Timer intervals configured, Hello 10, Dead 80, Wait 80, Retransmit 5

oob-resync timeout 40

Hello due in 00:00:03

Supports Link-local Signaling (LLS)

Cisco NSF helper support enabled

IETF NSF helper support enabled

Index 1/3/3, flood queue length 0

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

Last flood scan length is 1, maximum is 1

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

Neighbor Count is 1, Adjacent neighbor count is 1

Adjacent with neighbor 192.168.0.161 (Designated Router)

Suppress hello for 0 neighbor(s)

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

Internet Address 192.168.0.51/28, Area 2, Attached via Network Statement

Process ID 10, Router ID 192.168.0.145, Network Type BROADCAST, Cost: 1

Topology-MTID	Cost	Disabled	Shutdown	Topology Name
0	1	no	no	Base

Transmit Delay is 1 sec, State DR, Priority 1

Designated Router (ID) 192.168.0.145, Interface address 192.168.0.51

Backup Designated router (ID) 192.168.0.129, Interface address 192.168.0.49

```
Timer intervals configured, Hello 10, Dead 80, Wait 80, Retransmit 5
  oob-resync timeout 40
  Hello due in 00:00:06
Supports Link-local Signaling (LLS)
Cisco NSF helper support enabled
IETF NSF helper support enabled
Index 1/2/2, flood queue length 0
Next 0x0(0)/0x0(0)/0x0(0)
Last flood scan length is 2, maximum is 3
Last flood scan time is 0 msec, maximum is 0 msec
Neighbor Count is 1, Adjacent neighbor count is 1
  Adjacent with neighbor 192.168.0.129  (Backup Designated Router)
  Suppress hello for 0 neighbor(s)
R5#show ipv6 ospf interface
Loopback0 is up, line protocol is up
  Link Local Address FE80::B6A8:B9FF:FE47:9350, Interface ID 12
  Area 2, Process ID 10, Instance ID 0, Router ID 5.5.5.5
  Network Type LOOPBACK, Cost: 1
  Loopback interface is treated as a stub Host
GigabitEthernet0/0/1 is up, line protocol is up
  Link Local Address FE80::B6A8:B9FF:FE47:9351, Interface ID 7
  Area 2, Process ID 10, Instance ID 0, Router ID 5.5.5.5
  Network Type BROADCAST, Cost: 1
  Transmit Delay is 1 sec, State BDR, Priority 1
  Designated Router (ID) 6.6.6.6, local address FE80::227:90FF:FED5:F800
  Backup Designated router (ID) 5.5.5.5, local address FE80::B6A8:B9FF:FE47:9351
  Timer intervals configured, Hello 10, Dead 80, Wait 80, Retransmit 5
    Hello due in 00:00:02
  Graceful restart helper support enabled
  Index 1/3/3, flood queue length 0
  Next 0x0(0)/0x0(0)/0x0(0)
  Last flood scan length is 2, maximum is 2
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 6.6.6.6  (Designated Router)
  Suppress hello for 0 neighbor(s)
GigabitEthernet0/0/0 is up, line protocol is up
  Link Local Address FE80::B6A8:B9FF:FE47:9350, Interface ID 6
  Area 2, Process ID 10, Instance ID 0, Router ID 5.5.5.5
  Network Type BROADCAST, Cost: 1
  Transmit Delay is 1 sec, State DR, Priority 1
  Designated Router (ID) 5.5.5.5, local address FE80::B6A8:B9FF:FE47:9350
  Backup Designated router (ID) 4.4.4.4, local address FE80::CE8E:71FF:FE1E:22E1
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    Hello due in 00:00:05
  Graceful restart helper support enabled
  Index 1/2/2, flood queue length 0
  Next 0x0(0)/0x0(0)/0x0(0)
  Last flood scan length is 4, maximum is 6
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 4.4.4.4  (Backup Designated Router)
  Suppress hello for 0 neighbor(s)
```

## Router 6:

```
R6#show run
Building configuration...
Current configuration : 1614 bytes
Last configuration change at 18:23:08
UTC Tue Sep 28 2021
version 15.5
service timestamps debug datetime msec
service timestamps log datetime msec
no platform punt-keepalive disable-
kernel-core
hostname R6
boot-start-marker
boot-end-marker
vrf definition Mgmt-intf
address-family ipv4
exit-address-family
address-family ipv6
exit-address-family
no aaa new-model
ipv6 unicast-routing
subscriber templating
multilink bundle-name authenticated
license udi pid ISR4321/K9 sn
FDO214414DZ
spanning-tree extend system-id
redundancy
mode none
vlan internal allocation policy
ascending
interface Loopback0
ip address 192.168.0.161 255.255.255.240
ipv6 address 2001:DB8:ACAD:20::1/64
ipv6 ospf 10 area 2
interface GigabitEthernet0/0/0
ip address 192.168.0.67 255.255.255.240
negotiation auto
```

```
R6#show ip route
```

```
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

```
ipv6 address 2001:DB8:ACAD:14::2/64
ipv6 ospf 10 area 2
interface GigabitEthernet0/0/1
no ip address
shutdown
negotiation auto
interface Serial0/1/0
no ip address
shutdown
interface Serial0/1/1
no ip address
shutdown
interface GigabitEthernet0
vrf forwarding Mgmt-intf
no ip address
shutdown
negotiation auto
interface Vlan1
no ip address
shutdown
router ospf 10
network 192.168.0.64 0.0.0.15 area 2
network 192.168.0.160 0.0.0.15 area 2
ip forward-protocol nd
no ip http server
no ip http secure-server
ip tftp source-interface
GigabitEthernet0
ipv6 router ospf 10
router-id 6.6.6.6
control-plane
line con 0
stopbits 1
line aux 0
stopbits 1
line vty 0 4
login
end
```

```

    192.168.0.0/24 is variably subnetted, 13 subnets, 2 masks
O IA    192.168.0.0/28
        [110/5] via 192.168.0.65, 00:24:01, GigabitEthernet0/0/0
O IA    192.168.0.16/28
        [110/4] via 192.168.0.65, 00:24:01, GigabitEthernet0/0/0
O IA    192.168.0.32/28
        [110/3] via 192.168.0.65, 00:24:01, GigabitEthernet0/0/0
O       192.168.0.48/28
        [110/2] via 192.168.0.65, 00:24:01, GigabitEthernet0/0/0
C       192.168.0.64/28 is directly connected, GigabitEthernet0/0/0
L       192.168.0.67/32 is directly connected, GigabitEthernet0/0/0
O IA    192.168.0.81/32
        [110/6] via 192.168.0.65, 00:24:01, GigabitEthernet0/0/0
O IA    192.168.0.97/32
        [110/5] via 192.168.0.65, 00:24:01, GigabitEthernet0/0/0
O IA    192.168.0.113/32
        [110/4] via 192.168.0.65, 00:24:01, GigabitEthernet0/0/0
O       192.168.0.129/32
        [110/3] via 192.168.0.65, 00:24:01, GigabitEthernet0/0/0
O       192.168.0.145/32
        [110/2] via 192.168.0.65, 00:24:01, GigabitEthernet0/0/0
C       192.168.0.160/28 is directly connected, Loopback0
L       192.168.0.161/32 is directly connected, Loopback0

```

R6# show ipv6 route

IPv6 Routing Table - default - 14 entries

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

B - BGP, R - RIP, I1 - ISIS L1, I2 - ISIS L2

IA - ISIS interarea, IS - ISIS summary, D - EIGRP, EX - EIGRP external

ND - ND Default, NDp - ND Prefix, DCE - Destination, NDr - Redirect

O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2

ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2, a - Application

```

OI 2001:DB8:ACAD:10::/64 [110/5]
    via FE80::B6A8:B9FF:FE47:9351, GigabitEthernet0/0/0
OI 2001:DB8:ACAD:11::/64 [110/4]
    via FE80::B6A8:B9FF:FE47:9351, GigabitEthernet0/0/0
OI 2001:DB8:ACAD:12::/64 [110/3]
    via FE80::B6A8:B9FF:FE47:9351, GigabitEthernet0/0/0
O  2001:DB8:ACAD:13::/64 [110/2]
    via FE80::B6A8:B9FF:FE47:9351, GigabitEthernet0/0/0
C  2001:DB8:ACAD:14::/64 [0/0]
    via GigabitEthernet0/0/0, directly connected
L  2001:DB8:ACAD:14::2/128 [0/0]
    via GigabitEthernet0/0/0, receive
OI 2001:DB8:ACAD:15::1/128 [110/4]
    via FE80::B6A8:B9FF:FE47:9351, GigabitEthernet0/0/0
OI 2001:DB8:ACAD:16::1/128 [110/4]
    via FE80::B6A8:B9FF:FE47:9351, GigabitEthernet0/0/0
OI 2001:DB8:ACAD:17::1/128 [110/3]
    via FE80::B6A8:B9FF:FE47:9351, GigabitEthernet0/0/0
O  2001:DB8:ACAD:18::1/128 [110/2]
    via FE80::B6A8:B9FF:FE47:9351, GigabitEthernet0/0/0
O  2001:DB8:ACAD:19::1/128 [110/1]
    via FE80::B6A8:B9FF:FE47:9351, GigabitEthernet0/0/0

```

```
C    2001:DB8:ACAD:20::/64 [0/0]
    via Loopback0, directly connected
L    2001:DB8:ACAD:20::1/128 [0/0]
    via Loopback0, receive
L    FF00::/8 [0/0]
    via Null0, receive
```

```
R6#show ip ospf neighbor
```

Neighbor ID	Pri	State	Dead Time	Address	Interface
192.168.0.145	1	FULL/BDR	00:00:34	192.168.0.65	
GigabitEthernet0/0/0					

```
R6#show ipv6 ospf neighbor
```

```
OSPFv3 Router with ID (6.6.6.6) (Process ID 10)
```

Neighbor ID	Pri	State	Dead Time	Interface ID	Interface
5.5.5.5	1	FULL/BDR	00:00:39	7	
GigabitEthernet0/0/0					

```
R6#show ip ospf
```

```
Routing Process "ospf 10" with ID 192.168.0.161
Start time: 00:01:35.836, Time elapsed: 00:25:24.951
Supports only single TOS(TOS0) routes
Supports opaque LSA
Supports Link-local Signaling (LLS)
Supports area transit capability
Supports NSSA (compatible with RFC 3101)
Supports Database Exchange Summary List Optimization (RFC 5243)
Event-log enabled, Maximum number of events: 1000, Mode: cyclic
Router is not originating router-LSAs with maximum metric
Initial SPF schedule delay 5000 msec
Minimum hold time between two consecutive SPF's 10000 msec
Maximum wait time between two consecutive SPF's 10000 msec
Incremental-SPF disabled
Minimum LSA interval 5 secs
Minimum LSA arrival 1000 msec
LSA group pacing timer 240 secs
Interface flood pacing timer 33 msec
Retransmission pacing timer 66 msec
EXCHANGE/LOADING adjacency limit: initial 300, process maximum 300
Number of external LSA 0. Checksum Sum 0x000000
Number of opaque AS LSA 0. Checksum Sum 0x000000
Number of DCbitless external and opaque AS LSA 0
Number of DoNotAge external and opaque AS LSA 0
Number of areas in this router is 1. 1 normal 0 stub 0 nssa
Number of areas transit capable is 0
External flood list length 0
IETF NSF helper support enabled
Cisco NSF helper support enabled
Reference bandwidth unit is 100 mbps
Area 2
    Number of interfaces in this area is 2 (1 loopback)
    Area has no authentication
    SPF algorithm last executed 00:24:19.578 ago
```

```
SPF algorithm executed 3 times
Area ranges are
Number of LSA 11. Checksum Sum 0x04A842
Number of opaque link LSA 0. Checksum Sum 0x000000
Number of DCbitless LSA 0
Number of indication LSA 0
Number of DoNotAge LSA 0
Flood list length 0
```

```
R6#show ipv6 interface
GigabitEthernet0/0/0 is up, line protocol is up
IPv6 is enabled, link-local address is FE80::227:90FF:FED5:F800
No Virtual link-local address(es):
Global unicast address(es):
  2001:DB8:ACAD:14::2, subnet is 2001:DB8:ACAD:14::/64
Joined group address(es):
  FF02::1
  FF02::2
  FF02::5
  FF02::6
  FF02::1:FF00:2
  FF02::1:FFD5:F800
MTU is 1500 bytes
ICMP error messages limited to one every 100 milliseconds
ICMP redirects are enabled
ICMP unreachable are sent
ND DAD is enabled, number of DAD attempts: 1
ND reachable time is 30000 milliseconds (using 30000)
ND advertised reachable time is 0 (unspecified)
ND advertised retransmit interval is 0 (unspecified)
ND router advertisements are sent every 200 seconds
ND router advertisements live for 1800 seconds
ND advertised default router preference is Medium
Hosts use stateless autoconfig for addresses.
Loopback0 is up, line protocol is up
IPv6 is enabled, link-local address is FE80::227:90FF:FED5:F800
No Virtual link-local address(es):
Global unicast address(es):
  2001:DB8:ACAD:20::1, subnet is 2001:DB8:ACAD:20::/64
Joined group address(es):
  FF02::1
  FF02::2
  FF02::5
  FF02::1:FF00:1
  FF02::1:FFD5:F800
MTU is 1514 bytes
ICMP error messages limited to one every 100 milliseconds
ICMP redirects are enabled
ICMP unreachable are sent
ND DAD is not supported
ND reachable time is 30000 milliseconds (using 30000)
ND advertised reachable time is 0 (unspecified)
ND advertised retransmit interval is 0 (unspecified)
ND router advertisements live for 1800 seconds
ND advertised default router preference is Medium
```



ND RAs are suppressed (periodic)  
Hosts use stateless autoconfig for addresses.

```
R6#show ip ospf interface
Loopback0 is up, line protocol is up
  Internet Address 192.168.0.161/28, Area 2, Attached via Network Statement
  Process ID 10, Router ID 192.168.0.161, Network Type LOOPBACK, Cost: 1
  Topology-MTID      Cost      Disabled      Shutdown      Topology Name
    0                1        no          no          Base
  Loopback interface is treated as a stub Host
GigabitEthernet0/0/0 is up, line protocol is up
  Internet Address 192.168.0.67/28, Area 2, Attached via Network Statement
  Process ID 10, Router ID 192.168.0.161, Network Type BROADCAST, Cost: 1
  Topology-MTID      Cost      Disabled      Shutdown      Topology Name
    0                1        no          no          Base
  Transmit Delay is 1 sec, State DR, Priority 1
  Designated Router (ID) 192.168.0.161, Interface address 192.168.0.67
  Backup Designated router (ID) 192.168.0.145, Interface address 192.168.0.65
  Timer intervals configured, Hello 10, Dead 80, Wait 80, Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:00
  Supports Link-local Signaling (LLS)
  Cisco NSF helper support enabled
  IETF NSF helper support enabled
  Index 1/2/2, flood queue length 0
  Next 0x0(0)/0x0(0)/0x0(0)
  Last flood scan length is 3, maximum is 3
  Last flood scan time is 1 msec, maximum is 1 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 192.168.0.145  (Backup Designated Router)
  Suppress hello for 0 neighbor(s)
R6#show ipv6 ospf interface
Loopback0 is up, line protocol is up
  Link Local Address FE80::227:90FF:FED5:F800, Interface ID 12
  Area 2, Process ID 10, Instance ID 0, Router ID 6.6.6.6
  Network Type LOOPBACK, Cost: 1
  Loopback interface is treated as a stub Host
GigabitEthernet0/0/0 is up, line protocol is up
  Link Local Address FE80::227:90FF:FED5:F800, Interface ID 6
  Area 2, Process ID 10, Instance ID 0, Router ID 6.6.6.6
  Network Type BROADCAST, Cost: 1
  Transmit Delay is 1 sec, State DR, Priority 1
  Designated Router (ID) 6.6.6.6, local address FE80::227:90FF:FED5:F800
  Backup Designated router (ID) 5.5.5.5, local address FE80::B6A8:B9FF:FE47:9351
  Timer intervals configured, Hello 10, Dead 80, Wait 80, Retransmit 5
    Hello due in 00:00:02
  Graceful restart helper support enabled
  Index 1/2/2, flood queue length 0
  Next 0x0(0)/0x0(0)/0x0(0)
  Last flood scan length is 6, maximum is 6
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 5.5.5.5  (Backup Designated Router)
  Suppress hello for 0 neighbor(s)
```

## Pings:

### Router 1:

```
R1#ping 192.168.0.81
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.0.81, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
R1#ping 2001:db8:acad:15::1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:15::1, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
R1#ping 192.168.0.97
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.0.97, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
R1#ping 2001:db8:acad:16::1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:16::1, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
R1#ping 192.168.0.113
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.0.113, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
R1#ping 2001:db8:acad:17::1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:17::1, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/2/6 ms
R1#ping 192.168.0.129
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.0.129, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
R1#ping 2001:db8:acad:18::1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:18::1, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/2/6 ms
R1#ping 192.168.0.145
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.0.145, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
R1#ping 2001:db8:acad:19::1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:19::1, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/2/7 ms
R1#ping 192.168.0.161
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.0.161, timeout is 2 seconds:
```

```
!!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
R1#ping 2001:db8:acad:20::1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:20::1, timeout is 2 seconds:
!!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/2/6 ms
```

## Router 2:

```
R2#ping 192.168.0.81
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.0.81, timeout is 2 seconds:
!!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
R2#ping 2001:db8:acad:15::1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:15::1, timeout is 2 seconds:
!!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
R2#ping 192.168.0.97
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.0.97, timeout is 2 seconds:
!!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
R2#ping 2001:db8:acad:16::1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:16::1, timeout is 2 seconds:
!!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
R2#ping 192.168.0.113
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.0.113, timeout is 2 seconds:
!!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
R2#ping 2001:db8:acad:17::1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:17::1, timeout is 2 seconds:
!!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/2/8 ms
R2#ping 192.168.0.129
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.0.129, timeout is 2 seconds:
!!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
R2#ping 2001:db8:acad:18::1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:18::1, timeout is 2 seconds:
!!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
```

```
R2#ping 192.168.0.145
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.0.145, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
R2#ping 2001:db8:acad:19::1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:19::1, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
R2#ping 192.168.0.161
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.0.161, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
R2#ping 2001:db8:acad:20::1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:20::1, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
```

### Router 3:

```
R3#ping 192.168.0.81
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.0.81, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
R3#ping 2001:db8:acad:15::1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:15::1, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 2/2/3 ms
R3#ping 192.168.0.97
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.0.97, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
R3#ping 2001:db8:acad:16::1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:16::1, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/2 ms
R3#ping 192.168.0.113
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.0.113, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
R3#ping 2001:db8:acad:17::1
Type escape sequence to abort.
```

```
Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:17::1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
R3#ping 192.168.0.129
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.0.129, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
R3#ping 2001:db8:acad:18::1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:18::1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/2/8 ms
R3#ping 192.168.0.145
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.0.145, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
R3#ping 2001:db8:acad:19::1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:19::1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
R3#ping 192.168.0.161
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.0.161, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
R3#ping 2001:db8:acad:20::1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:20::1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
```

#### Router 4:

```
R4#ping 192.168.0.81
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.0.81, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
R4#ping 2001:db8:acad:15::1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:15::1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/2/6 ms
R4#ping 192.168.0.97
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.0.97, timeout is 2 seconds:
!!!!!
```

Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms  
R4#ping 2001:db8:acad:16::1  
Type escape sequence to abort.  
Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:16::1, timeout is 2 seconds:  
!!!!!  
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms  
R4#ping 192.168.0.113  
Type escape sequence to abort.  
Sending 5, 100-byte ICMP Echos to 192.168.0.113, timeout is 2 seconds:  
!!!!!  
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms  
R4#ping 2001:db8:acad:17::1  
Type escape sequence to abort.  
Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:17::1, timeout is 2 seconds:  
!!!!!  
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms  
R4#ping 192.168.0.129  
Type escape sequence to abort.  
Sending 5, 100-byte ICMP Echos to 192.168.0.129, timeout is 2 seconds:  
!!!!!  
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms  
R4#ping 2001:db8:acad:18::1  
Type escape sequence to abort.  
Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:18::1, timeout is 2 seconds:  
!!!!!  
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms  
R4#ping 192.168.0.145  
Type escape sequence to abort.  
Sending 5, 100-byte ICMP Echos to 192.168.0.145, timeout is 2 seconds:  
!!!!!  
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms  
R4#ping 2001:db8:acad:19::1  
Type escape sequence to abort.  
Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:19::1, timeout is 2 seconds:  
!!!!!  
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/2/8 ms  
R4#ping 192.168.0.161  
Type escape sequence to abort.  
Sending 5, 100-byte ICMP Echos to 192.168.0.161, timeout is 2 seconds:  
!!!!!  
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms  
R4#ping 2001:db8:acad:20::1  
Type escape sequence to abort.  
Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:20::1, timeout is 2 seconds:  
!!!!!  
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

### Router 5:

R5#ping 192.168.0.81

Type escape sequence to abort.  
Sending 5, 100-byte ICMP Echos to 192.168.0.81, timeout is 2 seconds:  
!!!!!  
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms  
R5#ping 2001:db8:acad:15::1  
Type escape sequence to abort.  
Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:15::1, timeout is 2 seconds:  
!!!!!  
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/2/8 ms  
R5#ping 192.168.0.97  
Type escape sequence to abort.  
Sending 5, 100-byte ICMP Echos to 192.168.0.97, timeout is 2 seconds:  
!!!!!  
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms  
R5#ping 2001:db8:acad:16::1  
Type escape sequence to abort.  
Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:16::1, timeout is 2 seconds:  
!!!!!  
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms  
R5#ping 192.168.0.113  
Type escape sequence to abort.  
Sending 5, 100-byte ICMP Echos to 192.168.0.113, timeout is 2 seconds:  
!!!!!  
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms  
R5#ping 2001:db8:acad:17::1  
Type escape sequence to abort.  
Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:17::1, timeout is 2 seconds:  
!!!!!  
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms  
R5#ping 192.168.0.129  
Type escape sequence to abort.  
Sending 5, 100-byte ICMP Echos to 192.168.0.129, timeout is 2 seconds:  
!!!!!  
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms  
R5#ping 2001:db8:acad:18::1  
Type escape sequence to abort.  
Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:18::1, timeout is 2 seconds:  
!!!!!  
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms  
R5#ping 192.168.0.145  
Type escape sequence to abort.  
Sending 5, 100-byte ICMP Echos to 192.168.0.145, timeout is 2 seconds:  
!!!!!  
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms  
R5#ping 2001:db8:acad:19::1  
Type escape sequence to abort.  
Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:19::1, timeout is 2 seconds:  
!!!!!  
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

```
R5#ping 192.168.0.161
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.0.161, timeout is 2 seconds:
!!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/2 ms
R5#ping 2001:db8:acad:20::1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:20::1, timeout is 2 seconds:
!!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/3/11 ms
```

### Router 6:

```
R6#ping 192.168.0.81
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.0.81, timeout is 2 seconds:
!!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 3/9/30 ms
R6#ping 2001:db8:acad:15::1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:15::1, timeout is 2 seconds:
!!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/2/7 ms
R6#ping 192.168.0.97
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.0.97, timeout is 2 seconds:
!!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
R6#ping 2001:db8:acad:16::1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:16::1, timeout is 2 seconds:
!!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/2 ms
R6#ping 192.168.0.113
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.0.113, timeout is 2 seconds:
!!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
R6#ping 2001:db8:acad:17::1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:17::1, timeout is 2 seconds:
!!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
R6#ping 192.168.0.129
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.0.129, timeout is 2 seconds:
!!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
R6#ping 2001:db8:acad:18::1
Type escape sequence to abort.
```



```
Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:18::1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
R6#ping 192.168.0.145
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.0.145, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
R6#ping 2001:db8:acad:19::1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:19::1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
R6#ping 192.168.0.161
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.0.161, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
R6#ping 2001:db8:acad:20::1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:20::1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
```

## Problems

As a result of using multi-areas of OSPF, we encountered difficulty in subnetting our network. We asked another student, Lucas, to proofread our subnetting scheme. He highlighted some potential flaws, and we were able to fix those errors along with some additional ones. After re-working our subnetting scheme, we found it functioned correctly. This lab also did not have strict requirements for how many routers to include in each OSPF area, so we encountered difficulty in choosing how to build our topology.

## Conclusions

We completed this lab by creating the topology and configuration virtually in packet tracer, then transferring this to the routers in the CCNP lab. We encountered some problems, but we were assisted by some peers in our lab and overcame these issues. Finally, we verified that our network functioned properly by pinging all the loopback interfaces and other routers in the network. Overall, this lab taught us a valuable networking concept that we can use in many scenarios in the future. Learning how to subnet multi-area OSPF properly with many areas will be a useful tool to know when working with larger networks.

## Instructor Signoff