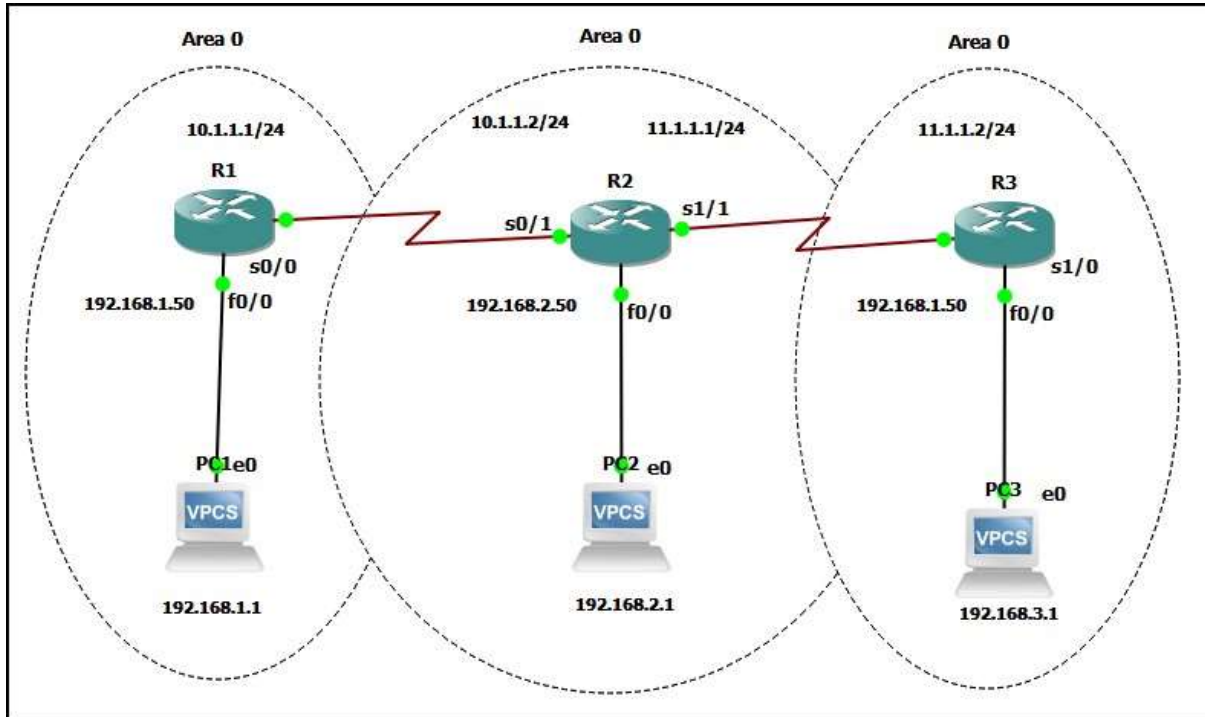


PRACTICAL No.: 06

AIM: OSPF Implementation

1. Implement Single-Area OSPFv2

Step 1: To create a network take 3 routers and 3 PC's



Step 2 : Configure PC

PC1 :

```
PC1> ip 192.168.1.1 255.255.255.0 gateway 192.168.1.50
Checking for duplicate address...
PC1 : 192.168.1.1 255.255.255.0 gateway 192.168.1.50

PC1> sh ip

NAME       : PC1[1]
IP/MASK    : 192.168.1.1/24
GATEWAY    : 192.168.1.50
DNS        :
MAC        : 00:50:79:66:68:00
LPORT      : 10028
RHOST:PORT : 127.0.0.1:10029
MTU        : 1500
```

PC2 :

```
PC2> ip 192.168.2.1 255.255.255.0 gateway 192.168.2.50
Checking for duplicate address...
PC1 : 192.168.2.1 255.255.255.0 gateway 192.168.2.50

PC2> sh ip

NAME       : PC2[1]
IP/MASK    : 192.168.2.1/24
GATEWAY    : 192.168.2.50
DNS        :
MAC        : 00:50:79:66:68:01
LPORT      : 10026
RHOST:PORT : 127.0.0.1:10027
MTU        : 1500
```

PC3 :

```
PC3> ip 192.168.3.1 255.255.255.0 gateway 192.168.3.50
Checking for duplicate address...
PC1 : 192.168.3.1 255.255.255.0 gateway 192.168.3.50

PC3> sh ip

NAME       : PC3[1]
IP/MASK    : 192.168.3.1/24
GATEWAY    : 192.168.3.50
DNS        :
MAC        : 00:50:79:66:68:02
LPORT      : 10024
RHOST:PORT : 127.0.0.1:10025
MTU        : 1500
```

Step 3 : Configure IP Address in Router

R1 :

```

R1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#int f0/0
R1(config-if)#ip add 192.168.1.50 255.255.255.0
R1(config-if)#no shut
R1(config-if)#ex
R1(config)#
*Mar 1 00:03:52.483: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to
up
*Mar 1 00:03:53.483: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet
0/0, changed state to up
R1(config)#int s0/0
R1(config-if)#ip add 10.1.1.1 255.255.255.0
R1(config-if)#no shut
R1(config-if)#ex
R1(config)#
*Mar 1 00:05:02.235: %LINK-3-UPDOWN: Interface Serial0/0, changed state to up
R1(config)#
*Mar 1 00:05:03.239: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0, c
hanged state to up
R1(config)#
*Mar 1 00:05:25.447: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0, c
hanged state to down
R1(config)#
*Mar 1 00:08:05.439: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0, c
hanged state to up
R1(config)#do wr
Building configuration...
[OK]

```

R2 :

```

R2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R2(config)#int f0/0
R2(config-if)#ip add 192.168.2.50 255.255.255.0
R2(config-if)#no shut
R2(config-if)#ex
R2(config)#
*Mar 1 00:05:16.987: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to
up

```

```

R2(config)#int s0/1
R2(config-if)#ip add 10.1.1.2 255.255.255.0
R2(config-if)#no shut
R2(config-if)#ex
R2(config)#
*Mar 1 00:06:39.751: %LINK-3-UPDOWN: Interface Serial0/1, changed state to up

```

```

R2(config)#int s1/1
R2(config-if)#ip add 11.1.1.1 255.255.255.0
R2(config-if)#no shut
R2(config-if)#ex
R2(config)#
*Mar 1 00:07:28.107: %LINK-3-UPDOWN: Interface Serial1/1, changed state to up

```

```

R2(config)#do wr
Building configuration...
[OK]

```

R3 :

```

R3#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R3(config)#int f0/0
R3(config-if)#ip add 192.168.3.50 255.255.255.0
R3(config-if)#no shut
R3(config-if)#ex
R3(config)#
*Mar 1 00:06:40.231: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to
up
*Mar 1 00:06:41.231: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet
0/0, changed state to up
R3(config)#int s1/0
R3(config-if)#ip add 11.1.1.2 255.255.255.0
R3(config-if)#no shut
R3(config-if)#ex
R3(config)#
*Mar 1 00:07:09.583: %LINK-3-UPDOWN: Interface Serial1/0, changed state to up
R3(config)#
*Mar 1 00:07:10.587: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/0, c
hanged state to up
R3(config)#do wr
Building configuration...
[OK]
R3(config)#

```

Step 4 :

```

R1(config)#do sh ip int br

```

Interface	IP-Address	OK?	Method	Status	Protocol
FastEthernet0/0	192.168.1.50	YES	manual	up	up
Serial0/0	10.1.1.1	YES	manual	up	up
FastEthernet0/1	unassigned	YES	unset	administratively down	down
Serial0/1	unassigned	YES	unset	administratively down	down

Check whether the IP Address assigned is correct or not by using 'do sh ip int br'

R2 :

```

R2(config)#do sh ip int br

```

Interface	IP-Address	OK?	Method	Status	Protocol
FastEthernet0/0	192.168.2.50	YES	manual	up	up
Serial0/0	unassigned	YES	unset	administratively down	down
FastEthernet0/1	unassigned	YES	unset	administratively down	down
Serial0/1	10.1.1.2	YES	manual	up	up

R1 :

```

R1(config)#do ping 10.1.1.2

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.1.1.2, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 28/31/40 ms

```

R1 :

R3 :


```
R3(config)#do sh ip int br
```

Interface	IP-Address	OK?	Method	Status	Protocol
FastEthernet0/0	192.168.3.50	YES	manual	up	up
Serial0/0	unassigned	YES	unset	administratively down	down
FastEthernet0/1	unassigned	YES	unset	administratively down	down
Serial0/1	unassigned	YES	unset	administratively down	down
Serial0/2	unassigned	YES	unset	administratively down	down
Serial0/3	unassigned	YES	unset	administratively down	down
Serial1/0	11.1.1.2	YES	manual	up	up
Serial1/1	unassigned	YES	unset	administratively down	down
Serial1/2	unassigned	YES	unset	administratively down	down

Step 5:

Check whether direct connection ping is working in all the routers and PCs

PC1 :

```
PC1> ping 192.168.1.50
84 bytes from 192.168.1.50 icmp_seq=1 ttl=255 time=32.175 ms
84 bytes from 192.168.1.50 icmp_seq=2 ttl=255 time=16.533 ms
84 bytes from 192.168.1.50 icmp_seq=3 ttl=255 time=16.503 ms
84 bytes from 192.168.1.50 icmp_seq=4 ttl=255 time=17.055 ms
84 bytes from 192.168.1.50 icmp_seq=5 ttl=255 time=15.675 ms
```

PC2 :

```
PC2> ping 192.168.2.50
84 bytes from 192.168.2.50 icmp_seq=1 ttl=255 time=14.766 ms
84 bytes from 192.168.2.50 icmp_seq=2 ttl=255 time=18.671 ms
84 bytes from 192.168.2.50 icmp_seq=3 ttl=255 time=16.041 ms
84 bytes from 192.168.2.50 icmp_seq=4 ttl=255 time=16.366 ms
84 bytes from 192.168.2.50 icmp_seq=5 ttl=255 time=15.690 ms
```

PC3 :

```
PC3> ping 192.168.3.50
84 bytes from 192.168.3.50 icmp_seq=1 ttl=255 time=25.745 ms
84 bytes from 192.168.3.50 icmp_seq=2 ttl=255 time=16.399 ms
84 bytes from 192.168.3.50 icmp_seq=3 ttl=255 time=14.540 ms
84 bytes from 192.168.3.50 icmp_seq=4 ttl=255 time=15.370 ms
84 bytes from 192.168.3.50 icmp_seq=5 ttl=255 time=16.309 ms
```

R2 :

```
R2(config)#do ping 10.1.1.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.1.1.1, timeout is 2 seconds:
!!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 16/24/32 ms
R2(config)#
```

R3 :

```
R3(config)#do ping 11.1.1.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 11.1.1.1, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 76/80/88 ms
R3(config)#
```

Direct Connection ping is working successfully. But indirect won't work because we haven't done any protocol. So, we will do OSPF in single area.

Step 6 : Configure OSPF protocol in all the routers.

R1:

```
R1(config)#router ospf 1
R1(config-router)#network 192.168.1.0 0.0.0.255 area 0
R1(config-router)#network 10.1.1.0 0.0.0.255 area 0
R1(config-router)#ex
R1(config)#do wr
Building configuration...
[OK]
```

R2:

```
R2(config)#router ospf 1
R2(config-router)#network 192.168.2.0 0.0.0.255 area 0
R2(config-router)#network 10.1.1.0 0.0.0.255 area 0
R2(config-router)#network 10.1.1.0 0.0.0.255 area 0
*Mar 1 00:32:35.423: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.1.50 on Serial0/1
R2(config-router)#network 11.1.1.0 0.0.0.255 area 0
R2(config-router)#ex
R2(config)#do wr
Building configuration...
[OK]
```

R3:

```
R3(config)#router ospf 1
R3(config-router)#network 192.168.3.0 0.0.0.255 area 0
R3(config-router)#network 11.1.1.0 0.0.0.255 area 0
R3(config-router)#ex
R3(config)#
*Mar 1 00:31:40.743: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.2.50 on Serial1/0
R3(config)#do wr
Building configuration...
[OK]
```

Software Defined Network

Step 7 : Enter command 'sh ip route' in all router to check whether OSPF is done properly.

Step 8: Enter command 'sh ip protocols' to check which all protocols are applied in our network

Software Defined Network

```
R1#sh ip route
Codes: 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

Gateway of last resort is not set

    10.0.0.0/24 is subnetted, 1 subnets
C       10.1.1.0 is directly connected, Serial0/0
    11.0.0.0/24 is subnetted, 1 subnets
O       11.1.1.0 [110/128] via 10.1.1.2, 00:02:02, Serial0/0
C       192.168.1.0/24 is directly connected, FastEthernet0/0
O       192.168.2.0/24 [110/74] via 10.1.1.2, 00:03:01, Serial0/0
O       192.168.3.0/24 [110/138] via 10.1.1.2, 00:00:36, Serial0/0
```

R2:

```
R2#sh ip route
Codes: 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

Gateway of last resort is not set

    10.0.0.0/24 is subnetted, 1 subnets
C       10.1.1.0 is directly connected, Serial0/1
    11.0.0.0/24 is subnetted, 1 subnets
C       11.1.1.0 is directly connected, Serial1/1
O       192.168.1.0/24 [110/74] via 10.1.1.1, 00:03:42, Serial0/1
C       192.168.2.0/24 is directly connected, FastEthernet0/0
O       192.168.3.0/24 [110/74] via 11.1.1.2, 00:01:27, Serial1/1
```

R3:

```
R3#sh ip route
Codes: 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

Gateway of last resort is not set

    10.0.0.0/24 is subnetted, 1 subnets
O       10.1.1.0 [110/128] via 11.1.1.1, 00:01:53, Serial1/0
    11.0.0.0/24 is subnetted, 1 subnets
C       11.1.1.0 is directly connected, Serial1/0
O       192.168.1.0/24 [110/138] via 11.1.1.1, 00:01:53, Serial1/0
O       192.168.2.0/24 [110/74] via 11.1.1.1, 00:01:53, Serial1/0
C       192.168.3.0/24 is directly connected, FastEthernet0/0
```


R1:

```

R1#sh ip protocols
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 192.168.1.50
  Number of areas in this router is 1. 1 normal 0 stub 0 nssa
  Maximum path: 4
  Routing for Networks:
    10.1.1.0 0.0.0.255 area 0
    192.168.1.0 0.0.0.255 area 0
  Reference bandwidth unit is 100 mbps
  Routing Information Sources:
    Gateway         Distance      Last Update
    192.168.2.50      110          00:04:54
    192.168.3.50      110          00:03:28
    192.168.1.50      110          00:09:55
  Distance: (default is 110)

```

R2:

```

R2#sh ip protocols
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 192.168.2.50
  Number of areas in this router is 1. 1 normal 0 stub 0 nssa
  Maximum path: 4
  Routing for Networks:
    10.1.1.0 0.0.0.255 area 0
    11.1.1.0 0.0.0.255 area 0
    192.168.2.0 0.0.0.255 area 0
  Reference bandwidth unit is 100 mbps
  Routing Information Sources:
    Gateway         Distance      Last Update
    192.168.2.50      110          00:05:26
    192.168.3.50      110          00:04:10
    192.168.1.50      110          00:06:25
  Distance: (default is 110)

```

R3:

```

R3#sh ip protocols
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 192.168.3.50
  Number of areas in this router is 1. 1 normal 0 stub 0 nssa
  Maximum path: 4
  Routing for Networks:
    11.1.1.0 0.0.0.255 area 0
    192.168.3.0 0.0.0.255 area 0
  Reference bandwidth unit is 100 mbps
  Routing Information Sources:
    Gateway         Distance      Last Update
    192.168.2.50      110          00:04:23
    192.168.3.50      110          00:04:23
    192.168.1.50      110          00:04:23
  Distance: (default is 110)

```

Software Defined Network

Step 9 : Enter command 'sh ip ospf neighbor' to check OSPF

Neighbor R1:

```
R1#sh ip ospf neighbor
```

Neighbor ID	Pri	State	Dead Time	Address	Interface
192.168.2.50	0	FULL/ -	00:00:32	10.1.1.2	Serial0/0

```
R1#
```

R2:

```
R2#sh ip ospf neighbor
```

Neighbor ID	Pri	State	Dead Time	Address	Interface
192.168.3.50	0	FULL/ -	00:00:39	11.1.1.2	Serial1/1
192.168.1.50	0	FULL/ -	00:00:30	10.1.1.1	Serial0/1

```
R2#
```

R3:

```
R3#sh ip ospf neighbor
```

Neighbor ID	Pri	State	Dead Time	Address	Interface
192.168.2.50	0	FULL/ -	00:00:30	11.1.1.1	Serial1/0

```
R3#
```

Step 10 :

Now you can ping any indirect connection because we have done OSPF on the router.

PC1:

```
PC1> ping 192.168.2.1
84 bytes from 192.168.2.1 icmp_seq=1 ttl=62 time=22.423 ms
84 bytes from 192.168.2.1 icmp_seq=2 ttl=62 time=30.506 ms
84 bytes from 192.168.2.1 icmp_seq=3 ttl=62 time=30.902 ms
84 bytes from 192.168.2.1 icmp_seq=4 ttl=62 time=30.872 ms
84 bytes from 192.168.2.1 icmp_seq=5 ttl=62 time=31.471 ms

PC1> █
```

PC2:

```
PC2> ping 192.168.1.1
84 bytes from 192.168.1.1 icmp_seq=1 ttl=62 time=34.780 ms
84 bytes from 192.168.1.1 icmp_seq=2 ttl=62 time=31.250 ms
84 bytes from 192.168.1.1 icmp_seq=3 ttl=62 time=30.876 ms
84 bytes from 192.168.1.1 icmp_seq=4 ttl=62 time=31.786 ms
84 bytes from 192.168.1.1 icmp_seq=5 ttl=62 time=16.942 ms

PC2> █
```

PC3:

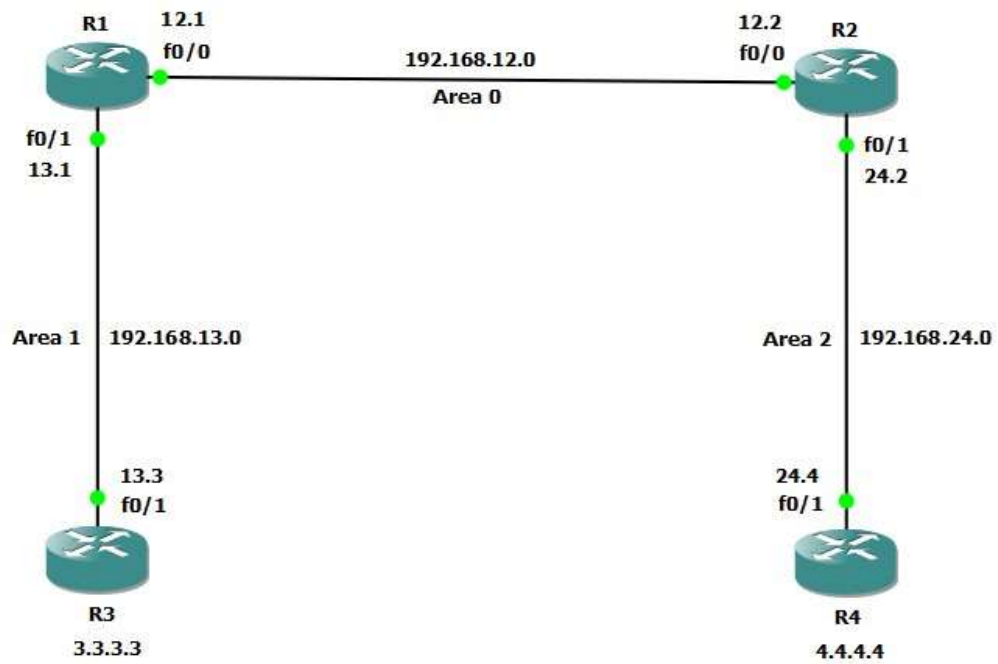
```
PC3> ping 192.168.1.1
84 bytes from 192.168.1.1 icmp_seq=1 ttl=61 time=65.298 ms
84 bytes from 192.168.1.1 icmp_seq=2 ttl=61 time=63.587 ms
84 bytes from 192.168.1.1 icmp_seq=3 ttl=61 time=61.473 ms
84 bytes from 192.168.1.1 icmp_seq=4 ttl=61 time=63.125 ms
84 bytes from 192.168.1.1 icmp_seq=5 ttl=61 time=60.119 ms

PC3> █
```

2 . Implement Multi-Area OSPFv2

Step 1: Take 4 Routers and make a network as below.

Software Defined Network



Step 2: Configure all the network as below

R1:

```
R1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#int f0/0
R1(config-if)#ip add 192.168.12.2 255.255.255.0
R1(config-if)#no shut
R1(config-if)#exit
R1(config)#
```

```
R1(config)#int f0/1
R1(config-if)#ip add 192.168.24.2 255.255.255.0
R1(config-if)#no shut
R1(config-if)#exit
R1(config)#do wr
Building configuration...
```

R2:

```
R2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R2(config)#int f0/0
R2(config-if)#ip add 192.168.12.2 255.255.255.0
R2(config-if)#no shut
R2(config-if)#exit
R2(config)#
```

```
R2(config)#int f0/1
R2(config-if)#ip add 192.168.24.2 255.255.255.0
R2(config-if)#no shut
R2(config-if)#exit
R2(config)#do wr
Building configuration...
```

R3:

Software Defined Network

```
R3#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R3(config)#int f0/1
R3(config-if)#ip add 192.168.13.3 255.255.255.0
R3(config-if)#no shut
R3(config-if)#e
R3(config)#ex
```

```
R3(config)#int loopback0
R3(config-if)#
*Mar 1 00:04:35.703: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, c
hanged state to up
R3(config-if)#ip add 3.3.3.3 255.255.255.255
R3(config-if)#no shut
R3(config-if)#exit
R3(config)#do wr
Building configuration...
[OK]
```

R4:

```
R4#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R4(config)#int f0/1
R4(config-if)#ip add 192.168.24.4 255.255.255.0
R4(config-if)#no shut
R4(config-if)#exit
R4(config)#
```

```
R4(config)#int loopback0
R4(config-if)#ip add 4.4.4.4 255.255.255.255
R4(config-if)#no shut
R4(config-if)#exit
R4(config)#do wr
Building configuration...
[OK]
```

Step 3 :

Now try to ping any router. It won't work because there is no Protocol applied.

So now we will apply Multi – Area OSPFv2(Area 0, 1, 2).

Configure the system for Multi – Area OSPFv2 as below:

Software Defined Network

R1:

```
R1(config)#router ospf 1
R1(config-router)#network 192.168.12.0 0.0.0.255 area 0
R1(config-router)#network 192.168.13.0 0.0.0.255 area 1
R1(config-router)#ex
R1(config)#do wr
Building configuration...
[OK]
R1(config)#end
R1#
```

R2:

```
R2(config)#router ospf 1
R2(config-router)#network 192.168.12.0 0.0.0.255 area 0
R2(config-router)#network 192.168.24.0 0.0.0.255 area 2
R2(config-router)#ex
R2(config)#do wr
Building configuration...
[OK]
R2(config)#end
R2#
```

R3:

```
R3(config)#router ospf 1
R3(config-router)#network 192.168.13.0 0.0.0.255 area 1
R3(config-router)#network 3.3.3.3 0.0.0.0 area 1
R3(config-router)#ex
R3(config)#do wr
Building configuration...
[OK]
R3(config)#end
R3#
```

R4:

```
R4(config)#router ospf 1
R4(config-router)#network 192.168.24.0 0.0.0.255 area 2
R4(config-router)#network 4.4.4.4 0.0.0.0 area 2
R4(config-router)#ex
R4(config)#do wr
Building configuration...
[OK]
R4(config)#end
R4#
```

Step 4:

Enter the command 'show ip route ospf' to check whether OSPF is successfully configured.

R1:

```
R1#show ip route ospf
      3.0.0.0/32 is subnetted, 1 subnets
O       3.3.3.3 [110/11] via 192.168.13.3, 00:02:24, FastEthernet0/1
      4.0.0.0/32 is subnetted, 1 subnets
O IA    4.4.4.4 [110/21] via 192.168.12.2, 00:00:32, FastEthernet0/0
O IA    192.168.24.0/24 [110/20] via 192.168.12.2, 00:03:14, FastEthernet0/0
R1#
```

R2:

```
R2#show ip route ospf
O IA    192.168.13.0/24 [110/20] via 192.168.12.1, 00:03:36, FastEthernet0/0
      3.0.0.0/32 is subnetted, 1 subnets
O IA    3.3.3.3 [110/21] via 192.168.12.1, 00:02:45, FastEthernet0/0
      4.0.0.0/32 is subnetted, 1 subnets
O       4.4.4.4 [110/11] via 192.168.24.4, 00:00:53, FastEthernet0/1
R2#
```

R3:

```
R3#show ip route ospf
O IA    192.168.12.0/24 [110/20] via 192.168.13.1, 00:02:55, FastEthernet0/1
      4.0.0.0/32 is subnetted, 1 subnets
O IA    4.4.4.4 [110/31] via 192.168.13.1, 00:01:04, FastEthernet0/1
O IA    192.168.24.0/24 [110/30] via 192.168.13.1, 00:02:55, FastEthernet0/1
R3#
```

R4:

```
R4#show ip route ospf
O IA    192.168.12.0/24 [110/20] via 192.168.24.2, 00:01:26, FastEthernet0/1
O IA    192.168.13.0/24 [110/30] via 192.168.24.2, 00:01:26, FastEthernet0/1
      3.0.0.0/32 is subnetted, 1 subnets
O IA    3.3.3.3 [110/31] via 192.168.24.2, 00:01:26, FastEthernet0/1
R4#
```

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

Neighbor ID	Pri	State	Dead Time	Address	Interface
192.168.24.2	1	FULL/BDR	00:00:38	192.168.12.2	FastEthernet0/0
3.3.3.3	1	FULL/BDR	00:00:36	192.168.13.3	FastEthernet0/1

```
R1#
```


Software Defined Network

Step 5:

To check the neighbor enter 'show ip ospf neighbor' and check the neighbor :

R1:

Software Defined Network

R2:

```
R2#show ip ospf neighbor
```

Neighbor ID	Pri	State	Dead Time	Address	Interface
192.168.13.1	1	FULL/DR	00:00:35	192.168.12.1	FastEthernet0/0
4.4.4.4	1	FULL/BDR	00:00:35	192.168.24.4	FastEthernet0/1

```
R2#
```

R3:

```
R3#show ip ospf neighbor
```

Neighbor ID	Pri	State	Dead Time	Address	Interface
192.168.13.1	1	FULL/DR	00:00:36	192.168.13.1	FastEthernet0/1

```
R3#
```

R4:

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

Neighbor ID	Pri	State	Dead Time	Address	Interface
192.168.24.2	1	FULL/DR	00:00:31	192.168.24.2	FastEthernet0/1

```
R4#
```

As now we have successfully configured and checked that OSPF multi-Area is there in our network.

Step 6 : Try pinging any router or loopback from any router.

```
R1#ping 192.168.13.3
```

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.13.3, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 20/25/32 ms

```
R1#ping 192.168.24.4
```

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.24.4, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 32/56/76 ms

```
R1#ping 3.3.3.3
```

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 3.3.3.3, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 32/37/48 ms

```
R1#ping 4.4.4.4
```

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 4.4.4.4, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 40/53/72 ms

```
R1#
```

R1:

R2:

```
R2#ping 192.168.13.3
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.13.3, timeout is 2 seconds:
!!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 36/50/60 ms
R2#ping 3.3.3.3
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 3.3.3.3, timeout is 2 seconds:
!!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 40/53/64 ms
R2#ping 4.4.4.4
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 4.4.4.4, timeout is 2 seconds:
!!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 16/30/40 ms
R2#
```

R3:

```
R3#ping 192.168.12.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.12.2, timeout is 2 seconds:
!!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 44/50/64 ms
R3#ping 192.168.24.4
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.24.4, timeout is 2 seconds:
!!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 64/89/120 ms
R3#ping 3.3.3.3
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 3.3.3.3, timeout is 2 seconds:
!!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/4 ms
R3#ping 4.4.4.4
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 4.4.4.4, timeout is 2 seconds:
!!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 72/88/104 ms
R3#
```

R4:


```
R4#ping 192.168.13.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.13.1, timeout is 2 seconds:
!!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 48/56/68 ms
R4#ping 192.168.12.1

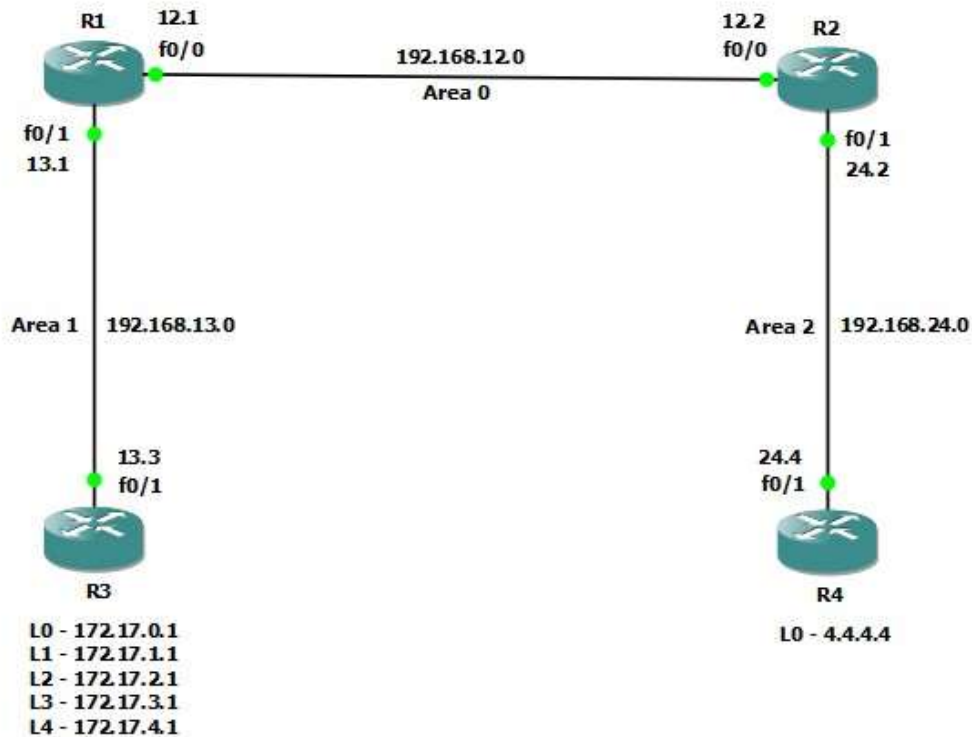
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.12.1, timeout is 2 seconds:
!!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 40/56/80 ms
R4#ping 192.168.13.3

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.13.3, timeout is 2 seconds:
!!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 64/96/144 ms
R4#ping 3.3.3.3

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 3.3.3.3, timeout is 2 seconds:
!!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 64/92/120 ms
R4#
```

3. OSPFv2 Route Summarization and Filtering

Step 1 : Follow the same Topology as the Multi – Area OSPFv2.



Step 2: Add more loopbacks to Router 3 and configure the OSPF accordingly.

```
R3#en
R3#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R3(config)#int loopback0
R3(config-if)#ip add 172.17.0.1 255.255.255.255
R3(config-if)#no shut
R3(config-if)#exit
R3(config)#int loopback1
R3(config-if)#ip add 172.17.1.1 255.255.255.255
R3(config-if)#no shut
R3(config-if)#exit
R3(config)#int loopback2
R3(config-if)#ip add 172.17.2.1 255.255.255.255
R3(config-if)#no shut
R3(config-if)#exit
R3(config)#int loopback3
R3(config-if)#ip add 172.17.3.1 255.255.255.255
R3(config-if)#no shut
R3(config-if)#exit
R3(config)#int loopback4
R3(config-if)#ip add 172.17.4.1 255.255.255.255
R3(config-if)#no shut
R3(config-if)#exit
R3(config)#
*Mar 1 00:05:10.035: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
*Mar 1 00:05:10.043: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback1, changed state to up
R3(config)#router ospf 1
R3(config-router)#network 172.17.0.1 0.0.0.255 area 1
R3(config-router)#network 172.17.1.1 0.0.0.255 area 1
R3(config-router)#network 172.17.2.1 0.0.0.255 area 1
R3(config-router)#network 172.17.3.1 0.0.0.255 area 1
R3(config-router)#network 172.17.4.1 0.0.0.255 area 1
R3(config-router)#end
R3#
*Mar 1 00:05:39.723: %SYS-5-CONFIG_I: Configured from console by console
R3#
```

Step 3: Enter 'show ip route' on R2 and you will see all the Loopback of R3.

Because till now we haven't performed any summarization on R1.

```
R2#show ip route
Codes: 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

Gateway of last resort is not set

C    192.168.12.0/24 is directly connected, FastEthernet0/0
O IA 192.168.13.0/24 [110/20] via 192.168.12.1, 00:05:53, FastEthernet0/0
      4.0.0.0/32 is subnetted, 1 subnets
O     4.4.4.4 [110/11] via 192.168.24.4, 00:05:43, FastEthernet0/1
C    192.168.24.0/24 is directly connected, FastEthernet0/1
      172.17.0.0/32 is subnetted, 5 subnets
O IA   172.17.4.1 [110/21] via 192.168.12.1, 00:01:04, FastEthernet0/0
O IA   172.17.0.1 [110/21] via 192.168.12.1, 00:01:04, FastEthernet0/0
O IA   172.17.1.1 [110/21] via 192.168.12.1, 00:01:06, FastEthernet0/0
O IA   172.17.2.1 [110/21] via 192.168.12.1, 00:01:06, FastEthernet0/0
O IA   172.17.3.1 [110/21] via 192.168.12.1, 00:01:06, FastEthernet0/0
```

Step 4: So now we will perform Summarization on R1

```
R1#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#router ospf 1
R1(config-router)#area 1 range 172.17.0.0 255.255.252.0
R1(config-router)#end
R1#
*Mar  1 00:08:47.647: %SYS-5-CONFIG_I: Configured from console by console
R1#show ip route
Codes: 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

Gateway of last resort is not set

C    192.168.12.0/24 is directly connected, FastEthernet0/0
C    192.168.13.0/24 is directly connected, FastEthernet0/1
      4.0.0.0/32 is subnetted, 1 subnets
O IA   4.4.4.4 [110/21] via 192.168.12.2, 00:00:09, FastEthernet0/0
O IA  192.168.24.0/24 [110/20] via 192.168.12.2, 00:00:09, FastEthernet0/0
      172.17.0.0/16 is variably subnetted, 6 subnets, 2 masks
O     172.17.4.1/32 [110/11] via 192.168.13.3, 00:00:09, FastEthernet0/1
O     172.17.0.1/32 [110/11] via 192.168.13.3, 00:00:09, FastEthernet0/1
O     172.17.1.1/32 [110/11] via 192.168.13.3, 00:00:11, FastEthernet0/1
O     172.17.0.0/22 is a summary, 00:00:11, Null0
O     172.17.2.1/32 [110/11] via 192.168.13.3, 00:00:11, FastEthernet0/1
O     172.17.3.1/32 [110/11] via 192.168.13.3, 00:00:11, FastEthernet0/1
```

Step 5:

Once again we will go to R2 and enter the command 'show ip route'.

Now we have done summarization on R1 so we will see only 2 loopbacks of R3.

```
R2#show ip route
Codes: 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

Gateway of last resort is not set

C    192.168.12.0/24 is directly connected, FastEthernet0/0
O IA 192.168.13.0/24 [110/20] via 192.168.12.1, 00:09:54, FastEthernet0/0
      4.0.0.0/32 is subnetted, 1 subnets
O      4.4.4.4 [110/11] via 192.168.24.4, 00:09:44, FastEthernet0/1
C    192.168.24.0/24 is directly connected, FastEthernet0/1
      172.17.0.0/16 is variably subnetted, 2 subnets, 2 masks
O IA   172.17.4.1/32 [110/21] via 192.168.12.1, 00:05:05, FastEthernet0/0
O IA   172.17.0.0/22 [110/21] via 192.168.12.1, 00:02:01, FastEthernet0/0
```

That's how we do summarization.

Step 6: And now you can ping any loopback of R3 from any router.

Just to confirm I have pinged the loopback of R3 via R4.

```
R4#ping 172.17.3.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.17.3.1, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 68/92/108 ms
R4#ping 172.17.4.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.17.4.1, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 88/95/104 ms
R4#ping 172.17.0.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.17.0.1, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 88/96/104 ms
R4#
```

I have pinged the loopback of R3 via R1.


```

R1#ping 172.17.2.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.17.2.1, timeout is 2 seconds:
!!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 16/28/48 ms
R1#ping 172.17.1.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.17.1.1, timeout is 2 seconds:
!!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 24/29/32 ms
R1#ping 172.17.4.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.17.4.1, timeout is 2 seconds:
!!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 28/33/36 ms
R1#

```

I have pinged the loopback of R3 via R2.

```

R2#ping 172.17.3.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.17.3.1, timeout is 2 seconds:
!!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 36/53/72 ms
R2#ping 172.17.4.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.17.4.1, timeout is 2 seconds:
!!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 36/56/76 ms
R2#ping 172.17.2.1

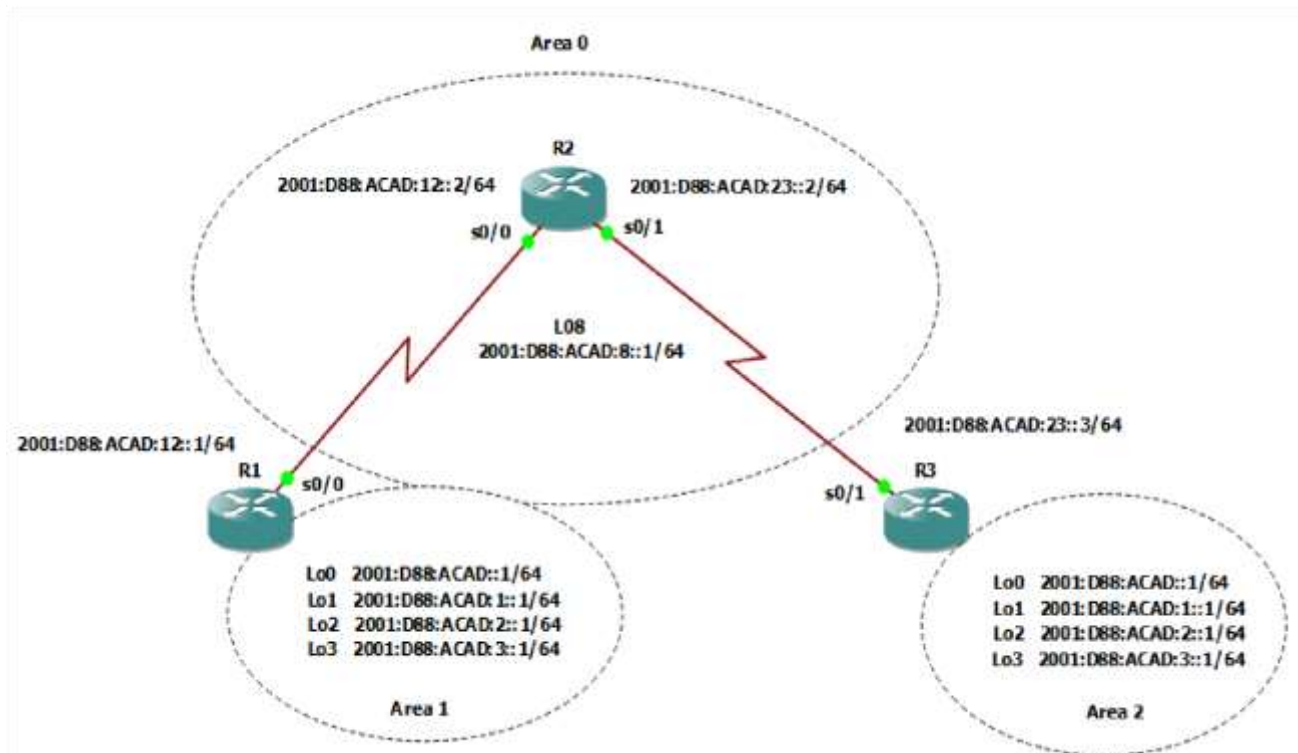
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.17.2.1, timeout is 2 seconds:
!!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 48/58/64 ms
R2#ping 172.17.0.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.17.0.1, timeout is 2 seconds:
!!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 36/57/76 ms
R2#

```

4. Implement Multiarea OSPFv3

Step 1: Build the topology



Step 2: Configure IP's address and Loopback in all the router according to the topology

We will use IPv6 for OSPF version 3

There's a different command for IPv6 configuration. Follow as below.

R1:

```

R1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#int s0/0
R1(config-if)#no shut
R1(config-if)#ipv6 address 2001:D88:ACAD:12::1/64
R1(config-if)#no shut
R1(config-if)#
R1(config-if)#int L0
R1(config-if)#no shut
R1(config-if)#ipv6 address 2001:D88:ACAD::1/64
R1(config-if)#no shut
R1(config-if)#
R1(config-if)#int L1
R1(config-if)#no shut
R1(config-if)#ipv6 address 2001:D88:ACAD:1::1/64
R1(config-if)#no shut
R1(config-if)#
R1(config-if)#
*Mar 1 00:11:02.931: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback1, changed state to up
R1(config-if)#
R1(config-if)#int L2
R1(config-if)#no shut
R1(config-if)#ipv6 address 2001:D88:ACAD:2::1/64
R1(config-if)#no shut
R1(config-if)#
*Mar 1 00:11:14.691: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback2, changed state to up
R1(config-if)#
R1(config-if)#int L3
R1(config-if)#no shut
R1(config-if)#ipv6 address 2001:D88:ACAD:3::1/64
R1(config-if)#no shut
R1(config-if)#do wr
Building configuration...

*Mar 1 00:11:38.359: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback3, changed state to up[OK]
R1(config-if)#ex
R1(config)#exit
R1#

```

R2:

```

R2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R2(config)#int s0/0
R2(config-if)#no shut
R2(config-if)#ipv6 address 2001:D88:ACAD:12::2/64
R2(config-if)#no shut
R2(config-if)#
*Mar 1 00:12:47.943: %LINK-3-UPDOWN: Interface Serial0/0, changed state to up
R2(config-if)#
*Mar 1 00:12:48.951: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0, changed state to up
R2(config-if)#
R2(config-if)#int s0/1
R2(config-if)#no shut
R2(config-if)#ipv6 address 2001:D88:ACAD:23::2/64
R2(config-if)#no shut
R2(config-if)#
*Mar 1 00:13:03.335: %LINK-3-UPDOWN: Interface Serial0/1, changed state to up
*Mar 1 00:13:04.339: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/1, changed state to up
R2(config-if)#
R2(config-if)#int L8
R2(config-if)#ipv6 address 2001:D88:ACAD::8::1/64
% Incomplete command.

R2(config-if)#no shut
R2(config-if)#do wr
Building configuration...
[OK]
R2(config-if)#ex

```

R3:

```

R3#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R3(config)#int s0/1
R3(config-if)#no shut
R3(config-if)#ipv6 address 2001:D88:ACAD:23::3/64
R3(config-if)#no shut
R3(config-if)#
*Mar 1 00:15:41.499: %LINK-3-UPDOWN: Interface Serial0/1, changed state to up
R3(config-if)#
*Mar 1 00:15:42.507: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/1, changed state to up
R3(config-if)#
R3(config-if)#int L4
R3(config-if)#no shut
R3(config-if)#ipv6 address 2001:D88:ACAD:4::1/64
R3(config-if)#no shut
R3(config-if)#
*Mar 1 00:15:52.355: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback4, changed state to up
R3(config-if)#
R3(config-if)#int L5
R3(config-if)#no shut
R3(config-if)#ipv6 address 2001:D88:ACAD:5::1/64
R3(config-if)#no shut
R3(config-if)#
*Mar 1 00:16:03.871: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback5, changed state to up
R3(config-if)#
R3(config-if)#int L6
R3(config-if)#no shut
R3(config-if)#ipv6 address 2001:D88:ACAD:6::1/64
R3(config-if)#no shut
R3(config-if)#
*Mar 1 00:16:16.167: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback6, changed state to up
R3(config-if)#
R3(config-if)#int L7
R3(config-if)#no shut
R3(config-if)#ipv6 address 2001:D88:ACAD:7::1/64
R3(config-if)#no shut
R3(config-if)#do wr
Building configuration...

*Mar 1 00:16:33.311: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback7, changed state to up[OK]
R3(config-if)#ex

```

Step 3: Once IP is assigned to all. We have to do IPv6 unicast. And we have to assign router ID to the routers.

R1:

```

R1#
R1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#ipv6 unicast
R1(config)#ipv6 unicast-routing
R1(config)#do wr
Building configuration...
[OK]
R1(config)#ipv6 router ospf 1
R1(config-rtr)#
*Mar 1 00:29:03.759: %OSPFv3-4-NORTRID: OSPFv3 process 1 could not pick a router-id,
please configure manually
R1(config-rtr)#router-id 1.1.1.1
R1(config-rtr)#do sh ipv6 ospf
Routing Process "ospfv3 1" with ID 1.1.1.1
SPF schedule delay 5 secs, Hold time between two SPFs 10 secs
Minimum LSA interval 5 secs, Minimum LSA arrival 1 secs
LSA group pacing timer 240 secs
Interface flood pacing timer 33 msecs
Retransmission pacing timer 66 msecs
Number of external LSA 0, Checksum Sum 0x000000
Number of areas in this router is 0, 0 normal 0 stub 0 nssa
Reference bandwidth unit is 100 mbps

```

R2:


```

R2#
R2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R2(config)#ipv6 unicast
R2(config)#ipv6 unicast-routing
R2(config)#do wr
Building configuration...
[OK]
R2(config)#ipv6 router ospf 1
R2(config-rtr)#
*Mar  1 00:30:56.095: %OSPFv3-4-NORTRID: OSPFv3 process 1 could not pick a router-id,
please configure manually
R2(config-rtr)#router-id 2.2.2.2
R2(config-rtr)#do sh ipv6 ospf
  Routing Process "ospfv3 1" with ID 2.2.2.2
  SPF schedule delay 5 secs, Hold time between two SPFs 10 secs
  Minimum LSA interval 5 secs. Minimum LSA arrival 1 secs
  LSA group pacing timer 240 secs
  Interface flood pacing timer 33 msec
  Retransmission pacing timer 66 msec
  Number of external LSA 0. Checksum Sum 0x000000
  Number of areas in this router is 0. 0 normal 0 stub 0 nssa
  Reference bandwidth unit is 100 mbps

```

R3:

```

R3#
R3#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R3(config)#ipv6 unicast
R3(config)#ipv6 unicast-routing
R3(config)#do wr
Building configuration...
[OK]
R3(config)#ipv6 router ospf 1
R3(config-rtr)#
*Mar  1 00:33:09.999: %OSPFv3-4-NORTRID: OSPFv3 process 1 could not pick a router-id,
please configure manually
R3(config-rtr)#router-id 3.3.3.3
R3(config-rtr)#do sh ipv6 ospf
  Routing Process "ospfv3 1" with ID 3.3.3.3
  SPF schedule delay 5 secs, Hold time between two SPFs 10 secs
  Minimum LSA interval 5 secs. Minimum LSA arrival 1 secs
  LSA group pacing timer 240 secs
  Interface flood pacing timer 33 msec
  Retransmission pacing timer 66 msec
  Number of external LSA 0. Checksum Sum 0x000000
  Number of areas in this router is 0. 0 normal 0 stub 0 nssa
  Reference bandwidth unit is 100 mbps
R3(config-rtr)#

```

Step 4: Now we will configure multi-area OSPFv3 in all the router R1:


```

R1(config-rtr)#ex
R1(config)#int L0
R1(config-if)#ipv6 ospf 1 area 1
R1(config-if)#ipv6 ospf network point-to-point
R1(config-if)#int L1`~~~~~`
                        ^
% Invalid input detected at '^' marker.

R1(config)#int L1
R1(config-if)#ipv6 ospf 1 area 1
R1(config-if)#ipv6 ospf network point-to-point
R1(config-if)#int L2
R1(config-if)#ipv6 ospf 1 area 1
R1(config-if)#ipv6 ospf network point-to-point
R1(config-if)#int L3
R1(config-if)#ipv6 ospf 1 area 1
R1(config-if)#ipv6 ospf network point-to-point
R1(config-if)#innt s0/0
                        ^
% Invalid input detected at '^' marker.

R1(config-if)#int s0/0
R1(config-if)#ipv6 ospf 1 area 0
R1(config-if)#do wr
Building configuration...
[OK]
R1(config-if)#ex
R1(config)#

```

R2:

```

R2(config-rtr)#int s0/0
R2(config-if)#ipv6 ospf 1 area 0
R2(config-if)#i
*Mar  1 00:38:51.019: %OSPFv3-5-ADJCHG: Process 1, Nbr 1.1.1.1 on Serial0/0 from LOADI
NG to FULL, Loading Done
R2(config-if)#int s0/1
R2(config-if)#ipv6 ospf 1 area 0
R2(config-if)#int l8
R2(config-if)#ipv6 ospf 1 area 0
R2(config-if)#ipv6 ospf network point-to-point
R2(config-if)#do wr
Building configuration...
[OK]
R2(config-if)#

```

R3:

```

R3(config-rtr)#exit
R3(config)#int l4
R3(config-if)#ipv6 ospf 1 area 2
R3(config-if)#ipv6 network point-to-point
      ^
% Invalid input detected at '^' marker.

R3(config-if)#ipv6 ospf network point-to-point
R3(config-if)#int l5
R3(config-if)#ipv6 ospf 1 area 2
R3(config-if)#ipv6 ospf network point-to-point
R3(config-if)#int l6
R3(config-if)#ipv6 ospf 1 area 2
R3(config-if)#ipv6 ospf network point-to-point
R3(config-if)#int l7
R3(config-if)#ipv6 ospf 1 area 2
R3(config-if)#ipv6 ospf network point-to-point
R3(config-if)#int s0/1
R3(config-if)#ipv6 ospf 1 area 0
R3(config-if)#
*Mar  1 00:43:17.659: %OSPFv3-5-ADJCHG: Process 1, Nbr 2.2.2.2 on Serial0/1 from LOADI
NG to FULL, Loading Done
R3(config-if)#do wr
Building configuration...
[OK]
R3(config-if)#

```

Step 5: Use the show ipv6 protocols command to verify multi-area OSPFv3 Status.

R1:

```

R1(config)#do sh ipv6 protocols
IPv6 Routing Protocol is "connected"
IPv6 Routing Protocol is "static"
IPv6 Routing Protocol is "ospf 1"
  Interfaces (Area 0):
    Serial0/0
  Interfaces (Area 1):
    Loopback3
    Loopback2
    Loopback1
    Loopback0
  Redistribution:
    None
R1(config)#

```

R2:

```
R2(config)#do sh ipv6 protocols
IPv6 Routing Protocol is "connected"
IPv6 Routing Protocol is "static"
IPv6 Routing Protocol is "ospf 1"
  Interfaces (Area 0):
    Loopback8
    Serial0/1
    Serial0/0
  Redistribution:
    None
R2(config)#
```

R3:

```
R3(config)#do sh ipv6 protocols
IPv6 Routing Protocol is "connected"
IPv6 Routing Protocol is "static"
IPv6 Routing Protocol is "ospf 1"
  Interfaces (Area 0):
    Serial0/1
  Interfaces (Area 2):
    Loopback7
    Loopback6
    Loopback5
    Loopback4
  Redistribution:
    None
R3(config)#
```

Step 6: Use the 'show ipv6 ospf' command to verify configurations. R1:


```

R1#show ipv6 ospf
Routing Process "ospfv3 1" with ID 1.1.1.1
It is an area border router
SPF schedule delay 5 secs, Hold time between two SPFs 10 secs
Minimum LSA interval 5 secs. Minimum LSA arrival 1 secs
LSA group pacing timer 240 secs
Interface flood pacing timer 33 msec
Retransmission pacing timer 66 msec
Number of external LSA 0. Checksum Sum 0x000000
Number of areas in this router is 2. 2 normal 0 stub 0 nssa
Reference bandwidth unit is 100 mbps
  Area BACKBONE(0)
    Number of interfaces in this area is 1
    SPF algorithm executed 4 times
    Number of LSA 16. Checksum Sum 0x0A7D9F
    Number of DCbitless LSA 0
    Number of indication LSA 0
    Number of DoNotAge LSA 0
    Flood list length 0
  Area 1
    Number of interfaces in this area is 4
    SPF algorithm executed 7 times
    Number of LSA 15. Checksum Sum 0x07010E
    Number of DCbitless LSA 0
    Number of indication LSA 0
    Number of DoNotAge LSA 0
    Flood list length 0

```

R2:

```

R1#show ipv6 ospf
Routing Process "ospfv3 1" with ID 1.1.1.1
It is an area border router
SPF schedule delay 5 secs, Hold time between two SPFs 10 secs
Minimum LSA interval 5 secs. Minimum LSA arrival 1 secs
LSA group pacing timer 240 secs
Interface flood pacing timer 33 msec
Retransmission pacing timer 66 msec
Number of external LSA 0. Checksum Sum 0x000000
Number of areas in this router is 2. 2 normal 0 stub 0 nssa
Reference bandwidth unit is 100 mbps
  Area BACKBONE(0)
    Number of interfaces in this area is 1
    SPF algorithm executed 4 times
    Number of LSA 16. Checksum Sum 0x0A7D9F
    Number of DCbitless LSA 0
    Number of indication LSA 0
    Number of DoNotAge LSA 0
    Flood list length 0
  Area 1
    Number of interfaces in this area is 4
    SPF algorithm executed 7 times
    Number of LSA 15. Checksum Sum 0x07010E
    Number of DCbitless LSA 0
    Number of indication LSA 0
    Number of DoNotAge LSA 0
    Flood list length 0

```

R3:

```

R3#show ipv6 ospf
Routing Process "ospfv3 1" with ID 3.3.3.3
It is an area border router
SPF schedule delay 5 secs, Hold time between two SPFs 10 secs
Minimum LSA interval 5 secs. Minimum LSA arrival 1 secs
LSA group pacing timer 240 secs
Interface flood pacing timer 33 msecs
Retransmission pacing timer 66 msecs
Number of external LSA 0. Checksum Sum 0x000000
Number of areas in this router is 2. 2 normal 0 stub 0 nssa
Reference bandwidth unit is 100 mbps
  Area BACKBONE(0)
    Number of interfaces in this area is 1
    SPF algorithm executed 2 times
    Number of LSA 16. Checksum Sum 0x0980B9
    Number of DCbitless LSA 0
    Number of indication LSA 0
    Number of DoNotAge LSA 0
    Flood list length 0
  Area 2
    Number of interfaces in this area is 4
    SPF algorithm executed 8 times
    Number of LSA 15. Checksum Sum 0x04448D
    Number of DCbitless LSA 0
    Number of indication LSA 0
    Number of DoNotAge LSA 0
    Flood list length 0

```

Step 7: Verify OSPFv3 neighbors and routing information.

R1:

```
R1#sh ipv6 ospf neighbor
```

Neighbor ID	Pri	State	Dead Time	Interface ID	Interface
2.2.2.2	1	FULL/ -	00:00:32	6	Serial0/0

```
R2#sh ipv6 ospf neighbor
```

Neighbor ID	Pri	State	Dead Time	Interface ID	Interface
3.3.3.3	1	FULL/ -	00:00:37	7	Serial0/1
1.1.1.1	1	FULL/ -	00:00:37	6	Serial0/0

Step 8: Check 'show ipv6 route ospf' to see the OSPF configuration R1:


```

R1#show ipv6 route ospf
IPv6 Routing Table - 21 entries
Codes: C - Connected, L - Local, S - Static, R - RIP, B - BGP
        U - Per-user Static route, M - MIPv6
        I1 - ISIS L1, I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary
        O - OSPF intra, OI - OSPF inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
        ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
        D - EIGRP, EX - EIGRP external
OI 2001:DB8:ACAD:4::/64 [110/129]
    via FE80::C002:4AFF:FEE0:0, Serial0/0
OI 2001:DB8:ACAD:5::/64 [110/129]
    via FE80::C002:4AFF:FEE0:0, Serial0/0
OI 2001:DB8:ACAD:6::/64 [110/129]
    via FE80::C002:4AFF:FEE0:0, Serial0/0
OI 2001:DB8:ACAD:7::/64 [110/129]
    via FE80::C002:4AFF:FEE0:0, Serial0/0
O 2001:DB8:ACAD:8::/64 [110/65]
    via FE80::C002:4AFF:FEE0:0, Serial0/0
O 2001:DB8:ACAD:23::/64 [110/128]
    via FE80::C002:4AFF:FEE0:0, Serial0/0

```

R2:

```

R2#show ipv6 route ospf
IPv6 Routing Table - 17 entries
Codes: C - Connected, L - Local, S - Static, R - RIP, B - BGP
        U - Per-user Static route, M - MIPv6
        I1 - ISIS L1, I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary
        O - OSPF intra, OI - OSPF inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
        ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
        D - EIGRP, EX - EIGRP external
OI 2001:DB8:ACAD::/64 [110/65]
    via FE80::C001:4AFF:FE50:0, Serial0/0
OI 2001:DB8:ACAD:1::/64 [110/65]
    via FE80::C001:4AFF:FE50:0, Serial0/0
OI 2001:DB8:ACAD:2::/64 [110/65]
    via FE80::C001:4AFF:FE50:0, Serial0/0
OI 2001:DB8:ACAD:3::/64 [110/65]
    via FE80::C001:4AFF:FE50:0, Serial0/0
OI 2001:DB8:ACAD:4::/64 [110/65]
    via FE80::C003:45FF:FE40:0, Serial0/1
OI 2001:DB8:ACAD:5::/64 [110/65]
    via FE80::C003:45FF:FE40:0, Serial0/1
OI 2001:DB8:ACAD:6::/64 [110/65]
    via FE80::C003:45FF:FE40:0, Serial0/1
OI 2001:DB8:ACAD:7::/64 [110/65]
    via FE80::C003:45FF:FE40:0, Serial0/1
O 2001:DBB:ACAD::/64 [110/128]
    via FE80::C001:4AFF:FE50:0, Serial0/0
O 2001:DBB:ACAD:12::/64 [110/128]
    via FE80::C001:4AFF:FE50:0, Serial0/0

```

R3:

```

R3#show ipv6 route ospf
IPv6 Routing Table - 19 entries
Codes: C - Connected, L - Local, S - Static, R - RIP, B - BGP
       U - Per-user Static route, M - MIPv6
       I1 - ISIS L1, I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary
       O - OSPF intra, OI - OSPF inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
       ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
       D - EIGRP, EX - EIGRP external
OI 2001:DB8:ACAD::/64 [110/129]
   via FE80::C002:4AFF:FEE0:0, Serial0/1
OI 2001:DB8:ACAD:1::/64 [110/129]
   via FE80::C002:4AFF:FEE0:0, Serial0/1
OI 2001:DB8:ACAD:2::/64 [110/129]
   via FE80::C002:4AFF:FEE0:0, Serial0/1
OI 2001:DB8:ACAD:3::/64 [110/129]
   via FE80::C002:4AFF:FEE0:0, Serial0/1
O 2001:DB8:ACAD:8::/64 [110/65]
   via FE80::C002:4AFF:FEE0:0, Serial0/1
O 2001:DB8:ACAD:12::/64 [110/128]
   via FE80::C002:4AFF:FEE0:0, Serial0/1
O 2001:DB8:ACAD::/64 [110/192]
   via FE80::C002:4AFF:FEE0:0, Serial0/1
O 2001:DB8:ACAD:12::/64 [110/192]
   via FE80::C002:4AFF:FEE0:0, Serial0/1

```

Step 9: Issue the 'show ipv6 ospf database' command on all routers to check the IPv6 OSPF Database

R1:

```

R1#show ipv6 ospf database

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

        Router Link States (Area 0)

ADV Router    Age      Seq#      Fragment ID  Link count  Bits
1.1.1.1       1146     0x80000002  0            1           B
2.2.2.2       880      0x80000005  0            2           None
3.3.3.3       881      0x80000001  0            1           B

        Inter Area Prefix Link States (Area 0)

ADV Router    Age      Seq#      Prefix
1.1.1.1       1270     0x80000001  2001:DB8:ACAD:3::/64
1.1.1.1       1270     0x80000001  2001:DB8:ACAD:2::/64
1.1.1.1       1270     0x80000001  2001:DB8:ACAD:1::/64
1.1.1.1       1270     0x80000001  2001:DB8:ACAD::/64
3.3.3.3       882      0x80000001  2001:DB8:ACAD:7::/64
3.3.3.3       882      0x80000001  2001:DB8:ACAD:6::/64
3.3.3.3       882      0x80000001  2001:DB8:ACAD:5::/64
3.3.3.3       882      0x80000001  2001:DB8:ACAD:4::/64

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

ADV Router    Age      Seq#      Link ID      Interface
1.1.1.1       1284     0x80000001  6            Se0/0
2.2.2.2       1162     0x80000001  6            Se0/0

        Intra Area Prefix Link States (Area 0)

ADV Router    Age      Seq#      Link ID      Ref-lstype  Ref-LSID
1.1.1.1       1285     0x80000001  0            0x2001      0
2.2.2.2       1117     0x80000004  0            0x2001      0
3.3.3.3       899      0x80000001  0            0x2001      0

        Router Link States (Area 1)

```

Router Link States (Area 1)						
ADV Router	Age	Seq#	Fragment ID	Link count	Bits	
1.1.1.1	1287	0x80000009	0	0	B	
Inter Area Prefix Link States (Area 1)						
ADV Router	Age	Seq#	Prefix			
1.1.1.1	1279	0x80000001	2001:DB8:ACAD:12::/64			
1.1.1.1	1280	0x80000001	2001:DB8:ACAD::/64			
1.1.1.1	1280	0x80000001	2001:DB8:ACAD:12::/64			
1.1.1.1	1144	0x80000001	2001:DB8:ACAD:23::/64			
1.1.1.1	1115	0x80000001	2001:DB8:ACAD:8::/64			
1.1.1.1	895	0x80000001	2001:DB8:ACAD:4::/64			
1.1.1.1	895	0x80000001	2001:DB8:ACAD:5::/64			
1.1.1.1	895	0x80000001	2001:DB8:ACAD:6::/64			
1.1.1.1	896	0x80000001	2001:DB8:ACAD:7::/64			
Link (Type-8) Link States (Area 1)						
ADV Router	Age	Seq#	Link ID	Interface		
1.1.1.1	1320	0x80000001	29	Lo3		
1.1.1.1	1335	0x80000001	28	Lo2		
1.1.1.1	1355	0x80000001	27	Lo1		
1.1.1.1	1385	0x80000001	26	Lo0		
Intra Area Prefix Link States (Area 1)						
ADV Router	Age	Seq#	Link ID	Ref-lstype	Ref-LSID	
1.1.1.1	1317	0x80000008	0	0x2001	0	
R1#						

R2:

```

R2#show ipv6 ospf database

OSPFv3 Router with ID (2.2.2.2) (Process ID 1)

Router Link States (Area 0)

ADV Router      Age      Seq#      Fragment ID  Link count  Bits
1.1.1.1         1189     0x80000002  0            1           B
2.2.2.2         921      0x80000005  0            2           None
3.3.3.3         922      0x80000001  0            1           B

Inter Area Prefix Link States (Area 0)

ADV Router      Age      Seq#      Prefix
1.1.1.1         1312     0x80000001  2001:DB8:ACAD:3::/64
1.1.1.1         1312     0x80000001  2001:DB8:ACAD:2::/64
1.1.1.1         1312     0x80000001  2001:DB8:ACAD:1::/64
1.1.1.1         1312     0x80000001  2001:DB8:ACAD::/64
3.3.3.3         923      0x80000001  2001:DB8:ACAD:7::/64
3.3.3.3         923      0x80000001  2001:DB8:ACAD:6::/64
3.3.3.3         923      0x80000001  2001:DB8:ACAD:5::/64
3.3.3.3         923      0x80000001  2001:DB8:ACAD:4::/64

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

ADV Router      Age      Seq#      Link ID      Interface
2.2.2.2         1145     0x80000001  26           Lo8
2.2.2.2         1175     0x80000001  7            Se0/1
3.3.3.3         926      0x80000001  7            Se0/1
1.1.1.1         1316     0x80000001  6            Se0/0
2.2.2.2         1192     0x80000001  6            Se0/0

Intra Area Prefix Link States (Area 0)

ADV Router      Age      Seq#      Link ID      Ref-lstype  Ref-LSID
1.1.1.1         1316     0x80000001  0            0x2001      0
2.2.2.2         1145     0x80000004  0            0x2001      0
3.3.3.3         926      0x80000001  0            0x2001      0

```

R3:


```
R3#show ipv6 ospf database
```

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

```
Router Link States (Area 0)
```

ADV Router	Age	Seq#	Fragment ID	Link count	Bits
1.1.1.1	1213	0x80000002	0	1	B
2.2.2.2	947	0x80000005	0	2	None
3.3.3.3	946	0x80000001	0	1	B

```
Inter Area Prefix Link States (Area 0)
```

ADV Router	Age	Seq#	Prefix
1.1.1.1	1337	0x80000001	2001:DB8:ACAD:3::/64
1.1.1.1	1337	0x80000001	2001:DB8:ACAD:2::/64
1.1.1.1	1337	0x80000001	2001:DB8:ACAD:1::/64
1.1.1.1	1337	0x80000001	2001:DB8:ACAD::/64
3.3.3.3	946	0x80000001	2001:DB8:ACAD:7::/64
3.3.3.3	946	0x80000001	2001:DB8:ACAD:6::/64
3.3.3.3	946	0x80000001	2001:DB8:ACAD:5::/64
3.3.3.3	946	0x80000001	2001:DB8:ACAD:4::/64

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

ADV Router	Age	Seq#	Link ID	Interface
2.2.2.2	1199	0x80000001	7	Se0/1
3.3.3.3	949	0x80000001	7	Se0/1

```
Intra Area Prefix Link States (Area 0)
```

ADV Router	Age	Seq#	Link ID	Ref-lstyp	Ref-LSID
1.1.1.1	1341	0x80000001	0	0x2001	0
2.2.2.2	1171	0x80000004	0	0x2001	0
3.3.3.3	951	0x80000001	0	0x2001	0

```
Router Link States (Area 2)
```

```
Router Link States (Area 2)
```

ADV Router	Age	Seq#	Fragment ID	Link count	Bits
3.3.3.3	951	0x80000009	0	0	B

```
Inter Area Prefix Link States (Area 2)
```

ADV Router	Age	Seq#	Prefix
3.3.3.3	943	0x80000001	2001:DB8:ACAD:12::/64
3.3.3.3	944	0x80000001	2001:DB8:ACAD::/64
3.3.3.3	944	0x80000001	2001:DB8:ACAD:12::/64
3.3.3.3	944	0x80000001	2001:DB8:ACAD:8::/64
3.3.3.3	945	0x80000001	2001:DB8:ACAD:23::/64
3.3.3.3	945	0x80000001	2001:DB8:ACAD::/64
3.3.3.3	945	0x80000001	2001:DB8:ACAD:1::/64
3.3.3.3	945	0x80000001	2001:DB8:ACAD:2::/64
3.3.3.3	945	0x80000001	2001:DB8:ACAD:3::/64

```
Link (Type-8) Link States (Area 2)
```

ADV Router	Age	Seq#	Link ID	Interface
3.3.3.3	979	0x80000001	29	Lo7
3.3.3.3	995	0x80000001	28	Lo6
3.3.3.3	1017	0x80000001	27	Lo5
3.3.3.3	1059	0x80000001	26	Lo4

```
Intra Area Prefix Link States (Area 2)
```

ADV Router	Age	Seq#	Link ID	Ref-lstyp	Ref-LSID
3.3.3.3	978	0x80000008	0	0x2001	0

Now you have successfully configured multi-area OSPF v3 using IPv6.