|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | | | | | | | |
|  | | Multi Area OSPF | | | | |  | |
|  |  | | | | | | |  |
|  | | | |  |  | | | |
|  | | | | Weizhen Chen |  | | | |
|  | | | | —CCNP—Jeffery Mason &Michael Hansen |  | | | |
|  | | |  | | |  | | |

Purpose

The objective of the lab was to use 5 routers to configure a multi-area OSPF system with three routers in one area and two routers in a second router. The routers also require ipv4 and ipv6 with full dual stack on the multi OSPF network. Finally, we need to make one tweak to the OSPF system.

Background information

OSPF is an open-standard, classless routing protocol. It uses SPF (Dijkstra’s Shortest Path First) algorithm to determine the best path to each network. OSPF first needs to have a database for the structure of the network; this is called link-state routing protocol. With the learned information the Link state routing protocols would make an informed routing decision. OSPF routers exchange Hellos with each neighbor to learn the Router ID (RID) and cost of their neighbors. the information of the Neighbors is kept in adjacency database. The router then constructs the appropriate Link State Advertisements (LSA), which includes the Router IDs and cost of each neighbor that is shared among the routing domains. Each router would run the SPF (Dijkstra’s Shortest Path First) algorithm to determine the best end-to-end path to each network. It then submits these paths for inclusion in the routing able or forwarding database. Multi-area OSPF is better than OSPF because multiple areas would have a smaller routing table than one huge area and it also has fewer routing table entries as network addresses can be summarized between areas. Multi-area also has the benefit of reduced link-state update overhead and reduced frequency of SPF calculations.

Lab summary

Before I started to configure the lab equipment, I first opened a notepad to create a topology with the OSPF configuration for the routers. My tweak to the OSPF was to create three areas and to accomplish this is used 6 routers instead of the required 5. We created three subnet masks with the correct IP address of the three areas for the router interfaces and networks. Next, we connected the 6 routers with a copper cross-over cable through the gigabit ethernet and connected the routers to the computer with the console cable. In the configuration we would first enter user exec mode through the enable command and then enter global configuration mode through the config terminal command. In the global configuration mode, we would give the correct Ipv4 and Ipv6 address according to the topology for the gigabit ethernet interfaces that I created. After that We then applied a separate set of Ip addresses for the loopback on each of the 6 routers according to their OSPF area. Finally, we would then enter OSPFv2 router config mode with the router ospf command with the process-id of 1 as the first area,2 as the second area and 3 as the third area. When in OSPFv2 mode we would use the network command with the Ip address of all the interfaces and loopback along with the wildcard mask and area id according to the area the routers in to notify the other IP addresses of the interfaces directly connected to the router in OSPF. To configure OSPF v3 we needed to use the router ospfv3 with the process id to enter router configuration mode for the IPv4 or IPv6 address family. Next, we would enter router id to use the fixed router Id and designate the interface with the correct Ipv6 process id and area. To show that OSPFv2 was working we used the show run command to show the configuration we did, used the show Ip ospf neighbor command to show the connected routers that use OSPF, show Ip ospf to show the ospf routing processes, show Ip ospf interface to display interface information, show Ip ospf border-routers to display internal OSPF routing entries and finally an ip route. To elaborate that Ip OSPFv3 was working, we needed to show ospf command for ipv6 to show the OSPF routing processes for OSPFv3, show ipv6 ospf interface command to display interface information for OSPFv3, and finally an ipv6 route command.

Lab commands

**router ospf [*process-id*]**: Allows router to enter OSPFv2 router config. mode, used for IPv4.

**network [ip address] [*wildcard mask*] area [area-id]**: Advertises the IP addresses of the interfaces directly connected to the router in OSPF.

**router ospfv3 [*process-id*]**: Enters router configuration mode for the IPv4 or IPv6 address family.

**router-id [*router-id]****:* Enter this command to use a fixed router ID.

**show ip ospf neighbor**: Allows one to see the router’s neighbor(s) that use OSPF, used for IPv4.

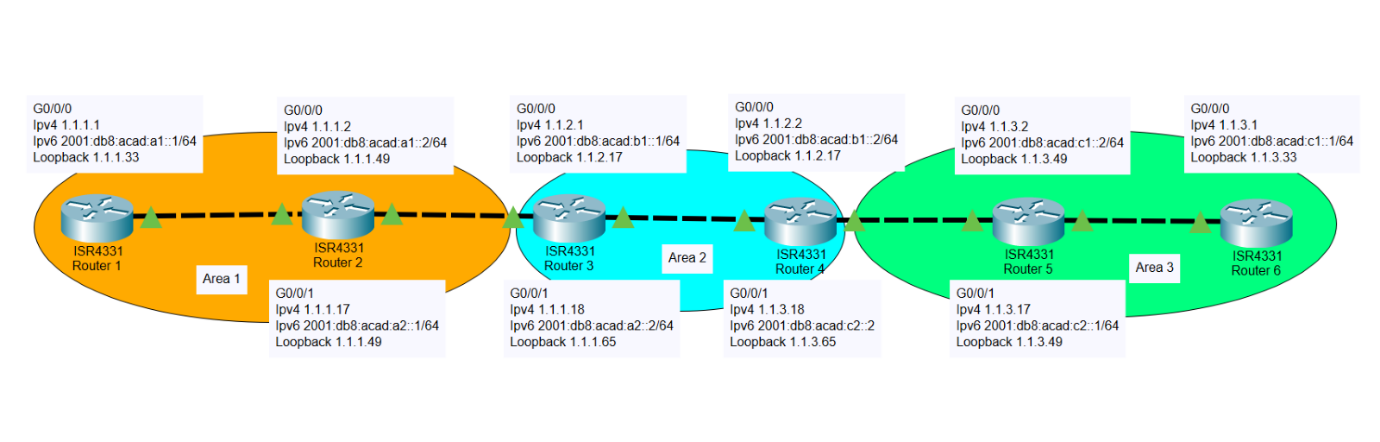
**show ip ospf [*process-id*]**: To display genral information about OSPF routing processes, use the show ip ospf command in user EXEC or privileged EXEC mode

**show ip [*ospf]* interface**: To display interface information related to OSPF, use the show ip ospf interface command in user EXEC or privileged EXEC mode

**show ip ospf border-routers**: To display the internal OSPF routing table entries to an ABR and ASBR, use the show ip ospf border-routers command in privileged EXEC mode.

**show ipv6 ospf *[process-id]***: To display general information about OSPF routing processes, use the show ipv6 ospfcommand in user EXEC or privileged EXEC mode.

Network diagram



|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Router** | **Interface** | **Ipv4** | **Ipv6** | **Subnet Mask** | **Subnet** | **Linked- Device** | **OSPF Area** | **Loopback** |
| Router 1 | G 0/0/0 | 1.1.1.1 | 2001:db8:acad:a1::1/64 | 255.255.255.240 | /64 | R2 G0/0/0 | Area 1 | 1.1.1.33 |
| Router 2 | G 0/0/0 | 1.1.1.2 | 2001:db8:acad:a1::2/64 | 255.255.255.240 | /64 | R1 G0/0/0 | Area 1 | 1.1.1.49 |
| Router 2 | G 0/0/1 | 1.1.1.17 | 2001:db8:acad:a2::1/64 | 255.255.255.240 | /64 | R3 G0/0/1 | Area 1 | 1.1.1.49 |
| Router 3 | G 0/0/1 | 1.1.1.18 | 2001:db8:acad:a2::2/64 | 255.255.255.240 | /64 | R2 G0/0/1 | Area 1 | 1.1.1.65 |
| Router 3 | G 0/0/0 | 1.1.2.1 | 2001:db8:acad:b1::1/64 | 255.255.255.240 | /64 | R4 G0/0/0 | Area 2 | 1.1.2.17 |
|  |  |  |  |  |  |  |  |  |
| Router 4 | G 0/0/0 | 1.1.2.2 | 2001:db8:acad:b1::2/64 | 255.255.255.240 | /64 | R3 G0/0/0 | Area 2 | 1.1.2.17 |
| Router 4 | G 0/0/1 | 1.1.3.18 | 2001:db8:acad:c2::2/64 | 255.255.255.240 | /64 | R5 G0/0/1 | Area 3 | 1.1.3.65 |
| Router 5 | G 0/0/1 | 1.1.3.17 | 2001:db8:acad:c2::1/64 | 255.255.255.240 | /64 | R4 G0/0/1 | Area 3 | 1.1.3.49 |
| Router 5 | G 0/0/0 | 1.1.3.2 | 2001:db8:acad:c1::2/64 | 255.255.255.240 | /64 | R6 G0/0/0 | Area 3 | 1.1.3.49 |
| Router 6 | G 0/0/0 | 1.1.3.1 | 2001:db8:acad:c1::1/64 | 255.255.255.240 | /64 | R5 G0/0/0 | Area 3 | 1.1.3.33 |

Configurations

**Router 1:**

R1#Show run

Building configuration...

Current configuration : 1751 bytes

Last configuration change at 18:08:14 UTC Wed Nov 3 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 FDO21482HZX

spanning-tree extend system-id

redundancy

mode none

vlan internal allocation policy ascending

interface Loopback1

ip address 1.1.1.33 255.255.255.240

interface GigabitEthernet0/0/0

ip address 1.1.1.1 255.255.255.240

negotiation auto

ipv6 address FE80::1 link-local

ipv6 address 2001:DB8:ACAD:A1::1/64

ipv6 ospf 1 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

vrf forwarding Mgmt-intf

no ip address

shutdown

negotiation auto

interface Vlan1

no ip address

shutdown

router ospfv3 1

router-id 1.1.1.1

address-family ipv6 unicast

exit-address-family

router ospf 1

network 1.1.1.0 0.0.0.15 area 1

network 1.1.1.16 0.0.0.15 area 1

network 1.1.1.32 0.0.0.15 area 1

network 1.1.1.48 0.0.0.15 area 1

network 1.1.1.64 0.0.0.15 area 1

network 1.1.1.80 0.0.0.15 area 1

ip forward-protocol nd

no ip http server

no ip http secure-server

ip tftp source-interface GigabitEthernet0

control-plane

line con 0

stopbits 1

line aux 0

stopbits 1

line vty 0 4

login

end

R1#Show ip ospf

Routing Process "ospf 1" with ID 1.1.1.33

Start time: 00:06:09.575, Time elapsed: 00:02:46.766

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 msecs

Minimum hold time between two consecutive SPFs 10000 msecs

Maximum wait time between two consecutive SPFs 10000 msecs

Incremental-SPF disabled

Minimum LSA interval 5 secs

Minimum LSA arrival 1000 msecs

LSA group pacing timer 240 secs

Interface flood pacing timer 33 msecs

Retransmission pacing timer 66 msecs

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 2 (1 loopback)

Area has no authentication

SPF algorithm last executed 00:01:54.658 ago

SPF algorithm executed 3 times

Area ranges are

Number of LSA 5. Checksum Sum 0x02FAF9

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

R1#Show ip ospf interface

Loopback1 is up, line protocol is up

Internet Address 1.1.1.33/28, Area 1, Attached via Network Statement

Process ID 1, Router ID 1.1.1.33, 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 1.1.1.1/28, Area 1, Attached via Network Statement

Process ID 1, Router ID 1.1.1.33, 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) 1.1.1.49, Interface address 1.1.1.2

Backup Designated router (ID) 1.1.1.33, Interface address 1.1.1.1

Timer intervals configured, Hello 10, Dead 40, Wait 40, 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 1/1/1, 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 1.1.1.49 (Designated Router)

Suppress hello for 0 neighbor(s)

R1#show ip ospf neighbor

Neighbor ID Pri State Dead Time Address Interface

1.1.1.49 1 FULL/DR 00:00:36 1.1.1.2 GigabitEthernet0/0/0

R1#show ip ospf border-routers

OSPF Router with ID (1.1.1.33) (Process ID 1)

Base Topology (MTID 0)

Internal Router Routing Table

Codes: i - Intra-area route, I - Inter-area route

R1#Show ipv6 ospf

Routing Process "ospfv3 1" with ID 1.1.1.1

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 msecs

Minimum hold time between two consecutive SPFs 10000 msecs

Maximum wait time between two consecutive SPFs 10000 msecs

Minimum LSA interval 5 secs

Minimum LSA arrival 1000 msecs

LSA group pacing timer 240 secs

Interface flood pacing timer 33 msecs

Retransmission pacing timer 66 msecs

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 1

SPF algorithm executed 1 times

Number of LSA 3. Checksum Sum 0x02033F

Number of DCbitless LSA 0

Number of indication LSA 0

Number of DoNotAge LSA 0

Flood list length 0

R1#Show ipv6 ospf interface

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

Link Local Address FE80::1, Interface ID 6

Area 1, Process ID 1, Instance ID 0, Router ID 1.1.1.1

Network Type BROADCAST, Cost: 1

Transmit Delay is 1 sec, State DR, Priority 1

Designated Router (ID) 1.1.1.1, local address FE80::1

No backup designated router on this network

Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5

Hello due in 00:00:02

Graceful restart helper support enabled

Index 1/1/1, flood queue length 0

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

Last flood scan length is 0, maximum is 0

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

Neighbor Count is 0, Adjacent neighbor count is 0

Suppress hello for 0 neighbor(s)

IPv6 Routing Table - default - 3 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:A1::/64 [0/0]

via GigabitEthernet0/0/0, directly connected

L 2001:DB8:ACAD:A1::1/128 [0/0]

via GigabitEthernet0/0/0, receive

L FF00::/8 [0/0]

via Null0, receive

R1#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

1.0.0.0/8 is variably subnetted, 7 subnets, 2 masks

C 1.1.1.0/28 is directly connected, GigabitEthernet0/0/0

L 1.1.1.1/32 is directly connected, GigabitEthernet0/0/0

O 1.1.1.16/28 [110/2] via 1.1.1.2, 00:04:15, GigabitEthernet0/0/0

C 1.1.1.32/28 is directly connected, Loopback1

L 1.1.1.33/32 is directly connected, Loopback1

O 1.1.1.49/32 [110/2] via 1.1.1.2, 00:04:15, GigabitEthernet0/0/0

O 1.1.1.65/32 [110/3] via 1.1.1.2, 00:04:15, GigabitEthernet0/0/0

**Router 2:**

R2#Show run

Building configuration...

Current configuration : 1854 bytes

! Last configuration change at 18:10:23 UTC Wed Nov 3 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 FDO21482DWJ

spanning-tree extend system-id

redundancy

mode none

vlan internal allocation policy ascending

interface Loopback1

ip address 1.1.1.49 255.255.255.240

interface GigabitEthernet0/0/0

ip address 1.1.1.2 255.255.255.240

negotiation auto

ipv6 address FE80::1 link-local

ipv6 address 2001:DB8:ACAD:A1::2/64

ipv6 ospf 1 area 1

interface GigabitEthernet0/0/1

ip address 1.1.1.17 255.255.255.240

negotiation auto

ipv6 address FE80::2 link-local

ipv6 address 2001:DB8:ACAD:A2::1/64

ipv6 ospf 1 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 ospfv3 1

router-id 1.1.1.17

address-family ipv6 unicast

exit-address-family

router ospf 1

network 1.1.1.0 0.0.0.15 area 1

network 1.1.1.16 0.0.0.15 area 1

network 1.1.1.32 0.0.0.15 area 1

network 1.1.1.48 0.0.0.15 area 1

network 1.1.1.64 0.0.0.15 area 1

network 1.1.1.80 0.0.0.15 area 1

ip forward-protocol nd

no ip http server

no ip http secure-server

ip tftp source-interface GigabitEthernet0

control-plane

line con 0

stopbits 1

line aux 0

stopbits 1

line vty 0 4

login

End

R2#Show ip ospf

Routing Process "ospf 1" with ID 1.1.1.49

Start time: 00:12:25.748, Time elapsed: 00:14:43.908

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 msecs

Minimum hold time between two consecutive SPFs 10000 msecs

Maximum wait time between two consecutive SPFs 10000 msecs

Incremental-SPF disabled

Minimum LSA interval 5 secs

Minimum LSA arrival 1000 msecs

LSA group pacing timer 240 secs

Interface flood pacing timer 33 msecs

Retransmission pacing timer 66 msecs

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 00:05:53.816 ago

SPF algorithm executed 10 times

Area ranges are

Number of LSA 5. Checksum Sum 0x02FAF9

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 ip ospf interface

Loopback1 is up, line protocol is up

Internet Address 1.1.1.49/28, Area 1, Attached via Network Statement

Process ID 1, Router ID 1.1.1.49, 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 1.1.1.17/28, Area 1, Attached via Network Statement

Process ID 1, Router ID 1.1.1.49, 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) 1.1.2.17, Interface address 1.1.1.18

Backup Designated router (ID) 1.1.1.49, Interface address 1.1.1.17

Timer intervals configured, Hello 10, Dead 40, Wait 40, 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 2

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

Neighbor Count is 1, Adjacent neighbor count is 1

Adjacent with neighbor 1.1.2.17 (Designated Router)

Suppress hello for 0 neighbor(s)

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

Internet Address 1.1.1.2/28, Area 1, Attached via Network Statement

Process ID 1, Router ID 1.1.1.49, 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) 1.1.1.49, Interface address 1.1.1.2

Backup Designated router (ID) 1.1.1.33, Interface address 1.1.1.1

Timer intervals configured, Hello 10, Dead 40, Wait 40, 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 1/1/1, 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 1.1.1.33 (Backup Designated Router)

Suppress hello for 0 neighbor(s)

R2#show ip ospf neighbor

Neighbor ID Pri State Dead Time Address Interface

1.1.2.17 1 FULL/DR 00:00:32 1.1.1.18 GigabitEthernet0/0/1

1.1.1.33 1 FULL/BDR 00:00:30 1.1.1.1 GigabitEthernet0/0/0

R2#show ip ospf border-routers

OSPF Router with ID (1.1.1.49) (Process ID 1)

Base Topology (MTID 0)

Internal Router Routing Table

Codes: i - Intra-area route, I - Inter-area route

R2#Show ipv6 ospf

Routing Process "ospfv3 1" with ID 1.1.1.17

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 msecs

Minimum hold time between two consecutive SPFs 10000 msecs

Maximum wait time between two consecutive SPFs 10000 msecs

Minimum LSA interval 5 secs

Minimum LSA arrival 1000 msecs

LSA group pacing timer 240 secs

Interface flood pacing timer 33 msecs

Retransmission pacing timer 66 msecs

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 2

SPF algorithm executed 1 times

Number of LSA 3. Checksum Sum 0x0102F5

Number of DCbitless LSA 0

Number of indication LSA 0

Number of DoNotAge LSA 0

Flood list length 0

R2#Show ipv6 ospf interface

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

Link Local Address FE80::2, Interface ID 7

Area 1, Process ID 1, Instance ID 0, Router ID 1.1.1.17

Network Type BROADCAST, Cost: 1

Transmit Delay is 1 sec, State DR, Priority 1

Designated Router (ID) 1.1.1.17, local address FE80::2

No backup designated router on this network

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 0, maximum is 0

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

1. Neighbor Count is 0, Adjacent neighbor count is 0
2. Suppress hello for 0 neighbor(s)

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

Link Local Address FE80::1, Interface ID 6

Area 1, Process ID 1, Instance ID 0, Router ID 1.1.1.17

Network Type BROADCAST, Cost: 1

Transmit Delay is 1 sec, State DOWN, Priority 1

No designated router on this network

No backup designated router on this network

Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5

R2#Show ipv6 route

IPv6 Routing Table - default - 3 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:A2::/64 [0/0]

via GigabitEthernet0/0/1, directly connected

L 2001:DB8:ACAD:A2::1/128 [0/0]

via GigabitEthernet0/0/1, receive

L FF00::/8 [0/0]

via Null0, receive

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

1.0.0.0/8 is variably subnetted, 8 subnets, 2 masks

C 1.1.1.0/28 is directly connected, GigabitEthernet0/0/0

L 1.1.1.2/32 is directly connected, GigabitEthernet0/0/0

C 1.1.1.16/28 is directly connected, GigabitEthernet0/0/1

L 1.1.1.17/32 is directly connected, GigabitEthernet0/0/1

O 1.1.1.33/32 [110/2] via 1.1.1.1, 00:07:31, GigabitEthernet0/0/0

C 1.1.1.48/28 is directly connected, Loopback1

L 1.1.1.49/32 is directly connected, Loopback1

O 1.1.1.65/32 [110/2] via 1.1.1.18, 00:13:53, GigabitEthernet0/0/1

**Router 3:**

R3#Show run

Building configuration...

Current configuration : 2154 bytes

! Last configuration change at 17:57:32 UTC Wed Nov 3 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 FDO214420HW

spanning-tree extend system-id

redundancy

mode none

vlan internal allocation policy ascending

interface Loopback1

ip address 1.1.1.65 255.255.255.240

interface Loopback2

ip address 1.1.2.17 255.255.255.240

interface GigabitEthernet0/0/0

ip address 1.1.2.1 255.255.255.240

negotiation auto

ipv6 address FE80::3 link-local

ipv6 address 2001:DB8:ACAD:B1::1/64

ipv6 ospf 2 area 2

interface GigabitEthernet0/0/1

ip address 1.1.1.18 255.255.255.240

negotiation auto

ipv6 address FE80::2 link-local

ipv6 address 2001:DB8:ACAD:A2::2/64

ipv6 ospf 1 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 ospfv3 1

router-id 1.1.1.18

address-family ipv6 unicast

exit-address-family

router ospfv3 2

router-id 1.1.2.1

address-family ipv6 unicast

exit-address-family

router ospf 1

network 1.1.1.0 0.0.0.15 area 1

network 1.1.1.16 0.0.0.15 area 1

network 1.1.1.32 0.0.0.15 area 1

network 1.1.1.48 0.0.0.15 area 1

network 1.1.1.64 0.0.0.15 area 1

network 1.1.1.80 0.0.0.15 area 1

router ospf 2

network 1.1.2.0 0.0.0.15 area 2

network 1.1.2.16 0.0.0.15 area 2

network 1.1.2.32 0.0.0.15 area 2

network 1.1.2.48 0.0.0.15 area 2

ip forward-protocol nd

no ip http server

no ip http secure-server

ip tftp source-interface GigabitEthernet0

control-plane

line con 0

stopbits 1

line aux 0

stopbits 1

line vty 0 4

login

end

R3#Show ip ospf

Routing Process "ospf 2" with ID 1.1.1.65

Start time: 00:10:51.406, Time elapsed: 00:16:12.847

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 msecs

Minimum hold time between two consecutive SPFs 10000 msecs

Maximum wait time between two consecutive SPFs 10000 msecs

Incremental-SPF disabled

Minimum LSA interval 5 secs

Minimum LSA arrival 1000 msecs

LSA group pacing timer 240 secs

Interface flood pacing timer 33 msecs

Retransmission pacing timer 66 msecs

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 00:14:15.969 ago

SPF algorithm executed 5 times

Area ranges are

Number of LSA 3. Checksum Sum 0x026DEA

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

Routing Process "ospf 1" with ID 1.1.2.17

Start time: 00:10:51.140, Time elapsed: 00:16:13.114

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 msecs

Minimum hold time between two consecutive SPFs 10000 msecs

Maximum wait time between two consecutive SPFs 10000 msecs

Incremental-SPF disabled

Minimum LSA interval 5 secs

Minimum LSA arrival 1000 msecs

LSA group pacing timer 240 secs

Interface flood pacing timer 33 msecs

Retransmission pacing timer 66 msecs

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 2 (1 loopback)

Area has no authentication

SPF algorithm last executed 00:08:44.694 ago

SPF algorithm executed 9 times

Area ranges are

Number of LSA 5. Checksum Sum 0x02FAF9

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

R3#Show ip ospf interface

Loopback2 is up, line protocol is up

Internet Address 1.1.2.17/28, Area 2, Attached via Network Statement

Process ID 2, Router ID 1.1.1.65, 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 1.1.2.1/28, Area 2, Attached via Network Statement

Process ID 2, Router ID 1.1.1.65, 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) 1.1.3.65, Interface address 1.1.2.2

Backup Designated router (ID) 1.1.1.65, Interface address 1.1.2.1

Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5

oob-resync timeout 40

Hello due in 00:00:04

Supports Link-local Signaling (LLS)

Cisco NSF helper support enabled

IETF NSF helper support enabled

Index 1/1/1, 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 1.1.3.65 (Designated Router)

Suppress hello for 0 neighbor(s)

Loopback1 is up, line protocol is up

Internet Address 1.1.1.65/28, Area 1, Attached via Network Statement

Process ID 1, Router ID 1.1.2.17, 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 1.1.1.18/28, Area 1, Attached via Network Statement

Process ID 1, Router ID 1.1.2.17, 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) 1.1.2.17, Interface address 1.1.1.18

Backup Designated router (ID) 1.1.1.49, Interface address 1.1.1.17

Timer intervals configured, Hello 10, Dead 40, Wait 40, 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 1/1/1, flood queue length 0

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

Last flood scan length is 0, 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 1.1.1.49 (Backup Designated Router)

Suppress hello for 0 neighbor(s)

R3#show ip ospf neighbor

Neighbor ID Pri State Dead Time Address Interface

1.1.3.65 1 FULL/DR 00:00:36 1.1.2.2 GigabitEthernet0/0/0

1.1.1.49 1 FULL/BDR 00:00:32 1.1.1.17 GigabitEthernet0/0/1

R3#show ip ospf border-routers

OSPF Router with ID (1.1.1.65) (Process ID 2)

Base Topology (MTID 0)

Internal Router Routing Table

Codes: i - Intra-area route, I - Inter-area route

OSPF Router with ID (1.1.2.17) (Process ID 1)

Base Topology (MTID 0)

Internal Router Routing Table

Codes: i - Intra-area route, I - Inter-area route

R3#Show ipv6 ospf

Routing Process "ospfv3 1" with ID 1.1.1.18

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 msecs

Minimum hold time between two consecutive SPFs 10000 msecs

Maximum wait time between two consecutive SPFs 10000 msecs

Minimum LSA interval 5 secs

Minimum LSA arrival 1000 msecs

LSA group pacing timer 240 secs

Interface flood pacing timer 33 msecs

Retransmission pacing timer 66 msecs

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 1

SPF algorithm executed 0 times

Number of LSA 0. Checksum Sum 0x000000

Number of DCbitless LSA 0

Number of indication LSA 0

Number of DoNotAge LSA 0

Flood list length 0

Routing Process "ospfv3 2" with ID 1.1.2.1

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 msecs

Minimum hold time between two consecutive SPFs 10000 msecs

Maximum wait time between two consecutive SPFs 10000 msecs

Minimum LSA interval 5 secs

Minimum LSA arrival 1000 msecs

LSA group pacing timer 240 secs

Interface flood pacing timer 33 msecs

Retransmission pacing timer 66 msecs

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 1

SPF algorithm executed 1 times

Number of LSA 3. Checksum Sum 0x0129F2

Number of DCbitless LSA 0

Number of indication LSA 0

Number of DoNotAge LSA 0

Flood list length 0

R3#Show ipv6 ospf interface

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

Link Local Address FE80::2, Interface ID 7

Area 1, Process ID 1, Instance ID 0, Router ID 1.1.1.18

Network Type BROADCAST, Cost: 1

Transmit Delay is 1 sec, State DOWN, Priority 1

No designated router on this network

No backup designated router on this network

Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5

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

Link Local Address FE80::3, Interface ID 6

Area 2, Process ID 2, Instance ID 0, Router ID 1.1.2.1

Network Type BROADCAST, Cost: 1

Transmit Delay is 1 sec, State DR, Priority 1

Designated Router (ID) 1.1.2.1, local address FE80::3

No backup designated router on this network

Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5

Hello due in 00:00:04

Graceful restart helper support enabled

Index 1/1/1, flood queue length 0

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

Last flood scan length is 0, maximum is 0

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

Neighbor Count is 0, Adjacent neighbor count is 0

Suppress hello for 0 neighbor(s)

R3#Show ipv6 route

IPv6 Routing Table - default - 3 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:B1::/64 [0/0]

via GigabitEthernet0/0/0, directly connected

L 2001:DB8:ACAD:B1::1/128 [0/0]

via GigabitEthernet0/0/0, receive

L FF00::/8 [0/0]

via Null0, receive

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

1.0.0.0/8 is variably subnetted, 11 subnets, 2 masks

O 1.1.1.0/28 [110/2] via 1.1.1.17, 00:11:15, GigabitEthernet0/0/1

C 1.1.1.16/28 is directly connected, GigabitEthernet0/0/1

L 1.1.1.18/32 is directly connected, GigabitEthernet0/0/1

O 1.1.1.33/32 [110/3] via 1.1.1.17, 00:10:26, GigabitEthernet0/0/1

O 1.1.1.49/32 [110/2] via 1.1.1.17, 00:16:58, GigabitEthernet0/0/1

C 1.1.1.64/28 is directly connected, Loopback1

L 1.1.1.65/32 is directly connected, Loopback1

C 1.1.2.0/28 is directly connected, GigabitEthernet0/0/0

L 1.1.2.1/32 is directly connected, GigabitEthernet0/0/0

C 1.1.2.16/28 is directly connected, Loopback2

L 1.1.2.17/32 is directly connected, Loopback2

**Router 4:**

R4#Show run

Building configuration...

Current configuration : 2192 bytes

! Last configuration change at 17:52:33 UTC Wed Nov 3 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

vtp domain cisco

vtp mode transparent

multilink bundle-name authenticated

license udi pid ISR4321/K9 sn FDO214421D1

spanning-tree extend system-id

redundancy

mode none

vlan internal allocation policy ascending

interface Loopback2

ip address 1.1.2.17 255.255.255.240

interface Loopback3

ip address 1.1.3.65 255.255.255.240

interface GigabitEthernet0/0/0

ip address 1.1.2.2 255.255.255.240

negotiation auto

ipv6 address FE80::3 link-local

ipv6 address 2001:DB8:ACAD:B1::2/64

ipv6 ospf 2 area 2

interface GigabitEthernet0/0/1

ip address 1.1.3.18 255.255.255.240

negotiation auto

ipv6 address FE80::4 link-local

ipv6 address 2001:DB8:ACAD:C2::2/64

ipv6 ospf 3 area 3

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 ospfv3 3

router-id 1.1.3.18

address-family ipv6 unicast

exit-address-family

router ospfv3 2

router-id 1.1.2.2

address-family ipv6 unicast

exit-address-family

router ospf 2

network 1.1.2.0 0.0.0.15 area 2

network 1.1.2.16 0.0.0.15 area 2

network 1.1.2.32 0.0.0.15 area 2

network 1.1.2.48 0.0.0.15 area 2

router ospf 3

network 1.1.3.0 0.0.0.15 area 3

network 1.1.3.16 0.0.0.15 area 3

network 1.1.3.32 0.0.0.15 area 3

network 1.1.3.48 0.0.0.15 area 3

network 1.1.3.64 0.0.0.15 area 3

network 1.1.3.80 0.0.0.15 area 3

ip forward-protocol nd

no ip http server

no ip http secure-server

ip tftp source-interface GigabitEthernet0

control-plane

line con 0

stopbits 1

line aux 0

stopbits 1

line vty 0 4

login

End

R4#Show ip ospf

Routing Process "ospf 3" with ID 1.1.2.17

Start time: 00:07:51.131, Time elapsed: 00:17:37.442

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 msecs

Minimum hold time between two consecutive SPFs 10000 msecs

Maximum wait time between two consecutive SPFs 10000 msecs

Incremental-SPF disabled

Minimum LSA interval 5 secs

Minimum LSA arrival 1000 msecs

LSA group pacing timer 240 secs

Interface flood pacing timer 33 msecs

Retransmission pacing timer 66 msecs

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 3

Number of interfaces in this area is 2 (1 loopback)

Area has no authentication

SPF algorithm last executed 00:12:09.433 ago

SPF algorithm executed 6 times

Area ranges are

Number of LSA 5. Checksum Sum 0x03198B

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

Routing Process "ospf 2" with ID 1.1.3.65

Start time: 00:07:50.982, Time elapsed: 00:17:37.591

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 msecs

Minimum hold time between two consecutive SPFs 10000 msecs

Maximum wait time between two consecutive SPFs 10000 msecs

Incremental-SPF disabled

Minimum LSA interval 5 secs

Minimum LSA arrival 1000 msecs

LSA group pacing timer 240 secs

Interface flood pacing timer 33 msecs

Retransmission pacing timer 66 msecs

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 00:16:41.040 ago

SPF algorithm executed 3 times

Area ranges are

Number of LSA 3. Checksum Sum 0x026DEA

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 ip ospf interface

Loopback3 is up, line protocol is up

Internet Address 1.1.3.65/28, Area 3, Attached via Network Statement

Process ID 3, Router ID 1.1.2.17, 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 1.1.3.18/28, Area 3, Attached via Network Statement

Process ID 3, Router ID 1.1.2.17, 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) 1.1.3.49, Interface address 1.1.3.17

Backup Designated router (ID) 1.1.2.17, Interface address 1.1.3.18

Timer intervals configured, Hello 10, Dead 40, Wait 40, 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 1/1/1, 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 1 msec, maximum is 1 msec

Neighbor Count is 1, Adjacent neighbor count is 1

Adjacent with neighbor 1.1.3.49 (Designated Router)

Suppress hello for 0 neighbor(s)

Loopback2 is up, line protocol is up

Internet Address 1.1.2.17/28, Area 2, Attached via Network Statement

Process ID 2, Router ID 1.1.3.65, 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 1.1.2.2/28, Area 2, Attached via Network Statement

Process ID 2, Router ID 1.1.3.65, 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) 1.1.3.65, Interface address 1.1.2.2

Backup Designated router (ID) 1.1.1.65, Interface address 1.1.2.1

Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5

oob-resync timeout 40

Hello due in 00:00:04

Supports Link-local Signaling (LLS)

Cisco NSF helper support enabled

IETF NSF helper support enabled

Index 1/1/1, 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 0 msec, maximum is 0 msec

Neighbor Count is 1, Adjacent neighbor count is 1

Adjacent with neighbor 1.1.1.65 (Backup Designated Router)

Suppress hello for 0 neighbor(s)

R4#show ip ospf neighbor

Neighbor ID Pri State Dead Time Address Interface

1.1.3.49 1 FULL/DR 00:00:32 1.1.3.17 GigabitEthernet0/0/1

1.1.1.65 1 FULL/BDR 00:00:39 1.1.2.1 GigabitEthernet0/0/0

R4#show ip ospf border-routers

OSPF Router with ID (1.1.2.17) (Process ID 3)

Base Topology (MTID 0)

Internal Router Routing Table

Codes: i - Intra-area route, I - Inter-area route

OSPF Router with ID (1.1.3.65) (Process ID 2)

Base Topology (MTID 0)

Internal Router Routing Table

Codes: i - Intra-area route, I - Inter-area route

R4#Show ipv6 ospf

Routing Process "ospfv3 2" with ID 1.1.2.2

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 msecs

Minimum hold time between two consecutive SPFs 10000 msecs

Maximum wait time between two consecutive SPFs 10000 msecs

Minimum LSA interval 5 secs

Minimum LSA arrival 1000 msecs

LSA group pacing timer 240 secs

Interface flood pacing timer 33 msecs

Retransmission pacing timer 66 msecs

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 1

SPF algorithm executed 0 times

Number of LSA 0. Checksum Sum 0x000000

Number of DCbitless LSA 0

Number of indication LSA 0

Number of DoNotAge LSA 0

Flood list length 0

Routing Process "ospfv3 3" with ID 1.1.3.18

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 msecs

Minimum hold time between two consecutive SPFs 10000 msecs

Maximum wait time between two consecutive SPFs 10000 msecs

Minimum LSA interval 5 secs

Minimum LSA arrival 1000 msecs

LSA group pacing timer 240 secs

Interface flood pacing timer 33 msecs

Retransmission pacing timer 66 msecs

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 3

Number of interfaces in this area is 1

SPF algorithm executed 1 times

Number of LSA 3. Checksum Sum 0x012F80

Number of DCbitless LSA 0

Number of indication LSA 0

Number of DoNotAge LSA 0

Flood list length 0

R4#Show ipv6 ospf interface

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

Link Local Address FE80::3, Interface ID 6

Area 2, Process ID 2, Instance ID 0, Router ID 1.1.2.2

Network Type BROADCAST, Cost: 1

Transmit Delay is 1 sec, State DOWN, Priority 1

No designated router on this network

No backup designated router on this network

Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5

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

Link Local Address FE80::4, Interface ID 7

Area 3, Process ID 3, Instance ID 0, Router ID 1.1.3.18

Network Type BROADCAST, Cost: 1

Transmit Delay is 1 sec, State DR, Priority 1

Designated Router (ID) 1.1.3.18, local address FE80::4

No backup designated router on this network

Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5

Hello due in 00:00:08

Graceful restart helper support enabled

Index 1/1/1, flood queue length 0

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

Last flood scan length is 0, maximum is 0

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

Neighbor Count is 0, Adjacent neighbor count is 0

Suppress hello for 0 neighbor(s)

R4#Show ipv6 route

IPv6 Routing Table - default - 3 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:C2::/64 [0/0]

via GigabitEthernet0/0/1, directly connected

L 2001:DB8:ACAD:C2::2/128 [0/0]

via GigabitEthernet0/0/1, receive

L FF00::/8 [0/0]

via Null0, receive

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

1.0.0.0/8 is variably subnetted, 11 subnets, 2 masks

C 1.1.2.0/28 is directly connected, GigabitEthernet0/0/0

L 1.1.2.2/32 is directly connected, GigabitEthernet0/0/0

C 1.1.2.16/28 is directly connected, Loopback2

L 1.1.2.17/32 is directly connected, Loopback2

O 1.1.3.0/28 [110/2] via 1.1.3.17, 00:14:21, GigabitEthernet0/0/1

C 1.1.3.16/28 is directly connected, GigabitEthernet0/0/1

L 1.1.3.18/32 is directly connected, GigabitEthernet0/0/1

O 1.1.3.33/32 [110/3] via 1.1.3.17, 00:13:36, GigabitEthernet0/0/1

O 1.1.3.49/32 [110/2] via 1.1.3.17, 00:14:21, GigabitEthernet0/0/1

C 1.1.3.64/28 is directly connected, Loopback3

L 1.1.3.65/32 is directly connected, Loopback3

**Router 5:**

R5#Show run

Building configuration...

Current configuration : 4171 bytes

! Last configuration change at 17:55:27 UTC Wed Nov 3 2021

version 16.9

service timestamps debug datetime msec

service timestamps log datetime msec

platform qfp utilization monitor load 80

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

login on-success log

subscriber templating

ipv6 unicast-routing

multilink bundle-name authenticated

crypto pki trustpoint TP-self-signed-859896477

enrollment selfsigned

subject-name cn=IOS-Self-Signed-Certificate-859896477

revocation-check none

rsakeypair TP-self-signed-859896477

crypto pki certificate chain TP-self-signed-859896477

certificate self-signed 01

3082032E 30820216 A0030201 02020101 300D0609 2A864886 F70D0101 05050030

30312E30 2C060355 04031325 494F532D 53656C66 2D536967 6E65642D 43657274

69666963 6174652D 38353938 39363437 37301E17 0D323131 31303331 37353233

335A170D 33303031 30313030 30303030 5A303031 2E302C06 03550403 1325494F

532D5365 6C662D53 69676E65 642D4365 72746966 69636174 652D3835 39383936

34373730 82012230 0D06092A 864886F7 0D010101 05000382 010F0030 82010A02

82010100 9E80F159 111F202B B855114D 9B6B1DD7 D9F60650 757A2030 B24925D5

D9FA2BFB CA166910 BDB7C7BE B2D7DAC0 8F2933D5 41854DF3 7AA773F9 470BE964

9225754F 794FE377 4C3DC326 BBA946C4 45094C39 1FECE024 6068A548 9AA31D0C

9CA634B9 A54F89F9 32827944 6176E9AC 0F16FD80 E1D15047 3EA7F7AE 1DE2519A

EB53FA1A 575C7FF6 09508CA3 836A55FC 5FECE290 FD23C65F F9E2592F C94D4C5A

C438957E 7F8FF2E5 D5C17DF4 5F3FDF80 7E50E8AB FCC9764A 52620A0F 5ADF303A

1FF517A7 E62B036F C127C97F 2E28A87C F5280FC4 E071ED71 D2CF4FB8 D6BBB351

77D989F6 C10581DB F245045E C9E407A3 C0A03FC8 10A8E4A7 EF40106E 002FCB1E

52A19789 02030100 01A35330 51300F06 03551D13 0101FF04 05300301 01FF301F

0603551D 23041830 168014B7 47DA44C9 072FF9BD 4153B3A9 D4A67348 D00A8230

1D060355 1D0E0416 0414B747 DA44C907 2FF9BD41 53B3A9D4 A67348D0 0A82300D

06092A86 4886F70D 01010505 00038201 0100570A 1D2F4B90 1D4D7797 062838BF

897220F7 CFB45B36 565DCD87 FFCB009B 81455344 1F62E507 58183686 74DC19DD

C3AC2F14 3C090152 1E3966DD 5CB1F718 F7DBA119 60FEF120 A50CA4CF 3224A28D

CC2D6FF6 572C64B3 A9D4EF82 A8A3B3DF BFD18F95 8E4FB001 C2571BA5 375C75C8

0827CF95 F9365918 1E5C4486 13766D60 5FEE84F6 31C9C57A 4CC34947 5997A1E5

A4375283 B2DC206E 655D8B7D EB145E25 E18243A2 5D2FD921 52F53A7B 937903AB

C68CA053 F38D8690 64B9684E B2CD744F 4DFE8F52 5039C7DB E6A572BF B3533B48

38FBE9BD 27A0D945 47EBDEBF 3F006EE9 31E862D2 8235E036 F918BBD9 ADC68358

BBF3ABBE 1211FCE5 E9344C54 7B712983 3B42

quit

license udi pid ISR4321/K9 sn FLM240608PJ

no license smart enable

diagnostic bootup level minimal

spanning-tree extend system-id

redundancy

mode none

interface Loopback3

ip address 1.1.3.49 255.255.255.240

interface GigabitEthernet0/0/0

ip address 1.1.3.2 255.255.255.240

negotiation auto

ipv6 address FE80::5 link-local

ipv6 address 2001:DB8:ACAD:C1::2/64

ipv6 ospf 3 area 3

interface GigabitEthernet0/0/1

ip address 1.1.3.17 255.255.255.240

negotiation auto

ipv6 address FE80::4 link-local

ipv6 address 2001:DB8:ACAD:C2::1/64

ipv6 ospf 3 area 3

interface GigabitEthernet0/1/0

no ip address

shutdown

negotiation auto

interface GigabitEthernet0/1/1

no ip address

shutdown

negotiation auto

interface GigabitEthernet0

vrf forwarding Mgmt-intf

no ip address

shutdown

negotiation auto

router ospfv3 3

router-id 1.1.3.17

address-family ipv6 unicast

exit-address-family

router ospf 3

network 1.1.3.0 0.0.0.15 area 3

network 1.1.3.16 0.0.0.15 area 3

network 1.1.3.32 0.0.0.15 area 3

network 1.1.3.48 0.0.0.15 area 3

network 1.1.3.64 0.0.0.15 area 3

network 1.1.3.80 0.0.0.15 area 3

ip forward-protocol nd

ip http server

ip http authentication local

ip http secure-server

ip tftp source-interface GigabitEthernet0

control-plane

line con 0

transport input none

stopbits 1

line aux 0

stopbits 1

line vty 0 4

login

end

R5#Show ip ospf

Routing Process "ospf 3" with ID 1.1.3.49

Start time: 00:09:49.220, Time elapsed: 00:16:08.618

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 50 msecs

Minimum hold time between two consecutive SPFs 200 msecs

Maximum wait time between two consecutive SPFs 5000 msecs

Incremental-SPF disabled

Initial LSA throttle delay 50 msecs

Minimum hold time for LSA throttle 200 msecs

Maximum wait time for LSA throttle 5000 msecs

Minimum LSA arrival 100 msecs

LSA group pacing timer 240 secs

Interface flood pacing timer 33 msecs

Retransmission pacing timer 66 msecs

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 3

Number of interfaces in this area is 3 (1 loopback)

Area has no authentication

SPF algorithm last executed 00:14:17.326 ago

SPF algorithm executed 15 times

Area ranges are

Number of LSA 5. Checksum Sum 0x03198B

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 ip ospf interface

Loopback3 is up, line protocol is up

Internet Address 1.1.3.49/28, Interface ID 11, Area 3

Attached via Network Statement

Process ID 3, Router ID 1.1.3.49, 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 1.1.3.17/28, Interface ID 7, Area 3

Attached via Network Statement

Process ID 3, Router ID 1.1.3.49, 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) 1.1.3.49, Interface address 1.1.3.17

Backup Designated router (ID) 1.1.2.17, Interface address 1.1.3.18

Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5

oob-resync timeout 40

Hello due in 00:00:04

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 1.1.2.17 (Backup Designated Router)

Suppress hello for 0 neighbor(s)

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

Internet Address 1.1.3.2/28, Interface ID 6, Area 3

Attached via Network Statement

Process ID 3, Router ID 1.1.3.49, 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) 1.1.3.49, Interface address 1.1.3.2

Backup Designated router (ID) 1.1.3.33, Interface address 1.1.3.1

Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5

oob-resync timeout 40

Hello due in 00:00:09

Supports Link-local Signaling (LLS)

Cisco NSF helper support enabled

IETF NSF helper support enabled

Index 1/1/1, 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 1.1.3.33 (Backup Designated Router)

Suppress hello for 0 neighbor(s)

R5#show ip ospf neighbor

Neighbor ID Pri State Dead Time Address Interface

1.1.2.17 1 FULL/BDR 00:00:35 1.1.3.18 GigabitEthernet0/0/1

1.1.3.33 1 FULL/BDR 00:00:37 1.1.3.1 GigabitEthernet0/0/0

R5#show ip ospf border-routers

OSPF Router with ID (1.1.3.49) (Process ID 3)

Base Topology (MTID 0)

Internal Router Routing Table

Codes: i - Intra-area route, I - Inter-area route

R5#Show ipv6 ospf

Routing Process "ospfv3 3" with ID 1.1.3.17

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 50 msecs

Minimum hold time between two consecutive SPFs 200 msecs

Maximum wait time between two consecutive SPFs 5000 msecs

Initial LSA throttle delay 50 msecs

Minimum hold time for LSA throttle 200 msecs

Maximum wait time for LSA throttle 5000 msecs

Minimum LSA arrival 100 msecs

LSA group pacing timer 240 secs

Interface flood pacing timer 33 msecs

Retransmission pacing timer 66 msecs

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 3

Number of interfaces in this area is 2

SPF algorithm executed 3 times

Number of LSA 1. Checksum Sum 0x005E9B

Number of DCbitless LSA 0

Number of indication LSA 0

Number of DoNotAge LSA 0

Flood list length 0

R5#Show ipv6 ospf interface

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

Link Local Address FE80::4, Interface ID 7

Area 3, Process ID 3, Instance ID 0, Router ID 1.1.3.17

Network Type BROADCAST, Cost: 1

Transmit Delay is 1 sec, State DOWN, Priority 1

No designated router on this network

No backup designated router on this network

Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5

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

Link Local Address FE80::5, Interface ID 6

Area 3, Process ID 3, Instance ID 0, Router ID 1.1.3.17

Network Type BROADCAST, Cost: 1

Transmit Delay is 1 sec, State DOWN, Priority 1

No designated router on this network

No backup designated router on this network

Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5

R5#Show ipv6 route

IPv6 Routing Table - default - 1 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

L FF00::/8 [0/0]

via Null0, receive

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

1.0.0.0/8 is variably subnetted, 8 subnets, 2 masks

C 1.1.3.0/28 is directly connected, GigabitEthernet0/0/0

L 1.1.3.2/32 is directly connected, GigabitEthernet0/0/0

C 1.1.3.16/28 is directly connected, GigabitEthernet0/0/1

L 1.1.3.17/32 is directly connected, GigabitEthernet0/0/1

O 1.1.3.33/32 [110/2] via 1.1.3.1, 00:16:01, GigabitEthernet0/0/0

C 1.1.3.48/28 is directly connected, Loopback3

L 1.1.3.49/32 is directly connected, Loopback3

O 1.1.3.65/32 [110/2] via 1.1.3.18, 00:16:45, GigabitEthernet0/0/1

**Router 6:**

R6#Show run

Building configuration...

Current configuration : 4063 bytes

! Last configuration change at 17:56:31 UTC Wed Nov 3 2021

version 16.9

service timestamps debug datetime msec

service timestamps log datetime msec

platform qfp utilization monitor load 80

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

ip dhcp pool webuidhcp

subscriber templating

ipv6 unicast-routing

multilink bundle-name authenticated

crypto pki trustpoint TP-self-signed-4288135047

enrollment selfsigned

subject-name cn=IOS-Self-Signed-Certificate-4288135047

revocation-check none

rsakeypair TP-self-signed-4288135047

crypto pki certificate chain TP-self-signed-4288135047

certificate self-signed 01

30820330 30820218 A0030201 02020101 300D0609 2A864886 F70D0101 05050030

31312F30 2D060355 04031326 494F532D 53656C66 2D536967 6E65642D 43657274

69666963 6174652D 34323838 31333530 3437301E 170D3231 31313033 31373536

33325A17 0D333030 31303130 30303030 305A3031 312F302D 06035504 03132649

4F532D53 656C662D 5369676E 65642D43 65727469 66696361 74652D34 32383831

33353034 37308201 22300D06 092A8648 86F70D01 01010500 0382010F 00308201

0A028201 0100B81D B0881088 E70DA523 A8B6D7D6 06BC58A3 5E5587FA F8F61692

E5AB94BA 2F808B54 9027DE6E 12CE049B 01CF9634 D23E8E88 CD252512 0927CEC7

9853B0DA C1DC16DF B0CAABA6 76017855 9B704FD3 FF32A39E D6BD8814 6552184B

8D7ABBC9 407C43BA 487CB585 8469B4B1 6C3B71E8 87B20F6F D47D2587 0C09DB1A

725808D4 256758D2 048AC003 8971DB2F 69F3DCE4 509C3AAA 093EE77E 9E14EC79

91D4F144 F7826B58 65E02EFD 764AB077 1A47FF17 6727FF9E B90789A0 2229C5EA

9D31DAA2 3D68D7F8 F0C32659 1C5F67F0 63FCD9FC 7999D56B 85406452 D2F00FAF

000CC3BE 5E0728D1 7BA1BB0A 54E7A657 FC79E864 94473E4E 7A29490A 1C11B56E

6A34D470 6D4D0203 010001A3 53305130 0F060355 1D130101 FF040530 030101FF

301F0603 551D2304 18301680 14147BEE 03EF328F 2771005D C6506FAD 01EE5747

40301D06 03551D0E 04160414 147BEE03 EF328F27 71005DC6 506FAD01 EE574740

300D0609 2A864886 F70D0101 05050003 82010100 A8119728 D83C1970 789DD0EA

503DD3B9 9BF696EF 7C5F6BA0 27E08DF7 629DB7DE 2D50CBED 8AFEC74E 4BEF0A3E

7C355272 A069BB82 B6B21626 4E625A0F 3B8F0A41 F4F45195 20EC1FB3 A3C90FF2

9F49B087 8F3C1282 FE2FD611 41049A85 40B20F7E E08D0DF2 C2F2CA07 50B9EAA9

A258C544 A985A187 1BEBD15D 6D1062CD 70D3413E 9D1F7C39 56E87CC4 D2A51741

2D3BFC70 4FF2549C A4351342 89CD8989 0AFBEB4E C933CF7D A8B9DF30 632479C7

27571CCB 03C4E0C0 B9FF7B6C 9A4C6012 BD294CB1 C1C43E7C 05B8F4E2 AC809075

EF3EF07F E66424FD 4FF44829 B702414B 61B28D62 76D7FBCB 2C3547C6 451AB3C7

CB3003C7 BF35F060 EEC3A6BF 719AC89E 3C2C8170

quit

license udi pid ISR4321/K9 sn FLM2406090M

no license smart enable

diagnostic bootup level minimal

spanning-tree extend system-id

redundancy

mode none

interface Loopback3

ip address 1.1.3.33 255.255.255.240

interface GigabitEthernet0/0/0

ip address 1.1.3.1 255.255.255.240

negotiation auto

ipv6 address dhcp

ipv6 address FE80::5 link-local

ipv6 address 2001:DB8:ACAD:C1::1/64

ipv6 address autoconfig

ipv6 enable

ipv6 dhcp client request vendor

interface GigabitEthernet0/0/1

no ip address

shutdown

negotiation auto

interface GigabitEthernet0/1/0

no ip address

shutdown

negotiation auto

interface GigabitEthernet0/1/1

no ip address

shutdown

negotiation auto

interface GigabitEthernet0

vrf forwarding Mgmt-intf

no ip address

shutdown

negotiation auto

router ospf 3

network 1.1.3.0 0.0.0.15 area 3

network 1.1.3.16 0.0.0.15 area 3

network 1.1.3.32 0.0.0.15 area 3

network 1.1.3.48 0.0.0.15 area 3

network 1.1.3.64 0.0.0.15 area 3

network 1.1.3.80 0.0.0.15 area 3

ip forward-protocol nd

ip http server

ip http authentication local

ip http secure-server

ip tftp source-interface GigabitEthernet0

control-plane

line con 0

transport input none

stopbits 1

line aux 0

stopbits 1

line vty 0 4

login

end

R6#Show ip ospf

Routing Process "ospf 3" with ID 1.1.3.33

Start time: 00:08:24.941, Time elapsed: 00:17:37.721

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 50 msecs

Minimum hold time between two consecutive SPFs 200 msecs

Maximum wait time between two consecutive SPFs 5000 msecs

Incremental-SPF disabled

Initial LSA throttle delay 50 msecs

Minimum hold time for LSA throttle 200 msecs

Maximum wait time for LSA throttle 5000 msecs

Minimum LSA arrival 100 msecs

LSA group pacing timer 240 secs

Interface flood pacing timer 33 msecs

Retransmission pacing timer 66 msecs

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 3

Number of interfaces in this area is 2 (1 loopback)

Area has no authentication

SPF algorithm last executed 00:16:42.810 ago

SPF algorithm executed 6 times

Area ranges are

Number of LSA 5. Checksum Sum 0x03198B

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 ip ospf interface

Loopback3 is up, line protocol is up

Internet Address 1.1.3.33/28, Interface ID 11, Area 3

Attached via Network Statement

Process ID 3, Router ID 1.1.3.33, 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 1.1.3.1/28, Interface ID 6, Area 3

Attached via Network Statement

Process ID 3, Router ID 1.1.3.33, 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) 1.1.3.49, Interface address 1.1.3.2

Backup Designated router (ID) 1.1.3.33, Interface address 1.1.3.1

Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5

oob-resync timeout 40

Hello due in 00:00:01

Supports Link-local Signaling (LLS)

Cisco NSF helper support enabled

IETF NSF helper support enabled

Index 1/1/1, 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 1.1.3.49 (Designated Router)

Suppress hello for 0 neighbor(s)

R6#show ip ospf neighbor

Neighbor ID Pri State Dead Time Address Interface

1.1.3.49 1 FULL/DR 00:00:34 1.1.3.2 GigabitEthernet0/0/0

R6#show ip ospf border-routers

OSPF Router with ID (1.1.3.33) (Process ID 3)

Base Topology (MTID 0)

Internal Router Routing Table

Codes: i - Intra-area route, I - Inter-area route

R6#Show ipv6 route

IPv6 Routing Table - default - 3 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:C1::/64 [0/0]

via GigabitEthernet0/0/0, directly connected

L 2001:DB8:ACAD:C1::1/128 [0/0]

via GigabitEthernet0/0/0, receive

L FF00::/8 [0/0]

via Null0, receive

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

1.0.0.0/8 is variably subnetted, 7 subnets, 2 masks

C 1.1.3.0/28 is directly connected, GigabitEthernet0/0/0

L 1.1.3.1/32 is directly connected, GigabitEthernet0/0/0

O 1.1.3.16/28 [110/2] via 1.1.3.2, 00:18:20, GigabitEthernet0/0/0

C 1.1.3.32/28 is directly connected, Loopback3

L 1.1.3.33/32 is directly connected, Loopback3

O 1.1.3.49/32 [110/2] via 1.1.3.2, 00:18:20, GigabitEthernet0/0/0

O 1.1.3.65/32 [110/3] via 1.1.3.2, 00:18:20, GigabitEthernet0/0/0

Problems

One of the biggest Problem that I faced in the lab was that I did not know how to configure a multi-area OSPF, so I looked at a multi-area packet tracer video along with an website on OSPFv3 ipv6 configuration to understand how to properly create a multi-area OSPF system. During the process of creating multi-area OSPF, I encountered many problems, some small while others are more devastating. One example of a minor problem that I encountered was creating a subnet mask that did not have enough addresses to include a loopback. This was an easy fix as I just needed to replace the old Ip address with new ones, but this process did take quite a bit of time. One major problem I found out while writing the lab was that my OSPFv3 and ipv6 addresses are not actually working, so I looked up on the OSPFv3 configuring to find out the solution to my problem. My problem was that I forgot to assign the interface with the Ipv6 address with the OSPF3 Area.

Conclusion

The purpose of the lab was to use 5 routers to configure an Ipv4 and Ipv6 multi-area OSPF system with three routers in one area and two routers in a second router along with a tweak to the current system. My tweak to the OSPF was creating three OSPF areas while using 6 routers. I found that multi-area OSPF had some advantages compared to OSPF as its smaller routing table allowed for fewer routing table entries as network addresses can be summarized between areas and reduced frequency of SPF calculations. In the lab I was able to learn how to correctly configure a Multi-area OSPF routing protocol that could be applied to real networks. I was also able to learn about the use of OSPFv3 along with the use of Ipv6 within the OSPF. One skill that I frequently use in this lab was looking up resources that are helpful to me and then applying them to my work. Personally, I thought this lab as helpful in understanding something new and improving my knowledge in cisco networking.