Single-Area OSPF

CCNP LAB 1

Jason Liu

CCNP – Mr. Mason, Mr. Hansen

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*Lab 1: Single-Area OSPF*

**Purpose**

The objective of the lab was to understand and configure basic OSPF practices for a single area of OSPF addressing. Another objective was to get acquainted with the lab, tools, racks, wires, ports, and other workspace content.

**Background Information**

OSPF is a link-state routing protocol for IP networks. As a routing protocol, it calculates the shortest path it takes to send a packet through the network to its destination. It does so through seeing the total *cost* of that path, as each hop between routers will have a different assigned *cost*. The total cost for a route is the sum of the costs, of each hop, it takes to get there. The cheapest cost will be assumed the best routing path.

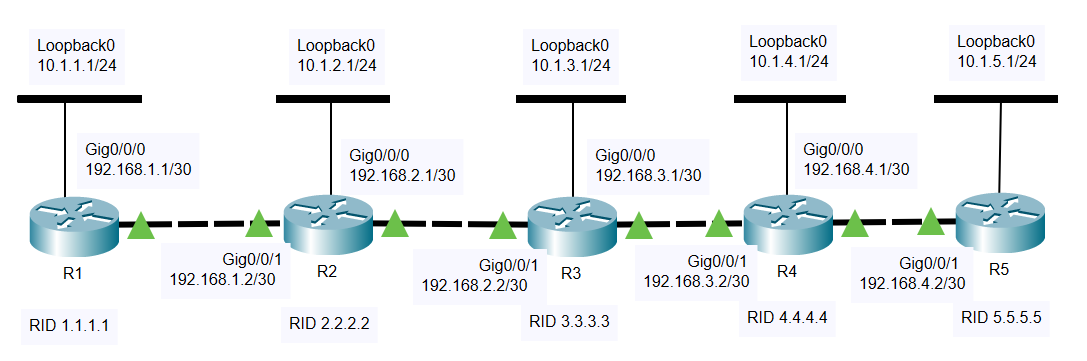
Each OSPF activated router will contain a link-state database, which acts as a topology map and a routing table of the OSPF area, shared throughout all the OSPF routers. OSPF routers can then see networks shared by other routers even when they are not directly connected because of the OSPF discovered routes. A router must be able to see the network to interact with it. The OSPF protocol establishes and maintains relationships with other OSPF routers to send data, updates, and changes in the network area. In a collective, single area, all routers share their databases with other OSPF activated ones.

The main benefit a dynamic routing protocol is that it will automatically determine the best paths through all the hops of the network. This is evidently more efficient then manually configuring routes, especially in terms of large, complicated networks consisting of numerous routers with numerous routes.

The OSPF database consists of the routers known in each respective area. Routers are identified by their unique Router-ID, in the form of an IPv4 address (32-bit binary number). Each router with the OSPF protocol will have one. Router-ID’s are automatically determined if not manually assigned. Router-ID’s are used in an election process to determine the Designated and Backup Designated Routers. The purpose of these roles is to centralize where Link-State Advertisement messages go, so total traffic can be reduced. Link-State Advertisements, or LSA’s are the name of the basic communication messages used to update and maintain relationships with other OSPF routers. There are several types of LSA messages, that communicate different things. On top of this, there are 7 OSPF operational states, in which some include the initializing state, loading state, and the full state. The full state informs that the OSPF relationship is up, and that the link-state database is fully synchronized and operational.

**Lab Summary**

In the lab, 5 routers were connected in one long line. Each one was connected via Gigabit Ethernet ports with cross-over cables, each router to the other in order of the line (see *Network Diagram).* A loopback interface was added on each router to simulate Local Area Networks (LANs). After using a process-id of 10 to enter Router-Configuration mode, OSPF is enabled as the protocol for the router. Then, the networks that are directly connected to this router are shared to the link-state database for the OSPF routers to recognize. This includes the directly connected networks that are in between the routers and the added Loopback networks. This is the most important step, as this decides which LANs are advertised, and which are not. Ultimately, routers have access to all the interfaces and IPs in the network, via OSPF, in this single-area topology.

**Network Diagram of IP’s**

**Table of IP’s**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **End Device** | **G0/0/1**  **Left Side on Routers** | **G0/0/0**  **Right Side on Routers** | **Interface Loopback0** | **Subnet Mask of Loopback Interfaces** | **OSPF Router ID** |
| **Router 1** | NA | 192.168.1.1/30 | 10.1.1.1/24 | 255.255.255.0 | 1.1.1.1 |
| **Router 2** | 192.168.1.2/30 | 192.168.2.1/30 | 10.1.2.1/24 | 255.255.255.0 | 2.2.2.2 |
| **Router 3** | 192.168.2.2/30 | 192.168.3.1/30 | 10.1.3.1/24 | 255.255.255.0 | 3.3.3.3 |
| **Router 4** | 192.168.3.2/30 | 192.168.4.1/30 | 10.1.4.1/24 | 255.255.255.0 | 4.4.4.4 |
| **Router 5** | 192.168.4.2/30 | NA | 10.1.5.1/24 | 255.255.255.0 | 5.5.5.5 |

**Lab Commands**

Most commands were common network fundamentals. Key commands to this lab include:

**router ospf [*process-id]*** *–* Enables OSPF routing protocol on the router and enters the router configuration mode. Process-id of 10 was used in this lab.

**network [*ip-address* *wildcard-mask]* area [*area-id]*** – Enables said network to be advertised to the OSPF database. The command is written with a wildcard-mask, which is the exact opposite of the subnet mask. The area is zero for this lab, as only a single-area of OSPF is used. Area zero is also called the *backbone* area, since it should be the center if more OSPF areas are added.

**show ip protocols –** Displays the details and parameters the particular protocol is using. Displays protocol name, metrics, and networks advertised.

**show ip route {ospf} –** Displays the routing table. {Specifically ospf discovered ones}

**show ip ospf –** Displays basic ospf information.

**show ip ospf database –** Displays data from OSPF database.

**Configurations**

Show IP Routes:

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

**R1**

10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks

C 10.1.1.0/24 is directly connected, Loopback0

L 10.1.1.1/32 is directly connected, Loopback0

O 10.1.2.1/32 [110/2] via 192.168.1.2, 00:17:56, GigabitEthernet0/0/0

O 10.1.3.1/32 [110/3] via 192.168.1.2, 00:19:18, GigabitEthernet0/0/0

O 10.1.4.1/32 [110/4] via 192.168.1.2, 00:20:24, GigabitEthernet0/0/0

O 10.1.5.1/32 [110/5] via 192.168.1.2, 00:21:18, GigabitEthernet0/0/0

192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks

C 192.168.1.0/30 is directly connected, GigabitEthernet0/0/0

L 192.168.1.1/32 is directly connected, GigabitEthernet0/0/0

192.168.2.0/30 is subnetted, 1 subnets

O 192.168.2.0 [110/2] via 192.168.1.2, 00:26:08, GigabitEthernet0/0/0

192.168.3.0/30 is subnetted, 1 subnets

O 192.168.3.0 [110/3] via 192.168.1.2, 00:26:08, GigabitEthernet0/0/0

192.168.4.0/30 is subnetted, 1 subnets

O 192.168.4.0 [110/4] via 192.168.1.2, 00:26:08, GigabitEthernet0/0/0

**R2**

10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks

O 10.1.1.1/32 [110/2] via 192.168.1.1, 00:25:49, GigabitEthernet0/0/1

C 10.1.2.0/24 is directly connected, Loopback0

L 10.1.2.1/32 is directly connected, Loopback0

O 10.1.3.1/32 [110/2] via 192.168.2.2, 00:19:53, GigabitEthernet0/0/0

O 10.1.4.1/32 [110/3] via 192.168.2.2, 00:20:59, GigabitEthernet0/0/0

O 10.1.5.1/32 [110/4] via 192.168.2.2, 00:21:53, GigabitEthernet0/0/0

192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks

C 192.168.1.0/30 is directly connected, GigabitEthernet0/0/1

L 192.168.1.2/32 is directly connected, GigabitEthernet0/0/1

192.168.2.0/24 is variably subnetted, 2 subnets, 2 masks

C 192.168.2.0/30 is directly connected, GigabitEthernet0/0/0

L 192.168.2.1/32 is directly connected, GigabitEthernet0/0/0

192.168.3.0/30 is subnetted, 1 subnets

O 192.168.3.0 [110/2] via 192.168.2.2, 00:30:43, GigabitEthernet0/0/0

192.168.4.0/30 is subnetted, 1 subnets

O 192.168.4.0 [110/3] via 192.168.2.2, 00:30:06, GigabitEthernet0/0/0

**R3**

10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks

O 10.1.1.1/32 [110/3] via 192.168.2.1, 00:15:02, GigabitEthernet0/0/1

O 10.1.2.1/32 [110/2] via 192.168.2.1, 00:07:44, GigabitEthernet0/0/1

C 10.1.3.0/24 is directly connected, Loopback0

L 10.1.3.1/32 is directly connected, Loopback0

O 10.1.4.1/32 [110/2] via 192.168.3.2, 00:10:12, GigabitEthernet0/0/0

O 10.1.5.1/32 [110/3] via 192.168.3.2, 00:11:06, GigabitEthernet0/0/0

192.168.1.0/30 is subnetted, 1 subnets

O 192.168.1.0 [110/2] via 192.168.2.1, 00:16:35, GigabitEthernet0/0/1

192.168.2.0/24 is variably subnetted, 2 subnets, 2 masks

C 192.168.2.0/30 is directly connected, GigabitEthernet0/0/1

L 192.168.2.2/32 is directly connected, GigabitEthernet0/0/1

192.168.3.0/24 is variably subnetted, 2 subnets, 2 masks

C 192.168.3.0/30 is directly connected, GigabitEthernet0/0/0

L 192.168.3.1/32 is directly connected, GigabitEthernet0/0/0

192.168.4.0/30 is subnetted, 1 subnets

O 192.168.4.0 [110/2] via 192.168.3.2, 00:19:19, GigabitEthernet0/0/0

**R4**

10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks

O 10.1.1.1/32 [110/4] via 192.168.3.1, 00:16:26, GigabitEthernet0/0/1

O 10.1.2.1/32 [110/3] via 192.168.3.1, 00:09:09, GigabitEthernet0/0/1

O 10.1.3.1/32 [110/2] via 192.168.3.1, 00:10:31, GigabitEthernet0/0/1

C 10.1.4.0/24 is directly connected, Loopback0

L 10.1.4.1/32 is directly connected, Loopback0

O 10.1.5.1/32 [110/2] via 192.168.4.2, 00:12:31, GigabitEthernet0/0/0

192.168.1.0/30 is subnetted, 1 subnets

O 192.168.1.0 [110/3] via 192.168.3.1, 00:18:00, GigabitEthernet0/0/1

192.168.2.0/30 is subnetted, 1 subnets

O 192.168.2.0 [110/2] via 192.168.3.1, 00:21:20, GigabitEthernet0/0/1

192.168.3.0/24 is variably subnetted, 2 subnets, 2 masks

C 192.168.3.0/30 is directly connected, GigabitEthernet0/0/1

L 192.168.3.2/32 is directly connected, GigabitEthernet0/0/1

192.168.4.0/24 is variably subnetted, 2 subnets, 2 masks

C 192.168.4.0/30 is directly connected, GigabitEthernet0/0/0

L 192.168.4.1/32 is directly connected, GigabitEthernet0/0/0

**R5**

10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks

O 10.1.1.1/32 [110/5] via 192.168.4.1, 00:18:27, GigabitEthernet0/0/1

O 10.1.2.1/32 [110/4] via 192.168.4.1, 00:11:10, GigabitEthernet0/0/1

O 10.1.3.1/32 [110/3] via 192.168.4.1, 00:12:32, GigabitEthernet0/0/1

O 10.1.4.1/32 [110/2] via 192.168.4.1, 00:13:37, GigabitEthernet0/0/1

C 10.1.5.0/24 is directly connected, Loopback0

L 10.1.5.1/32 is directly connected, Loopback0

192.168.1.0/30 is subnetted, 1 subnets

O 192.168.1.0 [110/4] via 192.168.4.1, 00:20:01, GigabitEthernet0/0/1

192.168.2.0/30 is subnetted, 1 subnets

O 192.168.2.0 [110/3] via 192.168.4.1, 00:22:45, GigabitEthernet0/0/1

192.168.3.0/30 is subnetted, 1 subnets

O 192.168.3.0 [110/2] via 192.168.4.1, 00:22:45, GigabitEthernet0/0/1

192.168.4.0/24 is variably subnetted, 2 subnets, 2 masks

C 192.168.4.0/30 is directly connected, GigabitEthernet0/0/1

L 192.168.4.2/32 is directly connected, GigabitEthernet0/0/1

Show Running-Configurations:

**R1**

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

no ip domain lookup

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 Loopback0**

**ip address 10.1.1.1 255.255.255.0**

**interface GigabitEthernet0/0/0**

**ip address 192.168.1.1 255.255.255.252**

**negotiation auto**

interface GigabitEthernet0/0/1

no ip address

shutdown

negotiation auto

interface Serial0/1/0

no ip address

shutdown

interface Serial0/1/1

no ip address

shutdown

interface GigabitEthernet0

vrf forwarding Mgmt-intf

no ip address

shutdown

negotiation auto

interface Vlan1

no ip address

shutdown

**router ospf 10**

**router-id 1.1.1.1**

**network 10.1.1.0 0.0.0.255 area 0**

**network 192.168.1.0 0.0.0.3 area 0**

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**

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

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 Loopback0**

**ip address 10.1.2.1 255.255.255.0**

**interface GigabitEthernet0/0/0**

**ip address 192.168.2.1 255.255.255.252**

**negotiation auto**

**interface GigabitEthernet0/0/1**

**ip address 192.168.1.2 255.255.255.252**

**negotiation auto**

interface Serial0/1/0

no ip address

shutdown

interface Serial0/1/1

no ip address

shutdown

interface GigabitEthernet0

vrf forwarding Mgmt-intf

no ip address

shutdown

negotiation auto

interface Vlan1

no ip address

shutdown

**router ospf 10**

**router-id 2.2.2.2**

**network 10.1.2.0 0.0.0.255 area 0**

**network 192.168.1.0 0.0.0.3 area 0**

**network 192.168.2.0 0.0.0.3 area 0**

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**

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

subscriber templating

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 Loopback0**

**ip address 10.1.3.1 255.255.255.0**

**interface GigabitEthernet0/0/0**

**ip address 192.168.3.1 255.255.255.252**

**negotiation auto**

**interface GigabitEthernet0/0/1**

**ip address 192.168.2.2 255.255.255.252**

**negotiation auto**

interface Serial0/1/0

no ip address

shutdown

interface Serial0/1/1

no ip address

shutdown

interface GigabitEthernet0

vrf forwarding Mgmt-intf

no ip address

shutdown

negotiation auto

interface Vlan1

no ip address

shutdown

**router ospf 10**

**router-id 3.3.3.3**

**network 10.1.3.0 0.0.0.255 area 0**

**network 192.168.2.0 0.0.0.3 area 0**

**network 192.168.3.0 0.0.0.3 area 0**

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**

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

subscriber templating

multilink bundle-name authenticated

license udi pid ISR4321/K9 sn FLM240608PJ

no license smart enable

diagnostic bootup level minimal

spanning-tree extend system-id

redundancy

mode none

**interface Loopback0**

**ip address 10.1.4.1 255.255.255.0**

**interface GigabitEthernet0/0/0**

**ip address 192.168.4.1 255.255.255.252**

**negotiation auto**

**interface GigabitEthernet0/0/1**

**ip address 192.168.3.2 255.255.255.252**

**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 10**

**router-id 4.4.4.4**

**network 10.1.4.0 0.0.0.255 area 0**

**network 192.168.3.0 0.0.0.3 area 0**

**network 192.168.4.0 0.0.0.3 area 0**

ip forward-protocol nd

no ip http server

ip http authentication local

no 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**

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

subscriber templating

multilink bundle-name authenticated

license udi pid ISR4321/K9 sn FLM2406090M

no license smart enable

diagnostic bootup level minimal

spanning-tree extend system-id

redundancy

mode none

**interface Loopback0**

**ip address 10.1.5.1 255.255.255.0**

interface GigabitEthernet0/0/0

no ip address

negotiation auto

**interface GigabitEthernet0/0/1**

**ip address 192.168.4.2 255.255.255.252**

**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 10**

**router-id 5.5.5.5**

**network 10.1.5.0 0.0.0.255 area 0**

**network 192.168.4.0 0.0.0.3 area 0**

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

Verification Commands – Pings:

**R1 Pings**

R1#ping 10.1.2.1

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 10.1.2.1, timeout is 2 seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

R1#ping 10.1.3.1

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 10.1.3.1, timeout is 2 seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

R1#ping 10.1.4.1

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 10.1.4.1, timeout is 2 seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

R1#ping 10.1.5.1

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 10.1.5.1, timeout is 2 seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

R1#ping 192.168.4.1

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 192.168.4.1, timeout is 2 seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

R1#ping 192.168.4.2

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 192.168.4.2, timeout is 2 seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/2 ms

**R5 Pings**

R5#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 = 1/1/1 ms

R5#ping 10.1.2.1

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 10.1.2.1, timeout is 2 seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

R5#ping 10.1.3.1

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 10.1.3.1, timeout is 2 seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

R5#ping 10.1.4.1

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 10.1.4.1, timeout is 2 seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

R5#ping 192.168.1.1

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 192.168.1.1, timeout is 2 seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

R5#ping 192.168.1.2

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 192.168.1.2, timeout is 2 seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

Verification Commands – Show Commands:

**R1**

**R1#show ip ospf**

Routing Process "ospf 10" with ID 1.1.1.1

Start time: 00:09:18.731, Time elapsed: 00:30:36.406

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 BACKBONE(0)

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

Area has no authentication

SPF algorithm last executed 00:07:03.410 ago

SPF algorithm executed 8 times

Area ranges are

Number of LSA 9. Checksum Sum 0x044D1D

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 protocols**

\*\*\* IP Routing is NSF aware \*\*\*

Routing Protocol is "application"

Sending updates every 0 seconds

Invalid after 0 seconds, hold down 0, flushed after 0

Outgoing update filter list for all interfaces is not set

Incoming update filter list for all interfaces is not set

Maximum path: 32

Routing for Networks:

Routing Information Sources:

Gateway Distance Last Update

Distance: (default is 4)

Routing Protocol is "ospf 10"

Outgoing update filter list for all interfaces is not set

Incoming update filter list for all interfaces is not set

Router ID 1.1.1.1

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 0.0.0.3 area 0

Routing Information Sources:

Gateway Distance Last Update

5.5.5.5 110 00:06:54

4.4.4.4 110 00:07:04

2.2.2.2 110 00:24:06

3.3.3.3 110 00:23:56

Distance: (default is 110)

**R1#show ip ospf database**

OSPF Router with ID (1.1.1.1) (Process ID 10)

Router Link States (Area 0)

Link ID ADV Router Age Seq# Checksum Link count

1.1.1.1 1.1.1.1 1483 0x80000003 0x008FA3 2

2.2.2.2 2.2.2.2 1484 0x80000005 0x0062DA 3

3.3.3.3 3.3.3.3 1433 0x80000007 0x008F9E 3

4.4.4.4 4.4.4.4 456 0x80000005 0x00C45E 3

5.5.5.5 5.5.5.5 456 0x80000003 0x0027E0 2

Net Link States (Area 0)

Link ID ADV Router Age Seq# Checksum

192.168.1.2 2.2.2.2 1484 0x80000001 0x00F6C5

192.168.2.2 3.3.3.3 1707 0x80000001 0x00228D

192.168.3.2 4.4.4.4 1434 0x80000001 0x004D55

192.168.4.2 5.5.5.5 457 0x80000001 0x00781D

**R2**

**R2#show ip ospf**

Routing Process "ospf 10" with ID 2.2.2.2

Start time: 00:10:00.672, Time elapsed: 00:32:38.705

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 BACKBONE(0)

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

Area has no authentication

SPF algorithm last executed 00:09:44.110 ago

SPF algorithm executed 12 times

Area ranges are

Number of LSA 9. Checksum Sum 0x044D1D

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 protocols**

\*\*\* IP Routing is NSF aware \*\*\*

Routing Protocol is "application"

Sending updates every 0 seconds

Invalid after 0 seconds, hold down 0, flushed after 0

Outgoing update filter list for all interfaces is not set

Incoming update filter list for all interfaces is not set

Maximum path: 32

Routing for Networks:

Routing Information Sources:

Gateway Distance Last Update

Distance: (default is 4)

Routing Protocol is "ospf 10"

Outgoing update filter list for all interfaces is not set

Incoming update filter list for all interfaces is not set

Router ID 2.2.2.2

Number of areas in this router is 1. 1 normal 0 stub 0 nssa

Maximum path: 4

Routing for Networks:

10.1.2.0 0.0.0.255 area 0

192.168.1.0 0.0.0.3 area 0

192.168.2.0 0.0.0.3 area 0

Routing Information Sources:

Gateway Distance Last Update

5.5.5.5 110 00:09:20

4.4.4.4 110 00:09:30

1.1.1.1 110 00:26:32

3.3.3.3 110 00:26:22

Distance: (default is 110)

**R2#show ip ospf database**

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

Router Link States (Area 0)

Link ID ADV Router Age Seq# Checksum Link count

1.1.1.1 1.1.1.1 1636 0x80000003 0x008FA3 2

2.2.2.2 2.2.2.2 1635 0x80000005 0x0062DA 3

3.3.3.3 3.3.3.3 1584 0x80000007 0x008F9E 3

4.4.4.4 4.4.4.4 608 0x80000005 0x00C45E 3

5.5.5.5 5.5.5.5 608 0x80000003 0x0027E0 2

Net Link States (Area 0)

Link ID ADV Router Age Seq# Checksum

192.168.1.2 2.2.2.2 1635 0x80000001 0x00F6C5

192.168.2.2 3.3.3.3 1859 0x80000001 0x00228D

192.168.3.2 4.4.4.4 1585 0x80000001 0x004D55

192.168.4.2 5.5.5.5 609 0x80000001 0x00781D

**R3**

**R3#show ip ospf**

Routing Process "ospf 10" with ID 3.3.3.3

Start time: 00:10:51.558, Time elapsed: 00:33:07.561

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 BACKBONE(0)

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

Area has no authentication

SPF algorithm last executed 00:11:03.403 ago

SPF algorithm executed 11 times

Area ranges are

Number of LSA 9. Checksum Sum 0x044D1D

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 protocols**

\*\*\* IP Routing is NSF aware \*\*\*

Routing Protocol is "application"

Sending updates every 0 seconds

Invalid after 0 seconds, hold down 0, flushed after 0

Outgoing update filter list for all interfaces is not set

Incoming update filter list for all interfaces is not set

Maximum path: 32

Routing for Networks:

Routing Information Sources:

Gateway Distance Last Update

Distance: (default is 4)

Routing Protocol is "ospf 10"

Outgoing update filter list for all interfaces is not set

Incoming update filter list for all interfaces is not set

Router ID 3.3.3.3

Number of areas in this router is 1. 1 normal 0 stub 0 nssa

Maximum path: 4

Routing for Networks:

10.1.3.0 0.0.0.255 area 0

192.168.2.0 0.0.0.3 area 0

192.168.3.0 0.0.0.3 area 0

Routing Information Sources:

Gateway Distance Last Update

5.5.5.5 110 00:10:51

4.4.4.4 110 00:11:01

1.1.1.1 110 00:27:53

2.2.2.2 110 00:28:47

Distance: (default is 110)

**R3#show ip ospf database**

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

Router Link States (Area 0)

Link ID ADV Router Age Seq# Checksum Link count

1.1.1.1 1.1.1.1 1710 0x80000003 0x008FA3 2

2.2.2.2 2.2.2.2 1710 0x80000005 0x0062DA 3

3.3.3.3 3.3.3.3 1657 0x80000007 0x008F9E 3

4.4.4.4 4.4.4.4 680 0x80000005 0x00C45E 3

5.5.5.5 5.5.5.5 681 0x80000003 0x0027E0 2

Net Link States (Area 0)

Link ID ADV Router Age Seq# Checksum

192.168.1.2 2.2.2.2 1710 0x80000001 0x00F6C5

192.168.2.2 3.3.3.3 1931 0x80000001 0x00228D

192.168.3.2 4.4.4.4 1658 0x80000001 0x004D55

192.168.4.2 5.5.5.5 681 0x80000001 0x00781D

**R4**

**R4#show ip ospf**

Routing Process "ospf 10" with ID 4.4.4.4

Start time: 00:04:42.897, Time elapsed: 00:29:22.947

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 BACKBONE(0)

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

Area has no authentication

SPF algorithm last executed 00:11:50.669 ago

SPF algorithm executed 5 times

Area ranges are

Number of LSA 9. Checksum Sum 0x044B1E

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 protocols**

\*\*\* IP Routing is NSF aware \*\*\*

Routing Protocol is "application"

Sending updates every 0 seconds

Invalid after 0 seconds, hold down 0, flushed after 0

Outgoing update filter list for all interfaces is not set

Incoming update filter list for all interfaces is not set

Maximum path: 32

Routing for Networks:

Routing Information Sources:

Gateway Distance Last Update

Distance: (default is 4)

Routing Protocol is "ospf 10"

Outgoing update filter list for all interfaces is not set

Incoming update filter list for all interfaces is not set

Router ID 4.4.4.4

Number of areas in this router is 1. 1 normal 0 stub 0 nssa

Maximum path: 4

Routing for Networks:

10.1.4.0 0.0.0.255 area 0

192.168.3.0 0.0.0.3 area 0

192.168.4.0 0.0.0.3 area 0

Routing Information Sources:

Gateway Distance Last Update

5.5.5.5 110 00:11:40

1.1.1.1 110 00:28:00

2.2.2.2 110 00:28:00

3.3.3.3 110 00:28:00

Distance: (default is 110)

**R4#show ip ospf database**

OSPF Router with ID (4.4.4.4) (Process ID 10)

Router Link States (Area 0)

Link ID ADV Router Age Seq# Checksum Link count

1.1.1.1 1.1.1.1 1758 0x80000003 0x008FA3 2

2.2.2.2 2.2.2.2 1758 0x80000005 0x0062DA 3

3.3.3.3 3.3.3.3 1706 0x80000007 0x008F9E 3

4.4.4.4 4.4.4.4 727 0x80000005 0x00C45E 3

5.5.5.5 5.5.5.5 728 0x80000003 0x0027E0 2

Net Link States (Area 0)

Link ID ADV Router Age Seq# Checksum

192.168.1.2 2.2.2.2 1758 0x80000001 0x00F6C5

192.168.2.2 3.3.3.3 45 0x80000002 0x00208E

192.168.3.2 4.4.4.4 1705 0x80000001 0x004D55

192.168.4.2 5.5.5.5 728 0x80000001 0x00781D

**R5**

**R5#show ip ospf**

Routing Process "ospf 10" with ID 5.5.5.5

Start time: 00:03:27.775, Time elapsed: 00:20:20.489

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 BACKBONE(0)

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

Area has no authentication

SPF algorithm last executed 00:13:41.542 ago

SPF algorithm executed 3 times

Area ranges are

Number of LSA 9. Checksum Sum 0x044B1E

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 protocols**

\*\*\* IP Routing is NSF aware \*\*\*

Routing Protocol is "application"

Sending updates every 0 seconds

Invalid after 0 seconds, hold down 0, flushed after 0

Outgoing update filter list for all interfaces is not set

Incoming update filter list for all interfaces is not set

Maximum path: 32

Routing for Networks:

Routing Information Sources:

Gateway Distance Last Update

Distance: (default is 4)

Routing Protocol is "ospf 10"

Outgoing update filter list for all interfaces is not set

Incoming update filter list for all interfaces is not set

Router ID 5.5.5.5

Number of areas in this router is 1. 1 normal 0 stub 0 nssa

Maximum path: 4

Routing for Networks:

10.1.5.0 0.0.0.255 area 0

192.168.4.0 0.0.0.3 area 0

Routing Information Sources:

Gateway Distance Last Update

1.1.1.1 110 00:12:53

2.2.2.2 110 00:12:53

3.3.3.3 110 00:12:53

4.4.4.4 110 00:12:53

Distance: (default is 110)

**R5#show ip ospf database**

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

Router Link States (Area 0)

Link ID ADV Router Age Seq# Checksum Link count

1.1.1.1 1.1.1.1 1868 0x80000003 0x008FA3 2

2.2.2.2 2.2.2.2 1868 0x80000005 0x0062DA 3

3.3.3.3 3.3.3.3 1815 0x80000007 0x008F9E 3

4.4.4.4 4.4.4.4 837 0x80000005 0x00C45E 3

5.5.5.5 5.5.5.5 836 0x80000003 0x0027E0 2

Net Link States (Area 0)

Link ID ADV Router Age Seq# Checksum

192.168.1.2 2.2.2.2 1868 0x80000001 0x00F6C5

192.168.2.2 3.3.3.3 155 0x80000002 0x00208E

192.168.3.2 4.4.4.4 1814 0x80000001 0x004D55

192.168.4.2 5.5.5.5 836 0x80000001 0x00781D

**Problems**

There were many physical complications. The main problem was getting accustomed to the physical rack. The racks were custom built for the classroom lab for ease of access and utility. Different computers were connected to different racks, so I accidentally confused the pairings, and then afterwards proceeded to incorrectly pair the console connection due to the unfamiliarity to the color-coded port hub that’s a part of the rack. Also, I learned that serial cables are very inconvenient to constantly plug and unplug, so simple Gigabit cross-over data cables were used to connect the routers for best practice. This surprised me since serial cables were often used in models as the connections between routers in curriculums and books.

In terms of the lab, one of the routers ended up in a non-configurable, and inoperable state where it was unable to boot and to be consoled. The issue was avoided by simply using another router. The issue was later resolved by a senior admin. It was only until after the OSPF routers were lined up that the prompt of adding Loopback interfaces were required. At that point, I did not understand why the Loopbacks were not appearing in the routing tables and being advertised by OSPF. With the helpful reminder of my lab partner seniors, Tyler Chung and Adhvitha Sivaghanesh, I learned that OSPF will only advertise the directly connected networks if specifically enabled to do so. I first thought it was the other way around, where the routers must choose and see which networks it takes in, but Mr. Mason clarified that the relationship is by which networks the routers choose to advertise. Finally, after everything was clarified, the OSPF network was successfully established.

**Conclusion**

Although this was a very simple setup for the logical network, it was greatly challenging and beneficial to get used to the physical challenges. As the first lab, this lab was a great transition to understanding the physical workspace. The main accomplishments derived from getting accustomed to the lab procedures and becoming familiar with the physical equipment. This was also a pleasant OSPF review, and a reminder for the properties of network commands and wildcard masks. This lab was very helpful.