

OSFPv2

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**Purpose**

The purpose of this lab is to configure single-area OSPFv2 on 7 routers, so they can find the best routing path between the source and the destination router. Students will learn to OSPF commands such as **router ospf** process-id and **network** ip-address wildcard-mask **area** area-id.

**Background Information on lab concepts**

OSPF or “Open Shortest Port First” is a routing protocol which helps routers find the best routing path between the source and the destination router. It is a link-state routing protocol, which means it exchanges Link State Advertisement (LSA) messages with other neighboring routers that also have OSPF configured.

OSPF has seven states while building neighborship with other routers, which are Down State, Attempt/Init state, two ways state, exstart state, exchange state, loading state, and full state.

Before configuring OSPF, the routers have no information about each other. In Down State, OSPF learns about the local interfaces that are configured with OSPF. Routers also prepare themselves for the neighborship process and choose a RID (Router ID). The RID is 32 bits long and is a unique identifier of a router in an OSPF network. It also must be unique within the network. To determine what its RID is, OSPF will check its manual configuration first. Manually configuring your RID will allow you to organize your network more. For example, you can use a simple IP scheme such as 1.1.1.1 for R1, 2.2.2.2 for R2, 3.3.3.3 for R3, 4.4.4.4 for R4, 5.5.5.5 for R5, etc. If the RID is not manually configured, OSPF will look at the loopback interface IP configuration. If a loopback interface is configured, OSPF will choose its IP address to be the RID. If multiple loopback interfaces are configured, the highest IP address will be chosen from all loopback interface configurations. If the RID is not manually configured and there are no loopback interfaces, OSPF will choose the highest IP address from all the IP interfaces that are up and operating. This is not a good option to use, however, because if the interface with the IP chosen happens to go down, OSPF will be forced to recalculate its RID.

In the Attempt/Init state, the neighborship building process starts. To explain this, I will use R1 (Router 1) and R2 (Router 2). R1 will multicast a hello packet so other routers in the network can learn about it as an OSPF router. This hello packet contains its Router ID and some other configuration values such as area ID, hello interval, stub flag, hold down timer, and maximum transition unit (MTU). These configuration values must be the same on routers who want to build an OSPF neighborship. Next, R2 will receive this packet and read the RID from the packet to see if there is an existing entry in its neighbor table. If it finds a match, it will skip the neighborship building process and reset the dead interval timer for that entry. If OSPF does not find a match in the neighbor table, it will consider R1 (sender router) as a possible OSPF neighbor and start the neighborship building process. R2 (receiver router) will then match its essential configuration values with values listed in packet, and if all the necessary configuration values match, it will add R1 to its neighbor table. After R2 adds R1 to its neighbor table, it will reply with a hello packet containing its RID, configuration values, and its own neighbor table data. Next, R1 will receive the hello packet from R2, and since its own RID is listed in R2’s neighbor table, R1 knows that R2 has accepted its neighborship request, putting these routers in a two-way state. Lastly, R1 will send a reply with a hello packet to R2, containing its own neighbor table, which now has R2 in it, confirming their two-way state.

In the Exstart state, routers who choose to build adjacency/neighborship will form a master/slave relationship. In each neighborship, the router who has the higher RID will become the master and the one with the lower RID will become the slave. For example, if R1 has an RID of 1.1.1.1 and R2 has an RID of 2.2.2.2, R2 will become the master and R1 will become the slave. This relationship is built between the two interfaces that need to exchange routing information and will help determine which router will start the exchange process. The master will always start the exchange, while the slave will always receive.

In the exchange state, OSPF routers will exchange database descriptor packets (DBD). Database descriptors contain link-state advertisement (LSA) headers that contain the contents of the link-state database (LSDB). The LSDB can be seen as a collection of all LSAs received by a router. The contents of the DBD are then compared with its own LSDB to check if changes or more updated link-state information is available from its neighbor.

In the Loading state, the actual exchange of link-state information occurs. Based on the DBD packets provided by neighbors, routers send link-state request packets (LSR), which are a list of all the LSAs that router doesn’t have in its own LSDB. Next, the neighbor provides the requested link-state information in link-state update packets (LSU). Link-state updates basically act as an envelope containing all the LSAs requested in the LSR. All OSPF packets are acknowledged with link-state acknowledge packets (LSACK), which make link-state advertisement flooding reliable, by confirming the information sent was received.

The final state OSPF goes through is Full state, which is the normal operating state of OSPF, indicating that everything is functioning the way it should. In this state, all the router and network LSAs have been exchanged, and the all routers’ databases are in sync.

**Lab Summary**

In this lab, I used seven 4321 Cisco Routers, six copper-straight through cables, and one fiber optic cable. To connect the seven routers, I used copper straight through cables. I connected 2 copper-straight through cables to each router, except the two routers on the ends. One cable went in the GigabitEthernet 0/0/0 interface and the other went in the GigabitEthernet 0/0/1 interface. Then, since there weren’t 7 routers available to me on one rack, I used a fiber optic cable on the first router, on the GigabitEthernet 0/0/0 interface, and connected it to the GigabitEthernet 0/0/0 interface on the first router on the second rack. After that, I assigned the interfaces of each router an IP address, and configured a loopback address on the router. Then, I configured OSPFv2 on the routers. Finally, I pinged my PCs and Routers to each other to verify connectivity, and did other commands like show ip router to ensure that OSPFv2 was working.

**Lab Commands**

Router(config)**#router ospf** process-id

This command is used to enable OSPFv2 and enter router configuration mode. The process-id is set by the network administrator and is a set value from 1 to 65,535. In this lab, I used a value of 1 for my process-id. It is best to use the same process-id for all OSPF routers.

Router(config)**#router-id** router-id

This command manually sets a router-id on the router to specify it as an OSPF router. The OSPF process will use this RID (router-id) when communicating with other OSPF neighbors. The router-id is a 32-bit value in the form of an IPv4 address. I set the router-id for R1 to 1.1.1.1, R2 to 2.2.2.2, R3 to 3.3.3.3, R4 to 4.4.4.4 and R5 to 5.5.5.5.

Router(config)**#network** network-address wildcard-mask **area** area-id

This command is used to identify which device interface will be included within the OSPF process and what area the interface will be assigned to. In the network portion of the command, you type the network-address of the interface you want OSPF to be enabled on. The wildcard-mask portion is more complicated, as you need to subtract the subnet mask from 255.255.255.255. So, for example, the subnet mask 255.255.255.0 would be identified with a wildcard-mask of 0.0.0.255, and the subnet mask 255.255.0.0 would be identified with a wildcard-mask of 0.0.255.255. I used the wildcard-mask of 0.0.0.255 since the subnet mask of all my networks was 255.255.255.0. The area-id portion is used to assign an interface into a specific OSPF area. For single-area OSPF, the area-id must be the same for all routers, and since in this lab I was only doing single-area OSPF, I used the value of 0 for all my routers.

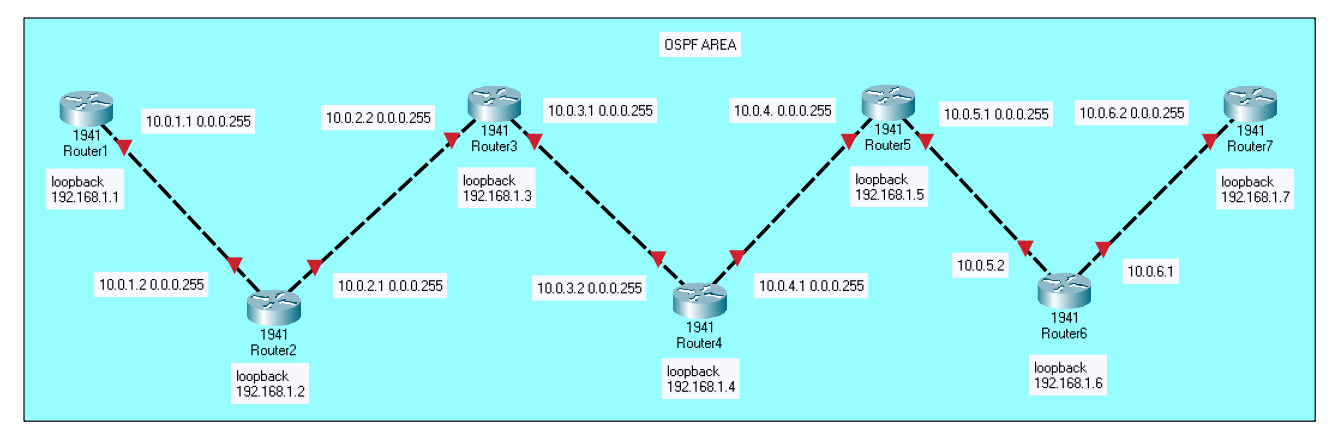
Router**#show ip ospf int**

This command allows you to see the OSPF enabled interfaces, and their OSPF information such as process-id, router-id, neighbor count, and adjacent neighbor count.

Router**#show ip ospf neighbor**

This command allows you to see the neighboring routers that also have OSPF enabled. It tells you the Neighbor ID, priority, state, dead time, address, and interface of the neighboring routers.

**Network Diagram with IP's**



|  |  |  |  |
| --- | --- | --- | --- |
| **Device** | **Interface** | **IP Address** | **Subnet Mask** |
| R1 | G0/0/0  G0/0/1 | 10.0.1.1  10.0.1.2 | 255.255.255.0  255.255.255.0 |
| R2 | G0/0/0 | 10.0.2.1 | 255.255.255.0 |
| G0/0/1 | 10.0.2.2 | 255.255.255.0 |
| R3 | G0/0/0 | 10.0.3.1 | 255.255.255.0 |
| G0/0/1 | 10.0.3.2 | 255.255.255.0 |
| R4 | G0/0/0 | 10.0.4.1 | 255.255.255.0 |
| G0/0/1 | 10.0.4.2 | 255.255.255.0 |
| R5 | G0/0/0 | 10.0.5.1 | 255.255.255.0 |
| G0/0/1 | 10.0.5.2 | 255.255.255.0 |
| R6 | G0/0/0 | 10.0.6.1 | 255.255.255.0 |
| G0/0/1 | 10.0.6.2 | 255.255.255.0 |
| R7 | G0/0/0 | 10.0.7.1 | 255.255.255.0 |
| G0/0/1 | 10.0.7.2 | 255.255.255.0 |

**Configurations**

**Router 1**

**show run**

R1#show run

Building configuration...

Current configuration : 781 bytes

!

version 15.4

service timestamps log datetime msec

service timestamps debug datetime msec

no service password-encryption

!

hostname R1

!

ip cef

no ipv6 cef

!

no ip domain-lookup

!

spanning-tree mode pvst

!

interface Loopback0

ip address 192.168.1.1 255.255.255.0

!

interface GigabitEthernet0/0/0

no ip address

duplex auto

speed auto

shutdown

!

interface GigabitEthernet0/0/1

ip address 10.0.1.1 255.255.255.0

duplex auto

speed auto

!

interface Vlan1

no ip address

shutdown

!

router ospf 1

router-id 1.1.1.1

log-adjacency-changes

network 10.0.1.0 0.0.0.255 area 0

network 192.168.1.0 0.0.0.255 area 0

!

ip classless

!

ip flow-export version 9

!

line con 0

login

!

line aux 0

!

line vty 0 4

login

!

end

**show ip route**

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, E - EGP

i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area

\* - candidate default, U - per-user static route, o - ODR

P - periodic downloaded static route

Gateway of last resort is not set

10.0.0.0/8 is variably subnetted, 7 subnets, 2 masks

C 10.0.1.0/24 is directly connected, GigabitEthernet0/0/1

L 10.0.1.1/32 is directly connected, GigabitEthernet0/0/1

O 10.0.2.0/24 [110/2] via 10.0.1.2, 00:16:43, GigabitEthernet0/0/1

O 10.0.3.0/24 [110/3] via 10.0.1.2, 00:16:33, GigabitEthernet0/0/1

O 10.0.4.0/24 [110/4] via 10.0.1.2, 00:16:33, GigabitEthernet0/0/1

O 10.0.5.0/24 [110/5] via 10.0.1.2, 00:16:33, GigabitEthernet0/0/1

O 10.0.6.0/24 [110/6] via 10.0.1.2, 00:16:33, GigabitEthernet0/0/1

192.168.1.0/24 is variably subnetted, 8 subnets, 2 masks

C 192.168.1.0/24 is directly connected, Loopback0

L 192.168.1.1/32 is directly connected, Loopback0

O 192.168.1.2/32 [110/2] via 10.0.1.2, 00:16:43, GigabitEthernet0/0/1

O 192.168.1.3/32 [110/3] via 10.0.1.2, 00:12:22, GigabitEthernet0/0/1

O 192.168.1.4/32 [110/4] via 10.0.1.2, 00:11:24, GigabitEthernet0/0/1

O 192.168.1.5/32 [110/5] via 10.0.1.2, 00:05:25, GigabitEthernet0/0/1

O 192.168.1.6/32 [110/6] via 10.0.1.2, 00:02:34, GigabitEthernet0/0/1

O 192.168.1.7/32 [110/7] via 10.0.1.2, 00:01:48, GigabitEthernet0/0/1

**show ip ospf neighbor**

R1#show ip ospf neighbor

Neighbor ID Pri State Dead Time Address Interface

2.2.2.2 1 FULL/DR 00:00:37 10.0.1.2 GigabitEthernet0/0/1

**Router 2**

**show run**

R2#show run

Building configuration...

Current configuration : 809 bytes

!

version 15.4

no service timestamps log datetime msec

no service timestamps debug datetime msec

no service password-encryption

!

hostname Router

!

ip cef

no ipv6 cef

!

spanning-tree mode pvst

!

interface Loopback0

ip address 192.168.1.2 255.255.255.0

!

interface GigabitEthernet0/0/0

ip address 10.0.1.2 255.255.255.0

duplex auto

speed auto

!

interface GigabitEthernet0/0/1

ip address 10.0.2.1 255.255.255.0

duplex auto

speed auto

!

interface Vlan1

no ip address

shutdown

!

router ospf 1

router-id 2.2.2.2

log-adjacency-changes

network 10.0.1.0 0.0.0.255 area 0

network 10.0.2.0 0.0.0.255 area 0

network 192.168.1.0 0.0.0.255 area 0

!

ip classless

!

ip flow-export version 9

!

line con 0

!

line aux 0

!

line vty 0 4

login

!

end

**show ip route**

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, E - EGP

i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area

\* - candidate default, U - per-user static route, o - ODR

P - periodic downloaded static route

Gateway of last resort is not set

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

C 10.0.1.0/24 is directly connected, GigabitEthernet0/0/0

L 10.0.1.2/32 is directly connected, GigabitEthernet0/0/0

C 10.0.2.0/24 is directly connected, GigabitEthernet0/0/1

L 10.0.2.1/32 is directly connected, GigabitEthernet0/0/1

O 10.0.3.0/24 [110/2] via 10.0.2.2, 00:18:12, GigabitEthernet0/0/1

O 10.0.4.0/24 [110/3] via 10.0.2.2, 00:18:12, GigabitEthernet0/0/1

O 10.0.5.0/24 [110/4] via 10.0.2.2, 00:18:12, GigabitEthernet0/0/1

O 10.0.6.0/24 [110/5] via 10.0.2.2, 00:18:12, GigabitEthernet0/0/1

192.168.1.0/24 is variably subnetted, 8 subnets, 2 masks

C 192.168.1.0/24 is directly connected, Loopback0

O 192.168.1.1/32 [110/2] via 10.0.1.1, 00:18:12, GigabitEthernet0/0/0

L 192.168.1.2/32 is directly connected, Loopback0

O 192.168.1.3/32 [110/2] via 10.0.2.2, 00:14:01, GigabitEthernet0/0/1

O 192.168.1.4/32 [110/3] via 10.0.2.2, 00:13:03, GigabitEthernet0/0/1

O 192.168.1.5/32 [110/4] via 10.0.2.2, 00:07:04, GigabitEthernet0/0/1

O 192.168.1.6/32 [110/5] via 10.0.2.2, 00:04:13, GigabitEthernet0/0/1

O 192.168.1.7/32 [110/6] via 10.0.2.2, 00:03:27, GigabitEthernet0/0/1

**show ip ospf neighbor**

R2#show ip ospf neighbor

Neighbor ID Pri State Dead Time Address Interface

3.3.3.3 1 FULL/DR 00:00:34 10.0.2.2 GigabitEthernet0/0/1

1.1.1.1 1 FULL/BDR 00:00:39 10.0.1.1 GigabitEthernet0/0/0

**Router 3**

**show run**

R3#show run

Building configuration...

Current configuration : 809 bytes

!

version 15.4

no service timestamps log datetime msec

no service timestamps debug datetime msec

no service password-encryption

!

hostname Router

!

ip cef

no ipv6 cef

!

spanning-tree mode pvst

!

interface Loopback0

ip address 192.168.1.3 255.255.255.0

!

interface GigabitEthernet0/0/0

ip address 10.0.2.2 255.255.255.0

duplex auto

speed auto

!

interface GigabitEthernet0/0/1

ip address 10.0.3.1 255.255.255.0

duplex auto

speed auto

!

interface Vlan1

no ip address

shutdown

!

router ospf 1

router-id 3.3.3.3

log-adjacency-changes

network 10.0.2.0 0.0.0.255 area 0

network 10.0.3.0 0.0.0.255 area 0

network 192.168.1.0 0.0.0.255 area 0

!

ip classless

!

ip flow-export version 9

!

line con 0

!

line aux 0

!

line vty 0 4

login

!

end

**show ip route**

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, E - EGP

i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area

\* - candidate default, U - per-user static route, o - ODR

P - periodic downloaded static route

Gateway of last resort is not set

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

O 10.0.1.0/24 [110/2] via 10.0.2.1, 00:19:10, GigabitEthernet0/0/0

C 10.0.2.0/24 is directly connected, GigabitEthernet0/0/0

L 10.0.2.2/32 is directly connected, GigabitEthernet0/0/0

C 10.0.3.0/24 is directly connected, GigabitEthernet0/0/1

L 10.0.3.1/32 is directly connected, GigabitEthernet0/0/1

O 10.0.4.0/24 [110/2] via 10.0.3.2, 00:19:10, GigabitEthernet0/0/1

O 10.0.5.0/24 [110/3] via 10.0.3.2, 00:19:10, GigabitEthernet0/0/1

O 10.0.6.0/24 [110/4] via 10.0.3.2, 00:19:10, GigabitEthernet0/0/1

192.168.1.0/24 is variably subnetted, 8 subnets, 2 masks

C 192.168.1.0/24 is directly connected, Loopback0

O 192.168.1.1/32 [110/3] via 10.0.2.1, 00:19:10, GigabitEthernet0/0/0

O 192.168.1.2/32 [110/2] via 10.0.2.1, 00:19:10, GigabitEthernet0/0/0

L 192.168.1.3/32 is directly connected, Loopback0

O 192.168.1.4/32 [110/2] via 10.0.3.2, 00:13:56, GigabitEthernet0/0/1

O 192.168.1.5/32 [110/3] via 10.0.3.2, 00:07:57, GigabitEthernet0/0/1

O 192.168.1.6/32 [110/4] via 10.0.3.2, 00:05:06, GigabitEthernet0/0/1

O 192.168.1.7/32 [110/5] via 10.0.3.2, 00:04:20, GigabitEthernet0/0/1

**show ip ospf neighbor**

R3#show ip ospf neighbor

Neighbor ID Pri State Dead Time Address Interface

2.2.2.2 1 FULL/BDR 00:00:30 10.0.2.1 GigabitEthernet0/0/0

4.4.4.4 1 FULL/DR 00:00:31 10.0.3.2 GigabitEthernet0/0/1

**Router 4**

**show run**

R4#show run

Building configuration...

Current configuration : 809 bytes

!

version 15.4

no service timestamps log datetime msec

no service timestamps debug datetime msec

no service password-encryption

!

hostname Router

!

ip cef

no ipv6 cef

!

spanning-tree mode pvst

!

interface Loopback0

ip address 192.168.1.4 255.255.255.0

!

interface GigabitEthernet0/0/0

ip address 10.0.4.1 255.255.255.0

duplex auto

speed auto

!

interface GigabitEthernet0/0/1

ip address 10.0.3.2 255.255.255.0

duplex auto

speed auto

!

interface Vlan1

no ip address

shutdown

!

router ospf 1

router-id 4.4.4.4

log-adjacency-changes

network 10.0.3.0 0.0.0.255 area 0

network 10.0.4.0 0.0.0.255 area 0

network 192.168.1.0 0.0.0.255 area 0

!

ip classless

!

ip flow-export version 9

!

line con 0

!

line aux 0

!

line vty 0 4

login

!

end

**show route**

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, E - EGP

i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area

\* - candidate default, U - per-user static route, o - ODR

P - periodic downloaded static route

Gateway of last resort is not set

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

O 10.0.1.0/24 [110/3] via 10.0.3.1, 00:20:17, GigabitEthernet0/0/1

O 10.0.2.0/24 [110/2] via 10.0.3.1, 00:20:17, GigabitEthernet0/0/1

C 10.0.3.0/24 is directly connected, GigabitEthernet0/0/1

L 10.0.3.2/32 is directly connected, GigabitEthernet0/0/1

C 10.0.4.0/24 is directly connected, GigabitEthernet0/0/0

L 10.0.4.1/32 is directly connected, GigabitEthernet0/0/0

O 10.0.5.0/24 [110/2] via 10.0.4.2, 00:20:17, GigabitEthernet0/0/0

O 10.0.6.0/24 [110/3] via 10.0.4.2, 00:20:07, GigabitEthernet0/0/0

192.168.1.0/24 is variably subnetted, 8 subnets, 2 masks

C 192.168.1.0/24 is directly connected, Loopback0

O 192.168.1.1/32 [110/4] via 10.0.3.1, 00:20:17, GigabitEthernet0/0/1

O 192.168.1.2/32 [110/3] via 10.0.3.1, 00:20:17, GigabitEthernet0/0/1

O 192.168.1.3/32 [110/2] via 10.0.3.1, 00:15:56, GigabitEthernet0/0/1

L 192.168.1.4/32 is directly connected, Loopback0

O 192.168.1.5/32 [110/2] via 10.0.4.2, 00:08:59, GigabitEthernet0/0/0

O 192.168.1.6/32 [110/3] via 10.0.4.2, 00:06:08, GigabitEthernet0/0/0

O 192.168.1.7/32 [110/4] via 10.0.4.2, 00:05:22, GigabitEthernet0/0/0

**show ip ospf neighbor**

R4#show ip ospf neighbor

Neighbor ID Pri State Dead Time Address Interface

5.5.5.5 1 FULL/DR 00:00:33 10.0.4.2 GigabitEthernet0/0/0

3.3.3.3 1 FULL/BDR 00:00:37 10.0.3.1 GigabitEthernet0/0/1

**Router 5**

**show run**

R5#show run

Building configuration...

Current configuration : 809 bytes

!

version 15.4

no service timestamps log datetime msec

no service timestamps debug datetime msec

no service password-encryption

!

hostname Router

!

ip cef

no ipv6 cef

!

spanning-tree mode pvst

!

interface Loopback0

ip address 192.168.1.5 255.255.255.0

!

interface GigabitEthernet0/0/0

ip address 10.0.4.2 255.255.255.0

duplex auto

speed auto

!

interface GigabitEthernet0/0/1

ip address 10.0.5.1 255.255.255.0

duplex auto

speed auto

!

interface Vlan1

no ip address

shutdown

!

router ospf 1

router-id 5.5.5.5

log-adjacency-changes

network 10.0.4.0 0.0.0.255 area 0

network 10.0.5.0 0.0.0.255 area 0

network 192.168.1.0 0.0.0.255 area 0

!

ip classless

!

ip flow-export version 9

!

line con 0

!

line aux 0

!

line vty 0 4

login

!

end

**show route**

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, E - EGP

i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area

\* - candidate default, U - per-user static route, o - ODR

P - periodic downloaded static route

Gateway of last resort is not set

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

O 10.0.1.0/24 [110/4] via 10.0.4.1, 00:23:33, GigabitEthernet0/0/0

O 10.0.2.0/24 [110/3] via 10.0.4.1, 00:23:33, GigabitEthernet0/0/0

O 10.0.3.0/24 [110/2] via 10.0.4.1, 00:23:33, GigabitEthernet0/0/0

C 10.0.4.0/24 is directly connected, GigabitEthernet0/0/0

L 10.0.4.2/32 is directly connected, GigabitEthernet0/0/0

C 10.0.5.0/24 is directly connected, GigabitEthernet0/0/1

L 10.0.5.1/32 is directly connected, GigabitEthernet0/0/1

O 10.0.6.0/24 [110/2] via 10.0.5.2, 00:23:33, GigabitEthernet0/0/1

192.168.1.0/24 is variably subnetted, 8 subnets, 2 masks

C 192.168.1.0/24 is directly connected, Loopback0

O 192.168.1.1/32 [110/5] via 10.0.4.1, 00:23:33, GigabitEthernet0/0/0

O 192.168.1.2/32 [110/4] via 10.0.4.1, 00:23:33, GigabitEthernet0/0/0

O 192.168.1.3/32 [110/3] via 10.0.4.1, 00:19:12, GigabitEthernet0/0/0

O 192.168.1.4/32 [110/2] via 10.0.4.1, 00:18:14, GigabitEthernet0/0/0

L 192.168.1.5/32 is directly connected, Loopback0

O 192.168.1.6/32 [110/2] via 10.0.5.2, 00:09:24, GigabitEthernet0/0/1

O 192.168.1.7/32 [110/3] via 10.0.5.2, 00:08:38, GigabitEthernet0/0/1

**show ip ospf neighbor**

R5#show ip ospf neighbor

Neighbor ID Pri State Dead Time Address Interface

6.6.6.6 1 FULL/DR 00:00:32 10.0.5.2 GigabitEthernet0/0/1

4.4.4.4 1 FULL/BDR 00:00:35 10.0.4.1 GigabitEthernet0/0/0

**Router 6**

**show run**

R6#show run

Building configuration...

Current configuration : 809 bytes

!

version 15.4

no service timestamps log datetime msec

no service timestamps debug datetime msec

no service password-encryption

!

hostname Router

!

ip cef

no ipv6 cef

!

spanning-tree mode pvst

!

interface Loopback0

ip address 192.168.1.6 255.255.255.0

!

interface GigabitEthernet0/0/0

ip address 10.0.6.1 255.255.255.0

duplex auto

speed auto

!

interface GigabitEthernet0/0/1

ip address 10.0.5.2 255.255.255.0

duplex auto

speed auto

!

interface Vlan1

no ip address

shutdown

!

router ospf 1

router-id 6.6.6.6

log-adjacency-changes

network 10.0.5.0 0.0.0.255 area 0

network 10.0.6.0 0.0.0.255 area 0

network 192.168.1.0 0.0.0.255 area 0

!

ip classless

!

ip flow-export version 9

!

line con 0

!

line aux 0

!

line vty 0 4

login

!

end

**show route**

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, E - EGP

i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area

\* - candidate default, U - per-user static route, o - ODR

P - periodic downloaded static route

Gateway of last resort is not set

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

O 10.0.1.0/24 [110/5] via 10.0.5.1, 00:24:19, GigabitEthernet0/0/1

O 10.0.2.0/24 [110/4] via 10.0.5.1, 00:24:19, GigabitEthernet0/0/1

O 10.0.3.0/24 [110/3] via 10.0.5.1, 00:24:29, GigabitEthernet0/0/1

O 10.0.4.0/24 [110/2] via 10.0.5.1, 00:24:29, GigabitEthernet0/0/1

C 10.0.5.0/24 is directly connected, GigabitEthernet0/0/1

L 10.0.5.2/32 is directly connected, GigabitEthernet0/0/1

C 10.0.6.0/24 is directly connected, GigabitEthernet0/0/0

L 10.0.6.1/32 is directly connected, GigabitEthernet0/0/0

192.168.1.0/24 is variably subnetted, 8 subnets, 2 masks

C 192.168.1.0/24 is directly connected, Loopback0

O 192.168.1.1/32 [110/6] via 10.0.5.1, 00:24:19, GigabitEthernet0/0/1

O 192.168.1.2/32 [110/5] via 10.0.5.1, 00:24:19, GigabitEthernet0/0/1

O 192.168.1.3/32 [110/4] via 10.0.5.1, 00:20:08, GigabitEthernet0/0/1

O 192.168.1.4/32 [110/3] via 10.0.5.1, 00:19:10, GigabitEthernet0/0/1

O 192.168.1.5/32 [110/2] via 10.0.5.1, 00:13:11, GigabitEthernet0/0/1

L 192.168.1.6/32 is directly connected, Loopback0

O 192.168.1.7/32 [110/2] via 10.0.6.2, 00:09:34, GigabitEthernet0/0/0

**show ip ospf neighbor**

R6#show ip ospf neighbor

Neighbor ID Pri State Dead Time Address Interface

7.7.7.7 1 FULL/DR 00:00:32 10.0.6.2 GigabitEthernet0/0/0

5.5.5.5 1 FULL/BDR 00:00:32 10.0.5.1 GigabitEthernet0/0/1

**Router 7**

**show run**

R7#show run

Building configuration...

Current configuration : 764 bytes

!

version 15.4

no service timestamps log datetime msec

no service timestamps debug datetime msec

no service password-encryption

!

hostname Router

!

ip cef

no ipv6 cef

!

!spanning-tree mode pvst

!

interface Loopback0

ip address 192.168.1.7 255.255.255.0

!

interface GigabitEthernet0/0/0

no ip address

duplex auto

speed auto

shutdown

!

interface GigabitEthernet0/0/1

ip address 10.0.6.2 255.255.255.0

duplex auto

speed auto

!

interface Vlan1

no ip address

shutdown

!

router ospf 1

router-id 7.7.7.7

log-adjacency-changes

network 10.0.6.0 0.0.0.255 area 0

network 192.168.1.0 0.0.0.255 area 0

!

ip classless

!

ip flow-export version 9

!

line con 0

!

line aux 0

!

line vty 0 4

login

!

end

**show route**

R7#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, E - EGP

i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area

\* - candidate default, U - per-user static route, o - ODR

P - periodic downloaded static route

Gateway of last resort is not set

10.0.0.0/8 is variably subnetted, 7 subnets, 2 masks

O 10.0.1.0/24 [110/6] via 10.0.6.1, 00:26:32, GigabitEthernet0/0/1

O 10.0.2.0/24 [110/5] via 10.0.6.1, 00:26:32, GigabitEthernet0/0/1

O 10.0.3.0/24 [110/4] via 10.0.6.1, 00:26:32, GigabitEthernet0/0/1

O 10.0.4.0/24 [110/3] via 10.0.6.1, 00:26:32, GigabitEthernet0/0/1

O 10.0.5.0/24 [110/2] via 10.0.6.1, 00:26:32, GigabitEthernet0/0/1

C 10.0.6.0/24 is directly connected, GigabitEthernet0/0/1

L 10.0.6.2/32 is directly connected, GigabitEthernet0/0/1

192.168.1.0/24 is variably subnetted, 8 subnets, 2 masks

C 192.168.1.0/24 is directly connected, Loopback0

O 192.168.1.1/32 [110/7] via 10.0.6.1, 00:26:32, GigabitEthernet0/0/1

O 192.168.1.2/32 [110/6] via 10.0.6.1, 00:26:32, GigabitEthernet0/0/1

O 192.168.1.3/32 [110/5] via 10.0.6.1, 00:22:16, GigabitEthernet0/0/1

O 192.168.1.4/32 [110/4] via 10.0.6.1, 00:21:18, GigabitEthernet0/0/1

O 192.168.1.5/32 [110/3] via 10.0.6.1, 00:15:19, GigabitEthernet0/0/1

O 192.168.1.6/32 [110/2] via 10.0.6.1, 00:12:28, GigabitEthernet0/0/1

L 192.168.1.7/32 is directly connected, Loopback0

**show ip ospf neighbor**

R7#show ip ospf neighbor

Neighbor ID Pri State Dead Time Address Interface

6.6.6.6 1 FULL/BDR 00:00:36 10.0.6.1 GigabitEthernet0/0/1

**Problems**

A problem I faced was that we didn’t have enough routers for our topology on one rack. To solve this problem, I had to put a fiber-optic cable going from the rack with most of my routers, to another rack with some other routers that I would be using. Another problem I faced was putting the copper-straight through cable in the wrong port. After configuring everything, I checked if OSPF was working properly by doing show ip route in my first router. When I looked at the output from the command, it only showed OSPF neighborship between routers 1-5. To figure out why the other two routers were not becoming neighbors with the other routers, I went into router 6 as that was the most likely cause of the problem since OSPF neighborship worked from routers 1-5. When I did a show run, I everything was configured correctly, so I then looked at the cables in my routers to make sure they were in the right place. After looking at the cables, I realized that the copper-straight through cable was plugged into GigabitEthernet0/0/0 instead of GigabitEthernet0/0/1. To fix this I plugged the copper-straight through into GigabitEthernet0/0/1, and after doing the show ip route command again, I had neighbor adjacency between all 7 routers.

**Conclusion**

OSPF is a routing protocol that allows routers to share the network information to find the best routing path, with the use of LSA’s. While going through the OSPF process, routers go through 7 steps to achieve neighborship/adjacency. To configure this, you need to use OSPF specific commands such as **router ospf** process-id, **network** ip-address wildcard-mask **area** area-id, and **router-id** router-id. There are also some OSPF specific show commands that are helpful when configuring OSPF. These include show **ip ospf int** and show **ip ospf neighbor.** I was able a configure a single-point OSPF area on 7 Cisco 4321 routers. Although having some problems achieving adjacency between routers, I was able to troubleshoot them, to get OSPF to work. Through this lab, I learned how to configure OSPF, as well as develop a deeper understanding of everything needed to make it work.

**Teacher Signoff Page of Lab Completed**

**Evan Choi has completed this OSPFv2 Lab**

**September 28, 2021**

