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Configuring OSPFv2

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*Author*:

Gabriel Rosas



Purpose

The purpose of this lab was to set up single area OSPFv2 across four Cisco catalyst 4321 routers. Since OSPF is a widely used *Interior Gateway Protocol* (IGP), knowledge of how OSPF functions, how to configure OSPF, even specifics such as pathfinding algorithms are impactful in the field of computer science. I tried to focus on building good habits, such as creating *IP schemes*, designing *topologies*, and debugging with *show* commands**,** which can be critical in troubleshooting and proofing.

Background Information

Routing

Routing is a significant process in networking as it allows hosts on different IP networks to connect to each other. *Open Shortest Path First* (OSPF) is a routing protocol simplifying the process of creating routes by using algorithms to figure out the directions automatically. OSPF excels in interior networks, which are smaller in scale, but would crash in large networks with hundreds of routes. In networking, routes are ultimately just *directions* for packets.

There are two options when dealing with traffic on a network; you can configure *static routes*, or you can set up a *routing protocol*. I like to think of static routes as absolute directions drawn onto a map, set in stone and unchangeable. The map can’t be altered unless it is manually redrawn. If you were to follow the map, you might find some of the routes to be outdated.

It would be nice if routes were adaptable, if they could update based on the fastest paths available. This is the difference between *static routing* and *routing protocols*. Routing protocols update their routing directions automatically based on information sent from neighbors. This is the magic of routing protocols: automatic updates and directions – like google maps – for packets. Routes are stored in a database on the router, known as a *routing table*.

Routing tables

Like a signpost at a fork in the road, routers contain directions for different destinations. These directions are stored in RAM memory on the router, which means that they are temporarily stored. RAM memory can be accessed much faster than hard drives or SSDs but is not saved after the device shuts down.

A packet arrives at a router. You can think of a router like an *intersection* or *crossroads*, interfaces representing a different path to take. This router has three interfaces: north, south, and east. The packet arrived on the east interface, so it either must turn north or south, assuming one of these paths lead to the destination. Luckily, there are directions in the router: *10.0.0.0/24* out interface *north*; *172.16.0.0/24* out interface *south*. The packet has a destination address of *10.0.0.3*, which matches up with the *north* interface. The router sends the packet out the north interface. Routes are either generated statically, by the admin, or automatically by routing protocols such as OSPF, BGP, etc.

Here is an example of a routing table:

|  |
| --- |
| Gateway of last resort is not set  10.0.0.0/8 is variably subnetted, 11 subnets, 2 masks  O IA 10.10.10.0/30 [110/128] via 10.10.10.5, 01:03:27, Serial0/1/1  C 10.10.10.4/30 is directly connected, Serial0/1/1  L 10.10.10.6/32 is directly connected, Serial0/1/1  C 10.10.10.8/30 is directly connected, Serial0/1/0  L 10.10.10.9/32 is directly connected, Serial0/1/0  O IA 10.10.10.12/30 [110/128] via 10.10.10.10, 01:03:27, Serial0/1/0  C 10.10.10.16/30 is directly connected, Serial0/2/0  L 10.10.10.17/32 is directly connected, Serial0/2/0  O IA 10.10.10.20/30 [110/128] via 10.10.10.18, 01:03:27, Serial0/2/0  O IA 10.10.10.24/30 [110/192] via 10.10.10.18, 01:03:27, Serial0/2/0  O E2 10.10.10.28/30 [110/100] via 10.10.10.18, 01:03:27, Serial0/2/0 |

Ignoring the letters on the left (the origin of the route), we can see a range of accessible addresses and the corresponding interface leading towards them. For example, *10.10.10.0/30* addresses direct out the *Serial0/1/1* interface. *Via \*ip\**, is also commonly seen as a direction, indicating that a packet should be sent to the specified neighboring router. Sometimes there is a combination of directions: both *interface* and *neighboring ips*.

Since we’ve defined what routing protocols are, I can go into more detail on how OSPF functions. Each router is like a junction for packets; packets usually have multiple roads they can turn down to reach further junctions, ultimately ending at their destination. Each router communicates with their neighboring routers to relay statuses and updates about themselves. If each router passes information about themselves and their neighbors to every other router, eventually all the routers will have complete knowledge of every direction to and from each other. In networking, having a table of directions to each destination is known as a routing table. All routers gain these directions by broadcasting their information to their neighbors. Via this process of broadcasting information, routers can get updates on what routes may or may not be viable to determine the best path from source to destination. These packets OSPF broadcasts to relay such information are known as **link-state advertisements** (LSAs). To see more on LSAs, check out *LSA Background Information*.

OSPF configured routers rely on **cost** to commute the shortest path through a network. While you can set the cost manually, OSPF will automatically determine the cost value per interface based on **reference bandwidth**, usually the bandwidth of the fastest interface in your network, and **interface bandwidth,** the bandwidth of the particular interface being assessed.

Lab Summary

In this lab, I set up seven IPv4 networks across four routers. Three of the seven IPv4 networks were the serial networks between the routers, and the other four were the end networks. For devices to be able to communicate they need IP addresses, which is why I began by constructing an IP scheme; my topology with IP addresses assigned to each device. Once all the IPv4 addresses were allocated correctly on my network, I configured OSPF to run on each router. Before OSPF was configured, the pings from the different end networks couldn’t reach each other but could reach their corresponding routers. After OSPF was set up, routes were created, and the pings could now extend outside of their routers.

Lab commands

|  |  |
| --- | --- |
| **CLI Command** | A statement necessary for a configuration to work, denoted in bold |
| **[*Argument*]** | An argument necessary for a command to function, denoted in bold italics. |
| *<Optional Argument>* | An optional argument, not necessary for a command to function, denoted in italics |

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

* Enables configuration on a specific interface.

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

* Enables the OSPF routing protocol and enters router configuration mode.

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

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

* Activates OSPFv2 for a specific network.

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

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

* Uniquely determines an OSPF router within a domain.

Router IDs are automatically determined if not manually set and can play a part in DR/BDR elections after OSPF priority.

Router# **show ipv6 ospf database**

* Displays the routing database.

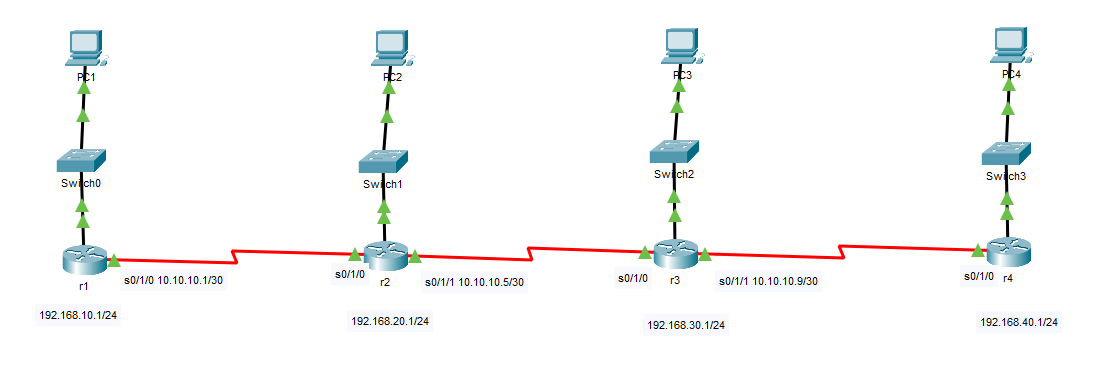
Router# **show ipv6 ospf neighbor**

* Displays information about adjacent routers configured with OSPF.

Router# **show ipv6 ospf interface**

* Displays information about each interface configured with OSPF.

Network Diagram



IP Scheme:

|  |  |
| --- | --- |
| **PC** | **IPv4 address** |
| 1 | 192.168.10.10/24 |
| 2 | 192.168.20.20/24 |
| 3 | 192.168.30.30/24 |
| 4 | 192.168.40.40/24 |

|  |  |  |  |
| --- | --- | --- | --- |
| **Router** | |  |  | | --- | --- | | **Interface** | **IPv4 address** | |
| 1 | |  |  | | --- | --- | | G0/0/0: | 192.168.10.1/24 | | S0/1/0: | 10.10.10.1/30 | |
| 2 | |  |  | | --- | --- | | G0/0/0: | 192.168.20.1/24 | | S0/1/0: | 10.10.10.2/30 | | S0/1/1: | 10.10.10.5/30 | |
| 3 | |  |  | | --- | --- | | G0/0/0: | 192.168.30.1/24 | | S0/1/0: | 10.10.10.6/30 | | S0/1/1: | 10.10.10.9/30 | |
| 4 | |  |  | | --- | --- | | G0/0/0: | 192.168.40.1/24 | | S0/1/0: | 10.10.10.10/30 | |

Configurations

Router 1

**r1#show running-config**

no service timestamps log datetime msec

no service timestamps debug datetime msec

no service password-encryption

hostname r1

no ip cef

ipv6 unicast-routing

no ipv6 cef

spanning-tree mode pvst

interface GigabitEthernet0/0/0

ip address 192.168.10.1 255.255.255.0

duplex auto

speed auto

ipv6 address FE80::1 link-local

ipv6 address A:1::A/64

ipv6 ospf 10 area 0

interface GigabitEthernet0/0/1

no ip address

duplex auto

speed auto

shutdown

interface Serial0/1/0

ip address 10.10.10.1 255.255.255.252

ipv6 address FE80::1 link-local

ipv6 address 1::1/64

ipv6 ospf 10 area 0

interface Serial0/1/1

no ip address

clock rate 2000000

shutdow

interface Vlan1

no ip address

shutdown

router ospf 10

router-id 1.1.1.1

log-adjacency-changes

network 192.168.10.0 0.0.0.255 area 0

network 10.10.10.0 0.0.0.3 area 0

ipv6 router ospf 10

log-adjacency-changes

ip classless

ip flow-export version 9

no cdp run

line con 0

line aux 0

line vty 0 4

login

end

**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, 4 subnets, 2 masks

C 10.10.10.0/30 is directly connected, Serial0/1/0

L 10.10.10.1/32 is directly connected, Serial0/1/0

O 10.10.10.4/30 [110/128] via 10.10.10.2, 00:11:10, Serial0/1/0

O 10.10.10.8/30 [110/192] via 10.10.10.2, 00:11:10, Serial0/1/0

192.168.10.0/24 is variably subnetted, 2 subnets, 2 masks

C 192.168.10.0/24 is directly connected, GigabitEthernet0/0/0

L 192.168.10.1/32 is directly connected, GigabitEthernet0/0/0

O 192.168.20.0/24 [110/65] via 10.10.10.2, 00:11:10, Serial0/1/0

O 192.168.30.0/24 [110/129] via 10.10.10.2, 00:11:10, Serial0/1/0

O 192.168.40.0/24 [110/193] via 10.10.10.2, 00:11:10, Serial0/1/0

**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

4.4.4.4 4.4.4.4 722 0x80000004 0x00c7e1 3

1.1.1.1 1.1.1.1 722 0x80000004 0x004fa5 3

2.2.2.2 2.2.2.2 722 0x80000006 0x008076 5

3.3.3.3 3.3.3.3 723 0x80000006 0x003696 5

**r1#show ip ospf interface**

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

Internet address is 192.168.10.1/24, Area 0

Process ID 10, 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, Interface address 192.168.10.1

No backup designated router on this network

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

Hello due in 00:00:06

Index 1/1, flood queue length 0

Next 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 0, Adjacent neighbor count is 0

Suppress hello for 0 neighbor(s)

Serial0/1/0 is up, line protocol is up

Internet address is 10.10.10.1/30, Area 0

Process ID 10, Router ID 1.1.1.1, Network Type POINT-TO-POINT, Cost: 64

Transmit Delay is 1 sec, State POINT-TO-POINT,

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

Hello due in 00:00:06

Index 2/2, flood queue length 0

Next 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 2.2.2.2

Suppress hello for 0 neighbor(s)

**r1# show ip ospf neighbor**

Neighbor ID Pri State Dead Time Address Interface

2.2.2.2 0 FULL/ - 00:00:35 10.10.10.2 Serial0/1/0

Router 2

**r2#show running-config**

no service timestamps log datetime msec

no service timestamps debug datetime msec

no service password-encryption

hostname r2

no ip cef

ipv6 unicast-routing

no ipv6 cef

spanning-tree mode pvst

interface GigabitEthernet0/0/0

ip address 192.168.20.1 255.255.255.0

duplex auto

speed auto

ipv6 address FE80::1 link-local

ipv6 address A:2::A/64

ipv6 ospf 10 area 0

interface GigabitEthernet0/0/1

no ip address

duplex auto

speed auto

shutdown

interface Serial0/1/0

ip address 10.10.10.2 255.255.255.252

ipv6 address FE80::2 link-local

ipv6 address 1::2/64

ipv6 ospf 10 area 0

clock rate 2000000

interface Serial0/1/1

ip address 10.10.10.5 255.255.255.252

ipv6 address FE80::1 link-local

ipv6 address 2::1/64

ipv6 ospf 10 area 0

interface Vlan1

no ip address

shutdown

router ospf 10

router-id 2.2.2.2

log-adjacency-changes

network 192.168.20.0 0.0.0.255 area 0

network 10.10.10.0 0.0.0.3 area 0

network 10.10.10.4 0.0.0.3 area 0

ipv6 router ospf 10

log-adjacency-changes

ip classless

ip flow-export version 9

no cdp run

line con 0

line aux 0

line vty 0 4

login

end

**r2#show ip route**

Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP

D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area

N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2

E1 - OSPF external type 1, E2 - OSPF external type 2, 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, 5 subnets, 2 masks

C 10.10.10.0/30 is directly connected, Serial0/1/0

L 10.10.10.2/32 is directly connected, Serial0/1/0

C 10.10.10.4/30 is directly connected, Serial0/1/1

L 10.10.10.5/32 is directly connected, Serial0/1/1

O 10.10.10.8/30 [110/128] via 10.10.10.6, 00:13:45, Serial0/1/1

O 192.168.10.0/24 [110/65] via 10.10.10.1, 00:13:45, Serial0/1/0

192.168.20.0/24 is variably subnetted, 2 subnets, 2 masks

C 192.168.20.0/24 is directly connected, GigabitEthernet0/0/0

L 192.168.20.1/32 is directly connected, GigabitEthernet0/0/0

O 192.168.30.0/24 [110/65] via 10.10.10.6, 00:13:45, Serial0/1/1

O 192.168.40.0/24 [110/129] via 10.10.10.6, 00:13:45, Serial0/1/1

**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

4.4.4.4 4.4.4.4 856 0x80000004 0x00c7e1 3

2.2.2.2 2.2.2.2 856 0x80000006 0x008076 5

1.1.1.1 1.1.1.1 856 0x80000004 0x004fa5 3

3.3.3.3 3.3.3.3 856 0x80000006 0x003696 5

**r2#show ip ospf interface**

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

Internet address is 192.168.20.1/24, Area 0

Process ID 10, Router ID 2.2.2.2, Network Type BROADCAST, Cost: 1

Transmit Delay is 1 sec, State DR, Priority 1

Designated Router (ID) 2.2.2.2, Interface address 192.168.20.1

No backup designated router on this network

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

Hello due in 00:00:03

Index 1/1, flood queue length 0

Next 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 0, Adjacent neighbor count is 0

Suppress hello for 0 neighbor(s)

Serial0/1/1 is up, line protocol is up

Internet address is 10.10.10.5/30, Area 0

Process ID 10, Router ID 2.2.2.2, Network Type POINT-TO-POINT, Cost: 64

Transmit Delay is 1 sec, State POINT-TO-POINT,

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

Hello due in 00:00:03

Index 2/2, flood queue length 0

Next 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 3.3.3.3

Suppress hello for 0 neighbor(s)

Serial0/1/0 is up, line protocol is up

Internet address is 10.10.10.2/30, Area 0

Process ID 10, Router ID 2.2.2.2, Network Type POINT-TO-POINT, Cost: 64

Transmit Delay is 1 sec, State POINT-TO-POINT,

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

Hello due in 00:00:00

Index 3/3, flood queue length 0

Next 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 1.1.1.1

Suppress hello for 0 neighbor(s)

**r2#show ip ospf neighbor**

Neighbor ID Pri State Dead Time Address Interface

1.1.1.1 0 FULL/ - 00:00:35 10.10.10.1 Serial0/1/0

3.3.3.3 0 FULL/ - 00:00:31 10.10.10.6 Serial0/1/1

Router 3

**r3#show running-config**

no service timestamps log datetime msec

no service timestamps debug datetime msec

no service password-encryption

hostname r3

no ip cef

ipv6 unicast-routing

no ipv6 cef

spanning-tree mode pvst

interface GigabitEthernet0/0/0

ip address 192.168.30.1 255.255.255.0

duplex auto

speed auto

ipv6 address FE80::1 link-local

ipv6 address A:3::A/64

ipv6 ospf 10 area 0

interface GigabitEthernet0/0/1

no ip address

duplex auto

speed auto

shutdown

interface Serial0/1/0

ip address 10.10.10.6 255.255.255.252

ipv6 address FE80::2 link-local

ipv6 address 2::2/64

ipv6 ospf 10 area 0

clock rate 2000000

interface Serial0/1/1

ip address 10.10.10.9 255.255.255.252

ipv6 address FE80::1 link-local

ipv6 address 3::1/64

ipv6 ospf 10 area 0

interface Vlan1

no ip address

shutdown

router ospf 10

router-id 3.3.3.3

log-adjacency-changes

network 192.168.30.0 0.0.0.255 area 0

network 10.10.10.4 0.0.0.3 area 0

network 10.10.10.8 0.0.0.3 area 0

ipv6 router ospf 10

log-adjacency-changes

ip classless

ip flow-export version 9

no cdp run

line con 0

line aux 0

line vty 0 4

login

end

**r3#show ip route**

Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP

D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area

N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2

E1 - OSPF external type 1, E2 - OSPF external type 2, 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, 5 subnets, 2 masks

O 10.10.10.0/30 [110/128] via 10.10.10.5, 00:15:13, Serial0/1/0

C 10.10.10.4/30 is directly connected, Serial0/1/0

L 10.10.10.6/32 is directly connected, Serial0/1/0

C 10.10.10.8/30 is directly connected, Serial0/1/1

L 10.10.10.9/32 is directly connected, Serial0/1/1

O 192.168.10.0/24 [110/129] via 10.10.10.5, 00:15:03, Serial0/1/0

O 192.168.20.0/24 [110/65] via 10.10.10.5, 00:15:13, Serial0/1/0

192.168.30.0/24 is variably subnetted, 2 subnets, 2 masks

C 192.168.30.0/24 is directly connected, GigabitEthernet0/0/0

L 192.168.30.1/32 is directly connected, GigabitEthernet0/0/0

O 192.168.40.0/24 [110/65] via 10.10.10.10, 00:15:13, Serial0/1/1

**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

4.4.4.4 4.4.4.4 935 0x80000004 0x00c7e1 3

3.3.3.3 3.3.3.3 935 0x80000006 0x003696 5

2.2.2.2 2.2.2.2 935 0x80000006 0x008076 5

1.1.1.1 1.1.1.1 935 0x80000004 0x004fa5 3

**r3#show ip ospf interface**

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

Internet address is 192.168.30.1/24, Area 0

Process ID 10, Router ID 3.3.3.3, Network Type BROADCAST, Cost: 1

Transmit Delay is 1 sec, State DR, Priority 1

Designated Router (ID) 3.3.3.3, Interface address 192.168.30.1

No backup designated router on this network

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

Hello due in 00:00:03

Index 1/1, flood queue length 0

Next 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 0, Adjacent neighbor count is 0

Suppress hello for 0 neighbor(s)

Serial0/1/1 is up, line protocol is up

Internet address is 10.10.10.9/30, Area 0

Process ID 10, Router ID 3.3.3.3, Network Type POINT-TO-POINT, Cost: 64

Transmit Delay is 1 sec, State POINT-TO-POINT,

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

Hello due in 00:00:03

Index 2/2, flood queue length 0

Next 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 4.4.4.4

Suppress hello for 0 neighbor(s)

Serial0/1/0 is up, line protocol is up

Internet address is 10.10.10.6/30, Area 0

Process ID 10, Router ID 3.3.3.3, Network Type POINT-TO-POINT, Cost: 64

Transmit Delay is 1 sec, State POINT-TO-POINT,

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

Hello due in 00:00:00

Index 3/3, flood queue length 0

Next 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 2.2.2.2

Suppress hello for 0 neighbor(s)

**r3#show ip ospf neighbor**

Neighbor ID Pri State Dead Time Address Interface

2.2.2.2 0 FULL/ - 00:00:34 10.10.10.5 Serial0/1/0

4.4.4.4 0 FULL/ - 00:00:30 10.10.10.10 Serial0/1/1

Router 4

**r4#show running-config**

no service timestamps log datetime msec

no service timestamps debug datetime msec

no service password-encryption

hostname r4

no ip cef

ipv6 unicast-routing

no ipv6 cef

spanning-tree mode pvst

interface GigabitEthernet0/0/0

ip address 192.168.40.1 255.255.255.0

duplex auto

speed auto

ipv6 address FE80::1 link-local

ipv6 address A:4::A/64

ipv6 ospf 10 area 0

interface GigabitEthernet0/0/1

no ip address

duplex auto

speed auto

shutdown

interface Serial0/1/0

ip address 10.10.10.10 255.255.255.252

ipv6 address FE80::2 link-local

ipv6 address 3::2/64

ipv6 ospf 10 area 0

clock rate 2000000

interface Serial0/1/1

no ip address

clock rate 2000000

shutdown

interface Vlan1

no ip address

shutdown

router ospf 10

router-id 4.4.4.4

log-adjacency-changes

network 192.168.40.0 0.0.0.255 area 0

network 10.10.10.8 0.0.0.3 area 0

ipv6 router ospf 10

log-adjacency-changes

ip classless

ip flow-export version 9

no cdp run

line con 0

line aux 0

line vty 0 4

login

end

**r4#show ip route**

Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP

D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area

N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2

E1 - OSPF external type 1, E2 - OSPF external type 2, 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, 4 subnets, 2 masks

O 10.10.10.0/30 [110/192] via 10.10.10.9, 00:16:28, Serial0/1/0

O 10.10.10.4/30 [110/128] via 10.10.10.9, 00:16:38, Serial0/1/0

C 10.10.10.8/30 is directly connected, Serial0/1/0

L 10.10.10.10/32 is directly connected, Serial0/1/0

O 192.168.10.0/24 [110/193] via 10.10.10.9, 00:16:28, Serial0/1/0

O 192.168.20.0/24 [110/129] via 10.10.10.9, 00:16:28, Serial0/1/0

O 192.168.30.0/24 [110/65] via 10.10.10.9, 00:16:38, Serial0/1/0

192.168.40.0/24 is variably subnetted, 2 subnets, 2 masks

C 192.168.40.0/24 is directly connected, GigabitEthernet0/0/0

L 192.168.40.1/32 is directly connected, GigabitEthernet0/0/0

**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

4.4.4.4 4.4.4.4 1019 0x80000004 0x00c7e1 3

3.3.3.3 3.3.3.3 1019 0x80000006 0x003696 5

1.1.1.1 1.1.1.1 1019 0x80000004 0x004fa5 3

2.2.2.2 2.2.2.2 1019 0x80000006 0x008076 5

**r4#show ip ospf interface**

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

Internet address is 192.168.40.1/24, Area 0

Process ID 10, Router ID 4.4.4.4, Network Type BROADCAST, Cost: 1

Transmit Delay is 1 sec, State DR, Priority 1

Designated Router (ID) 4.4.4.4, Interface address 192.168.40.1

No backup designated router on this network

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

Hello due in 00:00:08

Index 1/1, flood queue length 0

Next 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 0, Adjacent neighbor count is 0

Suppress hello for 0 neighbor(s)

Serial0/1/0 is up, line protocol is up

Internet address is 10.10.10.10/30, Area 0

Process ID 10, Router ID 4.4.4.4, Network Type POINT-TO-POINT, Cost: 64

Transmit Delay is 1 sec, State POINT-TO-POINT,

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

Hello due in 00:00:04

Index 2/2, flood queue length 0

Next 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 3.3.3.3

Suppress hello for 0 neighbor(s)

**r4#show ip ospf neighbor**

Neighbor ID Pri State Dead Time Address Interface

3.3.3.3 0 FULL/ - 00:00:30 10.10.10.9 Serial0/1/0

Ping Statistics – Testing Connectivity

**PC 1**

Packet Tracer PC Command Line 1.0

C:\>ping 192.168.10.10

Pinging 192.168.10.10 with 32 bytes of data:

Reply from 192.168.10.10: bytes=32 time=7ms TTL=128

Reply from 192.168.10.10: bytes=32 time=3ms TTL=128

Reply from 192.168.10.10: bytes=32 time=4ms TTL=128

Reply from 192.168.10.10: bytes=32 time=9ms TTL=128

Ping statistics for 192.168.10.10:

Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),

Approximate round trip times in milli-seconds:

Minimum = 3ms, Maximum = 9ms, Average = 5ms

C:\>ping 192.168.20.20

Pinging 192.168.20.20 with 32 bytes of data:

Request timed out.

Reply from 192.168.20.20: bytes=32 time=3ms TTL=126

Reply from 192.168.20.20: bytes=32 time=4ms TTL=126

Reply from 192.168.20.20: bytes=32 time=3ms TTL=126

Ping statistics for 192.168.20.20:

Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),

Approximate round trip times in milli-seconds:

Minimum = 3ms, Maximum = 4ms, Average = 3ms

C:\>ping 192.168.30.30

Pinging 192.168.30.30 with 32 bytes of data:

Request timed out.

Reply from 192.168.30.30: bytes=32 time=10ms TTL=125

Reply from 192.168.30.30: bytes=32 time=2ms TTL=125

Reply from 192.168.30.30: bytes=32 time=4ms TTL=125

Ping statistics for 192.168.30.30:

Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),

Approximate round trip times in milli-seconds:

Minimum = 2ms, Maximum = 10ms, Average = 5ms

C:\>ping 192.168.40.40

Pinging 192.168.40.40 with 32 bytes of data:

Request timed out.

Reply from 192.168.40.40: bytes=32 time=18ms TTL=124

Reply from 192.168.40.40: bytes=32 time=8ms TTL=124

Reply from 192.168.40.40: bytes=32 time=3ms TTL=124

Ping statistics for 192.168.40.40:

Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),

Approximate round trip times in milli-seconds:

Minimum = 3ms, Maximum = 18ms, Average = 9ms

PC 2

Packet Tracer PC Command Line 1.0

C:\>ping 192.168.10.10

Pinging 192.168.10.10 with 32 bytes of data:

Reply from 192.168.10.10: bytes=32 time=1ms TTL=126

Reply from 192.168.10.10: bytes=32 time=1ms TTL=126

Reply from 192.168.10.10: bytes=32 time=1ms TTL=126

Reply from 192.168.10.10: bytes=32 time=3ms TTL=126

Ping statistics for 192.168.10.10:

Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),

Approximate round trip times in milli-seconds:

Minimum = 1ms, Maximum = 3ms, Average = 1ms

C:\>ping 192.168.20.20

Pinging 192.168.20.20 with 32 bytes of data:

Reply from 192.168.20.20: bytes=32 time=4ms TTL=128

Reply from 192.168.20.20: bytes=32 time=3ms TTL=128

Reply from 192.168.20.20: bytes=32 time=3ms TTL=128

Reply from 192.168.20.20: bytes=32 time<1ms TTL=128

Ping statistics for 192.168.20.20:

Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),

Approximate round trip times in milli-seconds:

Minimum = 0ms, Maximum = 4ms, Average = 2ms

C:\>ping 192.168.30.30

Pinging 192.168.30.30 with 32 bytes of data:

Reply from 192.168.30.30: bytes=32 time=1ms TTL=126

Reply from 192.168.30.30: bytes=32 time=3ms TTL=126

Reply from 192.168.30.30: bytes=32 time=1ms TTL=126

Reply from 192.168.30.30: bytes=32 time=4ms TTL=126

Ping statistics for 192.168.30.30:

Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),

Approximate round trip times in milli-seconds:

Minimum = 1ms, Maximum = 4ms, Average = 2ms

C:\>ping 192.168.40.40

Pinging 192.168.40.40 with 32 bytes of data:

Reply from 192.168.40.40: bytes=32 time=14ms TTL=125

Reply from 192.168.40.40: bytes=32 time=2ms TTL=125

Reply from 192.168.40.40: bytes=32 time=7ms TTL=125

Reply from 192.168.40.40: bytes=32 time=7ms TTL=125

Ping statistics for 192.168.40.40:

Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),

Approximate round trip times in milli-seconds:

Minimum = 2ms, Maximum = 14ms, Average = 7ms

**PC 3**

Packet Tracer PC Command Line 1.0

C:\>ping 192.168.10.10

Pinging 192.168.10.10 with 32 bytes of data:

Reply from 192.168.10.10: bytes=32 time=8ms TTL=125

Reply from 192.168.10.10: bytes=32 time=11ms TTL=125

Reply from 192.168.10.10: bytes=32 time=2ms TTL=125

Reply from 192.168.10.10: bytes=32 time=2ms TTL=125

Ping statistics for 192.168.10.10:

Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),

Approximate round trip times in milli-seconds:

Minimum = 2ms, Maximum = 11ms, Average = 5ms

C:\>ping 192.168.20.20

Pinging 192.168.20.20 with 32 bytes of data:

Reply from 192.168.20.20: bytes=32 time=2ms TTL=126

Reply from 192.168.20.20: bytes=32 time=5ms TTL=126

Reply from 192.168.20.20: bytes=32 time=3ms TTL=126

Reply from 192.168.20.20: bytes=32 time=7ms TTL=126

Ping statistics for 192.168.20.20:

Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),

Approximate round trip times in milli-seconds:

Minimum = 2ms, Maximum = 7ms, Average = 4ms

C:\>ping 192.168.30.30

Pinging 192.168.30.30 with 32 bytes of data:

Reply from 192.168.30.30: bytes=32 time=5ms TTL=128

Reply from 192.168.30.30: bytes=32 time=2ms TTL=128

Reply from 192.168.30.30: bytes=32 time<1ms TTL=128

Reply from 192.168.30.30: bytes=32 time=5ms TTL=128

Ping statistics for 192.168.30.30:

Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),

Approximate round trip times in milli-seconds:

Minimum = 0ms, Maximum = 5ms, Average = 3ms

C:\>ping 192.168.40.40

Pinging 192.168.40.40 with 32 bytes of data:

Reply from 192.168.40.40: bytes=32 time=14ms TTL=126

Reply from 192.168.40.40: bytes=32 time=3ms TTL=126

Reply from 192.168.40.40: bytes=32 time=2ms TTL=126

Reply from 192.168.40.40: bytes=32 time=3ms TTL=126

Ping statistics for 192.168.40.40:

Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),

Approximate round trip times in milli-seconds:

Minimum = 2ms, Maximum = 14ms, Average = 5ms

**PC 4**

Packet Tracer PC Command Line 1.0

C:\>ping 192.168.10.10

Pinging 192.168.10.10 with 32 bytes of data:

Reply from 192.168.10.10: bytes=32 time=4ms TTL=124

Reply from 192.168.10.10: bytes=32 time=15ms TTL=124

Reply from 192.168.10.10: bytes=32 time=13ms TTL=124

Reply from 192.168.10.10: bytes=32 time=10ms TTL=124

Ping statistics for 192.168.10.10:

Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),

Approximate round trip times in milli-seconds:

Minimum = 4ms, Maximum = 15ms, Average = 10ms

C:\>ping 192.168.20.20

Pinging 192.168.20.20 with 32 bytes of data:

Reply from 192.168.20.20: bytes=32 time=6ms TTL=125

Reply from 192.168.20.20: bytes=32 time=5ms TTL=125

Reply from 192.168.20.20: bytes=32 time=7ms TTL=125

Reply from 192.168.20.20: bytes=32 time=6ms TTL=125

Ping statistics for 192.168.20.20:

Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),

Approximate round trip times in milli-seconds:

Minimum = 5ms, Maximum = 7ms, Average = 6ms

C:\>ping 192.168.30.30

Pinging 192.168.30.30 with 32 bytes of data:

Reply from 192.168.30.30: bytes=32 time=1ms TTL=126

Reply from 192.168.30.30: bytes=32 time=9ms TTL=126

Reply from 192.168.30.30: bytes=32 time=3ms TTL=126

Reply from 192.168.30.30: bytes=32 time=12ms TTL=126

Ping statistics for 192.168.30.30:

Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),

Approximate round trip times in milli-seconds:

Minimum = 1ms, Maximum = 12ms, Average = 6ms

C:\>ping 192.168.40.40

Pinging 192.168.40.40 with 32 bytes of data:

Reply from 192.168.40.40: bytes=32 time=5ms TTL=128

Reply from 192.168.40.40: bytes=32 time=1ms TTL=128

Reply from 192.168.40.40: bytes=32 time=3ms TTL=128

Reply from 192.168.40.40: bytes=32 time=1ms TTL=128

Ping statistics for 192.168.40.40:

Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),

Approximate round trip times in milli-seconds:

Minimum = 1ms, Maximum = 5ms, Average = 2ms

Problems

The first obstacle I overcame was creating my own IP scheme. Previously I hadn’t created any IP schemes, so I didn’t know where to start. I decided to use word and map a table of devices to IPs. This helped significantly later in the lab as I could tell what device was assigned to what IP and could refer and forth easily. The IP scheme can be found under the network diagram portion of this lab.

Then came setting up OSPFv2. After a couple of months without practicing CISCO labs or theory, I found myself forgetting lots commands I had learnt my previous year. After a bit of researching, I came across the **network <network address> <wildcard mask> area <#>** command. These network statements are a key part of configuring OSPF as they determine which interfaces of the router will be running OSPF. Once the network statements were complete on each router, I was able to ping any PC on the network.

Personally, I think documenting and creating IP schemes will be an important takeaway of this lab for me, so I don’t make mistakes early on that will be detrimental shortly after.

Conclusion

In this lab, I set up OSPFv2 in CISCO packet tracer. Though it was just a simulation, I think I could take this knowledge and configure OSPFv2 on a physical catalyst 4321 router. Configuring OSPF went quite smoothly for me, which can probably be credited to extensive documentation. Overall, this was a nice refresher back into the world of networking, and I will be documenting all my IP schemes from now on.