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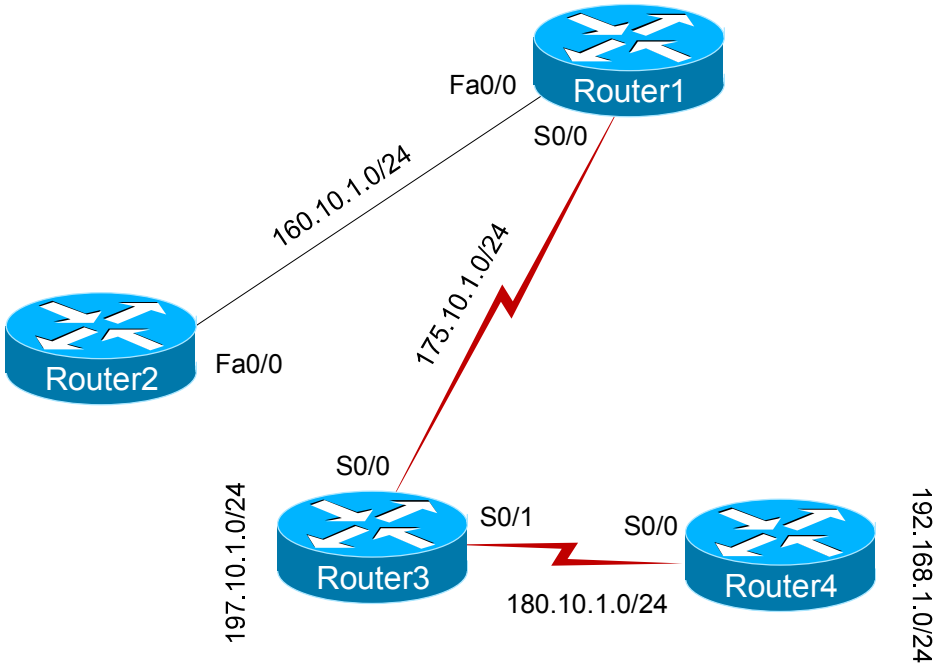
Sequential Lab: OSPF 2

Objective

Learn the commands needed to configure the Open Shortest Path First (OSPF) routing protocol.

Lab Topology

The topology diagram below represents the portion of the network you will configure in this lab.



Command Summary

Command	Description
configure terminal	enters global configuration mode from privileged EXEC mode
debug ip ospf [[**adjacency**] [**database-timer**] [**events**] [**flooding**] [**hello**]]	displays information on OSPF-related events, such as adjacencies, flooding information, designated router selection, and shortest path first (SPF) calculation
enable	enters privileged EXEC mode
end	ends and exits configuration mode
exit	exits one level in the menu structure
interface *type number*	changes from global configuration mode to interface configuration mode
ip ospf authentication {**message-digest** | **null**}	specifies the authentication type for an interface
ip ospf authentication-key *password*	assigns a password to be used by neighboring routers that are using OSPF Message Digest 5 (MD5) authentication

Command	Description
network *network-address wildcard-mask* **area** *area-id*	activates OSPF on the specified network and places the matching interface in the specified area
ping *ip-address*	sends an Internet Control Message Protocol (ICMP) echo request to the specified address
router ospf *process-id*	enters router configuration mode for an OSPF process
show ip interface brief	displays a brief summary of interface status and configuration
show ip ospf *process-id*	displays OSPF process information
show ip ospf interface	displays OSPF interface information
show ip ospf neighbor	displays OSPF neighbor information
show ip protocols	displays information about active routing protocols
show ip route	displays the IP routing table
show running-config	displays the active configuration file
undebug all	turns off diagnostic output

Lab Tasks

Passwords in this lab have been configured as **cisco**.

Task 1: Enable OSPF, and Test Connectivity

1. On Router1, Router2, Router3, and Router4, configure OSPF. Use process ID **1**, and configure OSPF to send and receive updates on all interfaces except Frame Relay interfaces.

2. Display the dynamic routing protocols that are running on Router4. How frequently does OSPF send routing updates? _____

3. On Router1, display Router1's OSPF neighbors.

4. On Router1, display the interfaces running OSPF. What is the OSPF cost for a 100-megabits per second (Mbps) FastEthernet interface? _____

5. Display the IP routing table on Router1. What is the administrative distance for OSPF? _____

6. From Router4, ping Router1 (175.10.1.1) and Router2 (160.10.1.2). These pings should succeed if OSPF is correctly configured on all routers.

Task 2: Enable OSPF Authentication

In this task, you will enable OSPF plain-text authentication between Router3 and Router4.

1. On Router3's Serial 0/1 interface, enable OSPF authentication using **boson** as a password.

2. On Router4's Serial 0/0 interface, enable OSPF authentication using **boson** as a password.

3. On Router4, display the IP routing table; verify that no changes have occurred in the routing table due to configuring plain-text authentication between Router3 and Router4.

4. From Router4, ping Router3's Serial 0/1 interface (180.10.1.1). The ping should be successful.

5. From Router4, ping Router1's Loopback 0 interface (160.10.2.1). Is the ping successful? Why or why not? _____

6. On the appropriate device, configure a **network** statement so that a route to the 160.10.2.0 network is listed in the routing table of Router4.

7. When advertising the route in this scenario, how can you calculate the OSPF wildcard mask? ____
   _____

8. Verify that Router4 has a route to Router1's Loopback 0 interface (160.10.2.1).

9. From Router4, ping Router1's Loopback 0 interface (160.10.2.1). The ping should be successful.

Task 3: Examine OSPF Debugging Output

In this task, you will be introduced to common OSPF troubleshooting commands.

1. On Router2, display OSPF process information. What is Router2's router ID, and why was it selected? _____
   _____

2. On Router1, display OSPF neighbor information. What is the state of the neighbor relationship between Router1 and Router2? _____

3. What is the state of the neighbor relationship between Router1 and Router3? _____

4. On Router1, display information about OSPF-related events; observe the output for a few seconds. What information can you obtain from the output displayed by this command? _____
   _____

5. On Router1, turn off debugging.

Lab Solutions

Passwords in this lab have been configured as **cisco**.

Task 1: Enable OSPF, and Test Connectivity

1. On Router1, Router2, Router3, and Router4, issue the following commands to correctly configure OSPF:

```
Router1(config)#router ospf 1
Router1(config-router)#network 160.10.1.0 0.0.0.255 area 0
Router1(config-router)#network 175.10.1.0 0.0.0.255 area 0

Router2(config)#router ospf 1
Router2(config-router)#network 160.10.1.0 0.0.0.255 area 0

Router3(config)#router ospf 1
Router3(config-router)#network 175.10.1.0 0.0.0.255 area 0
Router3(config-router)#network 180.10.1.0 0.0.0.255 area 0
Router3(config-router)#network 197.10.1.0 0.0.0.255 area 0

Router4(config)#router ospf 1
Router4(config-router)#network 180.10.1.0 0.0.0.255 area 0
Router4(config-router)#network 192.168.1.0 0.0.0.255 area 0
```

2. OSPF is a link-state routing protocol and does not send out periodic routing updates. OSPF floods link-state advertisements (LSAs) when a topology change occurs. You should issue the following command to display the dynamic routing protocols that are running on Router4; sample output is shown below:

```
Router4#show ip protocols
Routing Protocol is "ospf 1"
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Router ID 192.168.1.1
  Number of areas in this router is 1. 1 normal 0 stub 0 nssa
  Maximum path: 4
  Routing for Networks:
    180.10.1.0 0.0.0.255 area 0
    192.168.1.0 0.0.0.255 area 0
  Routing Information Sources:
    Gateway         Distance      Last Update
    160.10.2.1           110
    192.168.1.1          110
  Distance: (default is 110)
```

3. On Router1, issue the following command to display Router1's OSPF neighbors. Sample output is below:

```
Router1#show ip ospf neighbor
Neighbor ID   Pri   State       Dead Time   Address        Interface
160.10.1.2      1   FULL/BDR    00:00:37    160.10.1.2     FastEthernet0/0
197.10.1.1      0   FULL/  -    00:00:38    175.10.1.2     Serial0/0
```

4. On Router1, issue the following command to display the interfaces running OSPF. The default cost for a 100-Mbps FastEthernet interface is 10, which is calculated by dividing 100,000,000 by the speed of the interface. Sample output is shown below:

```
Router1#show ip ospf interface
FastEthernet0/0 is up, line protocol is up
  Internet Address 160.10.1.1/24, Area 0
  Process ID 1, Router ID 160.10.2.1, Network Type BROADCAST, Cost: 1
  Transmit Delay is 1 sec, State DR, Priority 1
  Designated Router (ID) 160.10.2.1, Interface address 160.10.1.1
  Backup Designated router (ID) 160.10.1.2, Interface address 160.10.1.2
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:00
  Supports Link-local Signaling (LLS)
  Index 1/1, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 0, maximum is 0
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 160.10.1.2  (Backup Designated Router)
  Suppress hello for 0 neighbor(s)
<output omitted>
```

Note: The default cost can be overridden using the **ip ospf cost** *interface-cost* command. The **ip ospf cost** *interface-cost* command is not supported by NetSim.

5. The administrative distance for OSPF is 110. You can view the administrative distance by issuing the following command on Router1; sample output is shown below:

```
Router1#show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B – BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       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, * - candidate default
       U - per-user static route

Gateway of last resort is not set

     160.10.0.0/16 is variably subnetted, 2 subnets
C       160.10.2.1/32 is directly connected, Loopback0
C       160.10.1.0/24 is directly connected, FastEthernet0/0
     175.10.0.0/24 is subnetted, 1 subnets
C       175.10.1.0 is directly connected, Serial0/0
     180.10.0.0/24 is subnetted, 1 subnets
O       180.10.1.0 [110/1626] via 175.10.1.2, 00:04:21, Serial0/0
O    197.10.1.0 [110/1563] via 175.10.1.2, 00:04:16, Serial0/0
O    192.168.1.0 [110/1627] via 175.10.1.2, 00:04:36, Serial0/0
```

6. Pings from Router4 to Router1 (175.10.1.1) and Router2 (160.10.1.2) should succeed if OSPF is correctly configured on all routers.

Task 2: Enable OSPF Authentication

1. On Router3, issue the following commands to enable OSPF authentication:

```
Router3(config)#interface serial 0/1
Router3(config-if)#ip ospf authentication
Router3(config-if)#ip ospf authentication-key boson
```

2. On Router4, issue the following commands to enable OSPF authentication:

```
Router4(config)#interface serial 0/0
Router4(config-if)#ip ospf authentication
Router4(config-if)#ip ospf authentication-key boson
```

3. On Router4, issue the following command and verify that no changes have occurred in the routing table due to configuring plain-text authentication between Router3 and Router4. Sample output is shown below:

```
Router4#show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B – BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       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, * - candidate default
       U - per-user static route

Gateway of last resort is not set

     180.10.0.0/24 is subnetted, 1 subnets
C       180.10.1.0 is directly connected, Serial0/0
C    192.168.1.0 is directly connected, FastEthernet0/1
     160.10.0.0/24 is subnetted, 1 subnets
O       160.10.1.0 [110/129] via 180.10.1.1, 00:00:10, Serial0/0
     175.10.0.0/24 is subnetted, 1 subnets
O       175.10.1.0 [110/128] via 180.10.1.1, 00:00:10, Serial0/0
O    197.10.1.0 [110/65] via 180.10.1.1, 00:00:10, Serial0/0
```

4. A ping from Router4 to Router3's Serial 0/1 interface (180.10.1.1) should be successful.

5. A ping from Router4 to Router1's Loopback 0 interface (160.10.2.1) is unsuccessful because Router4 does not have a route to the 160.10.2.0 network.

6. On Router1, issue the following commands to advertise the 160.10.2.0 network:

```
Router1(config)#router ospf 1
Router1(config-router)#network 160.10.2.0 0.0.0.255 area 0
```

7. A simple way to calculate the OSPF wildcard bits used to advertise the network is to subtract each byte in the subnet mask used on the Loopback 0 interface on Router1 (255.255.255.0) from each byte in 255.255.255.255. Performing the subtraction leaves 0.0.0.255 as the result. You should use area **0** as the OSPF area ID because all other interfaces are in the same area.

8. You can verify that Router4 has a route to the 160.10.2.0 network on Router1 by issuing the following command. You should see a route to Router1's loopback interface (160.10.2.1) in Router4's routing table, as shown in the following sample output.

```
Router4#show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B – BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       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, * - candidate default
       U - per-user static route

Gateway of last resort is not set

     180.10.0.0/24 is subnetted, 1 subnets
C       180.10.1.0 is directly connected, Serial0/0
C    192.168.1.0 is directly connected, FastEthernet0/1
     160.10.0.0/16 is variably subnetted, 2 subnets
O       160.10.1.0/24 [110/129] via 180.10.1.1, 00:11:54, Serial0/0
O       160.10.2.1/32 [110/129] via 180.10.1.1, 00:01:10, Serial0/0
O    197.10.1.0 [110/65] via 180.10.1.1, 00:11:54, Serial0/0
     175.10.0.0/24 is subnetted, 1 subnets
O       175.10.1.0 [110/128] via 180.10.1.1, 00:11:54, Serial0/0
```

9. A ping from Router4 to Router1's Loopback 0 interface (160.10.2.1) should be successful.

Task 3: Examine OSPF Debugging Output

1. By issuing the following command on Router2, you can determine that Router2's router ID is 160.10.1.2. The OSPF protocol selects a router ID from among the IP addresses configured on active interfaces unless a router ID is manually configured. The router ID that is chosen from the IP addresses of a router's active interfaces is the highest IP address first from any loopback interfaces, and if no loopback interfaces are configured, then the highest IP address from its physical interfaces. Router2's router ID was chosen because it was not manually configured with a router ID; was not configured with any loopback interfaces; and has the IP address of 160.10.1.2 on the only active interface. Sample output is shown below:

```
Router2#show ip ospf
Routing Process "ospf 1" with ID 160.10.1.2
Supports only single TOS(TOS0) routes
Supports opaque LSA
Supports Link-local Signaling (LLS)
<output omitted>
```

2. The output from the following command issued on Router1 shows that the state of the neighbor relationship between Router1 and Router2 is FULL/BDR. FULL indicates that a neighbor relationship has formed and that Router1 is exchanging OSPF packets with Router2. BDR indicates that Router2 is the backup router. Router1 is the designated router because it has a higher router ID than does Router2. Router1's router ID is 160.10.2.1 because its router ID was chosen from the IP address assigned to its loopback 0 interface, which is higher than the IP address assigned to Router2. If you issue the **show ip interface brief** command on Router1, you can see that the IP address assigned to the loopback interface is not the highest IP address assigned to interfaces on Router1. Sample output is shown below:

```
Router1#show ip ospf neighbor
Neighbor ID     Pri   State           Dead Time   Address       Interface
160.10.1.2        1   FULL/BDR        00:00:31    160.10.1.2    FastEthernet0/0
197.10.1.1        0   FULL/  -        00:00:31    175.10.1.2    Serial0/0
```

3. The state of the neighbor relationship between Router1 and Router3 is FULL. The – indicates that this is a point-to-point link, not a broadcast link like that between Router1 and Router2. Routers connected via a point-to-point link do not elect a designated or backup router.

```
197.10.1.1        0   FULL/  -        00:00:31    175.10.1.2    Serial0/0
```

4. By issuing the following command on Router1, you can see that Router1 is sending and receiving hello messages with its neighbors. Sample output is shown below:

```
Router1#debug ip ospf events
OSPF events debugging is on
*Jan 19 14:41:48.194: OSPF: Rcv hello from 160.10.1.2 area 0 from
FastEthernet0/0 160.10.1.2
*Jan 19 14:41:48.231: OSPF: End of hello processing
*Jan 19 14:41:49.140: OSPF: Rcv hello from 197.10.1.1 area 0 from Serial0/0
175.10.1.2
*Jan 19 14:41:49.175: OSPF: End of hello processing
*Jan 19 14:41:52.103: OSPF: Send hello to 224.0.0.5 area 0 on Serial0/0 from
175.10.1.1
*Jan 19 14:41:56.106: OSPF: Send hello to 224.0.0.5 area 0 on FastEthernet0/0
from 160.10.1.1
*Jan 19 14:41:58.218: OSPF: Rcv hello from 160.10.1.2 area 0 from
FastEthernet0/0 160.10.1.2
*Jan 19 14:41:58.253: OSPF: End of hello processing
*Jan 19 14:41:59.156: OSPF: Rcv hello from 197.10.1.1 area 0 from Serial0/0
175.10.1.2
*Jan 19 14:41:59.192: OSPF: End of hello processing
```

5. Issue the following command to turn off all debugging:

```
Router1#undebug all
All possible debugging has been turned off
```

Sample Configuration Script

Router1

```
Router1#show running-config
Building configuration...
Current configuration : 1184 bytes
!
Version 12.3
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname Router1
enable secret 5 $sdf$6978yhg$jnb76sd
enable password boson
!
ip subnet-zero
!
ip cef
no ip domain-lookup
ip host Router2 160.10.1.2
!
interface Loopback0
 ip address 160.10.2.1 255.255.255.0
 no ip directed broadcast
!
interface Serial0/0
 description Serial Link to Router3
 ip address 175.10.1.1 255.255.255.0
 no ip directed-broadcast
 clock rate 64000
 bandwidth 64
!
interface Serial0/1
 no ip address
 no ip directed-broadcast
 shutdown
!
```

Router1 (continued)

```
interface FastEthernet0/0
 ip address 160.10.1.1 255.255.255.0
 no ip directed-broadcast
 ip ospf cost 1
!
interface FastEthernet0/1
 no ip address
 no ip directed-broadcast
 shutdown
!
router ospf 1
 network 160.10.1.0 0.0.0.255 area 0
 network 160.10.2.0 0.0.0.255 area 0
 network 175.10.1.0 0.0.0.255 area 0
!
ip classless
no ip http server
!
cdp holdtime 20
cdp timer 50
!
banner motd ^C
Unauthorized Access Prohibited^C
line con 0
 login
 password cisco
line aux 0
line vty 0 4
!
no scheduler allocate
end
```

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