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NETWORK SIMULATOR®

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NetSim® NETWORK SIMULATOR®

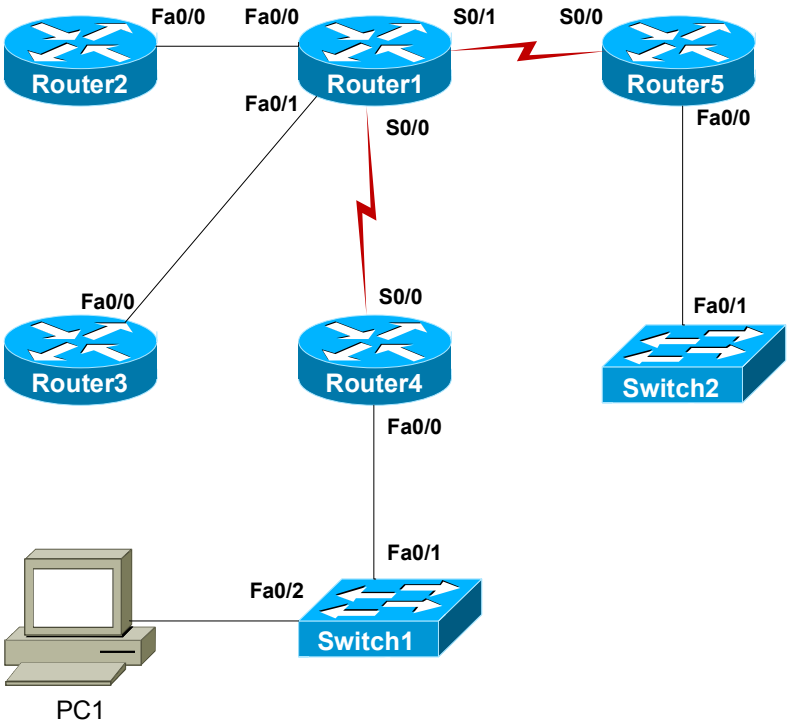
Stand-Alone Lab: OSPF 1

Objective

Learn to configure the Open Shortest Path First (OSPF) routing protocol. Configure the appropriate settings on Router1, Router2, and Router4.

Lab Topology

The topology diagram below represents the NetMap in the Simulator.



Command Summary

Command	Description
clock rate *clock-rate*	sets the clock rate for a Data Communications Equipment (DCE) interface
configure terminal	enters global configuration mode from privileged EXEC mode
enable	enters privileged EXEC mode
end	ends and exits configuration mode
hostname *host-name*	sets the device name
interface *type number*	changes from global configuration mode to interface configuration mode
ip address *ip-address subnet-mask*	assigns an IP address to an interface
network *address wildcard-mask* **area** *area-id*	defines which interfaces run OSPF and which areas they operate in

Command	Description
no shutdown	enables an interface
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 ospf database	displays the OSPF link state database
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

The IP addresses and subnet masks used in this lab are shown in the table below:

IP Addresses

Device	Interface	IP Address	Subnet Mask
Router1	FastEthernet 0/0 Serial 0/0	10.1.1.1 172.16.10.1	255.255.255.0 255.255.255.0
Router2	FastEthernet 0/0	10.1.1.2	255.255.255.0
Router4	Serial 0/0	172.16.10.2	255.255.255.0

Lab Tasks

Task 1: Configure the Routers

In this task, you will configure Router1, Router2, and Router4 so that they can communicate with each other using OSPF.

1. Configure Router1 with the appropriate host name, IP addresses, and subnet masks; refer to the IP Addresses table. Enable the interfaces. Configure a clock rate of 64 Kbps on the Serial 0/0 interface. A clock rate must be configured on Router1 because it is the DCE end of the link to Router4.

2. Configure Router2 with the appropriate host name, IP address, and subnet mask; refer to the IP Addresses table. Enable the interface.

3. Configure Router4 with the appropriate host name, IP address, and subnet mask; refer to the IP Addresses table. Enable the interface.

4. Verify that each router can ping its directly connected neighbor. From Router1, ping Router2 (10.1.1.2) and Router4 (172.16.10.2). From Router2, ping Router1's FastEthernet 0/0 interface (10.1.1.1). From Router4, ping Router1's Serial 0/0 interface (172.16.10.1). The pings should be successful.

Task 2: Configure OSPF

This task introduces you to configuring OSPF on a router. OSPF is a link-state routing protocol that uses the Dijkstra algorithm to calculate the shortest path to a network. OSPF maintains a tree view of the entire network and advertises changes to the topology via link-state advertisement (LSA) updates. OSPF incorporates the use of variable-length subnet masks (VLSMs) and multicasts LSAs to the 224.0.0.5 network address.

The OSPF routing protocol is more advanced than Routing Information Protocol (RIP) or Interior Gateway Routing Protocol (IGRP) and requires different commands to configure. For example, you must configure a process ID when enabling OSPF.

1. On Router1, enable OSPF and use a process ID of **100**.

2. When networks are configured on a router running OSPF, they must be configured with a wildcard mask and an area ID. Configure Router1 to advertise the networks of enabled interfaces; use an area ID of **0**.

3. On Router2, enable OSPF and use process ID **100**. Configure Router2 to advertise the networks of enabled interfaces; use an area ID of **0**.

4. On Router4, enable OSPF and use process ID **100**. Configure Router4 to advertise the networks of enabled interfaces; use an area ID of **0**.

Task 3: Verify OSPF

In this task, you will use the **ping** and **show** commands to enable you to verify the OSPF configurations you performed.

1. OSPF is now configured on all three routers. Allow a short period of time to elapse so that the network has time to converge. On Router2 and Router4, ping the routers that are not directly connected. Both pings should be successful.

   On Router2: 172.16.10.2
   On Router4: 10.1.1.2

2. On Router2, display the routing table. What is the administrative distance for OSPF to the 172.16.10.0 network? _____

3. On Router2, verify that OSPF is the IP routing protocol running on Router2.

4. On Router2, display the OSPF database. How is the router ID determined on a router? _____

5. On Router2, display all OSPF neighbors. What does `FULL` in the `State` field indicate in the output?
   _____

6. On Router2, display information about the interfaces that are running OSPF. What does `State BACKUP` indicate in the output? _____

Lab Solutions

Task 1: Configure the Routers

1. On Router1, you should issue the following commands to configure the appropriate host name, IP addresses, and subnet masks, to enable the interfaces, and to configure a clock rate on the Serial 0/0 interface:

```
Router>enable
Router#configure terminal
Router(config)#hostname Router1
Router1(config)#interface fastethernet 0/0
Router1(config-if)#ip address 10.1.1.1 255.255.255.0
Router1(config-if)#no shutdown
Router1(config-if)#interface serial 0/0
Router1(config-if)#ip address 172.16.10.1 255.255.255.0
Router1(config-if)#clock rate 64000
Router1(config-if)#no shutdown
```

2. On Router2, you should issue the following commands to configure the appropriate host name, IP address, and subnet mask and to enable the interface:

```
Router>enable
Router#configure terminal
Router(config)#hostname Router2
Router2(config)#interface fastethernet 0/0
Router2(config-if)#ip address 10.1.1.2 255.255.255.0
Router2(config-if)#no shutdown
```

3. On Router4, you should issue the following commands to configure the appropriate host name, IP address, and subnet mask and to enable the interface:

```
Router>enable
Router#configure terminal
Router(config)#hostname Router4
Router4(config)#interface serial 0/0
Router4(config-if)#ip address 172.16.10.2 255.255.255.0
Router4(config-if)#no shutdown
```

4. Verify that each router can ping its directly connected neighbor. The pings should be successful.

```
Router1(config-if)#end
Router1#ping 10.1.1.2
Router1#ping 172.16.10.2

Router2(config-if)#end
Router2#ping 10.1.1.1

Router4(config-if)#end
Router4#ping 172.16.10.1
```

Task 2: Configure OSPF

1. On Router1, issue the following commands to enable OSPF and use a process ID of **100**:

```
Router1#configure terminal
Router1(config)#router ospf 100
```

2. On Router1, issue the following commands to add the networks of the enabled interfaces, the appropriate masks, and the area ID:

```
Router1(config-router)#network 10.1.1.0 0.0.0.255 area 0
Router1(config-router)#network 172.16.10.0 0.0.0.255 area 0
```

3. On Router2, issue the following commands to enable OSPF and to add the appropriate network, mask, and area ID:

```
Router2#configure terminal
Router2(config)#router ospf 100
Router2(config-router)#network 10.1.1.0 0.0.0.255 area 0
```

4. On Router4, issue the following commands to enable OSPF and to add the appropriate network, mask, and area ID:

```
Router4#configure terminal
Router4(config)#router ospf 100
Router4(config-router)#network 172.16.10.0 0.0.0.255 area 0
```

Task 3: Verify OSPF

1. OSPF is now configured on all three routers. Allow a short period of time to elapse so that the network has time to converge. On Router2 and Router4, ping the routers that are not directly connected. Both pings should be successful.

```
Router2(config-router)#end
Router2#ping 172.16.10.2

Router4(config-router)#end
Router4#ping 10.1.1.2
```

2. The administrative distance for OSPF is 110 for the route to the 172.16.10.0 network. You can view the administrative distance of the best route to a network by issuing the **show ip route** command. The administrative distance is the first number inside the brackets in the output. For example, the output from the **show ip route** command displays an OSPF route with an administrative distance of 110:

```
Router2#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

     10.0.0.0/24 is subnetted, 1 subnets
C       10.1.1.0 is directly connected, FastEthernet0/0
     172.16.0.0/24 is subnetted, 1 subnets
O       172.16.10.0 [110/65] via 10.1.1.1, 00:11:56, FastEthernet0/0
```

3. On Router2, issue the **show ip protocols** command to verify that OSPF is the IP routing protocol running on Router2. Below is sample output:

```
Router2#show ip protocols
Routing Protocol is "ospf 100"
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Router ID 10.1.1.2
  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
  Routing Information Sources:
    Gateway         Distance      Last Update
    10.1.1.2             110
    172.16.10.1          110
  Distance: (default is 110)
```

4. On Router2, issue the **show ip ospf database** command to display the OSPF database on Router2. If the router ID is not manually configured, the router ID is the highest loopback IP address configured on a router. If a loopback IP address is not configured, the router ID is the highest IP address among configured interfaces on the router.

```
Router2#show ip ospf database

       OSPF Router with ID (10.1.1.2) (Process ID 100)

         Router Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum Link Count
10.1.1.2        10.1.1.2        234         0x80000002 0x009253 1
172.16.10.1     172.16.10.1     99          0x80000004 0x004505 3
172.16.10.2     172.16.10.2     309         0x80000002 0x006626 2


         Net Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum
10.1.1.1        172.16.10.1     375         0x80000001 0x00157D
```

5. On Router2, issue the **show ip ospf neighbor** command to display all OSPF neighbors. Below is sample output. `FULL` in the `State` field indicates that Router1 and Router2 have exchanged LSAs and that the routers' databases are fully synchronized.

```
Router2#show ip ospf neighbor
Neighbor ID   Pri  State      Dead Time   Address       Interface
172.16.10.1   0    FULL/DR    00:05:03    10.1.1.1      FastEthernet0/0
```

6. On Router2, issue the **show ip ospf interface** command to display information about the interfaces that are running OSPF. Below is sample output. `State BACKUP` in the output indicates that Router2 is the backup designated router on the network.

```
Router2#show ip ospf interface
FastEthernet0/0 is up, line protocol is up
  Internet Address 10.1.1.2/24, Area 0
  Process ID 100, Router ID 10.1.1.2, Network Type BROADCAST, Cost: 1
  Transmit Delay is 1 sec, State BACKUP, Priority 1
  Designated Router (ID) 172.16.10.1, Interface address 10.1.1.1
  Backup Designated router (ID) 10.1.1.2, Interface address 10.1.1.2
  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 172.16.10.1  (Designated Router)
  Suppress hello for 0 neighbor(s)
```

Sample Configuration Script

Router1

```
Router1#show running-config
Building configuration...
Current configuration : 810 bytes
!
Version 12.3
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname Router1
!
ip subnet-zero
!
ip cef
no ip domain-lookup
!
interface Serial0/0
 ip address 172.16.10.1 255.255.255.0
 no ip directed-broadcast
 clock rate 64000
!
interface Serial0/1
 no ip address
 no ip directed-broadcast
 shutdown
!
interface FastEthernet0/0
 ip address 10.1.1.1 255.255.255.0
 no ip directed-broadcast
!
interface FastEthernet0/1
 no ip address
 no ip directed-broadcast
 shutdown
!
router ospf 100
 log-adjacency-changes
 network 10.1.1.0 0.0.0.255 area 0
 network 172.16.10.0 0.0.0.255 area 0
!
ip classless
no ip http server
!
line con 0
line aux 0
line vty 0 4
!
no scheduler allocate
end
```