Cisco Networking Academy®
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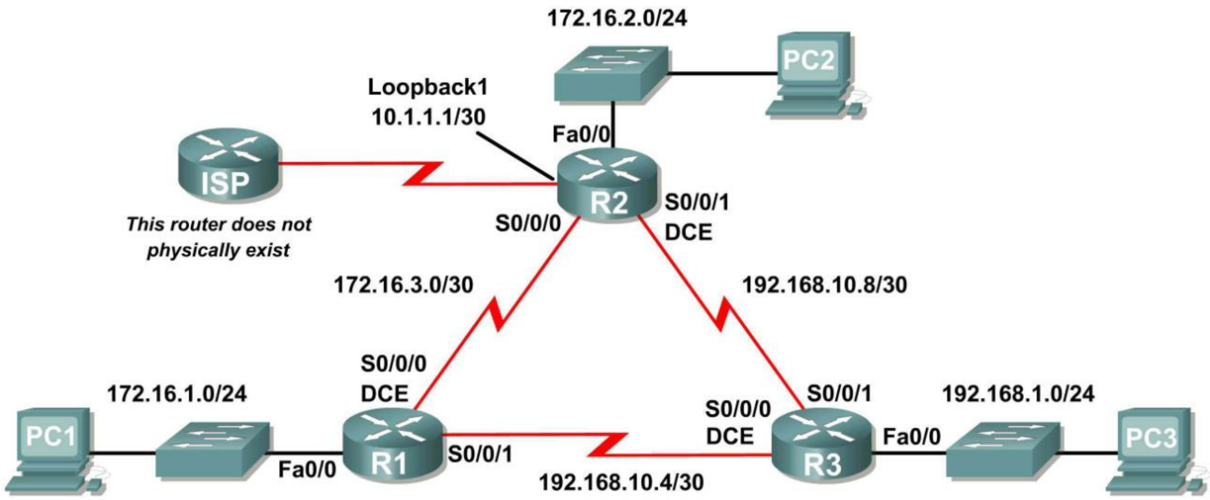
Lab 9.6.1: Basic EIGRP Configuration Lab

Topology Diagram



Addressing Table

Device	Interface	IP Address	Subnet Mask	Default Gateway
R1	**Fa0/0**	172.16.1.1	255.255.255.0	N/A
	S0/0/0	172.16.3.1	255.255.255.252	N/A
	S0/0/1	192.168.10.5	255.255.255.252	N/A
R2	**Fa0/0**	172.16.2.1	255.255.255.0	N/A
	S0/0/0	172.16.3.2	255.255.255.252	N/A
	S0/0/1	192.168.10.9	255.255.255.252	N/A
	Lo1	10.1.1.1	255.255.255.252	N/A
R3	**Fa0/0**	192.168.1.1	255.255.255.0	N/A
	S0/0/0	192.168.10.6	255.255.255.252	N/A
	S0/0/1	192.168.10.10	255.255.255.252	N/A
PC1	**NIC**	172.16.1.10	255.255.255.0	172.16.1.1
PC2	**NIC**	172.16.2.10	255.255.255.0	172.16.2.1
PC3	**NIC**	192.168.1.10	255.255.255.0	192.168.1.1

Learning Objectives

Upon completion of this lab, you will be able to:

- Cable a network according to the Topology Diagram.
- Erase the startup configuration and reload a router to the default state.
- Perform basic configuration tasks on a router.
- Configure and activate interfaces.
- Configure EIGRP routing on all routers.
- Verify EIGRP routing using **show** commands.
- Disable automatic summarization.
- Configure manual summarization.
- Configure a static default route.
- Propagate default route to EIGRP neighbors.
- Document the EIGRP configuration.

Scenario

In this lab activity, you will learn how to configure the routing protocol EIGRP using the network shown in the Topology Diagram. A loopback address will be used on the R2 router to simulate a connection to an ISP, where all traffic that is not destined for the local network will be sent. Some segments of the network have been subnetted using VLSM. EIGRP is a classless routing protocol that can be used to provide subnet mask information in the routing updates. This will allow VLSM subnet information to be propagated throughout the network.

Task 1: Prepare the Network.

Step 1: Cable a network that is similar to the one in the Topology Diagram.

You can use any current router in your lab as long as it has the required interfaces shown in the topology.

Step 2: Clear any existing configurations on the routers.

Task 2: Perform Basic Router Configurations,

Perform basic configuration of the R1, R2, and R3 routers according to the following guidelines:

1. Configure the router hostname.
2. Disable DNS lookup.
3. Configure an EXEC mode password.
4. Configure a message-of-the-day banner.
5. Configure a password for console connections.
6. Configure a password for VTY connections.

Task 3: Configure and Activate Serial and Ethernet Addresses.

Step 1: Configure the interfaces on the R1, R2, and R3 routers.

Configure the interfaces on the R1, R2, and R3 routers with the IP addresses from the table under the Topology Diagram.

Step 2: Verify IP addressing and interfaces.

Use the **`show ip interface brief`** command to verify that the IP addressing is correct and that the interfaces are active.

When you have finished, be sure to save the running configuration to the NVRAM of the router.

Step 3: Configure Ethernet interfaces of PC1, PC2, and PC3.

Configure the Ethernet interfaces of PC1, PC2, and PC3 with the IP addresses and default gateways from the table under the Topology Diagram.

Task 4: Configure EIGRP on the R1 Router.

Step 1: Enable EIGRP.

Use the **`router eigrp`** command in global configuration mode to enable EIGRP on the R1 router. Enter a process ID of 1 for the *`autonomous-system`* parameter.

```
R1(config)#router eigrp 1
R1(config-router)#
```

Step 2: Configure classful network 172.16.0.0.

Once you are in the Router EIGRP configuration sub-mode, configure the classful network 172.16.0.0 to be included in the EIGRP updates that are sent out of R1.

```
R1(config-router)#network 172.16.0.0
R1(config-router)#
```

The router will begin to send EIGRP update messages out each interface belonging to the 172.16.0.0 network. EIGRP updates will be sent out of the FastEthernet0/0 and Serial0/0/0 interfaces because they are both on subnets of the 172.16.0.0 network.

Step 3: Configure the router to advertise the 192.168.10.4/30 network attached to the Serial0/0/1 interface.

Use the *`wildcard-mask`* option with the **`network`** command to advertise only the subnet and not the entire 192.168.10.0 classful network.

Note: Think of a wildcard mask as the inverse of a subnet mask. The inverse of the subnet mask 255.255.255.252 is 0.0.0.3. To calculate the inverse of the subnet mask, subtract the subnet mask from 255.255.255.255:

```
    255.255.255.255
-   255.255.255.252      Subtract the subnet mask
-------------------
      0.  0.  0.  3      Wildcard mask
```

```
R1(config-router)# network 192.168.10.4 0.0.0.3
R1(config-router)#
```

When you are finished with the EIGRP configuration for R1, return to privileged EXEC mode and save the current configuration to NVRAM.

```
R1(config-router)#end
%SYS-5-CONFIG_I: Configured from console by console
R1#
```


Task 5: Configure EIGRP on the R2 and R3 Routers.

Step 1: Enable EIGRP routing on the R2 router using the `router eigrp` command.

Use a process ID of 1.

```
R2(config)#router eigrp 1
R2(config-router)#
```

Step 2: Use the classful address 172.16.0.0 to include the network for the FastEthernet0/0 interface.

```
R2(config-router)#network 172.16.0.0
R2(config-router)#
%DUAL-5-NBRCHANGE: IP-EIGRP 1: Neighbor 172.16.3.1 (Serial0/0/0) is up:
new adjacency
```

Notice that DUAL sends a notification message to the console stating that a neighbor relationship with another EIGRP router has been established.

What is the IP address of the EIGRP neighbor router?

____

What interface on the R2 router is the neighbor adjacent to?

____

Step 3: Configure the R2 router to advertise the 192.168.10.8/30 network attached to the Serial0/0/1 interface.

1. Use the *wildcard-mask* option with the **network** command to advertise only the subnet and not the entire 192.168.10.0 classful network.
2. When you are finished, return to privileged EXEC mode.

```
R2(config-router)#network 192.168.10.8 0.0.0.3
R2(config-router)#end
%SYS-5-CONFIG_I: Configured from console by console
R2#
```

Step 4: Configure EIGRP on the R3 router using the `router eigrp` and `network` commands.

1. Use a process ID of 1.
2. Use the classful network address for the network attached to the FastEthernet0/0 interface.
3. Include the wildcard masks for the subnets attached to the Serial0/0/0 and Serial 0/0/1 interfaces.
4. When you are finished, return to privileged EXEC mode.

```
R3(config)#router eigrp 1
R3(config-router)#network 192.168.1.0
R3(config-router)#network 192.168.10.4 0.0.0.3
R3(config-router)#
%DUAL-5-NBRCHANGE: IP-EIGRP 1: Neighbor 192.168.10.5 (Serial0/0/0) is up:
new adjacency
R3(config-router)#network 192.168.10.8 0.0.0.3
R3(config-router)#
%DUAL-5-NBRCHANGE: IP-EIGRP 1: Neighbor 192.168.10.9 (Serial0/0/1) is up:
new adjacency
R3(config-router)#end
%SYS-5-CONFIG_I: Configured from console by console
```



```
R3#
```

Notice that when the networks for the serial links from R3 to R1 and R3 to R2 are added to the EIGRP configuration, DUAL sends a notification message to the console stating that a neighbor relationship with another EIGRP router has been established.

Task 6: Verify EIGRP Operation.

Step 1: View neighbors.

On the R1 router, use the **show ip eigrp neighbors** command to view the neighbor table and verify that EIGRP has established an adjacency with the R2 and R3 routers. You should be able to see the IP address of each adjacent router and the interface that R1 uses to reach that EIGRP neighbor.

```
R1#show ip eigrp neighbors
IP-EIGRP neighbors for process 1
H   Address         Interface     Hold Uptime    SRTT    RTO   Q    Seq
                                  (sec)          (ms)          Cnt  Num
0   172.16.3.2      Ser0/0/0      10   00:36:51  40      500   0    13
1   192.168.10.6    Ser0/0/1      11   00:26:51  40      500   0    4
R1#
```

Step 2: View routing protocol information.

On the R1 router, use **the show ip protocols** command to view information about the routing protocol operation. Notice that the information that was configured in Task 5, such as protocol, process ID, and networks, is shown in the output. The IP addresses of the adjacent neighbors are also shown.

```
R1#show ip protocols

Routing Protocol is "eigrp  1 "
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Default networks flagged in outgoing updates
  Default networks accepted from incoming updates
  EIGRP metric weight K1=1, K2=0, K3=1, K4=0, K5=0
  EIGRP maximum hopcount 100
  EIGRP maximum metric variance 1
  Redistributing: eigrp 1
  Automatic network summarization is in effect
  Automatic address summarization:
  Maximum path: 4
  Routing for Networks:
     172.16.0.0
     192.168.10.4/30
  Routing Information Sources:
    Gateway         Distance      Last Update
    172.16.3.2      90            4811399
    192.168.10.6    90            5411677
  Distance: internal 90 external 170
```

Notice that the output specifies the process ID used by EIGRP. Remember, the process ID must be the same on all routers for EIGRP to establish neighbor adjacencies and share routing information.

Task7: Examine EIGRP Routes in the Routing Tables.

Step1: View the routing table on the R1 router.

EIGRP routes are denoted in the routing table with a **D**, which stands for DUAL (Diffusing Update Algorithm), which is the routing algorithm used by EIGRP.

```
R1#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
       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

     172.16.0.0/16 is variably subnetted, 4 subnets, 3 masks
D       172.16.0.0/16 is a summary, 01:16:19, Null0
C       172.16.1.0/24 is directly connected, FastEthernet0/0
D       172.16.2.0/24 [90/2172416] via 172.16.3.2, 01:16:20, Serial0/0/0
C       172.16.3.0/30 is directly connected, Serial0/0/0
D    192.168.1.0/24 [90/2172416] via 192.168.10.6, 01:06:18, Serial0/0/1
     192.168.10.0/24 is variably subnetted, 3 subnets, 2 masks
D       192.168.10.0/24 is a summary, 01:06:07, Null0
C       192.168.10.4/30 is directly connected, Serial0/0/1
D       192.168.10.8/30 [90/2681856] via 192.168.10.6, 01:06:07, Serial0/0/1
R1#
```

Notice that the 172.16.0.0/16 parent network is variably subnetted with three child routes using either a /24 or /30 mask. Also notice that EIGRP has automatically included a summary route to Null0 for the 172.16.0.0/16 network. The 172.16.0.0/16 route does not actually represent a path to reach the parent network, 172.16.0.0/16. If a packet destined for 172.16.0.0/16 does not match one of the level 2 child routes, it is sent to the Null0 interface.

```
     172.16.0.0/16 is variably subnetted, 4 subnets, 3 masks
D       172.16.0.0/16 is a summary, 01:16:19, Null0
C       172.16.1.0/24 is directly connected, FastEthernet0/0
D       172.16.2.0/24 [90/2172416] via 172.16.3.2, 01:16:20, Serial0/0/0
C       172.16.3.0/30 is directly connected, Serial0/0/0
```

The 192.168.10.0/24 Network is also variably subnetted and includes a Null0 route.

```
     192.168.10.0/24 is variably subnetted, 3 subnets, 2 masks
D       192.168.10.0/24 is a summary, 01:06:07, Null0
C       192.168.10.4/30 is directly connected, Serial0/0/1
D       192.168.10.8/30 [90/2681856] via 192.168.10.6, 01:06:07, Serial0/0/1
```

Step 2: View the routing table on the R3 router.

The routing table for R3 shows that both R1 and R2 are automatically summarizing the 172.16.0.0/16 network and sending it as a single routing update. Because of automatic summarization, R1 and R2 are not propagating the individual subnets. Because R3 is getting two equal cost routes for 172.16.0.0/16 from both R1 and R2, both routes are included in the routing table.


```
R3#show ip route

<output omitted>

D    172.16.0.0/16 [90/2172416] via 192.168.10.5, 01:15:35, Serial0/0/0
                   [90/2172416] via 192.168.10.9, 01:15:22, Serial0/0/1
C    192.168.1.0/24 is directly connected, FastEthernet0/0
     192.168.10.0/24 is variably subnetted, 3 subnets, 2 masks
D       192.168.10.0/24 is a summary, 01:15:22, Null0
C       192.168.10.4/30 is directly connected, Serial0/0/0
C       192.168.10.8/30 is directly connected, Serial0/0/1
R3#
```

Task 8: Configure EIGRP Metrics.

Step 1: View the EIGRP metric information.

Use the **`show interface serial0/0/0`** command to view the EIGRP metric information for the Serial0/0/0 interface on the R1 router. Notice the values that are shown for the bandwidth, delay, reliability, and load.

```
R1#show interface serial0/0/0
Serial0/0/0 is up, line protocol is up (connected)
  Hardware is HD64570
  Internet address is 172.16.3.1/30
  MTU 1500 bytes, BW 1544 Kbit, DLY 20000 usec, rely 255/255, load 1/255
  Encapsulation HDLC, loopback not set, keepalive set (10 sec)

<output omitted>
```

Step 2: Modify the bandwidth of the Serial interfaces.

On most serial links, the bandwidth metric will default to 1544 Kbits. If this is not the actual bandwidth of the serial link, the bandwidth will need to be changed so that the EIGRP metric can be calculated correctly.

For this lab, the link between R1 and R2 will be configured with a bandwidth of 64 kbps, and the link between R2 and R3 will be configured with a bandwidth of 1024 kbps. Use the **`bandwidth`** command to modify the bandwidth of the Serial interfaces of each router.

R1 router:
```
R1(config)#interface serial0/0/0
R1(config-if)#bandwidth 64
```

R2 router:
```
R2(config)#interface serial0/0/0
R2(config-if)#bandwidth 64
R2(config)#interface serial0/0/1
R2(config-if)#bandwidth 1024
```

R3 router:
```
R3(config)#interface serial0/0/1
R3(config-if)#bandwidth 1024
```

Note: The **`bandwidth`** command only modifies the bandwidth metric used by routing protocols, not the physical bandwidth of the link.

Step 3: Verify the bandwidth modifications.

Use the **show ip interface** command to verify that the bandwidth value of each link has been changed.

```
R1#show interface serial0/0/0
Serial0/0/0 is up, line protocol is up (connected)
  Hardware is HD64570
  Internet address is 172.16.3.1/30
  MTU 1500 bytes, BW 64 Kbit, DLY 20000 usec, rely 255/255, load 1/255
  Encapsulation HDLC, loopback not set, keepalive set (10 sec)

<output omitted>

R2#show interface serial0/0/0
Serial0/0/0 is up, line protocol is up (connected)
  Hardware is HD64570
  Internet address is 172.16.3.2/30
  MTU 1500 bytes, BW 64 Kbit, DLY 20000 usec, rely 255/255, load 1/255
  Encapsulation HDLC, loopback not set, keepalive set (10 sec)

<output omitted>

R3#show interface serial0/0/1
Serial0/0/1 is up, line protocol is up (connected)
  Hardware is HD64570
  Internet address is 192.168.10.10/30
  MTU 1500 bytes, BW 1024 Kbit, DLY 20000 usec, rely 255/255, load 1/255
  Encapsulation HDLC, loopback not set, keepalive set (10 sec)

<output omitted>
```

Note: Use the interface configuration command **no bandwidth** to return the bandwidth to its default value.

Task 9: Examine Successors and Feasible Distances.

Step 1: Examine the successors and feasible distances in the routing table on R2.

```
R2#show ip route

<output omitted>

     10.0.0.0/30 is subnetted, 1 subnets
C       10.1.1.0 is directly connected, Loopback1
     172.16.0.0/16 is variably subnetted, 4 subnets, 3 masks
D       172.16.0.0/16 is a summary, 00:00:52, Null0
D       172.16.1.0/24 [90/40514560] via 172.16.3.1, 00:00:52, Serial0/0/0
C       172.16.2.0/24 is directly connected, FastEthernet0/0
C       172.16.3.0/30 is directly connected, Serial0/0/0
D    192.168.1.0/24 [90/3014400] via 192.168.10.10, 00:00:11, Serial0/0/1
     192.168.10.0/24 is variably subnetted, 3 subnets, 2 masks
D       192.168.10.0/24 is a summary, 00:00:11, Null0
D       192.168.10.4/30 [90/3523840] via 192.168.10.10, 00:00:11,
Serial0/0/1
C       192.168.10.8/30 is directly connected, Serial0/0/1
R2#
```


Step 2: Answer the following questions:

What is the best path to PC1?

____

A successor is a neighboring router that is currently being used for packet forwarding. A successor is the least-cost route to the destination network. The IP address of a successor is shown in a routing table entry right after the word “via”.

What is the IP address and name of the successor router in this route?

____

Feasible distance (FD) is the lowest calculated metric to reach that destination. FD is the metric listed in the routing table entry as the second number inside the brackets.

What is the feasible distance to the network that PC1 is on?

____

Task 10: Determine if R1 is a Feasible Successor for the Route from R2 to the 192.168.1.0 Network.

A feasible successor is a neighbor who has a viable backup path to the same network as the successor. In order to be a feasible successor, R1 must satisfy the feasibility condition. The feasibility condition (FC) is met when a neighbor’s reported distance (RD) to a network is less than the local router’s feasible distance to the same destination network.

Step 1: Examine the routing table on R1.

```
R1#show ip route

<output omitted>

     172.16.0.0/16 is variably subnetted, 4 subnets, 3 masks
D       172.16.0.0/16 is a summary, 00:42:59, Null0
C       172.16.1.0/24 is directly connected, FastEthernet0/0
D       172.16.2.0/24 [90/40514560] via 172.16.3.2, 00:43:00, Serial0/0/0
C       172.16.3.0/30 is directly connected, Serial0/0/0
D    192.168.1.0/24 [90/2172416] via 192.168.10.6, 00:42:26, Serial0/0/1
     192.168.10.0/24 is variably subnetted, 3 subnets, 2 masks
D       192.168.10.0/24 is a summary, 00:42:20, Null0
C       192.168.10.4/30 is directly connected, Serial0/0/1
D       192.168.10.8/30 [90/3523840] via 192.168.10.6, 00:42:20,
Serial0/0/1
R1#
```

What is the reported distance to the 192.168.1.0 network?

____

Step 2: Examine the routing table on R2.

```
R2#show ip route

<output omitted>
```



```
     10.0.0.0/30 is subnetted, 1 subnets
C       10.1.1.0 is directly connected, Loopback1
     172.16.0.0/16 is variably subnetted, 4 subnets, 3 masks
D       172.16.0.0/16 is a summary, 00:00:52, Null0
D       172.16.1.0/24 [90/40514560] via 172.16.3.1, 00:00:52, Serial0/0/0
C       172.16.2.0/24 is directly connected, FastEthernet0/0
C       172.16.3.0/30 is directly connected, Serial0/0/0
D    192.168.1.0/24 [90/3014400] via 192.168.10.10, 00:00:11, Serial0/0/1
     192.168.10.0/24 is variably subnetted, 3 subnets, 2 masks
D       192.168.10.0/24 is a summary, 00:00:11, Null0
D       192.168.10.4/30 [90/3523840] via 192.168.10.10, 00:00:11, Serial0/0/1
C       192.168.10.8/30 is directly connected, Serial0/0/1
R2#
```

What is the feasible distance to the 192.168.1.0 network?

____

Would R2 consider R1 to be a feasible successor to the 192.168.1.0 network? _______

Task 11: Examine the EIGRP Topology Table.

Step 1: View the EIGRP topology table.

Use the **show ip eigrp topology** command to view the EIGRP topology table on R2.

```
R2#show ip eigrp topology
IP-EIGRP Topology Table for AS 1

Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - Reply status

P 172.16.2.0/24, 1 successors, FD is 28160
         via Connected, FastEthernet0/0
P 172.16.3.0/30, 1 successors, FD is 40512000
         via Connected, Serial0/0/0
P 192.168.10.8/30, 1 successors, FD is 3011840
         via Connected, Serial0/0/1
P 172.16.0.0/16, 1 successors, FD is 28160
         via Summary (28160/0), Null0
P 192.168.10.0/24, 1 successors, FD is 3011840
         via Summary (3011840/0), Null0
P 172.16.1.0/24, 1 successors, FD is 40514560
         via 172.16.3.1 (40514560/28160), Serial0/0/0
P 192.168.1.0/24, 1 successors, FD is 3014400
         via 192.168.10.10 (3014400/28160), Serial0/0/1
         via 172.16.3.1 (41026560/2172416), Serial0/0/0
P 192.168.10.4/30, 1 successors, FD is 3523840
         via 192.168.10.10 (3523840/2169856), Serial0/0/1
R2#
```

Step 2: View detailed EIGRP topology information.

Use the `[network]` parameter of the **show ip eigrp topology** command to view detailed EIGRP topology information for the 192.16.0.0 network.


```
R2#show ip eigrp topology 192.168.1.0
IP-EIGRP (AS 1): Topology entry for 192.168.1.0/24
  State is Passive, Query origin flag is 1, 1 Successor(s), FD is 3014400
  Routing Descriptor Blocks:
  192.168.10.10 (Serial0/0/1), from 192.168.10.10, Send flag is 0x0
      Composite metric is (3014400/28160), Route is Internal
      Vector metric:
        Minimum bandwidth is 1024 Kbit
        Total delay is 20100 microseconds
        Reliability is 255/255
        Load is 1/255
        Minimum MTU is 1500
        Hop count is 1
  172.16.3.1 (Serial0/0/0), from 172.16.3.1, Send flag is 0x0
      Composite metric is (41026560/2172416), Route is Internal
      Vector metric:
        Minimum bandwidth is 64 Kbit
        Total delay is 40100 microseconds
        Reliability is 255/255
        Load is 1/255
        Minimum MTU is 1500
        Hop count is 2
R2#
```

How many successors are there for this network?

____

What is the feasible distance to this network?

____

What is the IP address of the feasible successor?

____

What is the reported distance for 192.168.1.0 from the feasible successor?

____

What would be the feasible distance to 192.168.1.0 if R1 became the successor?

____

Task 12: Disable EIGRP Automatic Summarization.

Step 1: Examine the routing table of the R3 router.

Notice that R3 is not receiving individual routes for the 172.16.1.0/24, 172.16.2.0/24, and 172.16.3.0/24 subnets. Instead, the routing table only has a summary route to the classful network address of 172.16.0.0/16 through the R1 router. This will cause packets that are destined for the 172.16.2.0/24 network to be sent through the R1 router instead of being sent straight to the R2 router.

```
R3#show ip route

<output omitted>
```



```
D    172.16.0.0/16 [90/2172416] via 192.168.10.5, 01:21:54, Serial0/0/0
C    192.168.1.0/24 is directly connected, FastEthernet0/0
     192.168.10.0/24 is variably subnetted, 3 subnets, 2 masks
D       192.168.10.0/24 is a summary, 01:21:47, Null0
C       192.168.10.4/30 is directly connected, Serial0/0/0
C       192.168.10.8/30 is directly connected, Serial0/0/1
R3#
```

Why is the R1 router (192.168.10.5) the only successor for the route to the 172.16.0.0/16 network?

____

____

____

Notice that the reported distance from R2 is higher than the feasible distance from R1.

```
R3#show ip eigrp topology
IP-EIGRP Topology Table for AS 1

Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - Reply status

P 192.168.1.0/24, 1 successors, FD is 28160
         via Connected, FastEthernet0/0
P 192.168.10.4/30, 1 successors, FD is 2169856
         via Connected, Serial0/0/0
P 192.168.10.0/24, 1 successors, FD is 2169856
         via Summary (2169856/0), Null0
P 172.16.0.0/16, 1 successors, FD is 2172416
         via 192.168.10.5 (2172416/28160), Serial0/0/0
         via 192.168.10.9 (3014400/28160), Serial0/0/1
P 192.168.10.8/30, 1 successors, FD is 3011840
         via Connected, Serial0/0/1
```

Step 3: Disable automatic summarization on all three routers with the `no auto-summary` command.

```
R1(config)#router eigrp 1
R1(config-router)#no auto-summary

R2(config)#router eigrp 1
R2(config-router)#no auto-summary

R3(config)#router eigrp 1
R3(config-router)#no auto-summary
```

Step 4: View the routing table on R1 again.

Notice that individual routes for the 172.16.1.0/24, 172.16.2.0/24, and 172.16.3.0/24 subnets are now present and the summary Null route is no longer listed.

```
R3#show ip route

<output omitted>
```



```
     172.16.0.0/16 is variably subnetted, 4 subnets, 3 masks
D       172.16.1.0/24 [90/2172416] via 192.168.10.5, 00:02:37, Serial0/0/0
D       172.16.2.0/24 [90/3014400] via 192.168.10.9, 00:02:39, Serial0/0/1
D       172.16.3.0/30 [90/41024000] via 192.168.10.9, 00:02:39, Serial0/0/1
                      [90/41024000] via 192.168.10.5, 00:02:37, Serial0/0/0
C    192.168.1.0/24 is directly connected, FastEthernet0/0
     192.168.10.0/24 is variably subnetted, 3 subnets, 2 masks
C       192.168.10.4/30 is directly connected, Serial0/0/0
C       192.168.10.8/30 is directly connected, Serial0/0/1
R3#
```

Task 13: Configure Manual Summarization.

Step 1: Add loopback addresses to R3 router.

Add two loopback addresses, 192.168.2.1/24 and 192.168.3.1/24, to the R3 router. These virtual interfaces will be used to represent networks to be manually summarized along with the 192.168.1.0/24 LAN.

```
R3(config)#interface loopback1

%LINK-5-CHANGED: Interface Loopback1, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback1, changed state
to upR3(config-if)#ip address 192.168.2.1 255.255.255.0
R3(config-if)#interface loopback2

%LINK-5-CHANGED: Interface Loopback2, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback2, changed state
to up
R3(config-if)#ip address 192.168.3.1 255.255.255.0
R3(config-if)#
```

Step 2: Add the 192.168.2.0 and 192.168.3.0 networks to the EIGRP configuration on R3.

```
R3(config)#router eigrp 1
R3(config-router)#network 192.168.2.0
R3(config-router)#network 192.168.3.0
```

Step 3: Verify new routes.

View the routing table on the R1 router to verify that the new routes are being sent out in the EIGRP updates sent by R3.

```
R1#show ip route

<output omitted>

     172.16.0.0/16 is variably subnetted, 4 subnets, 3 masks
C       172.16.1.0/24 is directly connected, FastEthernet0/0
D       172.16.2.0/24 [90/3526400] via 192.168.10.6, 00:15:07, Serial0/0/1
C       172.16.3.0/30 is directly connected, Serial0/0/0
D    192.168.1.0/24 [90/2172416] via 192.168.10.6, 00:15:07, Serial0/0/1
D    192.168.2.0/24 [90/2297856] via 192.168.10.6, 00:01:07, Serial0/0/1
D    192.168.3.0/24 [90/2297856] via 192.168.10.6, 00:00:57, Serial0/0/1
     192.168.10.0/24 is variably subnetted, 3 subnets, 2 masks
C       192.168.10.4/30 is directly connected, Serial0/0/1
D       192.168.10.8/30 [90/3523840] via 192.168.10.6, 00:15:07, Serial0/0/1
R1#
```


Step 4: Apply manual summarization to outbound interfaces.

The routes to the 192.168.1.0/24, 192.168.2.0/24, and 192.168.3.0/24 networks can be summarized in the single network 192.168.0.0/22. Use the **ip summary-address eigrp** *as-number network-address subnet-mask* command to configure manual summarization on each of the outbound interfaces connected to EIGRP neighbors.

```
R3(config)#interface serial0/0/0
R3(config-if)#ip summary-address eigrp 1 192.168.0.0 255.255.252.0
R3(config-if)#interface serial0/0/1
R3(config-if)#ip summary-address eigrp 1 192.168.0.0 255.255.252.0
R3(config-if)#
```

Step 5: Verify the summary route.

View the routing table on the R1 router to verify that the summary route is being sent out in the EIGRP updates sent by R3.

```
R1#show ip route

<output omitted>

     172.16.0.0/16 is variably subnetted, 4 subnets, 3 masks
C       172.16.1.0/24 is directly connected, FastEthernet0/0
D       172.16.2.0/24 [90/3526400] via 192.168.10.6, 00:15:07, Serial0/0/1
C       172.16.3.0/30 is directly connected, Serial0/0/0
D    192.168.0.0/22 [90/2172416] via 192.168.10.6, 00:01:11, Serial0/0/1
     192.168.10.0/24 is variably subnetted, 3 subnets, 2 masks
C       192.168.10.4/30 is directly connected, Serial0/0/1
D       192.168.10.8/30 [90/3523840] via 192.168.10.6, 00:15:07, Serial0/0/1
R1#
```

Task 14: Configure and Distribute a Static Default Route.

Step 1: Configure a static default route on the R2 router.

Use the loopback address that has been configured to simulate a link to an ISP as the exit interface.

```
R2(config)#ip route 0.0.0.0 0.0.0.0 loopback1
R2(config)#
```

Step 2: Include the static route in EIGRP updates.

Use the **redistribute static** command to include the static route in the EIGRP updates that are sent from the R2 router.

```
R2(config)#router eigrp 1
R2(config-router)#redistribute static
R2(config-router)#
```

Step 3: Verify the static default route.

View the routing table on the R1 router to verify that the static default route is being redistributed via EIGRP.

```
R1#show ip route

<output omitted>
```



```
Gateway of last resort is 192.168.10.6 to network 0.0.0.0

     192.168.10.0/30 is subnetted, 2 subnets
C       192.168.10.4 is directly connected, Serial0/0/1
D       192.168.10.8 [90/3523840] via 192.168.10.6, 01:06:01, Serial0/0/1
     172.16.0.0/16 is variably subnetted, 3 subnets, 2 masks
C       172.16.1.0/24 is directly connected, FastEthernet0/0
D       172.16.2.0/24 [90/3526400] via 192.168.10.6, 01:05:39, Serial0/0/1
C       172.16.3.0/30 is directly connected, Serial0/0/0
D*EX 0.0.0.0/0 [170/3651840] via 192.168.10.6, 00:02:14, Serial0/0/1
D    192.168.0.0/22 [90/2172416] via 192.168.10.6, 01:05:38, Serial0/0/1
```

Task 15: Documentation

On each router, capture the following command output to a text (.txt) file and save for future reference.

- **show running-config**
- **show ip route**
- **show ip interface brief**
- **show ip protocols**

Task 16: Clean Up

Erase the configurations and reload the routers. Disconnect and store the cabling. For PC hosts that are normally connected to other networks (such as the school LAN or to the Internet), reconnect the appropriate cabling and restore the TCP/IP settings.

Lab 11.6.1: Basic OSPF Configuration Lab

Learning Objectives

Upon completion of this lab, you will be able to:

- Cable a network according to the Topology Diagram
- Erase the startup configuration and reload a router to the default state
- Perform basic configuration tasks on a router
- Configure and activate interfaces
- Configure OSPF routing on all routers
- Configure OSPF router IDs
- Verify OSPF routing using show commands
- Configure a static default route
- Propagate default route to OSPF neighbors
- Configure OSPF Hello and Dead Timers
- Configure OSPF on a Multi-access network
- Configure OSPF priority
- Understand the OSPF election process
- Document the OSPF configuration

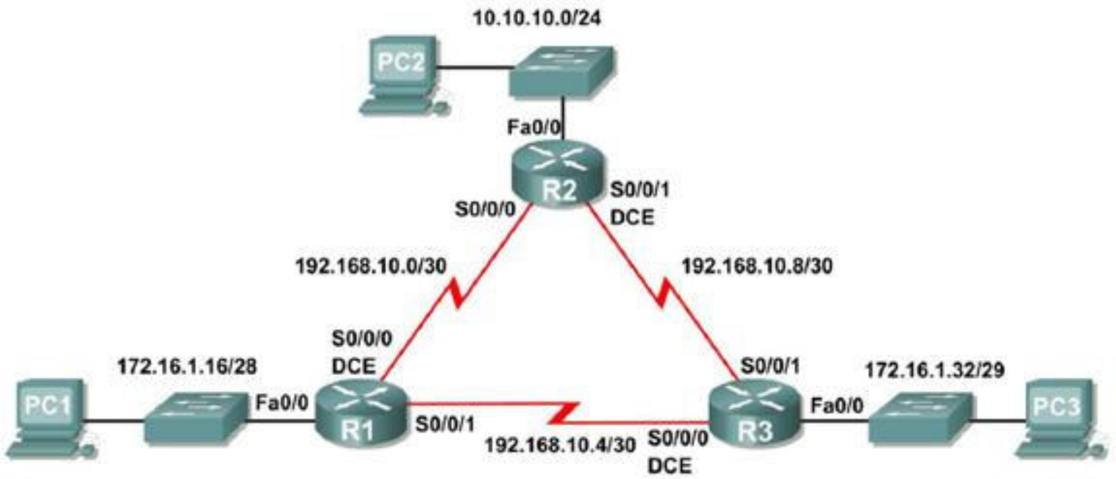
Scenarios

In this lab activity, there are two separate scenarios. In the first scenario, you will learn how to configure the routing protocol OSPF using the network shown in the Topology Diagram in Scenario A. The segments of the network have been subnetted using VLSM. OSPF is a classless routing protocol that can be used to provide subnet mask information in the routing updates. This will allow VLSM subnet information to be propagated throughout the network.

In the second scenario, you will learn to configure OSPF on a multi-access network. You will also learn to use the OSPF election process to determine the designated router (DR), backup designated router (BDR), and DRother states.

Scenario A: Basic OSPF Configuration

Topology Diagram



Addressing Table

Device	Interface	IP Address	Subnet Mask	Default Gateway
R1	Fa0/0	172.16.1.17	255.255.255.240	N/A
	S0/0/0	192.168.10.1	255.255.255.252	N/A
	S0/0/1	192.168.10.5	255.255.255.252	N/A
R2	Fa0/0	10.10.10.1	255.255.255.0	N/A
	S0/0/0	192.168.10.2	255.255.255.252	N/A
	S0/0/1	192.168.10.9	255.255.255.252	N/A
R3	Fa0/0	172.16.1.33	255.255.255.248	N/A
	S0/0/0	192.168.10.6	255.255.255.252	N/A
	S0/0/1	192.168.10.10	255.255.255.252	N/A
PC1	NIC	172.16.1.20	255.255.255.240	172.16.1.17
PC2	NIC	10.10.10.10	255.255.255.0	10.10.10.1
PC3	NIC	172.16.1.35	255.255.255.248	172.16.1.33

Task 1: Prepare the Network.

Step 1: Cable a network that is similar to the one in the Topology Diagram.

You can use any current router in your lab as long as it has the required interfaces shown in the topology.

Note: If you use 1700, 2500, or 2600 routers, the router outputs and interface descriptions will appear different.

Step 2: Clear any existing configurations on the routers.

Task 2: Perform Basic Router Configurations.

Perform basic configuration of the R1, R2, and R3 routers according to the following guidelines:

1. Configure the router hostname.
2. Disable DNS lookup.
3. Configure a privileged EXEC mode password.
4. Configure a message-of-the-day banner.
5. Configure a password for console connections.
6. Configure a password for VTY connections.

Task 3: Configure and Activate Serial and Ethernet Addresses.

Step 1: Configure interfaces on R1, R2, and R3.

Configure the interfaces on the R1, R2, and R3 routers with the IP addresses from the table under the Topology Diagram.

Step 2: Verify IP addressing and interfaces.

Use the **`show ip interface brief`** command to verify that the IP addressing is correct and that the interfaces are active.

When you have finished, be sure to save the running configuration to the NVRAM of the router.

Step 3: Configure Ethernet interfaces of PC1, PC2, and PC3.

Configure the Ethernet interfaces of PC1, PC2, and PC3 with the IP addresses and default gateways from the table under the Topology Diagram.

Step 4: Test the PC configuration by pinging the default gateway from the PC.

Task 4: Configure OSPF on the R1 Router

Step 1: Use the router ospf command in global configuration mode to enable OSPF on the R1 router. Enter a process ID of 1 for the *`process-ID`* parameter.

```
R1(config)#router ospf 1
R1(config-router)#
```

Step 2: Configure the `network` statement for the LAN network.

Once you are in the Router OSPF configuration sub-mode, configure the LAN network 172.16.1.16/28 to be included in the OSPF updates that are sent out of R1.

The OSPF **network** command uses a combination of *network-address* and *wildcard-mask* similar to that which can be used by EIGRP. Unlike EIGRP, the wildcard mask in OSPF is required.

Use an area ID of 0 for the OSPF *area-id* parameter. 0 will be used for the OSPF area ID in all of the **network** statements in this topology.

```
R1(config-router)#network 172.16.1.16 0.0.0.15 area 0
R1(config-router)#
```

Step 3: Configure the router to advertise the 192.168.10.0/30 network attached to the Serial0/0/0 interface.

```
R1(config-router)# network 192.168.10.0 0.0.0.3 area 0
R1(config-router)#
```

Step 4: Configure the router to advertise the 192.168.10.4/30 network attached to the Serial0/0/1 interface.

```
R1(config-router)# network 192.168.10.4 0.0.0.3 area 0
R1(config-router)#
```

Step 5: When you are finished with the OSPF configuration for R1, return to privileged EXEC mode.

```
R1(config-router)#end
%SYS-5-CONFIG_I: Configured from console by console
R1#
```

Task 5: Configure OSPF on the R2 and R3 Routers

Step 1: Enable OSPF routing on the R2 router using the router ospf command.
Use a process ID of 1.

```
R2(config)#router ospf 1
R2(config-router)#
```

Step 2: Configure the router to advertise the LAN network 10.10.10.0/24 in the OSPF updates.

```
R2(config-router)#network 10.10.10.0 0.0.0.255 area 0
R2(config-router)#
```

Step 3: Configure the router to advertise the 192.168.10.0/30 network attached to the Serial0/0/0 interface.

```
R2(config-router)#network 192.168.10.0 0.0.0.3 area 0
R2(config-router)#
00:07:27: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.10.5 on Serial0/0/0
from EXCHANGE to FULL, Exchange Done
```


Notice that when the network for the serial link from R1 to R2 is added to the OSPF configuration, the router sends a notification message to the console stating that a neighbor relationship with another OSPF router has been established.

Step 4: Configure the router to advertise the 192.168.10.8/30 network attached to the Serial0/0/1 interface.
When you are finished, return to privileged EXEC mode.

```
R2(config-router)#network 192.168.10.8 0.0.0.3 area 0
R2(config-router)#end
%SYS-5-CONFIG_I: Configured from console by console
R2#
```

Step 5: Configure OSPF on the R3 router using the `router ospf` and `network` commands.
Use a process ID of 1. Configure the router to advertise the three directly connected networks. When you are finished, return to privileged EXEC mode.

```
R3(config)#router ospf 1
R3(config-router)#network 172.16.1.32 0.0.0.7 area 0
R3(config-router)#network 192.168.10.4 0.0.0.3 area 0
R3(config-router)#
00:17:46: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.10.5 on Serial0/0/0
from LOADING to FULL, Loading Done
R3(config-router)#network 192.168.10.8 0.0.0.3 area 0
R3(config-router)#
00:18:01: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.10.9 on Serial0/0/1
from EXCHANGE to FULL, Exchange Done
R3(config-router)#end
%SYS-5-CONFIG_I: Configured from console by console
R3#
```

Notice that when the networks for the serial links from R3 to R1 and R3 to R2 are added to the OSPF configuration, the router sends a notification message to the console stating that a neighbor relationship with another OSPF router has been established.

Task 6: Configure OSPF Router IDs

The OSPF router ID is used to uniquely identify the router in the OSPF routing domain. A router ID is an IP address. Cisco routers derive the Router ID in one of three ways and with the following precedence:

1. IP address configured with the OSPF `router-id` command.
2. Highest IP address of any of the router's loopback addresses.
3. Highest active IP address on any of the router's physical interfaces.

Step 1: Examine the current router IDs in the topology.

Since no router IDs or loopback interfaces have been configured on the three routers, the router ID for each router is determined by the highest IP address of any active interface.

What is the router ID for R1? ____________________
What is the router ID for R2? ____________________
What is the router ID for R3? ____________________

The router ID can also be seen in the output of the **`show ip protocols`**, **`show ip ospf`**, and **`show ip ospf interfaces`** commands.

```
R3#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 192.168.10.10
  Number of areas in this router is 1. 1 normal 0 stub 0 nssa
  Maximum path: 4

<output omitted>


R3#show ip ospf
 Routing Process "ospf 1" with ID 192.168.10.10
 Supports only single TOS(TOS0) routes
 Supports opaque LSA
 SPF schedule delay 5 secs, Hold time between two SPFs 10 secs

<output omitted>

R3#show ip ospf interface
FastEthernet0/0 is up, line protocol is up
  Internet address is 172.16.1.33/29, Area 0
  Process ID 1, Router ID 192.168.10.10, Network Type BROADCAST, Cost:
1
  Transmit Delay is 1 sec, State DR, Priority 1
  Designated Router (ID) 192.168.10.10, Interface address 172.16.1.33
  No backup designated router on this network
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    Hello due in 00:00:00
  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)

<output omitted>

R3#
```

Step 2: Use loopback addresses to change the router IDs of the routers in the topology.

```
R1(config)#interface loopback 0
R1(config-if)#ip address 10.1.1.1 255.255.255.255

R2(config)#interface loopback 0
R2(config-if)#ip address 10.2.2.2 255.255.255.255

R3(config)#interface loopback 0
R3(config-if)#ip address 10.3.3.3 255.255.255.255
```


Step 3: Reload the routers to force the new Router IDs to be used.

When a new Router ID is configured, it will not be used until the OSPF process is restarted. Make sure that the current configuration is saved to NRAM, and then use the **reload** command to restart each of the routers..

When the router is reloaded, what is the router ID for R1? ____________________
When the router is reloaded, what is the router ID for R2? ____________________
When the router is reloaded, what is the router ID for R3? ____________________

Step 4: Use the show ip ospf neighbors command to verify that the router IDs have changed.

```
R1#show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address
Interface
10.3.3.3          0   FULL/  -        00:00:30    192.168.10.6
Serial0/0/1
10.2.2.2          0   FULL/  -        00:00:33    192.168.10.2
Serial0/0/0
```

```
R2#show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address
Interface
10.3.3.3          0   FULL/  -        00:00:36    192.168.10.10
Serial0/0/1
10.1.1.1          0   FULL/  -        00:00:37    192.168.10.1
Serial0/0/0
```

```
R3#show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address
Interface
10.2.2.2          0   FULL/  -        00:00:34    192.168.10.9
Serial0/0/1
10.1.1.1          0   FULL/  -        00:00:38    192.168.10.5
Serial0/0/0
```

Step 5: Use the router-id command to change the router ID on the R1 router.

Note: Some IOS versions do not support the **router-id** command. If this command is not available, continue to Task 7.

```
R1(config)#router ospf 1
R1(config-router)#router-id 10.4.4.4
Reload or use "clear ip ospf process" command, for this to take effect
```

If this command is used on an OSPF router process which is already active (has neighbors), the new router-ID is used at the next reload or at a manual OSPF process restart. To manually restart the OSPF process, use the **clear ip ospf process** command.


```
R1#(config-router)#end
R1# clear ip ospf process
Reset ALL OSPF processes? [no]:yes
R1#
```

Step 6: Use the `show ip ospf neighbor` command on router R2 to verify that the router ID of R1 has been changed.

```
R2#show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address
Interface
10.3.3.3          0   FULL/  -        00:00:36    192.168.10.10
Serial0/0/1
10.4.4.4          0   FULL/  -        00:00:37    192.168.10.1
Serial0/0/0
```

Step 7: Remove the configured router ID with the `no` form of the `router-id` command.

```
R1(config)#router ospf 1
R1(config-router)#no router-id 10.4.4.4
Reload or use "clear ip ospf process" command, for this to take effect
```

Step 8: Restart the OSPF process using the `clear ip ospf process` command.

Restarting the OSPF process forces the router to use the IP address configured on the Loopback 0 interface as the Router ID.

```
R1(config-router)#end
R1# clear ip ospf process
Reset ALL OSPF processes? [no]:yes
R1#
```

Task 7: Verify OSPF Operation

Step 1: On the R1 router, Use the `show ip ospf neighbor` command to view the information about the OSPF neighbor routers R2 and R3. You should be able to see the neighbor ID and IP address of each adjacent router, and the interface that R1 uses to reach that OSPF neighbor.

```
R1#show ip ospf neighbor
Neighbor ID     Pri   State           Dead Time   Address
Interface
10.2.2.2          0   FULL/-          00:00:32    192.168.10.2
Serial0/0/0
10.3.3.3          0   FULL/-          00:00:32    192.168.10.6
Serial0/0/1
R1#
```

Step 2: On the R1 router, use the `show ip protocols` command to view information about the routing protocol operation.

Notice that the information that was configured in the previous Tasks, such as protocol, process ID, neighbor ID, and networks, is shown in the output. The IP addresses of the adjacent neighbors are also shown.


```
R1#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 10.1.1.1
  Number of areas in this router is 1. 1 normal 0 stub 0 nssa
  Maximum path: 4
  Routing for Networks:
    172.16.1.16 0.0.0.15 area 0
    192.168.10.0 0.0.0.3 area 0
    192.168.10.4 0.0.0.3 area 0
  Routing Information Sources:
    Gateway         Distance      Last Update
    10.2.2.2             110      00:11:43
    10.3.3.3             110      00:11:43
  Distance: (default is 110)

R1#
```

Notice that the output specifies the process ID used by OSPF. Remember, the process ID must be the same on all routers for OSPF to establish neighbor adjacencies and share routing information.

Task8: Examine OSPF Routes in the Routing Tables

View the routing table on the R1 router. OSPF routes are denoted in the routing table with an “O”.

```
R1#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
       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, 2 subnets, 2 masks
C       10.1.1.1/32 is directly connected, Loopback0
O       10.10.10.0/24 [110/65] via 192.168.10.2, 00:01:02, Serial0/0/0
     172.16.0.0/16 is variably subnetted, 2 subnets, 2 masks
C       172.16.1.16/28 is directly connected, FastEthernet0/0
O       172.16.1.32/29 [110/65] via 192.168.10.6, 00:01:12, Serial0/0/1
     192.168.10.0/30 is subnetted, 3 subnets
C       192.168.10.0 is directly connected, Serial0/0/0
C       192.168.10.4 is directly connected, Serial0/0/1
O       192.168.10.8 [110/128] via 192.168.10.6, 00:01:12, Serial0/0/1
                     [110/128] via 192.168.10.2, 00:01:02, Serial0/0/0
R1#
```


Notice that unlike RIPv2 and EIGRP, OSPF does not automatically summarize at major network boundaries.

Task 9: Configure OSPF Cost

Step 1: Use the `show ip route` command on the R1 router to view the OSPF cost to reach the 10.10.10.0/24 network.

```
R1#show ip route

<output omitted>

     10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C       10.1.1.1/32 is directly connected, Loopback0
O       10.10.10.0/24 [110/65] via 192.168.10.2, 00:16:56, Serial0/0/0
     172.16.0.0/16 is variably subnetted, 2 subnets, 2 masks
C       172.16.1.16/28 is directly connected, FastEthernet0/0
O       172.16.1.32/29 [110/65] via 192.168.10.6, 00:17:06, Serial0/0/1
     192.168.10.0/30 is subnetted, 3 subnets
C       192.168.10.0 is directly connected, Serial0/0/0
C       192.168.10.4 is directly connected, Serial0/0/1
O       192.168.10.8 [110/128] via 192.168.10.6, 00:17:06, Serial0/0/1
                     [110/128] via 192.168.10.2, 00:16:56, Serial0/0/0
R1#
```

Step 2: Use the `show interfaces serial0/0/0` command on the R1 router to view the bandwidth of the Serial 0/0/0 interface.

```
R1#show interfaces serial0/0/0
Serial0/0/0 is up, line protocol is up (connected)
  Hardware is HD64570
  Internet address is 192.168.10.1/30
  MTU 1500 bytes, BW 1544 Kbit, DLY 20000 usec, rely 255/255, load
1/255
  Encapsulation HDLC, loopback not set, keepalive set (10 sec)
  Last input never, output never, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/75/0 (size/max/drops); Total output drops: 0
```

<output omitted>

On most serial links, the bandwidth metric will default to 1544 Kbits. If this is not the actual bandwidth of the serial link, the bandwidth will need to be changed so that the OSPF cost can be calculated correctly.

Step 3: Use the bandwidth command to change the bandwidth of the serial interfaces of the R1 and R2 routers to the actual bandwidth, 64 kbps.

R1 router:

```
R1(config)#interface serial0/0/0
R1(config-if)#bandwidth 64
R1(config-if)#interface serial0/0/1
R1(config-if)#bandwidth 64
```


R2 router:

```
R2(config)#interface serial0/0/0
R2(config-if)#bandwidth 64
R2(config)#interface serial0/0/1
R2(config-if)#bandwidth 64
```

Step 4: Use the `show ip ospf interface` command on the R1 router to verify the cost of the serial links.

The cost of each of the Serial links is now 1562, the result of the calculation: 10^8/64,000 bps.

```
R1#show ip ospf interface

<output omitted>

Serial0/0/0 is up, line protocol is up
  Internet address is 192.168.10.1/30, Area 0
  Process ID 1, Router ID 10.1.1.1, Network Type POINT-TO-POINT, Cost:
1562
  Transmit Delay is 1 sec, State POINT-TO-POINT,
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    Hello due in 00:00:05
  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 10.2.2.2
  Suppress hello for 0 neighbor(s)
Serial0/0/1 is up, line protocol is up
  Internet address is 192.168.10.5/30, Area 0
  Process ID 1, Router ID 10.1.1.1, Network Type POINT-TO-POINT, Cost:
1562
  Transmit Delay is 1 sec, State POINT-TO-POINT,

<output omitted>
```

Step 5: Use the `ip ospf cost` command to configure the OSPF cost on the R3 router.

An alternative method to using the **`bandwidth`** command is to use the **`ip ospf cost`** command, which allows you to directly configure the cost. Use the **`ip ospf cost`** command to change the bandwidth of the serial interfaces of the R3 router to 1562.

```
R3(config)#interface serial0/0/0
R3(config-if)#ip ospf cost 1562
R3(config-if)#interface serial0/0/1
R3(config-if)#ip ospf cost 1562
```

Step 6: Use the `show ip ospf interface` command on the R3 router to verify that the cost of the link the cost of each of the Serial links is now 1562.

```
R3#show ip ospf interface

<output omitted>
```



```
Serial0/0/1 is up, line protocol is up
  Internet address is 192.168.10.10/30, Area 0
  Process ID 1, Router ID 10.3.3.3, Network Type POINT-TO-POINT, Cost:
1562
  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 10.2.2.2
  Suppress hello for 0 neighbor(s)
Serial0/0/0 is up, line protocol is up
  Internet address is 192.168.10.6/30, Area 0
  Process ID 1, Router ID 10.3.3.3, Network Type POINT-TO-POINT, Cost:
1562
  Transmit Delay is 1 sec, State POINT-TO-POINT,

<output omitted>
```

Task 10: Redistribute an OSPF Default Route

Step 1: Configure a loopback address on the R1 router to simulate a link to an ISP.

```
R1(config)#interface loopback1

%LINK-5-CHANGED: Interface Loopback1, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback1, changed
state to up

R1(config-if)#ip address 172.30.1.1 255.255.255.252
```

Step 2: Configure a static default route on the R1 router.

Use the loopback address that ha been configured to simulate a link to an ISP as the exit interface.

```
R1(config)#ip route 0.0.0.0 0.0.0.0 loopback1
R1(config)#
```

Step 3: Use the `default-information originate` command to include the static route in the OSPF updates that are sent from the R1 router.

```
R1(config)#router ospf 1
R1(config-router)#default-information originate
R1(config-router)#
```


Step 4: View the routing table on the R2 router to verify that the static default route is being redistributed via OSPF.

```
R2#show ip route

<output omitted>

Gateway of last resort is 192.168.10.1 to network 0.0.0.0

     10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C       10.2.2.2/32 is directly connected, Loopback0
C       10.10.10.0/24 is directly connected, FastEthernet0/0
     172.16.0.0/16 is variably subnetted, 2 subnets, 2 masks
O       172.16.1.16/28 [110/1563] via 192.168.10.1, 00:29:28,
Serial0/0/0
O       172.16.1.32/29 [110/1563] via 192.168.10.10, 00:29:28,
Serial0/0/1
     192.168.10.0/30 is subnetted, 3 subnets
C       192.168.10.0 is directly connected, Serial0/0/0
O       192.168.10.4 [110/3124] via 192.168.10.10, 00:25:56,
Serial0/0/1
                    [110/3124] via 192.168.10.1, 00:25:56, Serial0/0/0
C       192.168.10.8 is directly connected, Serial0/0/1
O*E2 0.0.0.0/0 [110/1] via 192.168.10.1, 00:01:11, Serial0/0/0
R2#
```

Task 11: Configure Additional OSPF Features

Step 1: Use the `auto-cost reference-bandwidth` command to adjust the reference bandwidth value.

Increase the reference bandwidth to 10000 to simulate 10GigE speeds. Configure this command on all routers in the OSPF routing domain.

```
R1(config-router)#auto-cost reference-bandwidth 10000
% OSPF: Reference bandwidth is changed.
        Please ensure reference bandwidth is consistent across all
routers.

R2(config-router)#auto-cost reference-bandwidth 10000
% OSPF: Reference bandwidth is changed.
        Please ensure reference bandwidth is consistent across all
routers.


R3(config-router)#auto-cost reference-bandwidth 10000
% OSPF: Reference bandwidth is changed.
        Please ensure reference bandwidth is consistent across all
routers.
```

Step 2: Examine the routing table on the R1 router to verify the change in the OSPF cost metric.

Notice that the values are much larger cost values for OSPF routes.

```
R1#show ip route

<output omitted>
```



```
Gateway of last resort is 0.0.0.0 to network 0.0.0.0

     10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C       10.1.1.1/32 is directly connected, Loopback0
O       10.10.10.0/24 [110/65635] via 192.168.10.2, 00:01:01,
Serial0/0/0
     172.16.0.0/16 is variably subnetted, 2 subnets, 2 masks
C       172.16.1.16/28 is directly connected, FastEthernet0/0
O       172.16.1.32/29 [110/65635] via 192.168.10.6, 00:00:51,
Serial0/0/1
     172.30.0.0/30 is subnetted, 1 subnets
C       172.30.1.0 is directly connected, Loopback1
     192.168.10.0/30 is subnetted, 3 subnets
C       192.168.10.0 is directly connected, Serial0/0/0
C       192.168.10.4 is directly connected, Serial0/0/1
O       192.168.10.8 [110/67097] via 192.168.10.2, 00:01:01,
Serial0/0/0
S*   0.0.0.0/0 is directly connected, Loopback1
R1#
```

Step 3: Use the `show ip ospf neighbor` command on R1 to view the Dead Time counter.
The Dead Time counter is counting down from the default interval of 40 seconds.

```
R1#show ip ospf neighbor
Neighbor ID     Pri   State           Dead Time   Address
Interface
10.2.2.2          0   FULL/-          00:00:34    192.168.10.2
Serial0/0/0
10.3.3.3          0   FULL/-          00:00:34    192.168.10.6
Serial0/0/1
```

Step 4: Configure the OSPF Hello and Dead intervals.
The OSPF Hello and Dead intervals can be modified manually using the **`ip ospf hello-interval`** and **`ip ospf dead-interval`** interface commands. Use these commands to change the hello interval to 5 seconds and the dead interval to 20 seconds on the Serial 0/0/0 interface of the R1 router.

```
R1(config)#interface serial0/0/0
R1(config-if)#ip ospf hello-interval 5
R1(config-if)#ip ospf dead-interval 20
R1(config-if)#
01:09:04: %OSPF-5-ADJCHG: Process 1, Nbr 10.2.2.2 on Serial0/0/0 from
FULL to DOWN, Neighbor Down: Dead timer expired
01:09:04: %OSPF-5-ADJCHG: Process 1, Nbr 10.2.2.2 on Serial0/0/0 from
FULL to Down: Interface down or detached
```

After 20 seconds the Dead Timer on R1 expires. R1 and R2 loose adjacency because the Dead Timer and Hello Timers must be configured identically on each side of the serial link between R1 and R2.

Step 5: Modify the Dead Timer and Hello Timer intervals.
Modify the Dead Timer and Hello Timer intervals on the Serial 0/0/0 interface in the R2 router to match the intervals configured on the Serial 0/0/0 interface of the R1 router.


```
R2(config)#interface serial0/0/0
R2(config-if)#ip ospf hello-interval 5
R2(config-if)#ip ospf dead-interval 20
R2(config-if)#
01:12:10: %OSPF-5-ADJCHG: Process 1, Nbr 10.1.1.1 on Serial0/0/0 from
EXCHANGE to FULL, Exchange Done
```

Notice that the IOS displays a message when adjacency has been established with a state of Full.

Step 5: Use the `show ip ospf interface serial0/0/0` command to verify that the Hello Timer and Dead Timer intervals have been modified.

```
R2#show ip ospf interface serial0/0/0
Serial0/0/0 is up, line protocol is up
  Internet address is 192.168.10.2/30, Area 0
  Process ID 1, Router ID 10.2.2.2, Network Type POINT-TO-POINT, Cost:
1562
  Transmit Delay is 1 sec, State POINT-TO-POINT,
  Timer intervals configured, Hello 5, Dead 20, Wait 20, 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 10.1.1.1
  Suppress hello for 0 neighbor(s)
R2#
```

Step 6: Use the `show ip ospf neighbor` command on R1 to verify that the neighbor adjacency with R2 has been restored.

Notice that the Dead Time for Serial 0/0/0 is now much lower since it is counting down from 20 seconds instead of the default 40 seconds. Serial 0/0/1 is still operating with default timers.

```
R1#show ip ospf neighbor
Neighbor ID     Pri   State           Dead Time    Address
Interface
10.2.2.2          0   FULL/-          00:00:19     192.168.10.2
Serial0/0/0
10.3.3.3          0   FULL/-          00:00:34     192.168.10.6
Serial0/0/1
R1#
```

Task 12: Document the Router Configurations.

On each router, capture the following command output to a text file and save for future reference:

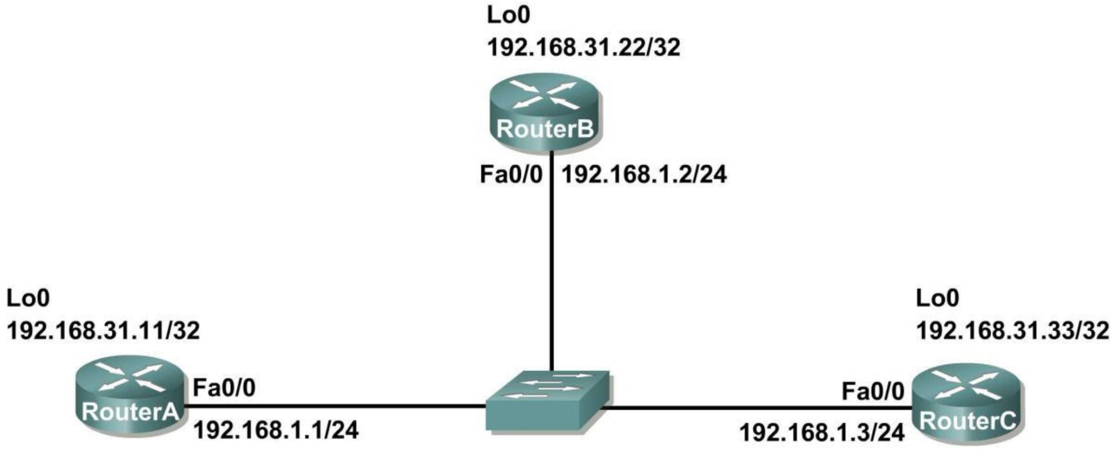
- Running configuration
- Routing table
- Interface summarization
- Output from **`show ip protocols`**

Task 11: Clean Up.

Erase the configurations and reload the routers. Disconnect and store the cabling. For PC hosts that are normally connected to other networks (such as the school LAN or to the Internet), reconnect the appropriate cabling and restore the TCP/IP settings.

Scenario B: Configure OSPF on a Multi-access Network

Topology Diagram



Device	Interface	IP Address	Subnet Mask	Default Gateway
R1	Fa0/0	192.168.1.1	255.255.255.0	N/A
	Loopback1	192.168.31.11	255.255.255.255	N/A
R2	Fa0/0	192.168.1.2	255.255.255.0	N/A
	Loopback1	192.168.31.22	255.255.255.255	N/A
R3	Fa0/0	192.168.1.3	255.255.255.0	N/A
	Loopback1	192.168.31.33	255.255.255.255	N/A

Task 1: Prepare the Network.

Step 1: Cable a network that is similar to the one in the Topology Diagram.

You can use any current router in your lab as long as it has the required interfaces shown in the topology.

Note: If you use 1700, 2500, or 2600 routers, the router outputs and interface descriptions will appear different.

In this topology we have three routers sharing a common Ethernet multiaccess network, 192.168.1.0/24. Each router will be configured with an IP address on the Fast Ethernet interface and a loopback address for the router ID.

Step 2: Clear any existing configurations on the routers.

Task 2: Perform Basic Router Configurations.

Perform basic configuration of the R1, R2, and R3 routers according to the following guidelines:

1. Configure the router hostname.
2. Disable DNS lookup.
3. Configure a privileged EXEC mode password.
4. Configure a message-of-the-day banner.
5. Configure a password for console connections.
6. Configure a password for VTY connections

Task 3: Configure and Activate Ethernet and Loopback Addresses

Step 1: Configure interfaces on R1, R2, and R3.

Configure the Ethernet and Loopback interfaces on the R1, R2, and R3 routers with the IP addresses from the table under the Topology Diagram. Use the **`show ip interface brief`** command to verify that the IP addressing is correct. When you have finished, be sure to save the running configuration to the NVRAM of the router.

Step 2: Verify IP addressing and interfaces.

Use the **show ip interface brief** command to verify that the IP addressing is correct and that the interfaces are active.

When you have finished, be sure to save the running configuration to the NVRAM of the router.

Task 4: Configure OSPF on the DR Router

The DR and BDR election process takes place as soon as the first router has its interface enabled on the multiaccess network. This can happen as the routers are powered-on or when the OSPF **`network`** command for that interface is configured. If a new router enters the network after the DR and BDR have already been elected, it will not become the DR or BDR even if it has a higher OSPF interface priority or router ID than the current DR or BDR. Configure the OSPF process on the router with the highest router ID first to ensure that this router becomes the DR.

Step 1: Use the `router ospf` command in global configuration mode to enable OSPF on the R3 router.

Enter a process ID of 1 for the *`process-ID`* parameter. Configure the router to advertise the 192.168.1.0/24 network. Use an area ID of 0 for the OSPF *`area-id`* parameter in the **`network`** statement.

```
R3(config)#router ospf 1
R3(config-router)#network 192.168.1.0 0.0.0.255 area 0
R3(config-router)#end
R3#
```

Step 2: Use the `show ip ospf interface` command to verify that the OSPF has been configured correctly and that R3 is the DR.

```
R3#show ip ospf interface
FastEthernet0/0 is up, line protocol is up
  Internet address is 192.168.1.3/24, Area 0
```



```
  Process ID 1, Router ID 192.168.31.33, Network Type BROADCAST, Cost:
1
  Transmit Delay is 1 sec, State DR, Priority 1
  Designated Router (ID) 192.168.31.33, Interface address 192.168.1.3
  No backup designated router on this network
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    Hello due in 00:00:07
  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)
R3#
```

Task 5: Configure OSPF on the BDR Router

Configure the OSPF process on the router with the second highest router ID next to ensure that this router becomes the BDR.

Step 1: Use the `router ospf` command in global configuration mode to enable OSPF on the R2 router.

Enter a process ID of 1 for the *process-ID* parameter. Configure the router to advertise the 192.168.1.0/24 network. Use an area ID of 0 for the OSPF *area-id* parameter in the **network** statement.

```
R2(config)#router ospf 1
R2(config-router)#network 192.168.1.0 0.0.0.255 area 0
R2(config-router)#end
%SYS-5-CONFIG_I: Configured from console by console
R2#
00:08:51: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.31.33 on
FastEthernet0/0 from LOADING to FULL, Loading Done
```

Notice that an adjacency is formed with the R3 router. It may take up to 40 seconds for the R3 router to send a hello packet. When this packet is received, the neighbor relationship is formed.

Step 2: Use the `show ip ospf interface` command to verify that the OSPF has been configured correctly and that R2 is the BDR.

```
R2#show ip ospf interface
FastEthernet0/0 is up, line protocol is up
  Internet address is 192.168.1.2/24, Area 0
  Process ID 1, Router ID 192.168.31.22, Network Type BROADCAST, Cost:
1
  Transmit Delay is 1 sec, State BDR, Priority 1
  Designated Router (ID) 192.168.31.33, Interface address 192.168.1.3
  Backup Designated Router (ID) 192.168.31.22, Interface address
192.168.1.2
  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 1, Adjacent neighbor count is 1
    Adjacent with neighbor 192.168.1.3  (Designated Router)
  Suppress hello for 0 neighbor(s)
R2#
```

Step 3: Use the `show ip ospf neighbors` command in global configuration mode to view information about the other routers in the OSPF area.

Notice that R3 is the DR.

```
R2#show ip ospf neighbor
Neighbor ID     Pri   State           Dead Time   Address
Interface
192.168.31.33     1   FULL/DR         00:00:33    192.168.1.3
FastEthernet0/0
```

Task 6: Configure OSPF on the DRother Router

Configure the OSPF process on the router with the lowest router ID last. This router will be designated as DRother instead of DR or BDR.

Step 1: Use the `router ospf` command in global configuration mode to enable OSPF on the R1 router.

Enter a process ID of 1 for the *`process-ID`* parameter. Configure the router to advertise the 192.168.1.0/24 network. Use an area ID of 0 for the OSPF *`area-id`* parameter in the **`network`** statement.

```
R1(config)#router ospf 1
R1(config-router)#network 192.168.1.0 0.0.0.255 area 0
R1(config-router)#end
%SYS-5-CONFIG_I: Configured from console by console
R1#
00:16:08: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.31.22 on
FastEthernet0/0 from LOADING to FULL, Loading Done
00:16:12: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.31.33 on
FastEthernet0/0 from EXCHANGE to FULL, Exchange Done
```

Notice that an adjacency is formed with the R2 and R3 routers. It may take up to 40 seconds for both the R2 and R3 routers to each send a hello packet.

Step 2: Use the `show ip ospf interface` command to verify that the OSPF has been configured correctly and that R1 is a DRother.

```
R1#show ip ospf interface
FastEthernet0/0 is up, line protocol is up
  Internet address is 192.168.1.1/24, Area 0
  Process ID 1, Router ID 192.168.31.11, Network Type BROADCAST, Cost:
1
  Transmit Delay is 1 sec, State DROTHER, Priority 1
  Designated Router (ID) 192.168.31.33, Interface address 192.168.1.3
  Backup Designated Router (ID) 192.168.31.22, Interface address
192.168.1.2
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
```



```
    Hello due in 00:00:00
  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 2, Adjacent neighbor count is 2
    Adjacent with neighbor 192.168.31.33  (Designated Router)
    Adjacent with neighbor 192.168.31.22  (Backup Designated Router)
  Suppress hello for 0 neighbor(s)
R1#
```

Step 3: Use the `show ip ospf neighbors` command in global configuration mode to view information about the other routers in the OSPF area.

Notice that R3 is the DR and R2 is the BDR.

```
R1#show ip ospf neighbor
Neighbor ID     Pri   State           Dead Time   Address
Interface
192.168.31.22     1   FULL/BDR        00:00:35    192.168.1.2
FastEthernet0/0
192.168.31.33     1   FULL/DR         00:00:30    192.168.1.3
FastEthernet0/0
```

Task 7: Use the OSPF Priority to Determine the DR and BDR

Step 1: Use the `ip ospf priority interface` command to change the OSPF priority of the R1 router to 255.

This is the highest possible priority.

```
R1(config)#interface fastEthernet0/0
R1(config-if)#ip ospf priority 255
R1(config-if)#end
```

Step 2: Use the `ip ospf priority interface` command to change the OSPF priority of the R3 router to 100.

```
R3(config)#interface fastEthernet0/0
R3(config-if)#ip ospf priority 100
R3(config-if)#end
```

Step 3: Use the `ip ospf priority interface` command to change the OSPF priority of the R2 router to 0. A priority of 0 causes the router to be ineligible to participate in an OSPF election and become a DR or BDR.

```
R2(config)#interface fastEthernet0/0
R2(config-if)#ip ospf priority 0
R2(config-if)#end
```

Step 4: Shut down and re-enable the FastEthernet0/0 interfaces to force an OSPF election. The FastEthernet0/0 interfaces of each of the routers can be shut down and re-enabled to force an OSPF election. Shut down the FastEthernet0/0 interface on each of the three routers. Notice that as the interfaces are shut down the OSPF adjacencies are lost.

R1:

```
R1(config)#interface fastethernet0/0
R1(config-if)#shutdown

%LINK-5-CHANGED: Interface FastEthernet0/0, changed state to
administratively down
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0,
changed state to down
02:17:22: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.31.22 on
FastEthernet0/0 from FULL to Down: Interface down or detached
02:17:22: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.31.33 on
FastEthernet0/0 from FULL to Down: Interface down or detached
```

R2:

```
R2(config)#interface fastethernet0/0
R2(config-if)#shutdown

%LINK-5-CHANGED: Interface FastEthernet0/0, changed state to
administratively down
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0,
changed state to down
02:17:06: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.31.33 on
FastEthernet0/0 from FULL to Down: Interface down or detached
02:17:06: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.31.11 on
FastEthernet0/0 from FULL to Down: Interface down or detached
```

R3:

```
R3(config)#interface fastethernet0/0
R3(config-if)#shutdown

%LINK-5-CHANGED: Interface FastEthernet0/0, changed state to
administratively down
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0,
changed state to down
02:17:22: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.31.22 on
FastEthernet0/0 from FULL to Down: Interface down or detached
02:17:22: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.31.11 on
FastEthernet0/0 from FULL to Down: Interface down or detached
```

Step 5: Re-enable the FastEthernet0/0 interface on the R2 router.

```
R2(config-if)#no shut
R2(config-if)#end
%SYS-5-CONFIG_I: Configured from console by console
R2#
```

Step 6: Re-enable the FastEthernet0/0 interface on the R1 router.

Notice that an adjacency is formed with the R2 router. It may take up to 40 seconds for the R2 router to send a hello packet.

```
R1(config-if)#no shutdown

%LINK-5-CHANGED: Interface FastEthernet0/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0,
changed state to up
```



```
R1(config-if)#end
%SYS-5-CONFIG_I: Configured from console by console
R1#
02:31:43: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.31.22 on
FastEthernet0/0 from EXCHANGE to FULL, Exchange Done
```

Step 7: Use the `show ip ospf neighbor` command on the R1 router to view the OSPF neighbor information for that router.

Notice that even though the R2 router has a higher router ID than R1, the R2 router has been set to a state of DRother because the OSPF priority has been set to 0.

```
R1#show ip ospf neighbor
Neighbor ID     Pri   State           Dead Time   Address
Interface
192.168.31.22     0   FULL/DROTHER    00:00:33    192.168.1.2
FastEthernet0/0
R1#
```

Step 8: Re-enable the FastEthernet0/0 interface on the R3 router.

Notice that an adjacency is formed with the R1 and R2 routers. It may take up to 40 seconds for both the R1 and R2 routers to each send a hello packet.

```
R3(config-if)#no shutdown

%LINK-5-CHANGED: Interface FastEthernet0/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0,
changed state to up
R3(config-if)#end
%SYS-5-CONFIG_I: Configured from console by console
02:37:32: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.31.11 on
FastEthernet0/0 from LOADING to FULL, Loading Done
02:37:36: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.31.22 on
FastEthernet0/0 from EXCHANGE to FULL, Exchange Done
```

Step 9: Use the `show ip ospf interface` command on the R3 router to verify that R3 has become the BDR.

```
R3#show ip ospf interface
FastEthernet0/0 is up, line protocol is up
  Internet address is 192.168.1.3/24, Area 0
  Process ID 1, Router ID 192.168.31.33, Network Type BROADCAST, Cost:
1
  Transmit Delay is 1 sec, State BDR, Priority 100
  Designated Router (ID) 192.168.31.11, Interface address 192.168.1.1

<output omitted>
```


Task 8: Document the Router Configurations.

On each router, capture the following command output to a text file and save for future reference:

- Running configuration
- Routing table
- Interface summarization
- Output from **`show ip protocols`**

Task 9: Clean Up.

Erase the configurations and reload the routers. Disconnect and store the cabling. For PC hosts that are normally connected to other networks (such as the school LAN or to the Internet), reconnect the appropriate cabling and restore the TCP/IP settings.

