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
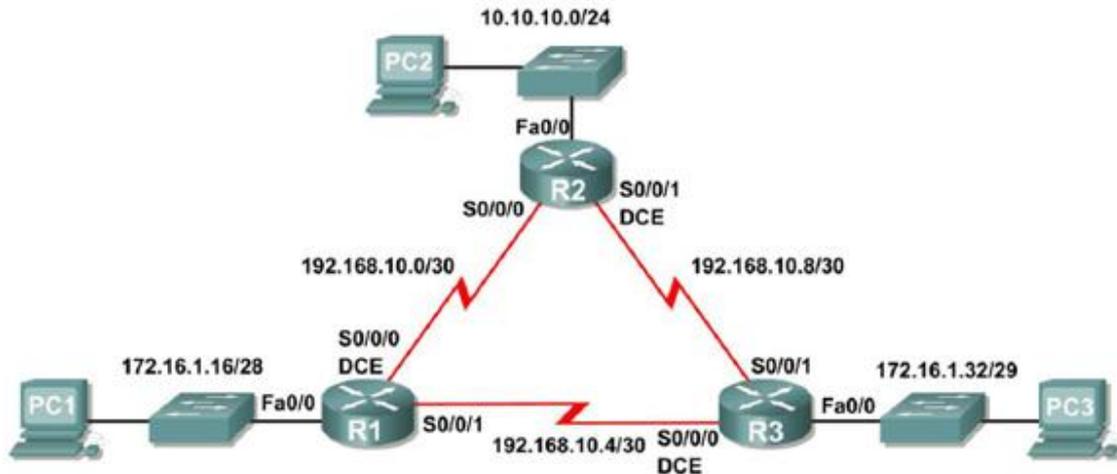
Addressing Table

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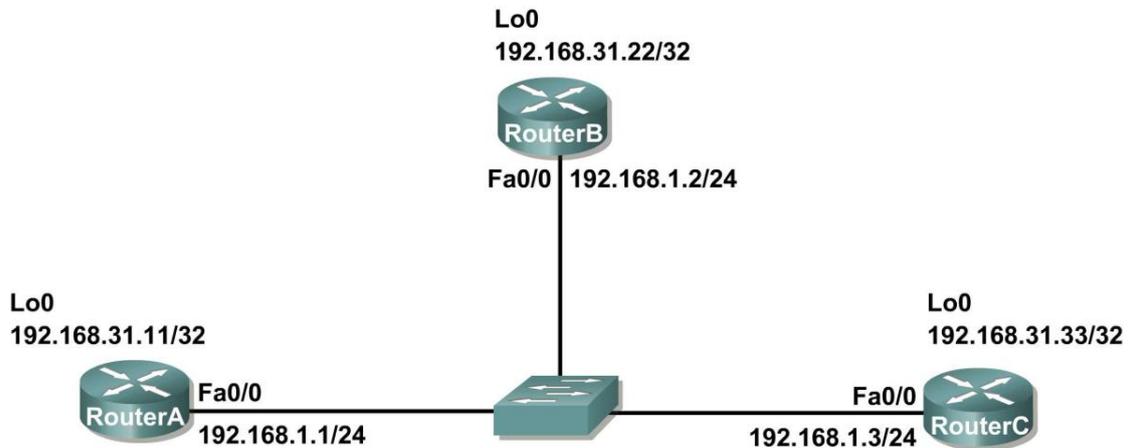
Device	Interface	IP Address	Subnet Mask	Default Gateway
R1	Fa0/0	192.168.1.1	255.255.255.0	N/A
R1	Loopback1	192.168.31.11	255.255.255.255	N/A
R2	Fa0/0	192.168.1.2	255.255.255.0	N/A
R2	Loopback1	192.168.31.22	255.255.255.255	N/A
R3	Fa0/0	192.168.1.3	255.255.255.0	N/A
R3	Loopback1	192.168.31.33	255.255.255.255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

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Lab 11.6.2: Challenge OSPF Configuration Lab

Topology Diagram
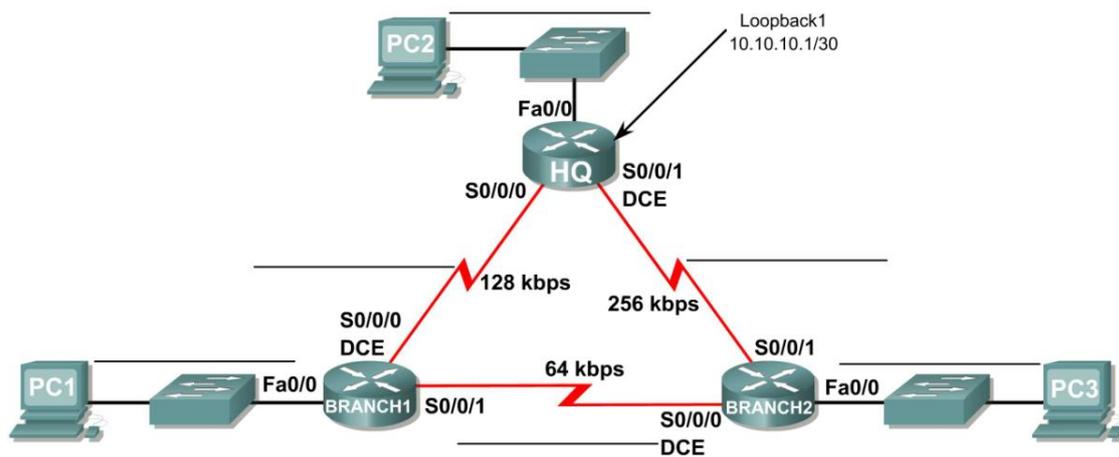
Addressing Table

Device	Interface	IP Address	Subnet Mask	Default Gateway
HQ	Fa0/0			N/A
	S0/0/0			N/A
	S0/0/1			N/A
	Lo1	10.10.10.1	255.255.255.252	N/A
Branch1	Fa0/0			N/A
	S0/0/0			N/A
	S0/0/1			N/A
Branch2	Fa0/0			N/A
	S0/0/0			N/A
	S0/0/1			N/A
PC1	NIC			
PC2	NIC			
PC3	NIC			

Learning Objectives

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

- Create an efficient VLSM design given requirements
- Assign appropriate addresses to interfaces and document
- Cable a network according to the Topology Diagram
- Erase the startup configuration and reload a router to the default state
- Configure routers including OSPF
- Configure and propagate a static default route
- Verify OSPF operation
- Test and verify full connectivity
- Reflect upon and document the network implementation

Scenario

In this lab activity, you will be given a network address that must be subnetted using VLSM to complete the addressing of the network shown in the Topology Diagram. A combination OSPF routing and static routing will be required so that hosts on networks that are not directly connected will be able to communicate with each other. OSPF area ID of 0 and process ID of 1 will be used in all OSPF configurations.

Task 1: Subnet the Address Space.

Step 1: Examine the network requirements.

The addressing for the Network has the following requirements.

- The 172.20.0.0/16 network must be subnetted to provide addresses for the LANs and serial links.
    - The HQ LAN will require 8000 addresses
    - The Branch1 LAN will require 4000 addresses
    - The Branch2 LAN will require 2000 addresses
    - The links between the routers will require two addresses for each link
- The loopback address representing the link between the HQ router and the ISP will use the 10.10.10.0/30 network.

Step 2: Consider the following questions when creating your network design.

How many subnets need to be created from the 172.20.0.0/16 network? _____

How many total IP addresses are required from the 172.20.0.0/16 network? _____

What subnet mask will be used for the HQ LAN subnet? _____

What is the maximum number of host addresses that could be used on this subnet? _____

What subnet mask will be used for the Branch1 LAN subnet? _____

What is the maximum number of host addresses that could be used on this subnet? _____

What subnet mask will be used for the Branch2 LAN subnet? _____

What is the maximum number of host addresses that could be used on this subnet? _____

What subnet mask will be used for the links between the three routers? _____

What is the maximum number of host addresses that could be used on each of these subnets? _____

Step 3: Assign subnetwork addresses to the Topology Diagram.

1. Assign subnet 0 of the 172.20.0.0/16 network to the HQ LAN subnet. What is the network address of this subnet? _____

2. Assign subnet 1 of the 172.20.0.0/16 network to the Branch1 LAN subnet. What is the network address of this subnet? _____

3. Assign subnet 2 of the 172.20.0.0/16 network to the Branch2 LAN subnet. What is the network address of this subnet? _____

4. Assign subnet 3 of the 172.20.0.0/16 network to the link between the HQ and Branch1 routers. What is the network address of this subnet? _____

5. Assign subnet 4 of the 172.20.0.0/16 network to the link between the HQ and Branch2 routers. What is the network address of this subnet? _____

6. Assign subnet 5 of the 172.20.0.0/16 network to the link between the Branch1 and Branch2 routers. What is the network address of this subnet? _____

Task 2: Determine Interface Addresses.

Assign appropriate addresses to the device interfaces.

1. Assign the first valid host address in the 10.10.10.0/30 network to the Loopback 1 interface on the HQ router.

2. Assign the first valid IP address of the HQ LAN network to the LAN interface of the HQ router.

3. Assign the last valid IP address of the HQ LAN network to PC2.

4. Assign the first valid IP address of the Branch1 LAN network to the LAN interface of the Branch1 router.

5. Assign the last valid IP address of the Branch1 LAN network to PC1.
6. Assign the first valid IP address of the Branch2 LAN network to the LAN interface of the Branch2 router.

7. Assign the last valid IP address of the Branch2 LAN network to PC3.

8. Assign the first valid IP address of the HQ to Branch1 link network to the Serial 0/0/0 interface of the HQ router.

9. Assign the last valid IP address of the HQ to Branch1 link network to the Serial0/0/0 interface of the Branch router.

10. Assign the first valid IP address of the HQ to Branch2 link network to the Serial 0/0/1 interface of the HQ router.

11. Assign the last valid IP address of the HQ to Branch2 link network to the Serial0/0/1 interface of the Branch2 router.

12. Assign the first valid IP address of the Branch1 to Branch2 link network to the Serial 0/0/1 interface of the Branch1 router.

13. Assign the last valid IP address of the Branch1 to Branch2 link network to the Serial0/0/0 interface of the Branch2 router.

Document the addresses to be used in the table provided under the Topology Diagram.

Task 3: 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 as shown in the topology.

Step 2: Clear any existing configurations on the routers.

Task 4: Perform Basic Router Configurations.

Perform basic configuration of the BRANCH, HQ, and ISP 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.
7. Synchronize unsolicited messages and debug output with solicited output and prompts for the console and virtual terminal lines.
8. Configure an EXEC timeout of 15 minutes.

Task 5: Configure and Activate Serial and Ethernet Addresses.

Step 1: Configure the interfaces on the HQ, Branch1, and Branch2 routers with the IP addresses from the table provided under the Topology Diagram.

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

Step 2: Configure the Ethernet interfaces of PC1, PC2, and PC3 with the IP addresses from the table provided under the Topology Diagram.

Step 3: Configure the correct bandwidth for the serial interfaces on the Branch 1 router.

What commands are required to accomplish this?

_____

_____

_____

_____

_____

_____

Step 4: Configure the correct bandwidth for the serial interfaces on the Branch 2 router.

What commands are required to accomplish this?

_____

_____

_____

_____

_____

_____

Step 5: Configure the correct bandwidth for the serial interfaces on the HQ router.

What commands are required to accomplish this?

_____

_____

_____

_____

_____

_____

Task 6: Verify Connectivity to Next Hop Device.

You should NOT have connectivity between end devices yet. However, you can test connectivity between two routers and between and end device and its default gateway.

Step 1: Verify that the HQ, Branch1, and Branch2 routers can ping each of the neighboring routers across the WAN links.

Step 2: Verify that PC1, PC2, and PC3 can ping their respective default gateway.

Task 7: Configure OSPF Routing on the Branch1 Router.

Step 1: Consider the networks that need to be included in the OSPF updates that are sent out by the Branch1 router.

What directly connected networks are present in the Branch1 routing table?

_____

_____

_____

What commands are required to enable OSPF and include the connected networks in the routing updates?

_____

_____

_____

_____

_____

Are there any router interfaces that do not need to have OSPF updates sent out? _____

What command is used to disable OSPF updates on these interfaces?

_____

Task 8: Configure OSPF and Static Routing on the HQ Router.

Step 1: Consider the type of static routing that is needed on HQ.

A static default route will need to be configured to send all packets with destination addresses that are not in the routing table to the loopback address representing the link between the HQ router and the ISP. What command is needed to accomplish this?

_____

What directly connected networks are present in the HQ routing table?

_____

_____

_____

_____

_____

Will the networks of the HQ LAN and the links between the Branch 1 and Branch2 routers need to have the subnet mask information included in the network statements? _____

What commands are required to enable OSPF and include the appropriate networks in the routing updates?

_____

_____

_____

_____

_____

_____

Are there any router interfaces that do not need to have OSPF updates sent out? _____

What command is used to disable OSPF updates on these interfaces?

_____

_____

The HQ router needs to send the default route information to the Branch1 and Branch2 routers in the OSPF updates. What command is used to configure this?

_____

Task 9: Configure OSPF Routing on the Branch2 Router.

Step 1: Consider the networks that need to be included in the OSPF updates that are sent out by the Branch2 router.

What directly connected networks are present in the Branch2 routing table?

_____

_____

_____

What commands are required to enable OSPF and include the connected networks in the routing updates?

_____

_____

_____

_____

_____

Are there any router interfaces that do not need to have OSPF updates sent out? _____

What command is used to disable OSPF updates on these interfaces?

_____

Task 10: Verify the Configurations

Answer the following questions to verify that the network is operating as expected.

From PC1, is it possible to ping PC2? _____

From PC1, is it possible to ping the PC3? _____

The answer to the above questions should be 'yes'. If any of the above pings failed, check your physical connections and configurations. Refer to your basic troubleshooting techniques used in the [Chapter 1] labs.

What OSPF routes are present in the routing table of the Branch1 router?

_____

_____

_____

_____

_____

What is the gateway of last resort in the routing table of the Branch1 router?

_____

What OSPF routes are present in the routing table of the HQ router?

_____

_____

_____

_____

_____

What is the gateway of last resort in the routing table of the HQ router?

_____

What OSPF routes are present in the routing table of the Branch2 router?

_____

_____

_____

_____

_____

What is the gateway of last resort in the routing table of the Branch2 router?

_____

Task 11: Reflection

On PC1, use the **tracert** command to examine the route that is used between PC1 and PC3.

What are the hops in the route to PC3?

_____

_____

_____

_____

Is this the least number of hops that can be used to reach PC3? _____

If the answer is no, why is a path with more than the minimum amount of hops used?

_____

_____

_____

_____

_____

_____

Task 12: 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**

If you need to review the procedures for capturing command output, refer to Lab 1.5.1

Task 13: 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.

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Lab 11.6.3: OSPF Troubleshooting Lab

Topology Diagram
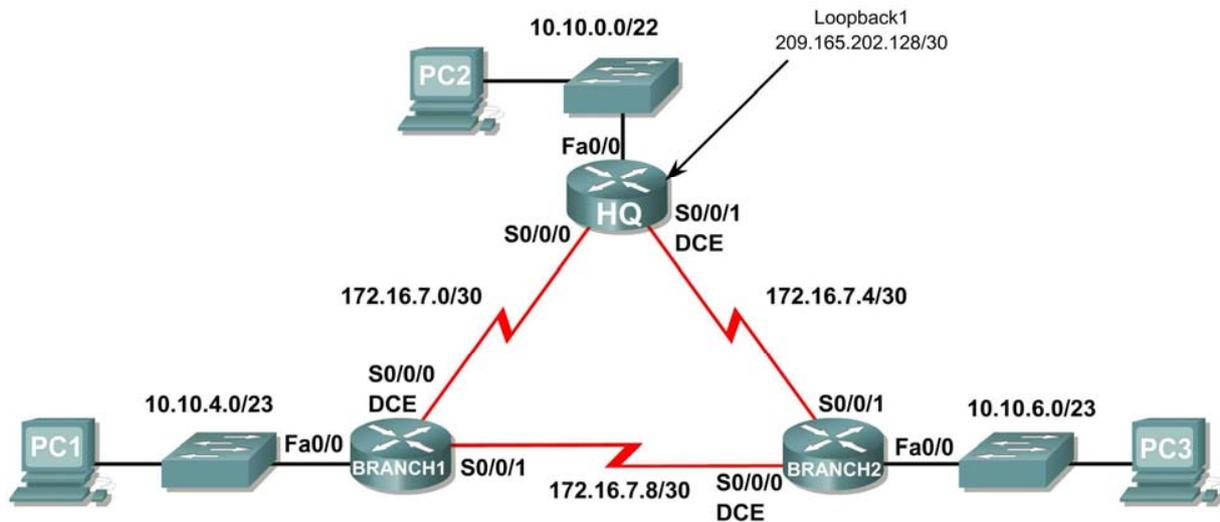
Addressing Table

Device	Interface	IP Address	Subnet Mask	Default Gateway
HQ	Fa0/0	10.10.0.1	255.255.252.0	N/A
	S0/0/0	172.16.7.1	255.255.255.252	N/A
	S0/0/1	172.16.7.5	255.255.255.252	N/A
	Lo1	209.165.202.129	255.255.255.252	N/A
Branch1	Fa0/0	10.10.4.1	255.255.254.0	N/A
	S0/0/0	172.16.7.2	255.255.255.252	N/A
	S0/0/1	172.16.7.9	255.255.255.252	N/A
Branch2	Fa0/0	10.10.6.1	255.255.254.0	N/A
	S0/0/0	172.16.7.10	255.255.255.252	N/A
	S0/0/1	172.16.7.6	255.255.255.252	N/A
PC1	NIC	10.10.5.254	255.255.254.0	10.10.4.1
PC2	NIC	10.10.3.254	255.255.252.0	10.10.0.1
PC3	NIC	10.10.7.254	255.255.254.0	10.10.6.1

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.
- Load the routers with supplied scripts.
- Discover where communication is not possible.
- Gather information about the misconfigured portion of the network along with any other errors.
- Analyze information to determine why communication is not possible.
- Propose solutions to network errors.
- Implement solutions to network errors.
- Document the corrected network.

Scenario

In this lab, you will begin by loading configuration scripts on each of the routers. These scripts contain errors that will prevent end-to-end communication across the network. You will need to troubleshoot each router to determine the configuration errors, and then use the appropriate commands to correct the configurations. When you have corrected all of the configuration errors, all of the hosts on the network should be able to communicate with each other.

The network should also have the following requirements met:

- OSPF routing is configured on the Branch1 router.
- OSPF routing is configured on the Branch2 router.
- OSPF routing is configured on the HQ router.
- OSPF updates must be disabled on the LAN and Loopback interfaces.
- The HQ router must redistribute the default route to the Loopback interface in the routing updates.
- All OSPF routers must use a process ID of 1.
- All OSPF routers must be in area 0.

Task 1: Cable, Erase, and Reload the Routers.

Step 1: Cable a network.

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

Step 2: Clear the configuration on each router.

Clear the configuration on each of the routers using the `erase startup-config` command and then **reload** the routers. Answer **no** if asked to save changes.

Task 2: Load Routers with the Supplied Scripts

Step 1: Load the following script onto the Branch1 router:

```
hostname Branch1
!
no ip domain-lookup
!
```

```
interface FastEthernet0/0
ip address 10.10.4.1 255.255.254.0
 duplex auto
 speed auto
 no shutdown
!
interface Serial0/0/0
ip address 172.16.7.2 255.255.255.252
 no shutdown
!
interface Serial0/0/1
 ip address 172.16.7.9 255.255.255.252
 no shutdown
!
router ospf 1
 passive-interface FastEthernet0/0
 network 10.10.4.0 0.0.1.255 area 0
 network 172.16.7.0 0.0.0.3 area 0
 network 172.16.7.8 0.0.0.3 area 0
!
ip classless
!
line con 0
line vty 0 4
 login
!
end
```

Step 2: Load the following script onto the Branch2 router.

```
hostname Branch2
!
interface FastEthernet0/0
 ip address 10.10.6.1 255.255.254.0
 duplex auto
 speed auto
 no shutdown
!
interface Serial0/0/0
 ip address 172.16.7.10 255.255.255.252
 clock rate 64000
 no shutdown
!
interface Serial0/0/1
 ip address 172.16.7.6 255.255.255.252
!
router ospf 1
 log-adjacency-changes
 passive-interface Serial0/0/1
 network 172.16.7.4 0.0.0.3 area 0
 network 172.16.7.8 0.0.0.3 area 0
 network 10.10.6.0 0.0.3.255 area 0
!
ip classless
!
line con 0
```

```
line vty 0 4
 login
!
end
```

Step 3: Load the following script onto the HQ router.

```
hostname HQ
!
no ip domain-lookup
!
interface FastEthernet0/0
 ip address 10.10.10.1 255.255.252.0
 duplex auto
 speed auto
 no shutdown
!
interface Serial0/0/0
 ip address 172.16.7.1 255.255.255.252
 no shutdown
!
interface Serial0/0/1
 ip address 172.16.7.5 255.255.255.252
 clock rate 64000
 no shutdown
!
interface Loopback1
 ip address 209.165.202.129 255.255.255.252
!
router ospf 1
 log-adjacency-changes
 passive-interface FastEthernet0/0
 passive-interface Loopback1
 network 172.16.7.0 0.0.0.3 area 0
 network 172.16.7.4 0.0.0.3 area 0
 network 10.10.0.0 0.0.7.255 area 0
!
ip classless
ip route 0.0.0.0 0.0.0.0 loopback1
!
line con 0
line vty 0 4
 login
!
end
```

Task 3: Troubleshoot the Branch1 Router

Step 1: Begin troubleshooting at the Host connected to the Branch1 router.

From the host PC1, is it possible to ping PC2? _____

From the host PC1, is it possible to ping PC3? _____

From the host PC1, is it possible to ping the default gateway? _____

Step 2: Examine the Branch1 router to find possible configuration errors.

Begin by viewing the summary of status information for each interface on the router.

Are there any problems with the status of the interfaces?

_____

_____

If there are any problems with the configuration of the interfaces, record any commands that will be necessary to correct the configuration errors.

_____

_____

_____

Step 3: If you have recorded any commands above, apply them to the router configuration now.

Step 4: View summary of the status information.

If any changes were made to the configuration in the previous step, view the summary of the status information for the router interfaces again.

Does the information in the interface status summary indicate any configuration errors on the Branch1 router? _____

If the answer is **yes**, troubleshoot the interface status of the interfaces again.

Step 5: Troubleshoot the routing configuration on the Branch1 router.

What routes are shown in the routing table?

_____

_____

_____

_____

_____

_____

Are there any problems with the routing table?

_____

_____

_____

_____

Does the information in routing table indicate any configuration errors on the Branch1 router, or will it be necessary to troubleshoot the configurations on the other two routers to correct the errors?

_____

_____

Step 6: Attempt to ping between the hosts again.

From the host PC1, is it possible to ping PC2? _____

From the host PC1, is it possible to ping PC3? _____

From the host PC1, is it possible to ping the Serial 0/0/0 interface of the HQ router? _____

From the host PC1, is it possible to ping the Serial 0/0/1 interface of the HQ router? _____

Task 4: Troubleshoot the HQ Router

Step 1: Begin troubleshooting at the host PC2.

From the host PC2, is it possible to ping PC1? _____

From the host PC2, is it possible to ping PC3? _____

From the host PC2, is it possible to ping the default gateway? _____

Step 2: Examine the HQ router to find possible configuration errors.

Begin by viewing the summary of status information for each interface on the router.

Are there any problems with the status of the interfaces?

_____

_____

_____

_____

If there are any problems with the configuration of the interfaces, record any commands that will be necessary to correct the configuration errors.

_____

_____

_____

_____

Are there any problems with the interface status that could be due to errors on other parts of the network?

_____

_____

_____

_____

Step 3: If you have recorded any commands above, apply them to the router configuration now.

Step 4: View summary of the status information.

If any changes were made to the configuration in the previous step, view the summary of the status information for the router interfaces again.

Does the information in the interface status summary indicate any configuration errors on the HQ router? _____

If the answer is **yes**, troubleshoot the interface status of the interfaces again.

Step 5: Troubleshoot the routing configuration on the HQ router.

What routes are shown in the routing table?

_____

_____

_____

_____

_____

_____

_____

_____

Are there any problems with the routing table?

_____

_____

_____

_____

Use the `show running-configuration`, `show ip protocols`, and `show ip ospf neighbor` commands to view information about the OSPF configuration on the HQ router. Are there any additional problems with the OSPF configuration?

_____

_____

_____

_____

If there are any problems with the OSPF configuration, record any commands that will be necessary to correct the configuration errors.

_____

_____

_____

_____

_____

_____

Are there any problems on the HQ router that could be due to errors on other parts of the network?

_____

_____

_____

_____

Step 6: If you have recorded any commands above; apply them to the router configuration now.

Step 7: View the routing information.

If any changes were made to the configuration in the previous steps, view the routing information again.

Does the information in routing table indicate any configuration errors on the HQ router? _____

If the answer to either of this is **yes**, troubleshoot the routing configuration again.

Step 8: Attempt to ping between the hosts again.

From the host PC2, is it possible to ping PC1? _____

From the host PC2, is it possible to ping PC3? _____

From the host PC2, is it possible to ping the Serial 0/0/0 interface of the Branch2 router? _____

From the host PC2, is it possible to ping the Serial 0/0/1 interface of the Branch2 router? _____

Task 5: Troubleshoot the Branch2 Router

Step 1: Begin troubleshooting at the Host PC3.

From the host PC3, is it possible to ping PC1? _____

From the host PC3, is it possible to ping PC2? _____

From the host PC3, is it possible to ping the default gateway? _____

From the host PC3, is it possible to ping the Serial0/0/1 interface of the Branch 2 router? _____

Step 2: Examine the Branch2 router to find possible configuration errors.

Begin by viewing the summary of status information for each interface on the router.

Are there any problems with the status of the interfaces?

_____
_____

If there are any problems with the configuration of the interfaces, record any commands that will be necessary to correct the configuration errors.

_____
_____
_____
_____

Step 3: If you have recorded any commands above, apply them to the router configuration now.

Step 4: View summary of the status information.

If any changes were made to the configuration in the previous step, view the summary of the status information for the router interfaces again.

Does the information in the interface status summary indicate any configuration errors on the Branch router? _____

If the answer is **yes**, troubleshoot the interface status of the interfaces again.

Step 5: Troubleshoot the routing configuration on the Branch2 router.

What routes are shown in the routing table?

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Are there any problems with the routing table?

_____

_____

Use the `show running-configuration`, `show ip protocols`, and `show ip ospf neighbor`
commands to view information about the OSPF configuration on the Branch2 router. Are there any
problems with the OSPF configuration?

_____

_____

_____

_____

If there are any problems with the OSPF configuration, record any commands that will be necessary to
correct the configuration errors.

_____

_____

_____

_____

_____

_____

Step 6: If you have recorded any commands above; apply them to the router configuration now.

Step 7: View the routing information.

If any changes were made to the configuration in the previous steps, view the routing information again.

Does the information in routing table indicate any configuration errors on the Branch2 router? _____

If the answer to this question is **yes**, troubleshoot the routing configuration again.

What routes are shown in the routing table?

_____

_____

_____

_____

_____

_____

_____

_____

Step 8: Attempt to ping between the hosts again.

From the host PC3, is it possible to ping PC1? _____

From the host PC3, is it possible to ping PC2? _____

From the host PC3, is it possible to ping the Serial 0/0/0 interface of the Branch1 router? _____

From the host PC3, is it possible to ping the Serial 0/0/1 interface of the Branch1 router? _____

Task 6: Reflection

There were a number of configuration errors in the scripts that were provided for this lab. Use the space below to write a brief description of the errors that you found.

_____

_____

_____

_____

_____

_____

_____

_____

Task 7: 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`**

If you need to review the procedures for capturing command output, refer to Lab 1.5.1

Task 8: 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.