Lab - Configuring OSFPv2 Advanced Features
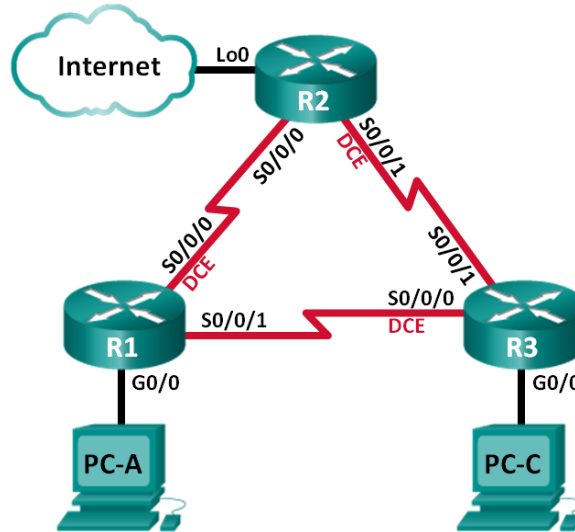
Topology

Addressing Table

Device	Interface	IP Address	Subnet Mask	Default Gateway
R1	G0/0	192.168.1.1	255.255.255.0	N/A
	S0/0/0 (DCE)	192.168.12.1	255.255.255.252	N/A
	S0/0/1	192.168.13.1	255.255.255.252	N/A
R2	Lo0	209.165.200.225	255.255.255.252	N/A
	S0/0/0	192.168.12.2	255.255.255.252	N/A
	S0/0/1 (DCE)	192.168.23.1	255.255.255.252	N/A
R3	G0/0	192.168.3.1	255.255.255.0	N/A
	S0/0/0 (DCE)	192.168.13.2	255.255.255.252	N/A
	S0/0/1	192.168.23.2	255.255.255.252	N/A
PC-A	NIC	192.168.1.3	255.255.255.0	192.168.1.1
PC-C	NIC	192.168.3.3	255.255.255.0	192.168.3.1

Objectives

Part 1: Build the Network and Configure Basic Device Settings

Part 2: Configure and Verify OSPF Routing

Part 3: Change OSPF Metrics

Part 4: Configure and Propagate a Static Default Route

Part 5: Configure OSPF Authentication

Background / Scenario

Open Shortest Path First (OSPF) has advanced features to allow changes to be made to control metrics, default route propagation, and security.

In this lab, you will adjust OSPF metrics on the router interfaces, configure OSPF route propagation, and use Message Digest 5 (MD5) authentication to secure OSPF routing information.

Note: The routers used with CCNA hands-on labs are Cisco 1941 Integrated Services Routers (ISRs) with Cisco IOS Release 15.2(4)M3 (universalk9 image). Other routers and Cisco IOS versions can be used. Depending on the model and Cisco IOS version, the commands available and output produced might vary from what is shown in the labs. Refer to the Router Interface Summary Table at the end of this lab for the correct interface identifiers.

Note: Make sure that the routers have been erased and have no startup configurations. If you are unsure, contact your instructor.

Required Resources

- 3 Routers (Cisco 1941 with Cisco IOS Release 15.2(4)M3 universal image or comparable)
- 2 PCs (Windows 7, Vista, or XP with terminal emulation program, such as Tera Term)
- Console cables to configure the Cisco IOS devices via the console ports
- Ethernet and serial cables as shown in the topology

Part 1:   Build the Network and Configure Basic Device Settings

In Part 1, you will set up the network topology and configure basic settings on the PC hosts and routers.

Step 1:   Cable the network as shown in the topology.

Step 2:   Initialize and reload the routers as necessary.

Step 3:   Configure basic settings for each router.

a. Disable DNS lookup.

b. Configure device name as shown in the topology.

c. Assign **class** as the privileged EXEC password.

d. Assign **cisco** as the console and vty passwords.

e. Encrypt the clear text passwords.

f. Configure a MOTD banner to warn users that unauthorized access is prohibited.

g. Configure **logging synchronous** for the console line.

h. Configure the IP addresses listed in the Addressing Table for all interfaces.

i. Set the clock rate for all DCE serial interfaces at 128000.

j. Copy the running configuration to the startup configuration.

Step 4:   Configure PC hosts.

Refer to the Addressing Table for PC host address information.

Step 5: Test connectivity.

At this point, the PCs are unable to ping each other. However, the routers should be able to ping the directly connected neighbor interfaces, and the PCs should be able to ping their default gateway. Verify and troubleshoot if necessary.

Part 2: Configure and Verify OSPF Routing

In Part 2, you will configure OSPFv2 routing on all routers in the network and then verify that routing tables are updated correctly.

Step 1: Configure the router ID on all routers.

Assign 1 as the process ID for this OSPF process. Each router should be given the following router ID assignments:

- R1 Router ID: **1.1.1.1**
- R2 Router ID: **2.2.2.2**
- R3 Router ID: **3.3.3.3**

Step 2: Configure OSPF network information on the routers.

Step 3: Verify OSPF routing.

a. Issue the **show ip ospf neighbor** command to verify that each router is listing the other routers in the network.

b. Issue the **show ip route ospf** command to verify that all OSPF networks are present in the routing table on all routers.

Step 4: Test end-to-end connectivity.

Ping PC-C from PC-A to verify end-to-end connectivity. The pings should be successful. If they are not, troubleshoot as necessary.

Note: It may be necessary to disable the PC firewall for the pings to be successful.

Part 3: Change OSPF Metrics

In Part 3, you will change OSPF metrics using the **bandwidth** command, the **auto-cost reference-bandwidth** command, and the **ip ospf cost** command. Making these changes will provide more accurate metrics to OSPF.

Note: All DCE interfaces should have been configured with a clocking rate of 128000 in Part 1.

Step 1: Change the bandwidth on all serial interfaces to 128Kb/s.

a. Issue the **show ip ospf interface brief** command to view the default cost settings on the router interfaces.

```
R1# show ip ospf interface brief
Interface     PID   Area            IP Address/Mask     Cost  State Nbrs F/C
Se0/0/1       1     0               192.168.13.1/30     64    P2P   1/1
Se0/0/0       1     0               192.168.12.1/30     64    P2P   1/1
Gi0/0         1     0               192.168.1.1/24      1     DR    0/0
```

b. Use the **bandwidth 128** interface command on all serial interfaces.

c. Issue the **show ip ospf interface brief** command to view the new cost settings.

```
R1# show ip ospf interface brief
Interface   PID   Area          IP Address/Mask    Cost  State Nbrs F/C
Se0/0/1     1     0             192.168.13.1/30    781   P2P   1/1
Se0/0/0     1     0             192.168.12.1/30    781   P2P   1/1
Gi0/0       1     0             192.168.1.1/24     1     DR    0/0
```

Step 2: Change the reference bandwidth on the routers.

a. Issue the **auto-cost reference-bandwidth 1000** command on the routers to change the default reference bandwidth setting to account for Gigabit Ethernet Interfaces.

b. Re-issue the **show ip ospf interface brief** command to view how this command has changed cost values.

```
R1# show ip ospf interface brief
Interface   PID   Area          IP Address/Mask    Cost  State Nbrs F/C
Se0/0/1     1     0             192.168.13.1/30    7812  P2P   0/0
Se0/0/0     1     0             192.168.12.1/30    7812  P2P   0/0
Gi0/0       1     0             192.168.1.1/24     1     DR    0/0
```

Note: If the router had Fast Ethernet interfaces instead of Gigabit Ethernet interfaces, then the cost would now be 10 on those interfaces.

Step 3: Change the route cost.

a. Issue the **show ip route ospf** command to display the current OSPF routes on R1. Notice that there are currently two routes in the table that use the S0/0/1 interface.

```
R1# show ip route ospf
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, 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, H - NHRP, l - LISP
       + - replicated route, % - next hop override


Gateway of last resort is not set


O    192.168.3.0/24 [110/7822] via 192.168.13.2, 00:00:12, Serial0/0/1
        192.168.23.0/30 is subnetted, 1 subnets
O       192.168.23.0 [110/15624] via 192.168.13.2, 00:00:12, Serial0/0/1
                     [110/15624] via 192.168.12.2, 00:20:03, Serial0/0/0
```

b. Apply the **ip ospf cost 16000** command to the S0/0/1 interface on R1. A cost of 16,000 is higher than the accumulated cost of the route through R2 which is 15,624.

c. Issue the **show ip ospf interface brief** command on R1 to view the cost change to S0/0/1.

```
R1# show ip ospf interface brief
Interface   PID   Area           IP Address/Mask    Cost  State Nbrs F/C
Se0/0/1     1     0              192.168.13.1/30    16000 P2P   1/1
Se0/0/0     1     0              192.168.12.1/30    7812  P2P   1/1
Gi0/0       1     0              192.168.1.1/24     1     DR    0/0
```

d. Re-issue the **show ip route ospf** command on R1 to display the effect this change has made on the routing table. All OSPF routes for R1 are now being routed through R2.

```
R1# show ip route ospf
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
        D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
        N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
        E1 - OSPF external type 1, E2 - OSPF external type 2
        i - IS-IS, su - IS-IS summary, 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, H - NHRP, l - LISP
        + - replicated route, % - next hop override

Gateway of last resort is not set

O     192.168.3.0/24 [110/15625] via 192.168.12.2, 00:05:31, Serial0/0/0
        192.168.23.0/30 is subnetted, 1 subnets
O        192.168.23.0 [110/15624] via 192.168.12.2, 01:14:02, Serial0/0/0
```

Explain why the route to the 192.168.3.0/24 network on R1 is now going through R2?

Part 4: Configure and Propagate a Static Default Route

In Part 4, you will use a loopback interface on R2 to simulate an ISP connection to the Internet. You will create a static default route on R2, and then OSPF will propagate that route to the other two routers on the network.

Step 1: Configure a static default route on R2 to loopback 0.

Configure a default route using the loopback interface configured in Part 1, to simulate a connection to an ISP.

Step 2: Have OSPF propagate the default static route.

Issue the **default-information originate** command to include the static default route in the OSPF updates that are sent from R2.

```
R2(config)# router ospf 1
R2(config-router)# default-information originate
```

Step 3: Verify OSPF static route propagation.

a. Issue the **show ip route static** command on R2.

```
R2# show ip route static
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, 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, H - NHRP, l - LISP
       + - replicated route, % - next hop override

Gateway of last resort is 0.0.0.0 to network 0.0.0.0

S*    0.0.0.0/0 is directly connected, Loopback0
```

b. Issue the **show ip route** command on R1 to verify the propagation of the static route from R2.

```
R1# show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, 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, H - NHRP, l - LISP
       + - replicated route, % - next hop override

Gateway of last resort is 192.168.12.2 to network 0.0.0.0

O*E2  0.0.0.0/0 [110/1] via 192.168.12.2, 00:02:57, Serial0/0/0
      192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.1.0/24 is directly connected, GigabitEthernet0/0
L        192.168.1.1/32 is directly connected, GigabitEthernet0/0
O     192.168.3.0/24 [110/15634] via 192.168.12.2, 00:03:35, Serial0/0/0
      192.168.12.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.12.0/30 is directly connected, Serial0/0/0
L        192.168.12.1/32 is directly connected, Serial0/0/0
      192.168.13.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.13.0/30 is directly connected, Serial0/0/1
L        192.168.13.1/32 is directly connected, Serial0/0/1
      192.168.23.0/30 is subnetted, 1 subnets
O        192.168.23.0 [110/15624] via 192.168.12.2, 00:05:18, Serial0/0/0
```

c. Verify end-to-end connectivity by issuing a ping from PC-A to the ISP interface address 209.165.200.225.

Were the pings successful?

Part 5: Configure OSPF Authentication

OSPF authentication can be set up at the link level or the area level. There are three authentication types available for OSPF authentication: Null, plain text, or MD5. In Part 5, you will set up OSPF MD5 authentication, which is the strongest available.

Step 1: Set up MD5 OSPF authentication on a single link.

a. Issue the **debug ip ospf adj** command on R2 to view OSPF adjacency messages.

```
R2# debug ip ospf adj
OSPF adjacency debugging is on
```

b. Assign an MD5 key for OSPF Authentication on R1, interface S0/0/0.

```
R1(config)# interface s0/0/0
R1(config-if)# ip ospf message-digest-key 1 md5 MD5KEY
```

c. Activate MD5 authentication on R1, interface S0/0/0.

```
R1(config-if)# ip ospf authentication message-digest
```

OSPF debug messages informing you of a Mismatched Authentication type displays on R2.

```
*Mar 19 00:03:18.187: OSPF-1 ADJ   Se0/0/0: Rcv pkt from 192.168.12.1 : Mismatched
Authentication type. Input packet specified type 2, we use type 0
```

d. Issue the **u all** command, which is the shortest version of the **undebug all** command on R2 to disable debugging.

e. Configure OSPF authentication on R2, interface S0/0/0. Use the same MD5 password you entered for R1.

f. Issue a **show ip ospf interface s0/0/0** command on R2. This command displays the type of authentication at the bottom of the output.

```
R2# show ip ospf interface s0/0/0
Serial0/0/0 is up, line protocol is up
  Internet Address 192.168.12.2/30, Area 0, Attached via Network Statement
  Process ID 1, Router ID 2.2.2.2, Network Type POINT_TO_POINT, Cost: 7812
  Topology-MTID    Cost    Disabled    Shutdown       Topology Name
       0           7812      no          no             Base
  Transmit Delay is 1 sec, State POINT_TO_POINT
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:03
  Supports Link-local Signaling (LLS)
  Cisco NSF helper support enabled
  IETF NSF helper support enabled
  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 1.1.1.1
  Suppress hello for 0 neighbor(s)
  Message digest authentication enabled
    Youngest key id is 1
```

Step 2:   Set up OSPF authentication at the area level.

a.   Issue the **area 0 authentication** command to set MD5 authentication for OSPF Area 0 on R1.

```
R1(config)# router ospf 1
R1(config-router)# area 0 authentication message-digest
```

b.   This option still requires that you assign the MD5 password at the interface level.

```
R1(config)# interface s0/0/1
R1(config-if)# ip ospf message-digest-key 1 md5 MD5KEY
```

c.   Issue the **show ip ospf neighbor** command on R3. R1 no longer has an adjacency with R3.

```
R3# show ip ospf neighbor


Neighbor ID     Pri   State           Dead Time   Address         Interface
2.2.2.2      0   FULL/  -       00:00:31   192.168.23.1   Serial0/0/1
```

d.   Set up area authentication on R3 and assign the same MD5 password to interface S0/0/0.

```
R3(config)# router ospf 1
R3(config-router)# area 0 authentication message-digest
R3(config-router)# interface s0/0/0
R3(config-if)# ip ospf message-digest-key 1 md5 MD5KEY
```

e.   Issue the **show ip ospf neighbor** command on R3. Notice that R1 is now showing as a neighbor, but R2 is missing.

```
R3# show ip ospf neighbor


Neighbor ID     Pri   State           Dead Time   Address         Interface
1.1.1.1      0   FULL/  -       00:00:38   192.168.13.1   Serial0/0/0
```

Why is R2 no longer showing as an OSPF neighbor?

_____

f.   Configure R2 to perform area-level MD5 authentication.

```
R2(config)# router ospf 1
R2(config-router)# area 0 authentication message-digest
```

g.   Assign **MD5KEY** as the MD5 password for the link between R2 and R3.

h.   Issue the **show ip ospf neighbor** command on all routers to verify that all adjacencies have been re-established.

```
R1# show ip ospf neighbor


Neighbor ID     Pri   State           Dead Time   Address         Interface
3.3.3.3          0   FULL/  -       00:00:39   192.168.13.2   Serial0/0/1
2.2.2.2          0   FULL/  -       00:00:35   192.168.12.2   Serial0/0/0


R2# show ip ospf neighbor


Neighbor ID     Pri   State           Dead Time   Address         Interface
3.3.3.3          0   FULL/  -       00:00:36   192.168.23.2   Serial0/0/1
1.1.1.1          0   FULL/  -       00:00:32   192.168.12.1   Serial0/0/0
```

```
R3# show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address         Interface
2.2.2.2           0   FULL/  -        00:00:33    192.168.23.1    Serial0/0/1
1.1.1.1           0   FULL/  -        00:00:39    192.168.13.1    Serial0/0/0
```

Reflection

1. What is the easiest and preferred method of manipulating OSPF route costs?

2. What does the **default-information originate** command do for a network using the OSPF routing protocol?

3. Why is it a good idea to use OSPF authentication?

Router Interface Summary Table

Router Interface Summary				
Router Model	**Ethernet Interface #1**	**Ethernet Interface #2**	**Serial Interface #1**	**Serial Interface #2**
1800	Fast Ethernet 0/0 (F0/0)	Fast Ethernet 0/1 (F0/1)	Serial 0/0/0 (S0/0/0)	Serial 0/0/1 (S0/0/1)
1900	Gigabit Ethernet 0/0 (G0/0)	Gigabit Ethernet 0/1 (G0/1)	Serial 0/0/0 (S0/0/0)	Serial 0/0/1 (S0/0/1)
2801	Fast Ethernet 0/0 (F0/0)	Fast Ethernet 0/1 (F0/1)	Serial 0/1/0 (S0/1/0)	Serial 0/1/1 (S0/1/1)
2811	Fast Ethernet 0/0 (F0/0)	Fast Ethernet 0/1 (F0/1)	Serial 0/0/0 (S0/0/0)	Serial 0/0/1 (S0/0/1)
2900	Gigabit Ethernet 0/0 (G0/0)	Gigabit Ethernet 0/1 (G0/1)	Serial 0/0/0 (S0/0/0)	Serial 0/0/1 (S0/0/1)
Note: To find out how the router is configured, look at the interfaces to identify the type of router and how many interfaces the router has. There is no way to effectively list all the combinations of configurations for each router class. This table includes identifiers for the possible combinations of Ethernet and Serial interfaces in the device. The table does not include any other type of interface, even though a specific router may contain one. An example of this might be an ISDN BRI interface. The string in parenthesis is the legal abbreviation that can be used in Cisco IOS commands to represent the interface.				