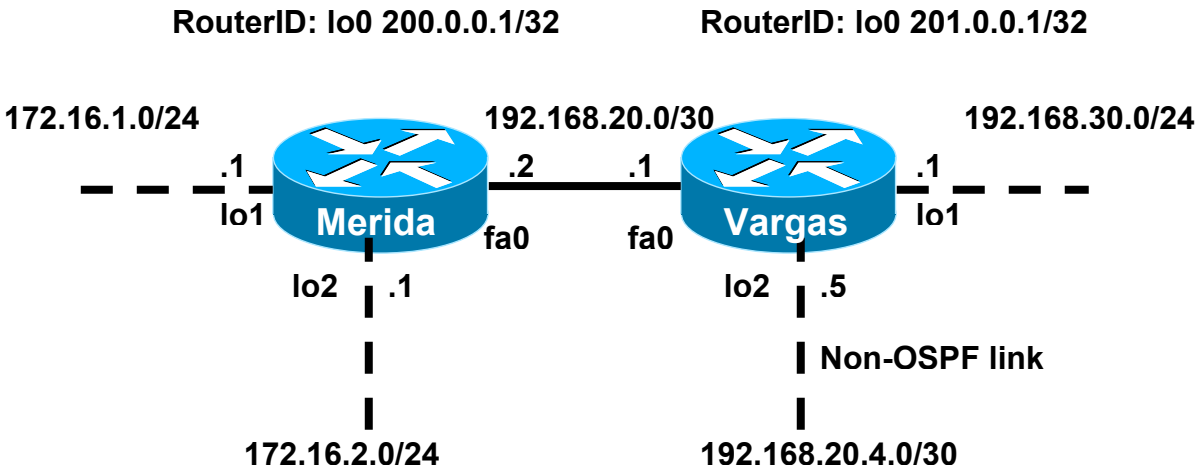
Single Area OSPF Lab



Scenario:

- Loopback0 is used for RouterID
- Loopback1 is a virtual network
- Loopback2 is a virtual network
- Note: OSPF routes loopback networks as /32 host routes.

Objective

- Configure OSPF so both routers will have the correct networks in their routing tables.

Part 1 – Basic OSPF Configuration
Part 2 – OSPF DR/BDR Election Process
Part 3 – Modifying the OSPF Cost with the ip ospf cost command
Part 4 – Modifying the OSPF Cost with bandwidth command
Part 5 – Configuring Simple (Plain Text) Authentication
Part 6 – Configuring MD5 Encrypted Authentication
Part 7 – Configuring Hello and Dead Timers
Part 8 – Configuring a Default Route

Part 1 – Basic OSPF Configuration

Preconfigurations

Merida

```
!
interface Loopback0     RouterID
 ip address 200.0.0.1 255.255.255.255
!
interface Loopback1     Virtual Network
 ip address 172.16.1.1 255.255.255.0
!
interface Loopback2     Virtual Network
 ip address 172.16.2.1 255.255.255.0
!
interface FastEthernet0
 ip address 192.168.20.2 255.255.255.252
!
line con 0
 exec-timeout 0 0
 logging synchronous
```

Vargas

```
!
interface Loopback0     RouterID
 ip address 201.0.0.1 255.255.255.255
!
interface Loopback1     Virtual Network
 ip address 192.168.30.1 255.255.255.0
!
interface Loopback2     Virtual Network
 ip address 192.168.20.5 255.255.255.252
!
interface FastEthernet0
 ip address 192.168.20.1 255.255.255.252
!
line con 0
 exec-timeout 0 0
 logging synchronous
```

Step 1: Enabling OSPF

On the Merida, enable OSPF to run on each interface. There are several ways to do this, but the commands below specify each individual subnet. Notice that the process IDs do not have to be the same on both routers.

```
Merida(config)#router ospf 1
Merida(config-router)#network 172.16.1.0 0.0.0.255 area 0
Merida(config-router)#network 172.16.2.0 0.0.0.255 area 0
Merida(config-router)#network 192.168.20.0 0.0.0.3 area 0
```

We do want to enable OSPF on FastEthernet0, 192.168.20.0/30, but not on the Loopback2 network, 192.168.20.4/30. We are also enabling OSPF on the Loopback1 network, 192.168.30.0/24. Again, there are several ways to do this, but the commands below specify each individual subnet.

```
Vargas(config)#router ospf 10
Vargas(config-router)#network 192.168.20.0 0.0.0.3 area 0
Vargas(config-router)#network 192.168.30.0 0.0.0.255 area 0
```

Step 2: Examine the Routing Tables

Notice, that Merida sees Vargas' network of 192,168.30.0/24 but does not see 192.168.20.4/30. This is because Vargas did not include the network command to include that network. Both routers display all other networks.

```
Merida#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

     192.168.30.0/32 is subnetted, 1 subnets
O       192.168.30.1 [110/2] via 192.168.20.1, 00:09:22, FastEthernet0
     200.0.0.0/32 is subnetted, 1 subnets
C       200.0.0.1 is directly connected, Loopback0
     172.16.0.0/24 is subnetted, 2 subnets
C       172.16.1.0 is directly connected, Loopback1
C       172.16.2.0 is directly connected, Loopback2
     192.168.20.0/30 is subnetted, 1 subnets
C       192.168.20.0 is directly connected, FastEthernet0
Merida#
```

From Meridas' perspective, there is a major network boundary (192.168.20.0/30) between it and Vargas. As you can see in Vargas' routing table, Meridas did not automatically summarize the 172.16.1.0/24 and 172.16.2.0/24 networks, as a classful routing protocol like RIP would do. OSPF does not automatically summarize routes. Smmarization must be manually configured.

```
Vargas#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

C    192.168.30.0/24 is directly connected, Loopback1
     201.0.0.0/32 is subnetted, 1 subnets
C       201.0.0.1 is directly connected, Loopback0
     172.16.0.0/32 is subnetted, 2 subnets
O       172.16.1.1 [110/2] via 192.168.20.2, 00:10:46, FastEthernet0
O       172.16.2.1 [110/2] via 192.168.20.2, 00:10:46, FastEthernet0
     192.168.20.0/30 is subnetted, 2 subnets
C       192.168.20.4 is directly connected, Loopback2
C       192.168.20.0 is directly connected, FastEthernet0
Vargas#
```

Step 3: show commands

```
Merida#show ip protocols
Routing Protocol is "ospf 1"
  Sending updates every 0 seconds
  Invalid after 0 seconds, hold down 0, flushed after 0
  Outgoing update filter list for all interfaces is
  Incoming update filter list for all interfaces is
  Redistributing: ospf 1
  Routing for Networks:
    172.16.1.0/24
    172.16.2.0/24
    192.168.20.0/30
  Routing Information Sources:
    Gateway         Distance      Last Update
    201.0.0.1            110      00:27:51
  Distance: (default is 110)
Merida#
```

If one router boots up first and elects itself as the DR before the other router is ready to participate in the DR/BDR election process, you may see a router with a lower RouterID as the DR. To force both routers to participate in the DR/BDR election process, you can **shutdown** both FastEthernet interfaces, followed by a simultaneous **no shutdown** (or within a few seconds of one another). Below, you can see that Vargas is the DR and Merida is the BDR.

```
Merida#show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address         Interface
201.0.0.1         1   FULL/DR         00:00:35    192.168.20.1    FastEthernet0
Merida#

Merida#show ip ospf
 Routing Process "ospf 1" with ID 200.0.0.1
 Supports only single TOS(TOS0) routes
 SPF schedule delay 5 secs, Hold time between two SPFs 10 secs
 Minimum LSA interval 5 secs. Minimum LSA arrival 1 secs
 Number of external LSA 0. Checksum Sum 0x0
 Number of DCbitless external LSA 0
 Number of DoNotAge external LSA 0
 Number of areas in this router is 1. 1 normal 0 stub 0 nssa
 External flood list length 0
    Area BACKBONE(0)
        Number of interfaces in this area is 3
        Area has no authentication
        SPF algorithm executed 7 times
        Area ranges are
        Number of LSA 3. Checksum Sum 0x1FB55
        Number of DCbitless LSA 0
        Number of indication LSA 0
        Number of DoNotAge LSA 0
        Flood list length 0
Merida#

Merida#show ip ospf interface
FastEthernet0 is up, line protocol is up
  Internet Address 192.168.20.2/30, Area 0
  Process ID 1, Router ID 200.0.0.1, Network Type BROADCAST, Cost: 1
  Transmit Delay is 1 sec, State BDR, Priority 1
  Designated Router (ID) 201.0.0.1, Interface address 192.168.20.1
  Backup Designated router (ID) 200.0.0.1, Interface address 192.168.20.2
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    Hello due in 00:00:06
  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 201.0.0.1  (Designated Router)
  Suppress hello for 0 neighbor(s)
Loopback1 is up, line protocol is up
  Internet Address 172.16.1.1/24, Area 0
  Process ID 1, Router ID 200.0.0.1, Network Type LOOPBACK, Cost: 1
  Loopback interface is treated as a stub Host
Loopback2 is up, line protocol is up
  Internet Address 172.16.2.1/24, Area 0
  Process ID 1, Router ID 200.0.0.1, Network Type LOOPBACK, Cost: 1
  Loopback interface is treated as a stub Host
Merida#
```

Part 2 – OSPF DR/BDR Election Process

In Part 2 we will modify the priority of a FastEthernet interface on Merida to force Merida to become the DR.

Step 1: Modify the OSPF Priority

```
Merida(config)#inter fa 0
Merida(config-if)#ip ospf priority 10
Merida(config-if)#
```

Notice that nothing has changed. A new DR/BDR election process will not happen unless both the DR and BDR fail. If the DR fails, the BDR will become the DR and a new election process will be held for the BDR. In this case, the DR has not failed, so Vargas is still the DR.

```
Merida#show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address         Interface
201.0.0.1         1   FULL/DR         00:00:34    192.168.20.1    FastEthernet0
Merida#
```

Step 2 Observe the DR/BDR Election Process

To force a new DR/BDR election process, we will **shutdown** both interfaces, followed by simultaneous **no shutdown** commands (or by disconnecting the Ethernet cables). We will also observe the DR/BDR election process with **debug ip ospf adj** (adjacency). You will also see the different "Steps to OSPF Operation."

```
Merida#debug ip ospf adj

Merida(config)#inter fa 0                Vargas(config)#inter fa 0
Merida(config-if)#shutdown               Vargas(config-if)#shutdown

Merida(config)#inter fa 0                Vargas(config)#inter fa 0
Merida(config-if)#no shutdown            Vargas(config-if)#no shutdown

04:19:42: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0, changed
 state to up
04:19:42: OSPF: Interface FastEthernet0 going Up
04:19:43: OSPF: Build router LSA for area 0, router ID 200.0.0.1, seq 0x8000000C
04:19:43: OSPF: Rcv hello from 201.0.0.1 area 0 from FastEthernet0 192.168.20.1
04:19:43: OSPF: End of hello processing
04:19:46: OSPF: Rcv hello from 201.0.0.1 area 0 from FastEthernet0 192.168.20.1
04:19:46: OSPF: 2 Way Communication to 201.0.0.1 on FastEthernet0, state 2WAY
04:19:46: OSPF: End of hello processing
04:19:56: OSPF: Rcv hello from 201.0.0.1 area 0 from FastEthernet0 192.168.20.1
04:19:56: OSPF: End of hello processing
04:20:06: OSPF: Rcv hello from 201.0.0.1 area 0 from FastEthernet0 192.168.20.1
04:20:06: OSPF: End of hello processing
04:20:16: OSPF: Rcv hello from 201.0.0.1 area 0 from FastEthernet0 192.168.20.1
04:20:16: OSPF: End of hello processing
04:20:22: OSPF: end of Wait on interface FastEthernet0
```

```
04:20:22: OSPF: DR/BDR election on FastEthernet0
04:20:22: OSPF: Elect BDR 200.0.0.1
04:20:22: OSPF: Elect DR 200.0.0.1
04:20:22: OSPF: Elect BDR 201.0.0.1
04:20:22: OSPF: Elect DR 200.0.0.1
04:20:22:        DR: 200.0.0.1 (Id)    BDR: 201.0.0.1 (Id)
04:20:22: OSPF: Send DBD to 201.0.0.1 on FastEthernet0 seq 0xE0C opt 0x2 flag 0x
7 len 32
04:20:23: OSPF: Build network LSA for FastEthernet0, router ID 200.0.0.1
04:20:23: OSPF: No full nbrs to build Net Lsa for interface FastEthernet0
04:20:23: OSPF: Rcv DBD from 201.0.0.1 on FastEthernet0 seq 0x2657 opt 0x2 flag
0x7 len 32  mtu 1500 state EXSTART
04:20:23: OSPF: NBR Negotiation Done. We are the SLAVE
04:20:23: OSPF: Send DBD to 201.0.0.1 on FastEthernet0 seq 0x2657 opt 0x2 flag 0
x2 len 92
04:20:23: OSPF: Rcv DBD from 201.0.0.1 on FastEthernet0 seq 0x2658 opt 0x2 flag
0x3 len 72  mtu 1500 state EXCHANGE
04:20:23: OSPF: Send DBD to 201.0.0.1 on FastEthernet0 seq 0x2658 opt 0x2 flag 0
x0 len 32
04:20:23: OSPF: Database request to 201.0.0.1
04:20:23: OSPF: sent LS REQ packet to 192.168.20.1, length 12
04:20:23: OSPF: Rcv DBD from 201.0.0.1 on FastEthernet0 seq 0x2659 opt 0x2 flag
0x1 len 32  mtu 1500 state EXCHANGE
04:20:23: OSPF: Exchange Done with 201.0.0.1 on FastEthernet0
04:20:23: OSPF: Send DBD to 201.0.0.1 on FastEthernet0 seq 0x2659 opt 0x2 flag 0
x0 len 32
04:20:23: OSPF: Synchronized with 201.0.0.1 on FastEthernet0, state FULL
04:20:24: OSPF: Build router LSA for area 0, router ID 200.0.0.1, seq 0x8000000D
04:20:26: OSPF: Rcv hello from 201.0.0.1 area 0 from FastEthernet0 192.168.20.1
04:20:26: OSPF: Neighbor change Event on interface FastEthernet0
04:20:26: OSPF: DR/BDR election on FastEthernet0
04:20:26: OSPF: Elect BDR 201.0.0.1
04:20:26: OSPF: Elect DR 200.0.0.1
04:20:26:        DR: 200.0.0.1 (Id)    BDR: 201.0.0.1 (Id)
04:20:26: OSPF: End of hello processing
04:20:28: OSPF: Build network LSA for FastEthernet0, router ID 200.0.0.1
04:20:36: OSPF: Rcv hello from 201.0.0.1 area 0 from FastEthernet0 192.168.20.1
04:20:36: OSPF: End of hello processing
04:20:46: OSPF: Rcv hello from 201.0.0.1 area 0 from FastEthernet0 192.168.20.1
04:20:46: OSPF: End of hello processing
Merida#
Merida#undebug all
All possible debugging has been turned off
Merida#
```

Notice that Merida is now the DR and Vargas is now the BDR.

```
Merida#show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address         Interface
201.0.0.1         1   FULL/BDR        00:00:36    192.168.20.1    FastEthernet0
Merida#

Vargas#show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address         Interface
200.0.0.1        10   FULL/DR         00:00:30    192.168.20.2    FastEthernet0
Vargas#
```

Part 3 – Modifying the OSPF Cost with the ip ospf cost command

In Part 3 we will modify the cost of an interface with the ip ospf cost command. We will modify the cost of Loopback1 on Merida and notice the change in the cost for that route in Vargas's routing table.

Step 1: View the current cost of Merida's Loopback1 interface, 172.16.16.1.1

```
Merida#show ip ospf interface loopback1
Loopback1 is up, line protocol is up
  Internet Address 172.16.1.1/24, Area 0
  Process ID 1, Router ID 200.0.0.1, Network Type LOOPBACK, Cost: 1
  Loopback interface is treated as a stub Host
Merida#
```

Step 2: Notice the current cost to 172.16.1.1 from Vargas:

```
Vargas#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

C    192.168.30.0/24 is directly connected, Loopback1
     201.0.0.0/32 is subnetted, 1 subnets
C       201.0.0.1 is directly connected, Loopback0
     172.16.0.0/32 is subnetted, 2 subnets
O       172.16.1.1 [110/2] via 192.168.20.2, 00:20:02, FastEthernet0
O       172.16.2.1 [110/2] via 192.168.20.2, 00:20:02, FastEthernet0
     192.168.20.0/30 is subnetted, 2 subnets
C       192.168.20.4 is directly connected, Loopback2
C       192.168.20.0 is directly connected, FastEthernet0
Vargas#
```

Step 3: Modify the cost of Merida's Loopback1 interface, 172.16.16.1.1:

```
Merida(config)#inter loop 1
Merida(config-if)#ip ospf cost 25
Merida(config-if)#
```

Step 4: Notice the change to the cost on this interface:

```
Merida#show ip ospf interface loop 1
Loopback1 is up, line protocol is up
  Internet Address 172.16.1.1/24, Area 0
  Process ID 1, Router ID 200.0.0.1, Network Type LOOPBACK, Cost: 25
  Loopback interface is treated as a stub Host
Merida#
```

Step 5: Notice the change to the cost from Vargas to 172.16.1.1:

The cost is the cumulative sum of the bandwidth, (Fa0) 1 + (Loopback1) 25 = 26.

```
Vargas#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

C    192.168.30.0/24 is directly connected, Loopback1
     201.0.0.0/32 is subnetted, 1 subnets
C       201.0.0.1 is directly connected, Loopback0
     172.16.0.0/32 is subnetted, 2 subnets
O       172.16.1.1 [110/26] via 192.168.20.2, 00:01:28, FastEthernet0
O       172.16.2.1 [110/2] via 192.168.20.2, 00:01:28, FastEthernet0
     192.168.20.0/30 is subnetted, 2 subnets
C       192.168.20.4 is directly connected, Loopback2
C       192.168.20.0 is directly connected, FastEthernet0
Vargas#
```

Part 4 – Modifying the OSPF Cost with bandwidth command

In Part 4 we will modify the cost of the FastEthernet interface between Merida and Vargas with the bandwidth command on both routers. Both routers' routing tables will be affected, however we will look at the changes from Merida's perspective.

Step 1: View Merida's current routing table

The cost is the cumulative sum of the bandwidth, (Fa0) 1 + (Loopback1) 1 = 2.

```
Merida#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

     192.168.30.0/32 is subnetted, 1 subnets
O       192.168.30.1 [110/2] via 192.168.20.1, 00:38:48, FastEthernet0
     200.0.0.0/32 is subnetted, 1 subnets
C       200.0.0.1 is directly connected, Loopback0
     172.16.0.0/24 is subnetted, 2 subnets
C       172.16.1.0 is directly connected, Loopback1
C       172.16.2.0 is directly connected, Loopback2
     192.168.20.0/30 is subnetted, 1 subnets
C       192.168.20.0 is directly connected, FastEthernet0
Merida#
```

Step 2: View the OSPF cost of FastEthernet 0

```
Merida#show ip ospf interface fa0
FastEthernet0 is up, line protocol is up
  Internet Address 192.168.20.2/30, Area 0
  Process ID 1, Router ID 200.0.0.1, Network Type BROADCAST, Cost: 1
<text omitted>
Merida#
```

Step 3: View the bandwidth of FastEthernet 0

```
Merida#show inter fa0
FastEthernet0 is up, line protocol is up
  Hardware is PQUICC_FEC, address is 00b0.c289.4337 (bia 00b0.c289.4337)
  Internet address is 192.168.20.2/30
  MTU 1500 bytes, BW 100000 Kbit, DLY 100 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ARPA, loopback not set
<text omitted>
Merida#
```

Step 4: Modify the bandwidth of FastEthernet 0

```
Merida(config)#inter fa 0
Merida(config-if)#bandwidth 10000
Merida(config-if)#
```

```
Vargas(config)#inter fa 0
Vargas(config-if)#band 10000
Vargas(config-if)#
```

Step 5: View the new bandwidth of FastEthernet 0

The bandwidth was 100,000 and is now 10,000.

```
Merida#show inter fa 0
FastEthernet0 is up, line protocol is up
  Hardware is PQUICC_FEC, address is 00b0.c289.4337 (bia 00b0.c289.4337)
  Internet address is 192.168.20.2/30
  MTU 1500 bytes, BW 10000 Kbit, DLY 100 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  <text omitted>
Merida#
```

Step 6: View the new OSPF cost of FastEthernet 0

The cost was 1 and is now 10. Remember Cost = 10^8/bandwidth.

```
Merida#show ip ospf inter fa 0
FastEthernet0 is up, line protocol is up
  Internet Address 192.168.20.2/30, Area 0
  Process ID 1, Router ID 200.0.0.1, Network Type BROADCAST, Cost: 10
<text omitted>
Merida#
```

Step 7: View Merida's new routing table

The cost to 192.168.30.1 was 2 and is now (Fa0) 10 + (Loopback1) 1 = 11.

```
Merida#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

     192.168.30.0/32 is subnetted, 1 subnets
O       192.168.30.1 [110/11] via 192.168.20.1, 00:01:39, FastEthernet0
<text omitted>
Merida#
```

Part 5 – Configuring Simple (Plain Text) Authentication

Step 1: Display the current OSPF information

```
Merida#show ip ospf
 Routing Process "ospf 1" with ID 200.0.0.1
 Supports only single TOS(TOS0) routes
 SPF schedule delay 5 secs, Hold time between two SPFs 10 secs
 Minimum LSA interval 5 secs. Minimum LSA arrival 1 secs
 Number of external LSA 0. Checksum Sum 0x0
 Number of DCbitless external LSA 0
 Number of DoNotAge external LSA 0
 Number of areas in this router is 1. 1 normal 0 stub 0 nssa
 External flood list length 0
    Area BACKBONE(0)
        Number of interfaces in this area is 3
        Area has no authentication
        SPF algorithm executed 21 times
        Area ranges are
        Number of LSA 3. Checksum Sum 0x8E7B
        Number of DCbitless LSA 0
        Number of indication LSA 0
        Number of DoNotAge LSA 0
        Flood list length 0

Merida#

Vargas#show ip ospf
 Routing Process "ospf 10" with ID 201.0.0.1
 Supports only single TOS(TOS0) routes
 SPF schedule delay 5 secs, Hold time between two SPFs 10 secs
 Minimum LSA interval 5 secs. Minimum LSA arrival 1 secs
 Number of external LSA 0. Checksum Sum 0x0
 Number of DCbitless external LSA 0
 Number of DoNotAge external LSA 0
 Number of areas in this router is 1. 1 normal 0 stub 0 nssa
 External flood list length 0
    Area BACKBONE(0)
        Number of interfaces in this area is 2
        Area has no authentication
        SPF algorithm executed 23 times
        Area ranges are
        Number of LSA 4. Checksum Sum 0x9EC8
        Number of DCbitless LSA 0
        Number of indication LSA 0
        Number of DoNotAge LSA 0
        Flood list length 0

Vargas#
```

Step 2: Modify the FastEthernet interaces on both routers for Plain Text Authentication.

```
Merida(config)#inter fa 0
Merida(config-if)#ip ospf authentication-key secret
Merida(config-if)#


Vargas(config)#inter fa 0
Vargas(config-if)#ip ospf authentication-key secret
Vargas(config-if)#
```

Step 3: Modify the OSPF on both routers for Plain Text Authentication.

```
Merida(config)#router ospf 1
Merida(config-router)#area 0 authentication
Merida(config-router)#


Vargas(config)#router ospf 10
Vargas(config-router)#area 0 authentication
Vargas(config-router)#
```

Step 4: Verify Plain Text Authentication.

```
Merida#show ip ospf
 Routing Process "ospf 1" with ID 200.0.0.1
 Supports only single TOS(TOS0) routes
 SPF schedule delay 5 secs, Hold time between two SPFs 10 secs
 Minimum LSA interval 5 secs. Minimum LSA arrival 1 secs
 Number of external LSA 0. Checksum Sum 0x0
 Number of DCbitless external LSA 0
 Number of DoNotAge external LSA 0
 Number of areas in this router is 1. 1 normal 0 stub 0 nssa
 External flood list length 0
    Area BACKBONE(0)
        Number of interfaces in this area is 3
        Area has simple password authentication
        SPF algorithm executed 21 times
        Area ranges are
        Number of LSA 3. Checksum Sum 0x8C7C
        Number of DCbitless LSA 0
        Number of indication LSA 0
        Number of DoNotAge LSA 0
        Flood list length 0

Merida#
```

```
Merida#show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address         Interface
201.0.0.1         1   FULL/BDR        00:00:35    192.168.20.1    FastEthernet0
Merida#


Merida#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

     192.168.30.0/32 is subnetted, 1 subnets
O       192.168.30.1 [110/11] via 192.168.20.1, 01:01:25, FastEthernet0
     200.0.0.0/32 is subnetted, 1 subnets
C       200.0.0.1 is directly connected, Loopback0
     172.16.0.0/24 is subnetted, 2 subnets
C       172.16.1.0 is directly connected, Loopback1
C       172.16.2.0 is directly connected, Loopback2
     192.168.20.0/30 is subnetted, 1 subnets
C       192.168.20.0 is directly connected, FastEthernet0
Merida#

Merida#ping 192.168.30.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.30.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/2/4 ms
Merida#
```

Part 6 – Configuring MD5 Encrypted Authentication

Note: **`debug ip ospf adj`** is an excellent command to use to locate problems with mismatched authentication types or authentication keys.

Step 1: Remove Plain Text Authentication on both routers.

```
Merida(config)#inter fa 0
Merida(config-if)#no ip ospf authentication-key secret
Merida(config-if)#

Merida(config)#router ospf 1
Merida(config-router)#no area 0 authentication
Merida(config-router)#


Vargas(config)#int fa 0
Vargas(config-if)#no ip ospf authentication-key secret
Vargas(config-if)#

Vargas(config)#router ospf 10
Vargas(config-router)#no area 0 authentication
Vargas(config-router)#
```

Step 2: Modify the FastEthernet interaces on both routers for MD5 Encrypted Authentication.

```
Merida(config)#inter fa 0
Merida(config-if)#ip ospf message-digest-key 1 md5 secret
Merida(config-if)#

Vargas(config)#inter fa 0
Vargas(config-if)#ip ospf message-digest-key 1 md5 secret
Vargas(config-if)#
```

Step 3: Modify the OSPF on both routers for MD5 Encrypted Authentication.

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

Vargas(config)#router ospf 10
Vargas(config-router)#area 0 authentication message-digest
Vargas(config-router)#
```

Step 4: Verify MD5 Encrypted Authentication.

```
Merida#show ip ospf
 Routing Process "ospf 1" with ID 200.0.0.1
 Supports only single TOS(TOS0) routes
 SPF schedule delay 5 secs, Hold time between two SPFs 10 secs
 Minimum LSA interval 5 secs. Minimum LSA arrival 1 secs
 Number of external LSA 0. Checksum Sum 0x0
 Number of DCbitless external LSA 0
 Number of DoNotAge external LSA 0
 Number of areas in this router is 1. 1 normal 0 stub 0 nssa
 External flood list length 0
    Area BACKBONE(0)
        Number of interfaces in this area is 3
        Area has message digest authentication
        SPF algorithm executed 27 times
        Area ranges are
        Number of LSA 4. Checksum Sum 0x184D3
        Number of DCbitless LSA 0
        Number of indication LSA 0
        Number of DoNotAge LSA 0
        Flood list length 0
Merida#

Merida#show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address         Interface
201.0.0.1         1   FULL/BDR        00:00:31    192.168.20.1    FastEthernet0
Merida#

Merida#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

     192.168.30.0/32 is subnetted, 1 subnets
O       192.168.30.1 [110/11] via 192.168.20.1, 00:07:55, FastEthernet0
     200.0.0.0/32 is subnetted, 1 subnets
C       200.0.0.1 is directly connected, Loopback0
     172.16.0.0/24 is subnetted, 2 subnets
C       172.16.1.0 is directly connected, Loopback1
C       172.16.2.0 is directly connected, Loopback2
     192.168.20.0/30 is subnetted, 1 subnets
C       192.168.20.0 is directly connected, FastEthernet0
Merida#

Merida#ping 192.168.30.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.30.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/2/4 ms
Merida#
```

Part 7 – Configuring Hello and Dead Timers

Step 1: Display default timers.

To form and maintain an adjacency with another router, OSPF Hello and Dead timers must match.

```
Merida#show ip ospf inter fa 0
FastEthernet0 is up, line protocol is up
  Internet Address 192.168.20.2/30, Area 0
  Process ID 1, Router ID 200.0.0.1, Network Type BROADCAST, Cost: 10
  Transmit Delay is 1 sec, State DR, Priority 10
  Designated Router (ID) 200.0.0.1, Interface address 192.168.20.2
  Backup Designated router (ID) 201.0.0.1, Interface address 192.168.20.1
  Timer intervals configured, Hello 10, Dead 40, Wait 40, 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 201.0.0.1  (Backup Designated Router)
  Suppress hello for 0 neighbor(s)
  Message digest authentication enabled
    Youngest key id is 1
Merida#

Vargas#show ip ospf inter fa 0
FastEthernet0 is up, line protocol is up
  Internet Address 192.168.20.1/30, Area 0
  Process ID 10, Router ID 201.0.0.1, Network Type BROADCAST, Cost: 10
  Transmit Delay is 1 sec, State BDR, Priority 1
  Designated Router (ID) 200.0.0.1, Interface address 192.168.20.2
  Backup Designated router (ID) 201.0.0.1, Interface address 192.168.20.1
  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 2
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 200.0.0.1  (Designated Router)
  Suppress hello for 0 neighbor(s)
  Message digest authentication enabled
    Youngest key id is 1
Vargas#
```

Step 2: Modify Merida's Hello timer for a mismatch.

You should never modify the OSPF timers unless you have a compelling reason to do so. We will modify Merida's Hello timer from the default of 10 seconds to 5 seconds, so it does not match Verida. The **`debug ip ospf events`** command will show us that there is a timer mismatch problem.

```
Merida#debug ip ospf events
OSPF events debugging is on

Merida#conf t
Merida(config)#inter fa 0
Merida(config-if)#ip ospf hello-interval 5
Merida(config-if)#end

Merida#
08:00:56: OSPF: Rcv hello from 201.0.0.1 area 0 from FastEthernet0 192.168.20.1
08:00:56: OSPF: Mismatched hello parameters from 192.168.20.1
08:00:56: Dead R 40 C 20, Hello R 10 C 5  Mask R 255.255.255.252 C 255.255.255.2
52
Merida#
```

Step 3: Verify the timer values.

You will notice that the Dead Interval timer changed automatically, to four times the new Hello interval, 20 seconds.

```
Merida#show ip ospf inter fa 0
FastEthernet0 is up, line protocol is up
  Internet Address 192.168.20.2/30, Area 0
  Process ID 1, Router ID 200.0.0.1, Network Type BROADCAST, Cost: 10
  Transmit Delay is 1 sec, State DR, Priority 10
  Designated Router (ID) 200.0.0.1, Interface address 192.168.20.2
  No backup designated router on this network
  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 2, maximum is 2
  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)
  Message digest authentication enabled
    Youngest key id is 1
Merida#
```

Step 4: Verify loss of adjacency between Merida and Vargas.

Notice that Vargas is no longer a adjacent neighbor and the routes via Vargas are no longer reachable.

```
Merida#show ip ospf neighbor

Merida#

Merida#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

     200.0.0.0/32 is subnetted, 1 subnets
C       200.0.0.1 is directly connected, Loopback0
     172.16.0.0/24 is subnetted, 2 subnets
C       172.16.1.0 is directly connected, Loopback1
C       172.16.2.0 is directly connected, Loopback2
     192.168.20.0/30 is subnetted, 1 subnets
C       192.168.20.0 is directly connected, FastEthernet0
Merida#
```

Step 5: Modify Varga's Hello timer to match Merida.

While **`debug ip ospf events`** is enabled, we will modify Varga's Hello (and Dead) timer to match Merida. After the change, you will notice the adjacency taking place and the "Steps to OSPF Operation."

```
Vargas#debug ip ospf events
OSPF events debugging is on
08:10:28: OSPF: Rcv hello from 200.0.0.1 area 0 from FastEthernet0 192.168.20.2
08:10:28: OSPF: Mismatched hello parameters from 192.168.20.2
08:10:28: Dead R 20 C 40, Hello R 5 C 10  Mask R 255.255.255.252 C 255.255.255.2
52

Vargas#conf t
Vargas(config)#inter fa 0
Vargas(config-if)#ip ospf hello-interval 5
Vargas(config-if)#end

08:10:48: OSPF: Rcv hello from 200.0.0.1 area 0 from FastEthernet0 192.168.20.2
08:10:48: OSPF: End of hello processing
08:10:49: %SYS-5-CONFIG_I: Configured from console by console
08:10:52: OSPF: Send with youngest Key 1
08:10:52: OSPF: Rcv DBD from 200.0.0.1 on FastEthernet0 seq 0x70A opt 0x2 flag 0
x7 len 32  mtu 1500 state INIT
08:10:52: OSPF: 2 Way Communication to 200.0.0.1 on FastEthernet0, state 2WAY
08:10:52: OSPF: Neighbor change Event on interface FastEthernet0
08:10:52: OSPF: DR/BDR election on FastEthernet0
08:10:52: OSPF: Elect BDR 0.0.0.0
08:10:52: OSPF: Elect DR 200.0.0.1
```

```
08:10:52: OSPF: Elect BDR 201.0.0.1
08:10:52: OSPF: Elect DR 200.0.0.1
08:10:52:         DR: 200.0.0.1 (Id)    BDR: 201.0.0.1 (Id)
08:10:52: OSPF: Send DBD to 200.0.0.1 on FastEthernet0 seq 0x1E6E opt 0x2 flag 0
x7 len 32
08:10:52: OSPF: Send with youngest Key 1
08:10:52: OSPF: Set FastEthernet0 flush timer
08:10:52: OSPF: Remember old DR 201.0.0.1 (id)
08:10:52: OSPF: First DBD and we are not SLAVE
08:10:52: OSPF: Rcv DBD from 200.0.0.1 on FastEthernet0 seq 0x1E6E opt 0x2 flag
0x2 len 72  mtu 1500 state EXSTART
08:10:52: OSPF: NBR Negotiation Done. We are the MASTER
08:10:52: OSPF: Send DBD to 200.0.0.1 on FastEthernet0 seq 0x1E6F opt 0x2 flag 0
x3 len 92
08:10:52: OSPF: Send with youngest Key 1
08:10:52: OSPF: Send with youngest Key 1
08:10:52: OSPF: Database request to 200.0.0.1
08:10:52: OSPF: sent LS REQ packet to 192.168.20.2, length 12
08:10:52: OSPF: Rcv DBD from 200.0.0.1 on FastEthernet0 seq 0x1E6F opt 0x2 flag
0x0 len 32  mtu 1500 state EXCHANGE
08:10:52: OSPF: Send DBD to 200.0.0.1 on FastEthernet0 seq 0x1E70 opt 0x2 flag 0
x1 len 32
08:10:52: OSPF: Send with youngest Key 1
08:10:52: OSPF: Send with youngest Key 1
08:10:52: OSPF: Rcv DBD from 200.0.0.1 on FastEthernet0 seq 0x1E70 opt 0x2 flag
0x0 len 32  mtu 1500 state EXCHANGE
08:10:52: OSPF: Exchange Done with 200.0.0.1 on FastEthernet0
08:10:52: OSPF: Synchronized with 200.0.0.1 on FastEthernet0, state FULL
08:10:52: OSPF: Send with youngest Key 1
08:10:53: OSPF: Rcv hello from 200.0.0.1 area 0 from FastEthernet0 192.168.20.2
08:10:53: OSPF: End of hello processing
08:10:53: OSPF: Send with youngest Key 1
08:10:55: OSPF: Send with youngest Key 1
08:10:57: OSPF: Send with youngest Key 1
08:10:57: OSPF: Send with youngest Key 1
08:10:58: OSPF: Send with youngest Key 1
08:10:58: OSPF: Rcv hello from 200.0.0.1 area 0 from FastEthernet0 192.168.20.2
08:10:58: OSPF: Neighbor change Event on interface FastEthernet0
08:10:58: OSPF: DR/BDR election on FastEthernet0
08:10:58: OSPF: Elect BDR 201.0.0.1
08:10:58: OSPF: Elect DR 200.0.0.1
08:10:58:         DR: 200.0.0.1 (Id)    BDR: 201.0.0.1 (Id)
08:10:58: OSPF: End of hello processing
08:11:00: OSPF: Send with youngest Key 1
08:11:02: OSPF: Send with youngest Key 1
08:11:03: OSPF: Rcv hello from 200.0.0.1 area 0 from FastEthernet0 192.168.20.2
08:11:03: OSPF: End of hello processing
08:11:07: OSPF: Send with youngest Key 1
08:11:08: OSPF: Rcv hello from 200.0.0.1 area 0 from FastEthernet0 192.168.20.2
08:11:08: OSPF: End of hello processing
Vargas#undebug all
All possible debugging has been turned off
Vargas#
```

Step 6: Verify adjacency between Merida and Vargas.

```
Vargas#show ip ospf neighbor
```

```
Neighbor ID     Pri   State           Dead Time   Address         Interface
200.0.0.1         10  FULL/DR         00:00:17    192.168.20.2    FastEthernet0
Vargas#
Vargas#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

C    192.168.30.0/24 is directly connected, Loopback1
     201.0.0.0/32 is subnetted, 1 subnets
C       201.0.0.1 is directly connected, Loopback0
     172.16.0.0/32 is subnetted, 2 subnets
O       172.16.1.1 [110/35] via 192.168.20.2, 00:00:01, FastEthernet0
O       172.16.2.1 [110/11] via 192.168.20.2, 00:00:01, FastEthernet0
     192.168.20.0/30 is subnetted, 2 subnets
C       192.168.20.4 is directly connected, Loopback2
C       192.168.20.0 is directly connected, FastEthernet0
Vargas#


Vargas#show ip ospf inter fa 0
FastEthernet0 is up, line protocol is up
  Internet Address 192.168.20.1/30, Area 0
  Process ID 10, Router ID 201.0.0.1, Network Type BROADCAST, Cost: 10
  Transmit Delay is 1 sec, State BDR, Priority 1
  Designated Router (ID) 200.0.0.1, Interface address 192.168.20.2
  Backup Designated router (ID) 201.0.0.1, Interface address 192.168.20.1
  Timer intervals configured, Hello 5, Dead 20, Wait 20, 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 2
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 200.0.0.1  (Designated Router)
  Suppress hello for 0 neighbor(s)
  Message digest authentication enabled
    Youngest key id is 1
Vargas#
```

Step 7: Verify the timer values.

Once again, you will notice that the Dead Interval timer changed automatically, to four times the new Hello interval, 20 seconds. Both the Hello timer and the Dead timer now match Merida.

```
Vargas#show ip ospf inter fa 0
FastEthernet0 is up, line protocol is up
  Internet Address 192.168.20.1/30, Area 0
  Process ID 10, Router ID 201.0.0.1, Network Type BROADCAST, Cost: 10
  Transmit Delay is 1 sec, State BDR, Priority 1
  Designated Router (ID) 200.0.0.1, Interface address 192.168.20.2
  Backup Designated router (ID) 201.0.0.1, Interface address 192.168.20.1
  Timer intervals configured, Hello 5, Dead 20, Wait 20, 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 2
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 200.0.0.1  (Designated Router)
  Suppress hello for 0 neighbor(s)
  Message digest authentication enabled
    Youngest key id is 1
Vargas#
```

Part 8 – Configuring a Default Route

Step 1: Add a static "quad-zero" route on Merida.

We will add a static quad-zero route on Merida. Since there is not another router, for purposes of this lab we will forward all default traffic to null0, the "bit-bucket."

```
Merida(config)#ip route 0.0.0.0 0.0.0.0 null0
```

Step 2: View routing tables

Notice that the default route is in Merida's routing table, but was not automatically propagated by OSPF to Vargas.

```
Merida#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 0.0.0.0 to network 0.0.0.0

     192.168.30.0/32 is subnetted, 1 subnets
O       192.168.30.1 [110/11] via 192.168.20.1, 00:14:35, FastEthernet0
     200.0.0.0/32 is subnetted, 1 subnets
C       200.0.0.1 is directly connected, Loopback0
     172.16.0.0/24 is subnetted, 2 subnets
C       172.16.1.0 is directly connected, Loopback1
C       172.16.2.0 is directly connected, Loopback2
     192.168.20.0/30 is subnetted, 1 subnets
C       192.168.20.0 is directly connected, FastEthernet0
S*   0.0.0.0/0 is directly connected, Null0
Merida#

Vargas#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

C    192.168.30.0/24 is directly connected, Loopback1
     201.0.0.0/32 is subnetted, 1 subnets
C       201.0.0.1 is directly connected, Loopback0
     172.16.0.0/32 is subnetted, 2 subnets
O       172.16.1.1 [110/35] via 192.168.20.2, 00:12:05, FastEthernet0
O       172.16.2.1 [110/11] via 192.168.20.2, 00:12:05, FastEthernet0
     192.168.20.0/30 is subnetted, 2 subnets
C       192.168.20.4 is directly connected, Loopback2
C       192.168.20.0 is directly connected, FastEthernet0
Vargas#
```

Step 3: Propagate default route via OSPF

Use the `default-information originate` command to propagate the default route via OSPF.

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

Step 4: View routing tables

Notice that the default route has now been propagated by OSPF to Vargas.

```
Vargas#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 192.168.20.2 to network 0.0.0.0

C    192.168.30.0/24 is directly connected, Loopback1
     201.0.0.0/32 is subnetted, 1 subnets
C       201.0.0.1 is directly connected, Loopback0
     172.16.0.0/32 is subnetted, 2 subnets
O       172.16.1.1 [110/35] via 192.168.20.2, 00:01:32, FastEthernet0
O       172.16.2.1 [110/11] via 192.168.20.2, 00:01:32, FastEthernet0
     192.168.20.0/30 is subnetted, 2 subnets
     192.168.20.0/30 is subnetted, 2 subnets
C       192.168.20.0 is directly connected, FastEthernet0
O*E2 0.0.0.0/0 [110/1] via 192.168.20.2, 00:01:33, FastEthernet0
Vargas#
```