Scenario 3-4: OSPF over Frame Relay in an NBMA Environment

This scenario covers configuring OSPF over Frame Relay in an NBMA environment. This scenario helps you discover some of the advanced features of OSPF, such as DR election in an NBMA environment.

Figure 3-4 displays the three-router network over Frame Relay used in this scenario. Included in Figure 3-4 are the IP addressing scheme, Frame Relay DLCI numbering, and OSPF area assignments.

This scenario involves three routers running OSPF over Frame Relay. Start by configuring the Frame Relay parameters. Figure 3-4 displays the Frame Relay DLCIs and Local Management Interface (LMI) types. Example 3-35 displays R3's Frame Relay configuration. You do not use sub interfaces in this scenario to demonstrate an NBMA environment.
Example 3-35. R3's Frame Relay Configuration

R3(config)#interface serial 0
R3(config-if)#ip address 141.108.1.1 255.255.255.248
R3(config-if)#encapsulation frame-relay
R3(config-if)# frame-relay interface-dlci 103
R3(config-fr-dlci)# frame-relay interface-dlci 108

Example 3-35 shows you how to configure the IP address and how to enable Frame Relay encapsulation. R3 also requires the DLCI information, as displayed in Figure 3-4. The specific DLCIs are 103, which is the path to R4, and 108, which is the path to R5.

Example 3-36 and Example 3-37 show the configurations of R4 and R5, respectively.

Example 3-36. The Frame Relay Configuration on R4

interface Serial0
  ip address 141.108.1.2 255.255.255.248
  encapsulation frame-relay
  frame-relay interface-dlci 107
frame-relay map ip 141.108.1.1 107 broadcast

Example 3-37. The Frame Relay Configuration on R5

interface Serial0
  ip address 141.108.1.3 255.255.255.248
  encapsulation frame-relay
  frame-relay interface-dlci 106
frame-relay map ip 141.108.1.1 106 broadcast

Note

In Examples 3-36 and 3-37, R4 and R5 map IP over Frame Relay, but this is not the case on R3 in Example 3-35. Frame Relay, like any protocol, needs to map Layer 2 of the Open System Interconnection (OSI) model to Layer 3. R3 is not configured for static mapping, because Frame Relay dynamically discovers the maps because R3 is a hub router using Frame Relay inverse Address resolution Protocol (ARP) protocol. Frame Relay inverse ARP automatically discovers the DLCI and next hop IP address.

Now that you have enabled Frame Relay, you can start the OSPF configuration. Example 3-38 displays the OSPF configuration on R3 along with the IP address assignment to E0.

Example 3-38. OSPF and IP Address Configuration on R3

R3(config)#interface ethernet 0
R3(config-if)#ip address 141.108.3.1 255.255.255.0
R3(config-if)#router ospf 3
R3(config-router)#network 141.108.3.0 0.0.0.255 area 3
R3(config-router)#network 141.108.1.0 0.0.0.7 area 0

You must also enable OSPF on Routers R4 and R5. Example 3-39 displays the OSPF configuration on R4 along with the IP address assignment to E0.

**Example 3-39. OSPF and IP Address Configuration on R4**

R4(config)#interface ethernet 0
R4(config-if)#ip address 141.108.4.1 255.255.255.0
R4(config)#router ospf 4
R4(config-router)#network 141.108.4.0 0.0.0.255 area
R4(config-router)#network 141.108.1.0 0.0.0.7 area 0

Example 3-40 displays the OSPF configuration on R5 along with the IP address assignment to E0.

**Example 3-40. OSPF and IP Address Configuration on R5**

R5(config-if)#ip address 141.108.5.1 255.255.255.0
R5(config-if)#interface ethernet 1
R5(config-if)#ip address 141.108.6.1 255.255.255.0
R5(config-if)#router ospf 5
R5(config-router)#network 141.108.5.0 0.0.3.255 area 5
R5(config-router)#network 141.108.1.0 0.0.0.7 area 0

Note

Example 3-40 places the two Ethernet networks with the one OSPF statement.

Ensure that OSPF adjacencies are up and in a FULL state on R3. Example 3-41 displays the OSPF neighbor state on router R3.

**Example 3-41. show ip ospf neighbor Command on R3**

R3>show ip ospf neighbor
R3>

As you can see from the lack of output in Example 3-41, Router R3 has no adjacencies. The IOS on R3 in Example 3-41 tells you there are no OSPF relationships to R4 and R5. That lack of relationships is because OSPF Hello packets (using multicast address, of course) are not sent over a nonbroadcast OSPF network type.

Figure 3-4 shows a classic example of OSPF over NBMA. In an NBMA environment, broadcasts or multicasts do not propagate over the Frame Relay. Example 3-42 displays the OSPF network type on R3 link to R4 and R5.
Example 3-42. show ip ospf interface serial 0 Command on R3

```
R3>show ip ospf int s 0
Serial0 is up, line protocol is up
    Internet Address 141.108.1.1/29, Area 0
    Process ID 3, Router ID 141.108.10.5, Network Type NON_BROADCAST, Cost: 64
    Transmit Delay is 1 sec, State DR, Priority 1
    Designated Router (ID) 141.108.10.5, Interface address 141.108.1.1
    No backup designated router on this network
    Timer intervals configured, Hello 30, Dead 120, Wait 120, Retransmit 5
    Hello due in 00:00:00
    Neighbor Count is 0, Adjacent neighbor count is 0
    Suppress hello for 0 neighbor(s)
```

Example 3-42 displays no neighbor and the main fact that the link is considered a nonbroadcast link. OSPF can be configured a variety of ways to accomplish this. To demonstrate OSPF over NBMA in this scenario, you do not modify the network type, but rather you statically configure a neighbor relationship from R3 to R4 and R5. To enable a static OSPF neighbor relationship, enter the following command:

```
neighbor ip address of neighbor
```

Example 3-43 displays the configuration on R3 to remote routers R4 and R5.

Example 3-43. Static Neighbor Configuration on R3

```
R3(config)#router ospf 3
R3(config-router)#neighbor 141.108.1.2
R3(config-router)#neighbor 141.108.1.3
```

The command `neighbor 141.108.1.2` configures the neighbor to R4. The command `neighbor 141.108.1.3` configures the neighbor to R5.

Example 3-43 overcomes the need to change the network environment from nonbroadcast and allows a static configuration of remote OSPF routers. One more important task is required. Router R4 and R5 are spoke, or edge, routers. The hub router, R3, must become the DR, because R3 has links to both R4 and R5 and information will be sent from R4 to R5, for example, through R3. The easiest way to make R3 the DR is to disable R4 and R5 from ever becoming the DR by applying a 0 priority on R4 and R5. Example 3-44 demonstrates how to set the priority to 0, in effect disabling any chance for R4 or R5 to become the DR.

Example 3-44. IP OSPF Priority Set to 0 on R4 and R5

```
R4(config)#interface serial 0
R4(config-if)#ip ospf priority 0
R5(config)#interface serial 0
R5(config-if)#ip ospf priority 0
```
Examples 3-45 displays the OSPF neighbors on R3.

**Example 3-45. show ip ospf neighbor Command on R3**

```
R3#show ip ospf nei
Neighbor ID Pri State Dead Time Address Interface
141.108.5.1 0 FULL/DROTHER 00:01:54 141.108.1.3 Serial0
141.108.1.2 0 FULL/DROTHER 00:01:44 141.108.1.2 Serial0
```

The state shown in Example 3-45 displays a FULL adjacency and a state known as DROTHER, which indicates that the neighbor was not chosen as the DR or BDR and cannot be because the priority has been set to zero. Example 3-46 displays the full working configuration of R3.

**Example 3-46. R3's Full Configuration**

```
version 12.0
!
hostname R3
!
enable password cisco
!
ip subnet-zero
!
interface Ethernet0
 ip address 141.108.3.1 255.255.255.0
!
interface Ethernet1
 no ip address
 shutdown
!
interface Serial0
 ip address 141.108.1.1 255.255.255.248
 encapsulation frame-relay
 frame-relay interface-dlci 103
 frame-relay interface-dlci 108
!
interface Serial1
 ip address 141.108.10.5 255.255.255.252
!
router ospf 3
 network 141.108.1.0 0.0.0.7 area 0
 network 141.108.3.0 0.0.0.255 area 3
 neighbor 141.108.1.3
 neighbor 141.108.1.2
!
line con 0
line aux 0
line vty 0 4
end
```

Example 3-47 displays the full working configuration of R4.

**Example 3-47. R4's Full Configuration**
version 12.0
!
hostname R4
!
enable password cisco
!
ip subnet-zero
!
interface Ethernet0
  ip address 141.108.4.1 255.255.255.0
interface Serial0
  ip address 141.108.1.2 255.255.255.248
  encapsulation frame-relay
  ip ospf priority 0
  frame-relay map ip 141.108.1.1 107 broadcast
  frame-relay interface-dlci 107
  frame-relay lmi-type cisco
!
interface Serial1
  shutdown
!
router ospf 4
  network 141.108.1.0 0.0.0.7 area 0
  network 141.108.4.0 0.0.0.255 area 4
!
line con 0
line aux 0
line vty 0 4
!
end

Example 3-48 displays the full working configuration of R5.

**Example 3-48. R5's Full Configuration**

version 12.0
!
hostname R5
!
enable password cisco
!
ip subnet-zero
!
interface Ethernet0
  ip address 141.108.5.1 255.255.255.0
!
interface Ethernet1
  ip address 141.108.6.1 255.255.255.0
!
interface Serial0
  ip address 141.108.1.3 255.255.255.248
  encapsulation frame-relay
  ip ospf priority 0
  frame-relay map ip 141.108.1.1 106 broadcast
  frame-relay interface-dlci 106
!
interface Serial1
   shutdown
!
router ospf 5
   network 141.108.1.0 0.0.0.7 area 0
   network 141.108.4.0 0.0.3.255 area 5
!
line con 0
line aux 0
line vty 0 4
!
end

The final scenario covers common show and debug commands used to verify correct OSPF implementation.