Lab 2-2 Configuring Frame Relay at the Customer Edge

Learning Objectives

As a result of this lab section, you should achieve the following tasks:

- Configuration of frame relay interfaces on the customer edge.
- Establishment of RIP in a hub and spoke network.
- Establishment of OSPF in a hub and spoke (NBMA) network.
- Configuration of frame relay interfaces when using the OSPF point-to-multipoint network type.

Topology

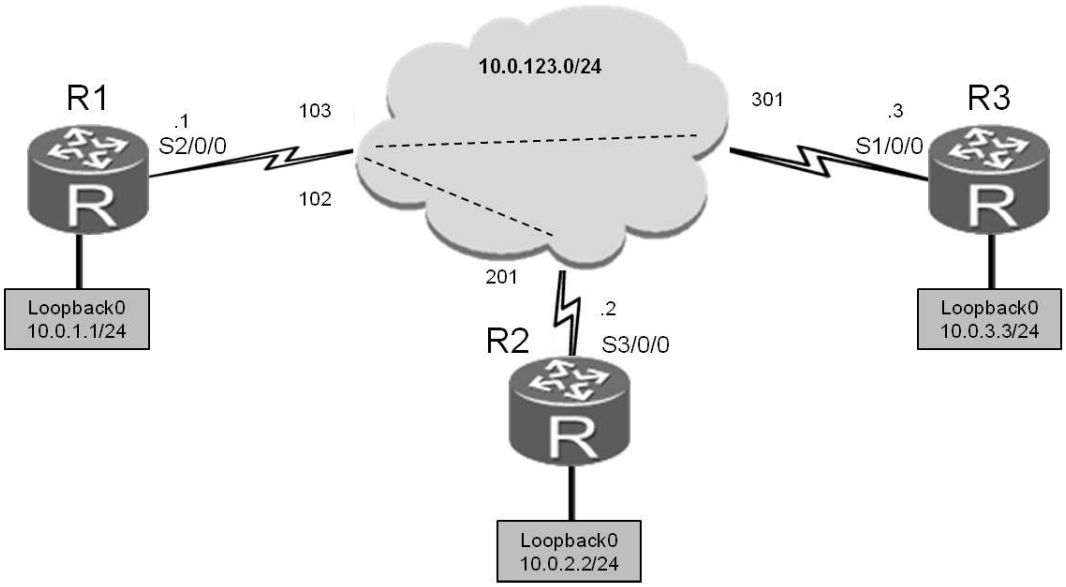

Figure 2.2 Lab topology for frame relay configuration

Scenario

The enterprise network has existing frame relay virtual circuits between the HQ and some branch offices. A recent change in equipment requires that these frame relay VC be re-established. The virtual circuits had been

provided by the service provider at the time the service was first implemented and it is the task of the administrator to implement the frame relay configuration on the edge routers for the HQ and branch offices. The administrator must configure frame relay on the WAN links and perform mapping between the local DLCI and IP addresses.

Tasks

Step 1 Preparing the environment.

If you are starting this section with a non-configured device, begin here and then move to step 3. For those continuing from previous labs, begin at step 2.

```
<Huawei>system-view
Enter system view, return user view with Ctrl+Z.
[Huawei]sysname R1

<Huawei>system-view
Enter system view, return user view with Ctrl+Z.
[Huawei]sysname R2

<Huawei>system-view
Enter system view, return user view with Ctrl+Z.
[Huawei]sysname R3
```

Step 2 Clean up the previous configuration.

Disable the serial interfaces used for establishing the HDLC & PPP networks.

```
[R1]interface Serial 1/0/0
[R1-Serial1/0/0]shutdown

[R2]interface Serial 1/0/0
[R2-Serial1/0/0]shutdown
[R2-Serial1/0/0]interface Serial 2/0/0
[R2-Serial2/0/0]shutdown

[R3]interface Serial 2/0/0
[R3-Serial2/0/0]shutdown
```

Step 3 **Establish frame relay encapsulation.**

Set basic parameters, including IP addresses. Manually define the mapping between the peer and DLCI. The inverse ARP function should be disabled. Ensure that the broadcast parameter is used in the fr map command to allow the network on the loopback interface to be advertised using RIP.

```
[R1]interface Serial 2/0/0
[R1-Serial2/0/0]link-protocol fr
Warning: The encapsulation protocol of the link will be changed. Continue? [Y/N]:y
[R1-Serial2/0/0]ip address 10.0.123.1 24
[R1-Serial2/0/0]undo fr inarp
[R1-Serial2/0/0]fr map ip 10.0.123.2 102 broadcast
[R1-Serial2/0/0]fr map ip 10.0.123.3 103 broadcast
[R1-Serial2/0/0]interface loopback 0
[R1-LoopBack0]ip address 10.0.1.1 24

[R2]interface Serial 3/0/0
[R2-Serial3/0/0]link-protocol fr
Warning: The encapsulation protocol of the link will be changed. Continue? [Y/N]:y
[R2-Serial3/0/0]ip address 10.0.123.2 24
[R2-Serial3/0/0]undo fr inarp
[R2-Serial3/0/0]fr map ip 10.0.123.1 201 broadcast
[R2-Serial3/0/0]interface loopback 0
[R2-LoopBack0]ip address 10.0.2.2 24

[R3]interface Serial 1/0/0
[R3-Serial1/0/0]link-protocol fr
Warning: The encapsulation protocol of the link will be changed. Continue? [Y/N]:y
[R3-Serial1/0/0]ip address 10.0.123.3 24
[R3-Serial1/0/0]undo fr inarp
[R3-Serial1/0/0]fr map ip 10.0.123.1 301 broadcast
[R3-Serial1/0/0]interface loopback 0
[R3-LoopBack0]ip address 10.0.3.3 24
```

After the IP addresses are configured, test network connectivity.

```
<R1>ping 10.0.123.2
  PING 10.0.123.2: 56  data bytes, press CTRL_C to break
    Reply from 10.0.123.2: bytes=56 Sequence=1 ttl=255 time=64 ms
    Reply from 10.0.123.2: bytes=56 Sequence=2 ttl=255 time=59 ms
    Reply from 10.0.123.2: bytes=56 Sequence=3 ttl=255 time=59 ms
```

```
    Reply from 10.0.123.2: bytes=56 Sequence=4 ttl=255 time=59 ms
    Reply from 10.0.123.2: bytes=56 Sequence=5 ttl=255 time=59 ms

  --- 10.0.123.2 ping statistics ---
    5 packet(s) transmitted
    5 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 59/60/64 ms
<R1>ping 10.0.123.3
  PING 10.0.123.3: 56  data bytes, press CTRL_C to break
    Reply from 10.0.123.3: bytes=56 Sequence=1 ttl=255 time=64 ms
    Reply from 10.0.123.3: bytes=56 Sequence=2 ttl=255 time=59 ms
    Reply from 10.0.123.3: bytes=56 Sequence=3 ttl=255 time=59 ms
    Reply from 10.0.123.3: bytes=56 Sequence=4 ttl=255 time=59 ms
    Reply from 10.0.123.3: bytes=56 Sequence=5 ttl=255 time=59 ms

  --- 10.0.123.3 ping statistics ---
    5 packet(s) transmitted
    5 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 59/60/64 ms
```

Run the following commands to view the FR encapsulation information for the R1 interfaces.

```
<R1>display fr interface Serial 2/0/0
Serial2/0/0, DTE, physical up, protocol up

<R1>display fr lmi-info interface Serial 2/0/0
Frame relay LMI statistics for interface Serial2/0/0 (DTE, Q933)
  T391DTE = 10 (hold timer 10)
  N391DTE = 6, N392DTE = 3, N393DTE = 4
  out status enquiry = 180, in status = 178
  status timeout = 0, discarded messages = 0

<R1>display fr map-info interface Serial 2/0/0
Map Statistics for interface Serial2/0/0 (DTE)
  DLCI = 102, IP 10.0.123.2, Serial2/0/0
    create time = 2011/11/16 09:28:49, status = ACTIVE
    encapsulation = ietf, vlink = 1, broadcast
  DLCI = 103, IP 10.0.123.3, Serial2/0/0
    create time = 2011/11/16 09:28:56, status = ACTIVE
    encapsulation = ietf, vlink = 2, broadcast
```

Step 4 **Configure RIPv2 between R1, R2, and R3.**

Configure RIPv2 on R1, R2 and R3. If you are continuing from the previous HDLC/PPP lab, the RIP routes for network 10.0.0.0 may have already been configured, however the automatic summary must still be disabled to uniquely identify the routes of the peers.

In addition, split horizon is disabled by default on frame relay networks, and so It is not necessary for the split horizon parameters to be modified in this exercise.

```
[R1]rip 1
[R1-rip-1]version 2
[R1-rip-1]network 10.0.0.0
[R1-rip-1]undo summary

[R2]rip 1
[R2-rip-1]version 2
[R2-rip-1]network 10.0.0.0
[R2-rip-1]undo summary

[R3]rip 1
[R3-rip-1]version 2
[R3-rip-1]network 10.0.0.0
[R3-rip-1]undo summary
```

View the routing tables on R1, R2, and R3 to check the learned routes.

```
<R1>display ip routing-table protocol rip
Route Flags: R - relay, D - download to fib
------------------------------------------------------------------------------
Public routing table : RIP
        Destinations : 2        Routes : 2

RIP routing table status : <Active>
        Destinations : 2        Routes : 2

Destination/Mask    Proto   Pre  Cost      Flags NextHop         Interface

      10.0.2.0/24   RIP     100  1         D   10.0.123.2      Serial2/0/0
      10.0.3.0/24   RIP     100  1         D   10.0.123.3      Serial2/0/0

RIP routing table status : <Inactive>
        Destinations : 0        Routes : 0
```

```
<R2>display ip routing-table protocol rip
Route Flags: R - relay, D - download to fib
------------------------------------------------------------------------------
Public routing table : RIP
       Destinations : 2       Routes : 2

RIP routing table status : <Active>
       Destinations : 2       Routes : 2

Destination/Mask    Proto   Pre  Cost      Flags NextHop         Interface

      10.0.1.0/24  RIP    100  1         D   10.0.123.1      Serial3/0/0
      10.0.3.0/24  RIP    100  2         D   10.0.123.1      Serial3/0/0

RIP routing table status : <Inactive>
       Destinations : 0       Routes : 0

[R3]display ip routing-table protocol rip
Route Flags: R - relay, D - download to fib
------------------------------------------------------------------------------
Public routing table : RIP
       Destinations : 2       Routes : 2

RIP routing table status : <Active>
       Destinations : 2       Routes : 2

Destination/Mask    Proto   Pre  Cost      Flags NextHop         Interface

      10.0.1.0/24  RIP    100  1         D   10.0.123.1      Serial1/0/0
      10.0.2.0/24  RIP    100  2         D   10.0.123.1      Serial1/0/0

RIP routing table status : <Inactive>
       Destinations : 0       Routes : 0
```

Verify that the 10.0.3.0 network of R3 is capable of reaching the 10.0.1.0 network of R1.

```
[R3]ping -a 10.0.3.3 10.0.1.1
  PING 10.0.1.1: 56  data bytes, press CTRL_C to break
    Reply from 10.0.1.1: bytes=56 Sequence=1 ttl=255 time=68 ms
    Reply from 10.0.1.1: bytes=56 Sequence=2 ttl=255 time=63 ms
    Reply from 10.0.1.1: bytes=56 Sequence=3 ttl=255 time=63 ms
    Reply from 10.0.1.1: bytes=56 Sequence=4 ttl=255 time=63 ms
    Reply from 10.0.1.1: bytes=56 Sequence=5 ttl=255 time=63 ms
```

```
  --- 10.0.1.1 ping statistics ---
    5 packet(s) transmitted
    5 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 63/64/68 ms
```

Perform the same test to network 10.0.2.2 of R2 from network 10.0.3.3 of R3.

```
<R3>ping -a 10.0.3.3 10.0.2.2
  PING 10.0.2.2: 56  data bytes, press CTRL_C to break
    Reply from 10.0.2.2: bytes=56 Sequence=1 ttl=254 time=101 ms
    Reply from 10.0.2.2: bytes=56 Sequence=2 ttl=254 time=110 ms
    Reply from 10.0.2.2: bytes=56 Sequence=3 ttl=254 time=101 ms
    Reply from 10.0.2.2: bytes=56 Sequence=4 ttl=254 time=101 ms
    Reply from 10.0.2.2: bytes=56 Sequence=5 ttl=254 time=101 ms

  --- 10.0.2.2 ping statistics ---
    5 packet(s) transmitted
    5 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 101/102/110 ms
```

The RIP routing protocol has enabled a route between the loopback interfaces of R2 and R3 to be established via R1.

Attempt the same procedure to network 10.0.2.2 of R2 from the S2/0/0 (10.0.123.3) interface of R3.

```
[R3]ping 10.0.2.2
  PING 10.0.2.2: 56  data bytes, press CTRL_C to break
    Request time out
    Request time out
    Request time out
    Request time out
    Request time out

  --- 10.0.2.2 ping statistics ---
    5 packet(s) transmitted
    0 packet(s) received
    100.00% packet loss
```

The preceding test results indicate that R3 is unable to communicate with R2 (and vice versa) when the serial interface is the source. Check the

routes to find out why R3 and R2 are disconnected. The procedure for diagnosing this fault is as follows:

View the R3 routing table and check whether any route is destined for the IP address 10.0.2.2.

If there is such a route, find out the next hop IP address of this route. Then check whether R3 can reach the next hop and whether there is mapping between the layer-3 IP addresses and layer-2 PVCs.

If R3 can reach the next hop and there is mapping between Layer-3 IP addresses and Layer-2 PVCs, check the devices on the route to determine whether there is any route that can reach IP address 10.0.2.2, whether the next hop of this route is reachable, and whether there is mapping between Layer-3 IP addresses and Layer-2 PVCs.

If there is a route that can reach IP address 10.0.2.2 and there is mapping between Layer-3 IP addresses and Layer-2 PVCs, check R2 to determine whether there is any route that reaches the destination IP address of the response packets and whether the next hop of this route is reachable.

If the next hop of this route is unreachable and the destination IP address of the response packets is 10.0.123.3, R2 has the route that reaches this address but there is no mapping between Layer-3 IP addresses and Layer-2 PVCs.

The following is the output of the commands used in the preceding fault diagnosis procedure.

```
<R3>display ip routing-table
Route Flags: R - relay, D - download to fib
------------------------------------------------------------------------------
Routing Tables: Public
        Destinations : 13      Routes : 13

Destination/Mask    Proto   Pre  Cost      Flags NextHop         Interface

    10.0.1.0/24     RIP     100  1           D   10.0.123.1      Serial1/0/0
    10.0.2.0/24     RIP     100  2           D   10.0.123.1      Serial1/0/0
    10.0.3.0/24     Direct  0    0           D   10.0.3.3        LoopBack0
    10.0.3.3/32     Direct  0    0           D   127.0.0.1       InLoopBack0
    10.0.3.255/32   Direct  0    0           D   127.0.0.1       InLoopBack0
    10.0.123.0/24   Direct  0    0           D   10.0.123.3      Serial1/0/0
    10.0.123.1/32   Direct  0    0           D   10.0.123.1      Serial1/0/0
    10.0.123.3/32   Direct  0    0           D   127.0.0.1       InLoopBack0
    10.0.123.255/32 Direct  0    0           D   127.0.0.1       InLoopBack0
```

```
    127.0.0.0/8     Direct  0    0           D   127.0.0.1       InLoopBack0
    127.0.0.1/32    Direct  0    0           D   127.0.0.1       InLoopBack0
127.255.255.255/32  Direct  0    0           D   127.0.0.1       InLoopBack0
255.255.255.255/32  Direct  0    0           D   127.0.0.1       InLoopBack0

<R3>display fr map-info interface Serial 1/0/0
Map Statistics for interface Serial1/0/0 (DTE)
  DLCI = 301, IP 10.0.123.1, Serial1/0/0
    create time = 2011/11/16 09:22:30, status = ACTIVE
    encapsulation = ietf, vlink = 1, broadcast

<R1>display ip routing-table
Route Flags: R - relay, D - download to fib
------------------------------------------------------------------------------
Routing Tables: Public
        Destinations : 14      Routes : 14

Destination/Mask    Proto   Pre  Cost      Flags NextHop         Interface

    10.0.1.0/24     Direct  0    0           D   10.0.1.1        LoopBack0
    10.0.1.1/32     Direct  0    0           D   127.0.0.1       InLoopBack0
    10.0.1.255/32   Direct  0    0           D   127.0.0.1       InLoopBack0
    10.0.2.0/24     RIP     100  1           D   10.0.123.2      Serial2/0/0
    10.0.3.0/24     RIP     100  1           D   10.0.123.3      Serial2/0/0
    10.0.123.0/24   Direct  0    0           D   10.0.123.1      Serial2/0/0
    10.0.123.1/32   Direct  0    0           D   127.0.0.1       InLoopBack0
    10.0.123.2/32   Direct  0    0           D   10.0.123.2      Serial2/0/0
    10.0.123.3/32   Direct  0    0           D   10.0.123.3      Serial2/0/0
    10.0.123.255/32 Direct  0    0           D   127.0.0.1       InLoopBack0
    127.0.0.0/8     Direct  0    0           D   127.0.0.1       InLoopBack0
    127.0.0.1/32    Direct  0    0           D   127.0.0.1       InLoopBack0
127.255.255.255/32  Direct  0    0           D   127.0.0.1       InLoopBack0
255.255.255.255/32  Direct  0    0           D   127.0.0.1       InLoopBack0

<R1>display fr map-info interface Serial 2/0/0
Map Statistics for interface Serial2/0/0 (DTE)
  DLCI = 102, IP 10.0.123.2, Serial2/0/0
    create time = 2011/11/16 09:28:49, status = ACTIVE
    encapsulation = ietf, vlink = 1, broadcast
  DLCI = 103, IP 10.0.123.3, Serial2/0/0
    create time = 2011/11/16 09:28:56, status = ACTIVE
    encapsulation = ietf, vlink = 2, broadcast
```

```
<R2>display ip routing-table
Route Flags: R - relay, D - download to fib
------------------------------------------------------------------------------
Routing Tables: Public
        Destinations : 13      Routes : 13

Destination/Mask    Proto   Pre  Cost      Flags NextHop         Interface

    10.0.1.0/24     RIP     100 1           D   10.0.123.1      Serial3/0/0
    10.0.2.0/24     Direct  0   0           D   10.0.2.2        LoopBack0
    10.0.2.2/32     Direct  0   0           D   127.0.0.1       InLoopBack0
    10.0.2.255/32   Direct  0   0           D   127.0.0.1       InLoopBack0
    10.0.3.0/24     RIP     100 2           D   10.0.123.1      Serial3/0/0
    10.0.123.0/24   Direct  0   0           D   10.0.123.2      Serial3/0/0
    10.0.123.1/32   Direct  0   0           D   10.0.123.1      Serial3/0/0
    10.0.123.2/32   Direct  0   0           D   127.0.0.1       InLoopBack0
    10.0.123.255/32 Direct  0   0           D   127.0.0.1       InLoopBack0
    127.0.0.0/8     Direct  0   0           D   127.0.0.1       InLoopBack0
    127.0.0.1/32    Direct  0   0           D   127.0.0.1       InLoopBack0
127.255.255.255/32  Direct  0   0           D   127.0.0.1       InLoopBack0
255.255.255.255/32  Direct  0   0           D   127.0.0.1       InLoopBack0

<R2>display fr map-info interface Serial 3/0/0
Map Statistics for interface Serial3/0/0 (DTE)
  DLCI = 201, IP 10.0.123.1, Serial3/0/0
    create time = 2011/11/16 09:21:10, status = ACTIVE
    encapsulation = ietf, vlink = 1, broadcast
```

The conclusion is that there is no PVC that allows R2 to reach IP address 10.0.123.3.

Step 5 Modify network parameters to enable the connection between R2 and R3.

The fault diagnosis results from step 2 indicate that communication fails since there is no virtual circuit between the frame relay interfaces on R2 and R3. In order to resolve this, configure a frame relay PVC between the interfaces on R2 and R3.

```
[R2]interface Serial 3/0/0
[R2-Serial3/0/0]fr map ip 10.0.123.3 201

[R3]interface Serial 1/0/0
[R3-Serial1/0/0]fr map ip 10.0.123.2 301
```

After the mapping has been configured between IP addresses and PVCs, check the IP address-PVC mapping tables on R2 and R3 and detect network connectivity.

```
<R3>display fr lmi-info inter Serial 1/0/0
Frame relay LMI statistics for interface Serial1/0/0 (DTE, Q933)
  T391DTE = 10 (hold timer 10)
  N391DTE = 6, N392DTE = 3, N393DTE = 4
  out status enquiry = 326, in status = 324
  status timeout = 0, discarded messages = 0

<R3>display fr map-info interface Serial 1/0/0
Map Statistics for interface Serial1/0/0 (DTE)
  DLCI = 301, IP 10.0.123.1, Serial1/0/0
    create time = 2011/11/16 09:22:30, status = ACTIVE
    encapsulation = ietf, vlink = 1, broadcast
  DLCI = 301, IP 10.0.123.2, Serial1/0/0
    create time = 2011/11/16 09:55:23, status = ACTIVE
    encapsulation = ietf, vlink = 2

<R3>ping 10.0.2.2
  PING 10.0.2.2: 56  data bytes, press CTRL_C to break
    Reply from 10.0.2.2: bytes=56 Sequence=1 ttl=254 time=118 ms
    Reply from 10.0.2.2: bytes=56 Sequence=2 ttl=254 time=123 ms
    Reply from 10.0.2.2: bytes=56 Sequence=3 ttl=254 time=123 ms
    Reply from 10.0.2.2: bytes=56 Sequence=4 ttl=254 time=123 ms
    Reply from 10.0.2.2: bytes=56 Sequence=5 ttl=254 time=123 ms

  --- 10.0.2.2 ping statistics ---
    5 packet(s) transmitted
    5 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 118/122/123 ms
```

Step 6 **Configure OSPF between R1 and R2.**

Delete the RIP configurations referenced in step 2 and the frame relay mapping between R2 and R3 that was established during step 3.

```
[R1]undo rip 1
Warning: The RIP process will be deleted. Continue?[Y/N]y

[R2]interface Serial 3/0/0
[R2-Serial3/0/0]undo fr map ip 10.0.123.3 201
```

```
[R2-Serial3/0/0]quit
[R2]undo rip 1
Warning: The RIP process will be deleted. Continue?[Y/N]y

[R3]interface Serial 1/0/0
[R3-Serial1/0/0]undo fr map ip 10.0.123.2 301
[R3-Serial1/0/0]quit
[R3]undo rip 1
Warning: The RIP process will be deleted. Continue?[Y/N]y
[R3]
```

Configure single-area OSPF on R1, R2, and R3.

```
[R1]ospf 1 router-id 10.0.1.1
[R1-ospf-1]area 0
[R1-ospf-1-area-0.0.0.0]network 10.0.0.0 0.255.255.255

[R2]ospf 1 router-id 10.0.2.2
[R2-ospf-1]area 0
[R2-ospf-1-area-0.0.0.0]network 10.0.0.0 0.255.255.255

[R3]ospf 1 router-id 10.0.3.3
[R3-ospf-1]area 0
[R3-ospf-1-area-0.0.0.0]network 10.0.0.0 0.255.255.255
```

After the basic parameters are set, OSPF cannot establish neighbor adjacencies. When using frame relay for data link layer encapsulation, OSPF will set the network type to NBMA by default. As a result, OSPF does not support broadcasts, and therefore cannot automatically discover neighbors.

```
<R3>display ospf interface Serial 1/0/0 verbose
        OSPF Process 1 with Router ID 10.0.3.3
               Interfaces

 Interface: 10.0.123.3 (Serial1/0/0)
 Cost: 1562    State: DR       Type: NBMA      MTU: 1500
 Priority: 1
 Designated Router: 10.0.123.3
 Backup Designated Router: 0.0.0.0
 Timers: Hello 30 , Dead 120 , Poll  120 , Retransmit 5 , Transmit Delay 1
  IO Statistics
            Type         Input     Output
            Hello            0          0
   DB Description            0          0
   Link-State Req            0          0
```

```
Link-State Update           0         0
   Link-State Ack           0         0
 OpaqueId: 0   PrevState: Waiting
```

Step 7 Configuring the NBMA environment.

While R3 is the DR, R2 is unable to establish a full adjacency with the DR since R3 is not reachable via the PVC between R2 and R1. Therefore the DR must be set on R1. Additionally OSPF hello messages are unicast in an NBMA network. Peers must be manually specified to allow hello packet forwarding.

```
[R1]ospf
[R1-ospf-1]peer 10.0.123.2
[R1-ospf-1]peer 10.0.123.3
[R1-ospf-1]interface Serial 2/0/0
[R1-Serial2/0/0]ospf dr-priority 255

[R2]ospf
[R2-ospf-1]peer 10.0.123.1

[R3]ospf
[R3-ospf-1]peer 10.0.123.1
```

Optionally the DR priority for R2 and R3 can be set to 0 to force their exemption from any DR election.

```
<R1>display ospf interface Serial 2/0/0 verbose
        OSPF Process 1 with Router ID 10.0.1.1
               Interfaces

Interface: 10.0.123.1 (Serial2/0/0)
 Cost: 1562    State: DR       Type: NBMA     MTU: 1500
 Priority: 255
 Designated Router: 10.0.123.1
 Backup Designated Router: 10.0.123.3
 Timers: Hello 30 , Dead 120 , Poll  120 , Retransmit 5 , Transmit Delay 1
  IO Statistics
             Type        Input     Output
            Hello        32          32
   DB Description        8           29
   Link-State Req        3           2
Link-State Update        16          30
   Link-State Ack        20          9
 OpaqueId: 0   PrevState: BDR
```

```
 Effective cost: 1562, enabled by OSPF Protocol
```

If R1 is not the designated router, reset the ospf process on all routers using the following command and reattempt the above display command

```
<R1>reset ospf process graceful-restart
```

Display the routing table to confirm that OSPF has been established over the frame relay network.

```
<R1>display ip routing-table
Route Flags: R - relay, D - download to fib
------------------------------------------------------------------------------
Routing Tables: Public
        Destinations : 14      Routes : 14

Destination/Mask    Proto   Pre  Cost      Flags NextHop         Interface

    10.0.1.0/24     Direct  0    0           D   10.0.1.1        LoopBack0
    10.0.1.1/32     Direct  0    0           D   127.0.0.1       LoopBack0
    10.0.1.255/32   Direct  0    0           D   127.0.0.1       LoopBack0
    10.0.2.2/32     OSPF    10   1562        D   10.0.123.2      Serial2/0/0
    10.0.3.3/32     OSPF    10   1562        D   10.0.123.3      Serial2/0/0
    10.0.123.0/24   Direct  0    0           D   10.0.123.1      Serial2/0/0
    10.0.123.1/32   Direct  0    0           D   127.0.0.1       Serial2/0/0
    10.0.123.2/32   Direct  0    0           D   10.0.123.2      Serial2/0/0
    10.0.123.3/32   Direct  0    0           D   10.0.123.3      Serial2/0/0
    10.0.123.255/32 Direct  0    0           D   127.0.0.1       Serial2/0/0
    127.0.0.0/8     Direct  0    0           D   127.0.0.1       InLoopBack0
    127.0.0.1/32    Direct  0    0           D   127.0.0.1       InLoopBack0
127.255.255.255/32  Direct  0    0           D   127.0.0.1       InLoopBack0
255.255.255.255/32  Direct  0    0           D   127.0.0.1       InLoopBack0

<R1>ping -a 10.0.1.1 10.0.2.2
  PING 10.0.2.2: 56  data bytes, press CTRL_C to break
    Reply from 10.0.2.2: bytes=56 Sequence=1 ttl=255 time=51 ms
    Reply from 10.0.2.2: bytes=56 Sequence=2 ttl=255 time=60 ms
    Reply from 10.0.2.2: bytes=56 Sequence=3 ttl=255 time=51 ms
    Reply from 10.0.2.2: bytes=56 Sequence=4 ttl=255 time=51 ms
    Reply from 10.0.2.2: bytes=56 Sequence=5 ttl=255 time=60 ms

  --- 10.0.2.2 ping statistics ---
    5 packet(s) transmitted
    5 packet(s) received
    0.00% packet loss
```

```
  round-trip min/avg/max = 51/54/60 ms
```

Attempts to establish a connection between 10.0.2.2 and 10.0.3.3 when using the NBMA network type will fail unless a virtual circuit (PVC) is established between R2 and R3. Alternatively the point-to-multipoint network type can be applied.

Step 8 Setting the OSPF network type to point-to-multipoint.

OSPF configuration can also use the point-to-multipoint OSPF network type over frame relay networks. First remove the manual peering and change the network type to point-to-multipoint.

```
[R1]ospf
[R1-ospf-1]undo peer 10.0.123.2
[R1-ospf-1]undo peer 10.0.123.3

[R2]ospf
[R2-ospf-1]undo peer 10.0.123.1

[R3]ospf
[R3-ospf-1]undo peer 10.0.123.1
```

Establish the Point-to-multipoint network type.

```
[R1]interface Serial 2/0/0
[R1-Serial2/0/0]ospf network-type p2mp

[R2]interface Serial 3/0/0
[R2-Serial3/0/0]ospf network-type p2mp

[R3]interface Serial 1/0/0
[R3-Serial1/0/0]ospf network-type p2mp
```

After setting the OSPF network type, wait until the neighbor relationship is established, then check the neighbor relationship and route information.

```
<R1>display ospf peer brief

        OSPF Process 1 with Router ID 10.0.1.1
                Peer Statistic Information
 ----------------------------------------------------------------------------
 Area Id          Interface                     Neighbor id      State
 0.0.0.0          Serial2/0/0                    10.0.2.2        Full
```

```
0.0.0.0         Serial2/0/0                  10.0.3.3        Full
 ------------------------------------------------------------------------------


<R1>display ip routing-table
Route Flags: R - relay, D - download to fib
------------------------------------------------------------------------------
Routing Tables: Public
        Destinations : 14       Routes : 14

Destination/Mask    Proto   Pre  Cost      Flags NextHop         Interface

    10.0.1.0/24     Direct  0    0           D   10.0.1.1        LoopBack0
    10.0.1.1/32     Direct  0    0           D   127.0.0.1       LoopBack0
    10.0.1.255/32   Direct  0    0           D   127.0.0.1       LoopBack0
    10.0.2.2/32     OSPF    10   1562        D   10.0.123.2      Serial2/0/0
    10.0.3.3/32     OSPF    10   1562        D   10.0.123.3      Serial2/0/0
    10.0.123.0/24   Direct  0    0           D   10.0.123.1      Serial2/0/0
    10.0.123.1/32   Direct  0    0           D   127.0.0.1       Serial2/0/0
    10.0.123.2/32   Direct  0    0           D   10.0.123.2      Serial2/0/0
    10.0.123.3/32   Direct  0    0           D   10.0.123.3      Serial2/0/0
    10.0.123.255/32 Direct  0    0           D   127.0.0.1       Serial2/0/0
    127.0.0.0/8     Direct  0    0           D   127.0.0.1       InLoopBack0
    127.0.0.1/32    Direct  0    0           D   127.0.0.1       InLoopBack0
127.255.255.255/32  Direct  0    0           D   127.0.0.1       InLoopBack0
255.255.255.255/32  Direct  0    0           D   127.0.0.1       InLoopBack0

<R2>display ospf peer brief

        OSPF Process 1 with Router ID 10.0.2.2
                Peer Statistic Information
 ------------------------------------------------------------------------------
 Area Id         Interface                    Neighbor id     State
 0.0.0.0         Serial3/0/0                   10.0.1.1        Full
 ------------------------------------------------------------------------------

<R2>display ip routing-table
Route Flags: R - relay, D - download to fib
------------------------------------------------------------------------------
Routing Tables: Public
        Destinations : 14       Routes : 14

Destination/Mask    Proto   Pre  Cost      Flags NextHop         Interface
```

```
    10.0.1.1/32     OSPF    10  1562        D   10.0.123.1      Serial3/0/0
    10.0.2.0/24     Direct  0   0           D   10.0.2.2        LoopBack0
    10.0.2.2/32     Direct  0   0           D   127.0.0.1       LoopBack0
    10.0.2.255/32   Direct  0   0           D   127.0.0.1       LoopBack0
    10.0.3.3/32     OSPF    10  3124        D   10.0.123.1      Serial3/0/0
    10.0.123.0/24   Direct  0   0           D   10.0.123.2      Serial3/0/0
    10.0.123.1/32   Direct  0   0           D   10.0.123.1      Serial3/0/0
    10.0.123.2/32   Direct  0   0           D   127.0.0.1       Serial3/0/0
    10.0.123.3/32   OSPF    10  3124        D   10.0.123.1      Serial3/0/0
    10.0.123.255/32 Direct  0   0           D   127.0.0.1       Serial3/0/0
    127.0.0.0/8     Direct  0   0           D   127.0.0.1       InLoopBack0
    127.0.0.1/32    Direct  0   0           D   127.0.0.1       InLoopBack0
127.255.255.255/32  Direct  0   0           D   127.0.0.1       InLoopBack0
255.255.255.255/32  Direct  0   0           D   127.0.0.1       InLoopBack0

<R3>display ospf peer brief

        OSPF Process 1 with Router ID 10.0.3.3
                Peer Statistic Information
 ----------------------------------------------------------------------------
 Area Id          Interface                       Neighbor id      State
 0.0.0.0          Serial1/0/0                      10.0.1.1        Full
 ----------------------------------------------------------------------------

<R3>display ip routing-table
Route Flags: R - relay, D - download to fib
------------------------------------------------------------------------------
Routing Tables: Public
        Destinations : 14       Routes : 14

Destination/Mask    Proto   Pre Cost      Flags NextHop         Interface

    10.0.1.1/32     OSPF    10  1562        D   10.0.123.1      Serial1/0/0
    10.0.2.2/32     OSPF    10  3124        D   10.0.123.1      Serial1/0/0
    10.0.3.0/24     Direct  0   0           D   10.0.3.3        LoopBack0
    10.0.3.3/32     Direct  0   0           D   127.0.0.1       LoopBack0
    10.0.3.255/32   Direct  0   0           D   127.0.0.1       LoopBack0
    10.0.123.0/24   Direct  0   0           D   10.0.123.3      Serial1/0/0
    10.0.123.1/32   Direct  0   0           D   10.0.123.1      Serial1/0/0
    10.0.123.2/32   OSPF    10  3124        D   10.0.123.1      Serial1/0/0
    10.0.123.3/32   Direct  0   0           D   127.0.0.1       Serial1/0/0
    10.0.123.255/32 Direct  0   0           D   127.0.0.1       Serial1/0/0
```

```
    127.0.0.0/8     Direct  0    0           D   127.0.0.1       InLoopBack0
    127.0.0.1/32    Direct  0    0           D   127.0.0.1       InLoopBack0
127.255.255.255/32  Direct  0    0           D   127.0.0.1       InLoopBack0
255.255.255.255/32  Direct  0    0           D   127.0.0.1       InLoopBack0
```

Perform a network connectivity test on R3 from the source 10.0.3.3.

```
<R3>ping -a 10.0.3.3 10.0.1.1
  PING 10.0.1.1: 56  data bytes, press CTRL_C to break
    Reply from 10.0.1.1: bytes=56 Sequence=1 ttl=255 time=60 ms
    Reply from 10.0.1.1: bytes=56 Sequence=2 ttl=255 time=51 ms
    Reply from 10.0.1.1: bytes=56 Sequence=3 ttl=255 time=50 ms
    Reply from 10.0.1.1: bytes=56 Sequence=4 ttl=255 time=60 ms
    Reply from 10.0.1.1: bytes=56 Sequence=5 ttl=255 time=51 ms

  --- 10.0.1.1 ping statistics ---
    5 packet(s) transmitted
    5 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 50/54/60 ms

<R3>ping -a 10.0.3.3 10.0.123.2
    PING 10.0.123.2: 56  data bytes, press CTRL_C to break
      Reply from 10.0.123.2: bytes=56 Sequence=1 ttl=254 time=110 ms
      Reply from 10.0.123.2: bytes=56 Sequence=2 ttl=254 time=101 ms
      Reply from 10.0.123.2: bytes=56 Sequence=3 ttl=254 time=101 ms
      Reply from 10.0.123.2: bytes=56 Sequence=4 ttl=254 time=110 ms
      Reply from 10.0.123.2: bytes=56 Sequence=5 ttl=254 time=101 ms

    --- 10.0.123.2 ping statistics ---
      5 packet(s) transmitted
      5 packet(s) received
      0.00% packet loss
      round-trip min/avg/max = 101/104/110 ms

<R3>ping -a 10.0.3.3 10.0.2.2
     PING 10.0.2.2: 56  data bytes, press CTRL_C to break
       Reply from 10.0.2.2: bytes=56 Sequence=1 ttl=254 time=102 ms
       Reply from 10.0.2.2: bytes=56 Sequence=2 ttl=254 time=101 ms
       Reply from 10.0.2.2: bytes=56 Sequence=3 ttl=254 time=110 ms
       Reply from 10.0.2.2: bytes=56 Sequence=4 ttl=254 time=101 ms
       Reply from 10.0.2.2: bytes=56 Sequence=5 ttl=254 time=102 ms
```

```
     --- 10.0.2.2 ping statistics ---
       5 packet(s) transmitted
       5 packet(s) received
       0.00% packet loss
       round-trip min/avg/max = 101/103/110 ms
```

Final Configuration

```
[R1]display current-configuration
[V200R003C00SPC200]
#
 sysname R1
#
 interface Serial2/0/0
 link-protocol fr
 undo fr inarp
 fr map ip 10.0.123.2 102 broadcast
 fr map ip 10.0.123.3 103 broadcast
 ip address 10.0.123.1 255.255.255.0
 ospf network-type p2mp
 ospf dr-priority 255
#
interface LoopBack0
 ip address 10.0.1.1 255.255.255.0
#
ospf 1 router-id 10.0.1.1
 area 0.0.0.0
  network 10.0.0.0 0.255.255.255
#
user-interface con 0
 authentication-mode password
 set authentication password
cipher %$%$dD#}P<HzJ;Xs%X>hOkm!,.+Iq61QK`K6tI}cc-;k_o`C.+L,%$%$
user-interface vty 0 4
#
return

[R2]display current-configuration
[V200R003C00SPC200]
#
 sysname R2
#
```

```
interface Serial3/0/0
 link-protocol fr
 undo fr inarp
 fr map ip 10.0.123.1 201 broadcast
 ip address 10.0.123.2 255.255.255.0
 ospf network-type p2mp
#
interface LoopBack0
 ip address 10.0.2.2 255.255.255.0
#
ospf 1 router-id 10.0.2.2
 area 0.0.0.0
  network 10.0.0.0 0.255.255.255
#
user-interface con 0
 authentication-mode password
 set authentication password
cipher %$%$|nRPL^hr2IXi7LHDID!/,.*%.8%h;3:,hXO2dk#ikaWI.*(,%$%$
user-interface vty 0 4
#
return

[R3]display current-configuration
[V200R003C00SPC200]
#
 sysname R3
#
interface Serial1/0/0
 link-protocol fr
 undo fr inarp
 fr map ip 10.0.123.1 301 broadcast
 ip address 10.0.123.3 255.255.255.0
 ospf network-type p2mp
#
interface LoopBack0
 ip address 10.0.3.3 255.255.255.0
#
ospf 1 router-id 10.0.3.3
 area 0.0.0.0
  network 10.0.0.0 0.255.255.255
#
user-interface con 0
 authentication-mode password
```

```
 set authentication password
cipher %$%$W|$)M5D}v@bY^gK\;>QR,.*d;8Mp>|+EU,:~D~8b59~..*g,%$%$
user-interface vty 0 4
#
return
```