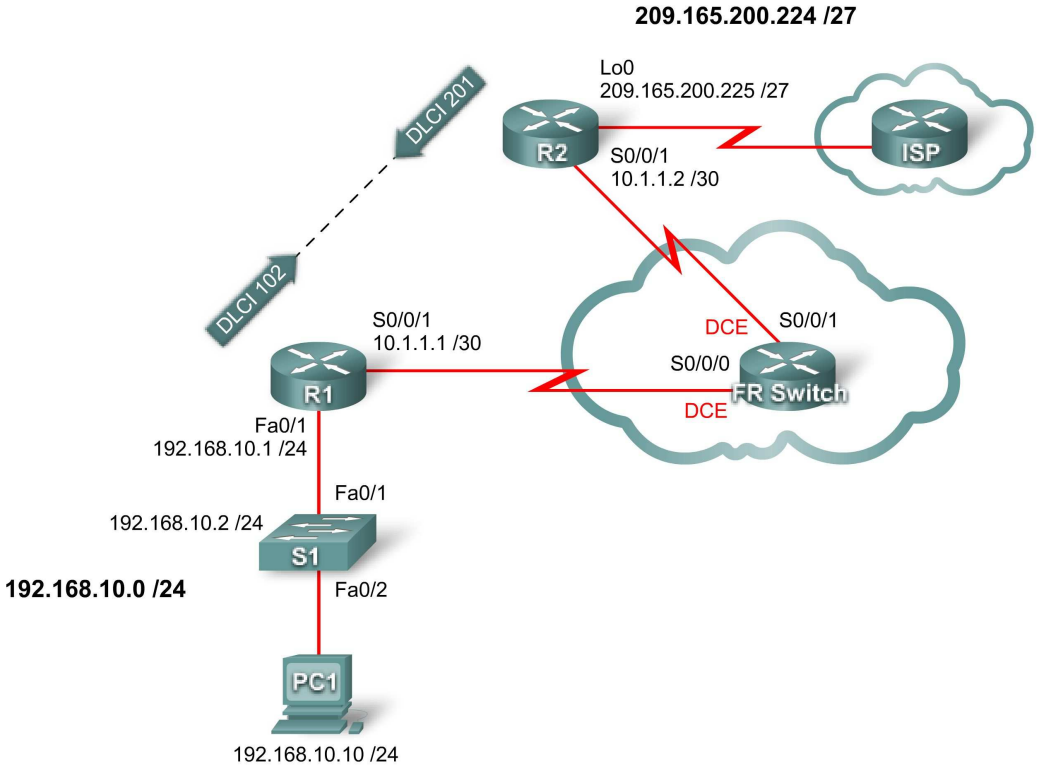
# Lab 3.5.1: Basic Frame Relay

## Topology Diagram




## Addressing Table

| Device | Interface | IP Address | Subnet Mask | Default Gateway |
|---|---|---|---|---|
| **R1** | **Fa0/0** | 192.168.10.1 | 255.255.255.0 | N/A |
| | **S0/0/1** | 10.1.1.1 | 255.255.255.252 | N/A |
| **R2** | **S0/0/1** | 10.1.1.2 | 255.255.255.252 | N/A |
| | **Lo 0** | 209.165.200.225 | 255.255.255.224 | N/A |
| **S1** | **VLAN1** | 192.168.10.2 | 255.255.255.0 | 192.168.10.1 |
| **PC1** | **NIC** | 192.168.10.10 | 255.255.255.0 | 192.168.10.1 |

## Learning Objectives

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

- Cable a network according to the topology diagram
- Erase the startup configuration and reload a router to the default state

- Perform basic configuration tasks on a router
- Configure and activate interfaces
- Configure EIGRP routing on all routers
- Configure Frame Relay encapsulation on all serial interfaces
- Configure a router as a Frame Relay switch
- Understand the output of the **show frame-relay** commands
- Learn the effects of the **debug frame-relay lmi** command
- Intentionally break and restore a Frame Relay link
- Change the Frame Relay encapsulation type from the Cisco default to IETF
- Change the Frame Relay LMI type from Cisco to ANSI
- Configure a Frame Relay subinterface

## Scenario

In this lab, you will learn how to configure Frame Relay encapsulation on serial links using the network shown in the topology diagram. You will also learn how to configure a router as a Frame Relay switch. There are both Cisco standards and Open standards that apply to Frame Relay. You will learn both. Pay special attention in the lab section in which you intentionally break the Frame Relay configurations. This will help you in the Troubleshooting lab associated with this chapter.

### Task 1: Prepare the Network

#### Step 1: Cable a network that is similar to the one in the topology diagram.

You can use any current router in your lab as long as it has the required interfaces shown in the topology. The Frame Relay labs, unlike any of the other labs in Exploration 4, have two DCE links on the same router. Be sure to change your cabling to reflect the topology diagram.

Note: If you use 1700, 2500, or 2600 routers, the router output and interface descriptions appear differently.

#### Step 2: Clear any existing configurations on the routers.

### Task 2: Perform Basic Router Configuration

Configure the R1 and R2 routers and the S1 switch according to the following guidelines:

- Configure the router hostname.
- Disable DNS lookup.
- Configure an EXEC mode password.
- Configure a message-of-the-day banner.
- Configure a password for console connections.
- Configure a password for vty connections.
- Configure IP addresses on R1 and R2

  Important: Leave serial interfaces shut down.
- Enable EIGRP AS 1 on R1 and R2 for all networks.

```
enable
configure terminal
no ip domain-lookup
enable secret class
banner motd ^CUnauthorized access strictly prohibited, violators
will be prosecuted to the full extent of the law^C
!
!
!
line console 0
logging synchronous
 password cisco
 login
!
line vty 0 4
password cisco
login
end
copy running-config startup-config
```

!R1

```
interface serial 0/0/1
ip address 10.1.1.1 255.255.255.252
shutdown
!The serial interfaces should remain shutdown until the Frame Relay
!switch is configured

interface fastethernet 0/0
ip address 192.168.10.1 255.255.255.0
no shutdown
router eigrp 1
no auto-summary
network 10.0.0.0
network 192.168.10.0
!
```

!R2

```
interface serial 0/0/1
ip address 10.1.1.2 255.255.255.252
shutdown
!The serial interfaces should remain shutdown until the Frame Relay
!switch is configured

interface loopback 0
ip address 209.165.200.225 255.255.255.224
router eigrp 1
no auto-summary
network 10.0.0.0
network 209.165.200.0
```

!

## Task 3: Configure Frame Relay

You will now set up a basic point-to-point Frame Relay connection between routers 1 and 2. You first need to configure FR Switch as a Frame Relay switch and create DLCIs.

What does DLCI stand for?

_____

What is a DLCI used for?

_____

_____

What is a PVC and how is it used?

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_____

### Step 1: Configure FR Switch as a Frame Relay switch and create a PVC between R1 and R2.

This command enables Frame Relay switching globally on the router, allowing it to forward frames based on the incoming DLCI rather than on an IP address basis:

```
FR-Switch(config)#frame-relay switching
```

Change the interface encapsulation type to Frame Relay. Like HDLC or PPP, Frame Relay is a data link layer protocol that specifies the framing of Layer 2 traffic.

```
FR-Switch(config)#interface serial 0/0/0
FR-Switch(config)#clock rate 64000
```

```
FR-Switch(config-if)#encapsulation frame-relay
```

Changing the interface type to DCE tells the router to send LMI keepalives and allows Frame Relay route statements to be applied. You cannot set up PVCs using the **frame-relay route** command between two Frame Relay DTE interfaces.

```
FR-Switch(config-if)#frame-relay intf-type dce
```

Note: Frame Relay interface types do not need to match the underlying physical interface type. A physical DTE serial interface can act as a Frame Relay DCE interface, and a physical DCE interface can act as a logical Frame Relay DTE interface.

Configure the router to forward incoming traffic on interface serial 0/0/0 with DLCI 102 to serial 0/0/1 with an output DLCI of 201.

```
FR-Switch(config-if)#frame-relay route 102 interface serial 0/0/1 201
FR-Switch(config-if)#no shutdown
```

This configuration creates two PVCs: one from R1 to R2 (DLCI 102), and one from R2 to R1 (DLCI 201). You can verify the configuration using the **show frame-relay pvc** command.

 

```
FR-Switch(config-if)#interface serial 0/0/1
FR-Switch(config)#clock rate 64000
FR-Switch(config-if)#encapsulation frame-relay
FR-Switch(config-if)#frame-relay intf-type dce
FR-Switch(config-if)#frame-relay route 201 interface serial 0/0/0 102
FR-Switch(config-if)#no shutdown


FR-Switch#show frame-relay pvc

PVC Statistics for interface Serial0/0/0 (Frame Relay DCE)

             Active     Inactive      Deleted       Static
  Local         0           0           0           0
  Switched      0           1           0           0
  Unused        0           0           0           0

DLCI = 102, DLCI USAGE = SWITCHED, PVC STATUS = INACTIVE, INTERFACE =
Serial0/0/0

  input pkts 0            output pkts 0           in bytes 0
  out bytes 0             dropped pkts 0          in pkts dropped 0
  out pkts dropped 0       out bytes dropped 0
  in FECN pkts 0          in BECN pkts 0          out FECN pkts 0
  out BECN pkts 0         in DE pkts 0            out DE pkts 0
  out bcast pkts 0        out bcast bytes 0
  30 second input rate 0 bits/sec, 0 packets/sec
  30 second output rate 0 bits/sec, 0 packets/sec
  switched pkts 0
  Detailed packet drop counters:
  no out intf 0           out intf down 0         no out PVC 0
  in PVC down 0           out PVC down 0          pkt too big 0
  shaping Q full 0        pkt above DE 0          policing drop 0
  pvc create time 00:03:33, last time pvc status changed 00:00:19

PVC Statistics for interface Serial0/0/1 (Frame Relay DCE)

             Active     Inactive      Deleted       Static
  Local         0           0           0           0
  Switched      0           1           0           0
  Unused        0           0           0           0

DLCI = 201, DLCI USAGE = SWITCHED, PVC STATUS = INACTIVE, INTERFACE =
Serial0/0/1

  input pkts 0            output pkts 0           in bytes 0
  out bytes 0             dropped pkts 0          in pkts dropped 0
  out pkts dropped 0              out bytes dropped 0
  in FECN pkts 0          in BECN pkts 0          out FECN pkts 0
  out BECN pkts 0         in DE pkts 0            out DE pkts 0
  out bcast pkts 0        out bcast bytes 0
  30 second input rate 0 bits/sec, 0 packets/sec
  30 second output rate 0 bits/sec, 0 packets/sec
  switched pkts 0
  Detailed packet drop counters:
  no out intf 0           out intf down 0         no out PVC 0
```

 

```
  in PVC down 0           out PVC down 0          pkt too big 0
  shaping Q full 0         pkt above DE 0          policing drop 0
  pvc create time 00:02:02, last time pvc status changed 00:00:18
```

Notice the 1 in the Inactive column. The PVC you have created does not have any endpoints configured. The Frame Relay switch knows this and has marked the PVC as Inactive.

Issue the **show frame-relay route** command. This command shows any existing Frame Relay routes, their interfaces, DLCIs, and status. This is the Layer 2 route that Frame Relay traffic takes through the network. Do not confuse this with Layer 3 IP routing.

```
FR-Switch#show frame-relay route

Input Intf      Input Dlci      Output Intf     Output Dlci     Status
Serial0/0/0     102             Serial0/0/1     201             inactive
Serial0/0/1     201             Serial0/0/0     102             inactive
```

**Step 2: Configure R1 for Frame Relay.**

Inverse ARP allows distant ends of a Frame Relay link to dynamically discover each other and provides a dynamic method of mapping IP addresses to DLCIs. Although Inverse ARP is useful, it is not always reliable. The best practice is to statically map IP addresses to DLCIs and to disable inverse-arp.

```
R1(config)#interface serial 0/0/1
R1(config-if)#encapsulation frame-relay
R1(config-if)#no frame-relay inverse-arp
```

Why would you want to map an IP address to a DLCI?

_____

_____

_____

_____

The command **frame-relay map** statically maps an IP address to a DLCI. In addition to mapping IP to a DLCI, Cisco IOS software allows several other Layer 3 protocol addresses to mapped. The **broadcast** keyword in the following command sends any multicast or broadcast traffic destined for this link over the DLCI. Most routing protocols require the **broadcast** keyword to properly function over Frame Relay. You can use the **broadcast** keyword on multiple DLCIs on the same interface. The traffic is replicated to all PVCs.

```
R1(config-if)#frame-relay map ip 10.1.1.2 102 broadcast
```

Is the DLCI mapped to the local IP address or the IP address at the other end of the PVC?

_____

```
R1(config-if)#no shutdown
```

 

Why is the **no shutdown** command used after the **no frame-relay inverse-arp** command?

_____

_____

_____

_____

**Step 3: Configure R2 for Frame Relay.**

```
R2(config)#interface serial 0/0/1
R2(config-if)#encapsulation frame-relay
R2(config-if)#no frame-relay inverse-arp
R2(config-if)#frame-relay map ip 10.1.1.1 201 broadcast
R2(config-if)#no shutdown
```

At this point, you receive messages indicating that the interfaces have come up and that EIGRP neighbor adjacency has been established.

```
R1#*Sep  9 17:05:08.771: %DUAL-5-NBRCHANGE: IP-EIGRP(0) 1: Neighbor
10.1.1.2 (Serial0/0/1) is up: new adjacency
```

```
R2#*Sep  9 17:05:47.691: %DUAL-5-NBRCHANGE: IP-EIGRP(0) 1: Neighbor
10.1.1.1 (Serial0/0/1) is up: new adjacency
```

The **show ip route** command shows complete routing tables.

**R1:**

```
R1#show ip route

Codes: 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

Gateway of last resort is not set

C    192.168.10.0/24 is directly connected, FastEthernet0/0
D    209.165.200.0/24 [90/20640000] via 10.1.1.2, 00:00:07, Serial0/0/1
     10.0.0.0/30 is subnetted, 1 subnets
C       10.1.1.0 is directly connected, Serial0/0/1
```

**R2:**

```
R2#show ip route

Codes: 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


Gateway of last resort is not set

D    192.168.10.0/24 [90/20514560] via 10.1.1.1, 00:26:03, Serial0/0/1
     209.165.200.0/27 is subnetted, 1 subnets
C       209.165.200.224 is directly connected, Loopback0
     10.0.0.0/30 is subnetted, 1 subnets
C       10.1.1.0 is directly connected, Serial0/0/1
```

## Task 4: Verify the Configuration

You should now be able to ping from R1 to R2. It may take several seconds after bringing up the interfaces for the PVC to become active. You can also see EIGRP routes for each router.

### Step 1: Ping R1 and R2.

Ensure that you can ping router R2 from router R1.

```
R1#ping 10.1.1.2

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.1.1.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 28/29/32
ms
R2#ping 10.1.1.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.1.1.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 28/29/32
ms
```

### Step 2: Get PVC information.

The **show frame-relay pvc** command displays information on all PVCs configured on the router. The output also includes the associated DLCI.

**R1:**

```
R1#show frame-relay pvc

PVC Statistics for interface Serial0/0/1 (Frame Relay DTE)

                Active     Inactive      Deleted       Static
  Local            1            0            0            0
  Switched         0            0            0            0
  Unused           0            0            0            0

DLCI = 102, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE =
Serial0/0/1
```

 

```
  input pkts 5             output pkts 5            in bytes 520
  out bytes 520            dropped pkts 0           in pkts dropped 0
  out pkts dropped 0                 out bytes dropped 0
  in FECN pkts 0           in BECN pkts 0           out FECN pkts 0
  out BECN pkts 0          in DE pkts 0             out DE pkts 0
  out bcast pkts 0         out bcast bytes 0
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
  pvc create time 10:26:41, last time pvc status changed 00:01:04
```

**R2:**

```
R2#show frame-relay pvc

PVC Statistics for interface Serial0/0/1 (Frame Relay DTE)

               Active     Inactive      Deleted       Static
  Local           1            0            0            0
  Switched        0            0            0            0
  Unused          0            0            0            0

DLCI = 201, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE =
Serial0/0/1

  input pkts 5             output pkts 5            in bytes 520
  out bytes 520            dropped pkts 0           in pkts dropped 0
  out pkts dropped 0                 out bytes dropped 0
  in FECN pkts 0           in BECN pkts 0           out FECN pkts 0
  out BECN pkts 0          in DE pkts 0             out DE pkts 0
  out bcast pkts 0         out bcast bytes 0
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
  pvc create time 10:25:31, last time pvc status changed 00:00:00
```

**FR Switch:**

```
FR-Switch#show frame-relay pvc

PVC Statistics for interface Serial0/0/0 (Frame Relay DCE)

               Active     Inactive      Deleted       Static
  Local           0            0            0            0
  Switched        1            0            0            0
  Unused          0            0            0            0

DLCI = 102, DLCI USAGE = SWITCHED, PVC STATUS = ACTIVE, INTERFACE =
Serial0/0/0

  input pkts 0             output pkts 0            in bytes 0
  out bytes 0              dropped pkts 0           in pkts dropped 0
  out pkts dropped 0                 out bytes dropped 0
  in FECN pkts 0           in BECN pkts 0           out FECN pkts 0
  out BECN pkts 0          in DE pkts 0             out DE pkts 0
  out bcast pkts 0         out bcast bytes 0
  30 second input rate 0 bits/sec, 0 packets/sec
  30 second output rate 0 bits/sec, 0 packets/sec
```

 

```
  switched pkts 0
  Detailed packet drop counters:
  no out intf 0           out intf down 0          no out PVC 0
  in PVC down 0           out PVC down 0           pkt too big 0
  shaping Q full 0        pkt above DE 0           policing drop 0
  pvc create time 10:28:31, last time pvc status changed 00:03:57

PVC Statistics for interface Serial0/0/1 (Frame Relay DCE)

              Active     Inactive      Deleted       Static
  Local          0           0            0            0
  Switched       1           0            0            0
  Unused         0           0            0            0

DLCI = 201, DLCI USAGE = SWITCHED, PVC STATUS = ACTIVE, INTERFACE =
Serial0/0/1

  input pkts 0            output pkts 0           in bytes 0
  out bytes 0             dropped pkts 0          in pkts dropped 0
  out pkts dropped 0               out bytes dropped 0
  in FECN pkts 0          in BECN pkts 0          out FECN pkts 0
  out BECN pkts 0         in DE pkts 0            out DE pkts 0
  out bcast pkts 0        out bcast bytes 0
  30 second input rate 0 bits/sec, 0 packets/sec
  30 second output rate 0 bits/sec, 0 packets/sec
  switched pkts 0
  Detailed packet drop counters:
  no out intf 0           out intf down 0          no out PVC 0
  in PVC down 0           out PVC down 0           pkt too big 0
  shaping Q full 0        pkt above DE 0           policing drop 0
  pvc create time 10:27:00, last time pvc status changed 00:04:03
```

**Step 3: Verify Frame Relay mappings.**

The **show frame-relay map** command displays information on the static and dynamic mappings of Layer 3 addresses to DLCIs. Because Inverse ARP has been turned off, there are only static maps.

**R1:**

```
R1#show frame-relay map
Serial0/0/1 (up): ip 10.1.1.2 dlci 102(0x66,0x1860), static,
              CISCO, status defined, active
```

**R2:**

```
R2#show frame-relay map
Serial0/0/1 (up): ip 10.1.1.1 dlci 201(0xC9,0x3090), static,
              CISCO, status defined, active
```

**FR Switch:**

FR Switch acts as a Layer 2 device, so there is no need to map Layer 3 addresses to Layer 2 DLCIs.

**Step 4: Debug the Frame Relay LMI.**

What purpose does the LMI serve in a Frame Relay network?

 

_____

_____

_____

_____

What are the three different types of LMI?

_____

What DLCI does the LMI operate on?

_____

Issue the **debug frame-relay lmi** command. The output gives detailed information on all LMI data. Keepalives are sent every 10 seconds, so you may have to wait until you see any output.

The debug output shows two LMI packets: the first outgoing, the second incoming.

```
R1#debug frame-relay lmi
Frame Relay LMI debugging is on
Displaying all Frame Relay LMI data
R1#
*Aug 24 06:19:15.920: Serial0/0/1(out): StEnq, myseq 196, yourseen
195, DTE up
*Aug 24 06:19:15.920: datagramstart = 0xE73F24F4, datagramsize = 13
*Aug 24 06:19:15.920: FR encap = 0xFCF10309
*Aug 24 06:19:15.920: 00 75 01 01 00 03 02 C4 C3
*Aug 24 06:19:15.920:
*Aug 24 06:19:15.924: Serial0/0/1(in): Status, myseq 196, pak size 21
*Aug 24 06:19:15.924: RT IE 1, length 1, type 0
*Aug 24 06:19:15.924: KA IE 3, length 2, yourseq 196, myseq 196
*Aug 24 06:19:15.924: PVC IE 0x7 , length 0x6 , dlci 102, status 0x2
, bw 0
R1#undebug all
Port Statistics for unclassified packets is not turned on.

All possible debugging has been turned off
```

Notice that the output shows an outgoing LMI packet with a sequence number of 196. The last LMI message received from the FR Switch had sequence number 195.

```
*Aug 24 06:19:15.920: Serial0/0/1(out): StEnq, myseq 196, yourseen
195, DTE up
```

This line indicates an incoming LMI message from the FR Switch to R1 with sequence number 196.

 

```
*Aug 24 06:19:15.924: Serial0/0/1(in): Status, myseq 196, pak size 21
```

FR Switch sent this as sequence number 196 (myseq), and the last LMI message received by the FR-Switch from R1 had sequence number 196 (yourseq).

```
*Aug 24 06:19:15.924: KA IE 3, length 2, yourseq 196, myseq 196
```

DLCI 102 is the only DLCI on this link, and it is currently active.

```
*Aug 24 06:19:15.924: PVC IE 0x7 , length 0x6 , dlci 102, status 0x2
, bw 0
```

## Task 4: Troubleshooting Frame Relay.

A variety of tools are available for troubleshooting Frame Relay connectivity issues. To learn about troubleshooting, you will break the Frame Relay connection established earlier and then re-establish it.

### Step 1: Remove the frame map from R1.

```
R1#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#interface serial0/0/1
R1(config-if)#encapsulation frame-relay
R1(config-if)#no frame-relay map ip 10.1.1.2 102 broadcast
```

Now that you have removed the frame map statement from R1, try to ping router R1 from router R2. You will get no response.

```
R2#ping 10.1.1.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.1.1.1, timeout is 2 seconds:
.....
Success rate is 0 percent (0/5)
```

Additionally, you should get console messages reporting the EIGRP adjacency going up and down.

```
R1(config-if)#*Sep  9 17:28:36.579: %DUAL-5-NBRCHANGE: IP-EIGRP(0) 1:
Neighbor 10.1.1.2 (Serial0/0/1) is down: Interface Goodbye received

R1(config-if)#*Sep  9 17:29:32.583: %DUAL-5-NBRCHANGE: IP-EIGRP(0) 1:
Neighbor 10.1.1.2 (Serial0/0/1) is up: new adjacency

R1(config-if)#*Sep  9 17:32:37.095: %DUAL-5-NBRCHANGE: IP-EIGRP(0) 1:
Neighbor 10.1.1.2 (Serial0/0/1) is down: retry limit exceeded

R2#*Sep  9 17:29:15.359: %DUAL-5-NBRCHANGE: IP-EIGRP(0) 1: Neighbor
10.1.1.1 (Serial0/0/1) is down: holding time expired
```

Issue the **debug ip icmp** command on R1:

```
R1#debug ip icmp

ICMP packet debugging is on
```

Now ping the serial interface of R1 again. The following debug message appears on R1:

```
R2#ping 10.1.1.1

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 10.1.1.1, timeout is 2 seconds:
```

 

```
.....
Success rate is 0 percent (0/5)
R1#*Sep  9 17:42:13.415: ICMP: echo reply sent, src 10.1.1.1, dst
10.1.1.2
R1#*Sep  9 17:42:15.411: ICMP: echo reply sent, src 10.1.1.1, dst
10.1.1.2
R1#*Sep  9 17:42:17.411: ICMP: echo reply sent, src 10.1.1.1, dst
10.1.1.2
R1#*Sep  9 17:42:19.411: ICMP: echo reply sent, src 10.1.1.1, dst
10.1.1.2
R1#*Sep  9 17:42:21.411: ICMP: echo reply sent, src 10.1.1.1, dst
10.1.1.2
```

As is shown by this debug message, the ICMP packet from R2 is reaching R1.

Why does the ping fail?

_____

_____

Issuing the **show frame-relay map** command returns a blank line.

```
R1#show frame-relay map

R1#
```

Turn off all debugging with the **undebug all** command, and re-apply the **frame-relay map ip** command but without using the **broadcast** keyword.

```
R1#undebug all

Port Statistics for unclassified packets is not turned on.

All possible debugging has been turned off

R1#configure terminal

Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#interface serial0/0/1
R1(config-if)#encapsulation frame-relay
R1(config-if)#frame-relay map ip 10.1.1.2 102
R2#ping 10.1.1.1


Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.1.1.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 40/41/44 ms
```

Notice that while pings are successful, the EIGRP adjacency continues to “flap” (go up and down).

```
R1(config-if)#*Sep  9 17:47:58.375: %DUAL-5-NBRCHANGE: IP-EIGRP(0) 1:
Neighbor 10.1.1.2 (Serial0/0/1) is up: new adjacency

R1(config-if)#*Sep  9 17:51:02.887: %DUAL-5-NBRCHANGE: IP-EIGRP(0) 1:
Neighbor 10.1.1.2 (Serial0/0/1) is down: retry limit exceeded

R1(config-if)#*Sep  9 17:51:33.175: %DUAL-5-NBRCHANGE: IP-EIGRP(0) 1:
Neighbor 10.1.1.2 (Serial0/0/1) is up: new adjacency
```

 

```
R1(config-if)#*Sep  9 17:54:37.687: %DUAL-5-NBRCHANGE: IP-EIGRP(0) 1:
Neighbor 10.1.1.2 (Serial0/0/1) is down: retry limit exceeded
```

Why does the EIGRP adjacency continue to flap?

_____

_____

Replace the Frame Relay map statement and include the **broadcast** keyword this time. Verify that the full routing table is restored and that you have full end-to-end connectivity.

```
R1#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#interface serial0/0/1
R1(config-if)#encapsulation frame-relay
R1(config-if)#frame-relay map ip 10.1.1.2 102 broadcast
R1#show ip route
Codes: 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
Gateway of last resort is not set
C    192.168.10.0/24 is directly connected, FastEthernet0/0
     209.165.200.0/27 is subnetted, 1 subnets
D    209.165.200.224 [90/20640000] via 10.1.1.2, 00:00:05, Serial0/0/1
     10.0.0.0/30 is subnetted, 1 subnets
C    10.1.1.0 is directly connected, Serial0/0/1
```

**Step 2: Change the Frame Relay encapsulation type.**

Cisco IOS software supports two types of Frame Relay encapsulation: the default Cisco encapsulation and the standards-based IETF encapsulation. Change the Frame Relay encapsulation on serial0/0/1 on R2 to IETF.

```
R2(config-if)#encapsulation frame-relay ietf
```

Notice that the interface does not go down. You might be surprised by this. Cisco routers can correctly interpret Frame Relay frames that use either the default Cisco Frame Relay encapsulation or the IETF standard Frame Relay encapsulation. If your network is composed entirely of Cisco routers, then it does not make any difference whether you use the default Cisco Frame Relay encapsulation or the IETF standard. Cisco routers understand both types of incoming frames. However, if you have routers from different vendors using Frame Relay, then the IETF standard must be used. The command **encapsulation frame-relay ietf** forces the Cisco router to encapsulate its outgoing frames using the IETF standard. This standard can be correctly understood by the router of another vendor.

```
R2#show interface serial 0/0/1
Serial0/0/1 is up, line protocol is up
```

 

```
  Hardware is GT96K Serial
  Internet address is 10.1.1.2/30
  MTU 1500 bytes, BW 128 Kbit, DLY 20000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation FRAME-RELAY IETF, loopback not set

<output omitted>

FR-Switch#show int s0/0/0
Serial0/0/0 is up, line protocol is up
  Hardware is GT96K Serial
  MTU 1500 bytes, BW 128 Kbit, DLY 20000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation FRAME-RELAY, loopback not set
```

Note the difference in output between the two **show interface** commands. Also notice that the EIGRP adjacency is still up. Although FR Switch and R2 are using different encapsulation types, they are still passing traffic.

Change the encapsulation type back to the default:

```
R2(config-if)#encapsulation frame-relay
```

**Step 3: Change the LMI type.**

On R2, change the LMI type to ANSI.

```
R2#configure terminal

Enter configuration commands, one per line.  End with CNTL/Z.
R2(config)#interface serial 0/0/1
R2(config-if)#encapsulation frame-relay
R2(config-if)#frame-relay lmi-type ansi
R2(config-if)#^Z
R2#copy run start
Destination filename [startup-config]?
Building configuration...
[OK]

*Sep  9 18:41:08.351: %LINEPROTO-5-UPDOWN: Line protocol on Interface
Serial0/0/1, changed state to down

*Sep  9 18:41:08.351: %DUAL-5-NBRCHANGE: IP-EIGRP(0) 1: Neighbor
10.1.1.1 (Serial0/0/1) is down: interface down

R2#show interface serial 0/0/1

Serial0/0/1 is up, line protocol is down

R2#show frame-relay lmi

LMI Statistics for interface Serial0/0/1 (Frame Relay DTE) LMI TYPE =
ANSI
  Invalid Unnumbered info 0              Invalid Prot Disc 0
  Invalid dummy Call Ref 0               Invalid Msg Type 0
  Invalid Status Message 0               Invalid Lock Shift 0
  Invalid Information ID 0               Invalid Report IE Len 0
  Invalid Report Request 0               Invalid Keep IE Len 0
  Num Status Enq. Sent 1391              Num Status msgs Rcvd 1382
  Num Update Status Rcvd 0               Num Status Timeouts 10
```

 

```
  Last Full Status Req 00:00:27          Last Full Status Rcvd 00:00:27
```

If you continue issuing the **show frame-relay lmi** command, you will notice the highlighted times incrementing. When 60 seconds have passed, the interface changes its state to Up Down, because R2 and FR Switch are no longer exchanging keepalives or any other link-state information.

Issue the **debug frame-relay lmi** command. Notice that LMI packets are no longer showing up in pairs. While all outgoing LMI messages are logged, no incoming messages are shown. This is because R2 is expecting ANSI LMI, and FR Switch is sending Cisco LMI.

```
R2#debug frame-relay lmi

*Aug 25 04:34:25.774: Serial0/0/1(out): StEnq, myseq 20, yourseen 0,
DTE down
*Aug 25 04:34:25.774: datagramstart = 0xE73F2634, datagramsize = 14
*Aug 25 04:34:25.774: FR encap = 0x00010308
*Aug 25 04:34:25.774: 00 75 95 01 01 00 03 02 14 00
*Aug 25 04:34:25.774:
```

Leave debugging on and restore the LMI type to Cisco on R2.

```
R2(config-if)#frame-relay lmi-type cisco
*Aug 25 04:42:45.774: Serial0/0/1(out): StEnq, myseq 2, yourseen 1, DTE
down
*Aug 25 04:42:45.774: datagramstart = 0xE7000D54, datagramsize = 13
*Aug 25 04:42:45.774: FR encap = 0xFCF10309
*Aug 25 04:42:45.774: 00 75 01 01 01 03 02 02 01
*Aug 25 04:42:45.774:
*Aug 25 04:42:45.778: Serial0/0/1(in): Status, myseq 2, pak size 21
*Aug 25 04:42:45.778: RT IE 1, length 1, type 0
*Aug 25 04:42:45.778: KA IE 3, length 2, yourseq 2 , myseq 2
*Aug 25 04:42:45.778: PVC IE 0x7 , length 0x6 , dlci 201, status 0x2 ,
bw 0
*Aug 25 04:42:55.774: Serial0/0/1(out): StEnq, myseq 3, yourseen 2, DTE
up
*Aug 25 04:42:55.774: datagramstart = 0xE7001614, datagramsize = 13
*Aug 25 04:42:55.774: FR encap = 0xFCF10309
*Aug 25 04:42:55.774: 00 75 01 01 01 03 02 03 02
*Aug 25 04:42:55.774:
*Aug 25 04:42:55.778: Serial0/0/1(in): Status, myseq 3, pak size 21
*Aug 25 04:42:55.778: RT IE 1, length 1, type 0
*Aug 25 04:42:55.778: KA IE 3, length 2, yourseq 1 , myseq 3
*Aug 25 04:42:55.778: PVC IE 0x7 , length 0x6 , dlci 201, status 0x2 ,
bw 0
*Aug 25 04:42:56.774: %LINEPROTO-5-UPDOWN: Line protocol on Interface
Serial0/0/1, changed state to up
```

As you can see, the LMI sequence number has been reset to 1, and R2 began to understand the LMI messages coming in from FR Switch. After FR Switch and R2 had successfully exchanged LMI messages, the interface changed state to Up.

## Task 5: Configure a Frame Relay Sub-interface

Frame Relay supports two types of sub-interfaces: point-to-point and point-to-multipoint. Point-to-multipoint sub-interfaces support non-broadcast multi-access topologies. For example, a hub and

 

spoke topology would use a point-to-multipoint sub-interface. In this lab, you will create a point-to-point sub-interface.

**Step 1: On FR Switch, create a new PVC between R1 and R2.**

```
FR-Switch(config)#interface serial 0/0/0
FR-Switch(config-if)#frame-relay route 112 interface serial 0/0/1 212
FR-Switch(config-if)#interface serial 0/0/1
FR-Switch(config-if)#frame-relay route 212 interface serial 0/0/0 112
```

**Step 2: Create and configure a point-to-point sub-interface on R1.**

Create subinterface 112 as a point-to-point interface. Frame Relay encapsulation must be specified on the physical interface before subinterfaces can be created.

```
R1(config)#interface serial 0/0/1.112 point-to-point
R1(config-subif)#ip address 10.1.1.5 255.255.255.252
R1(config-subif)#frame-relay interface-dlci 112
```

**Step 3: Create and configure a point-to-point sub-interface on R2.**

```
R2(config)#interface serial 0/0/1.212 point-to-point
R2(config-subif)#ip address 10.1.1.6 255.255.255.252
R2(config-subif)#frame-relay interface-dlci 212
```

**Step 4: Verify connectivity.**

You should be able to ping across the new PVC.

```
R1#ping 10.1.1.6
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.1.1.6, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 28/28/32 ms

R2#ping 10.1.1.5

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.1.1.5, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 28/28/32 ms
```

You can also verify the configuration using the **show frame-relay pvc** and **show frame-relay map** commands in Task 4.

**R1:**

```
R1#show frame-relay pvc

PVC Statistics for interface Serial0/0/1 (Frame Relay DTE)

                Active     Inactive      Deleted       Static
  Local            2            0            0            0
  Switched         0            0            0            0
  Unused           0            0            0            0

DLCI = 102, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE =
Serial0/0/1
```

 

```
  input pkts 319           output pkts 279          in bytes 20665
  out bytes 16665          dropped pkts 0           in pkts dropped 0
  out pkts dropped 0                 out bytes dropped 0
  in FECN pkts 0           in BECN pkts 0           out FECN pkts 0
  out BECN pkts 0          in DE pkts 0             out DE pkts 0
  out bcast pkts 193       out bcast bytes 12352
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
  pvc create time 04:43:35, last time pvc status changed 01:16:05

DLCI = 112, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE =
Serial0/0/1.112

  input pkts 15            output pkts 211          in bytes 2600
  out bytes 17624          dropped pkts 0           in pkts dropped 0
  out pkts dropped 0                 out bytes dropped 0
  in FECN pkts 0           in BECN pkts 0           out FECN pkts 0
  out BECN pkts 0          in DE pkts 0             out DE pkts 0
  out bcast pkts 200       out bcast bytes 16520
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
  pvc create time 00:19:16, last time pvc status changed 00:18:56
```

**R2:**

```
R2#show frame-relay pvc

PVC Statistics for interface Serial0/0/1 (Frame Relay DTE)

               Active     Inactive      Deleted       Static
  Local           2            0            0            0
  Switched        0            0            0            0
  Unused          0            0            0            0

DLCI = 201, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE =
Serial0/0/1

  input pkts 331           output pkts 374          in bytes 19928
  out bytes 24098          dropped pkts 0           in pkts dropped 0
  out pkts dropped 0                 out bytes dropped 0
  in FECN pkts 0           in BECN pkts 0           out FECN pkts 0
  out BECN pkts 0          in DE pkts 0             out DE pkts 0
  out bcast pkts 331       out bcast bytes 21184
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
  pvc create time 05:22:55, last time pvc status changed 01:16:36

DLCI = 212, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE =
Serial0/0/1.212

  input pkts 217           output pkts 16           in bytes 18008
  out bytes 2912           dropped pkts 0           in pkts dropped 0
  out pkts dropped 0                 out bytes dropped 0
  in FECN pkts 0           in BECN pkts 0           out FECN pkts 0
  out BECN pkts 0          in DE pkts 0             out DE pkts 0
  out bcast pkts 6         out bcast bytes 1872
```

 

```
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
  pvc create time 00:19:37, last time pvc status changed 00:18:57
```

**FR Switch**:

```
FR-Switch#show frame-relay pvc

PVC Statistics for interface Serial0/0/0 (Frame Relay DCE)

              Active     Inactive      Deleted       Static
  Local          0            0            0            0
  Switched       2            0            0            0
  Unused         0            0            0            0

DLCI = 102, DLCI USAGE = SWITCHED, PVC STATUS = ACTIVE, INTERFACE =
Serial0/0/0

  input pkts 335           output pkts 376          in bytes 20184
  out bytes 24226          dropped pkts 2           in pkts dropped 2
  out pkts dropped 0                out bytes dropped 0
  in FECN pkts 0           in BECN pkts 0           out FECN pkts 0
  out BECN pkts 0          in DE pkts 0             out DE pkts 0
  out bcast pkts 0         out bcast bytes 0
  30 second input rate 0 bits/sec, 0 packets/sec
  30 second output rate 0 bits/sec, 0 packets/sec
  switched pkts 333
  Detailed packet drop counters:
  no out intf 0            out intf down 0          no out PVC 0
  in PVC down 0            out PVC down 2           pkt too big 0
  shaping Q full 0         pkt above DE 0           policing drop 0
  pvc create time 05:23:43, last time pvc status changed 01:18:32

DLCI = 112, DLCI USAGE = SWITCHED, PVC STATUS = ACTIVE, INTERFACE =
Serial0/0/0

  input pkts 242           output pkts 18           in bytes 20104
  out bytes 3536           dropped pkts 0           in pkts dropped 0
  out pkts dropped 0                out bytes dropped 0
  in FECN pkts 0           in BECN pkts 0           out FECN pkts 0
  out BECN pkts 0          in DE pkts 0             out DE pkts 0
  out bcast pkts 0         out bcast bytes 0
  30 second input rate 0 bits/sec, 0 packets/sec
  30 second output rate 0 bits/sec, 0 packets/sec
  switched pkts 242
  Detailed packet drop counters:
  no out intf 0            out intf down 0          no out PVC 0
  in PVC down 0            out PVC down 0           pkt too big 0
  shaping Q full 0         pkt above DE 0           policing drop 0
  pvc create time 00:21:41, last time pvc status changed 00:21:22

PVC Statistics for interface Serial0/0/1 (Frame Relay DCE)

              Active     Inactive      Deleted       Static
  Local          0            0            0            0
  Switched       2            0            0            0
```

 

```
  Unused         0            0            0            0

DLCI = 201, DLCI USAGE = SWITCHED, PVC STATUS = ACTIVE, INTERFACE =
Serial0/0/1

  input pkts 376           output pkts 333          in bytes 24226
  out bytes 20056          dropped pkts 0           in pkts dropped 0
  out pkts dropped 0                 out bytes dropped 0
  in FECN pkts 0           in BECN pkts 0           out FECN pkts 0
  out BECN pkts 0          in DE pkts 0             out DE pkts 0
  out bcast pkts 0         out bcast bytes 0
  30 second input rate 0 bits/sec, 0 packets/sec
  30 second output rate 0 bits/sec, 0 packets/sec
  switched pkts 376
  Detailed packet drop counters:
  no out intf 0            out intf down 0          no out PVC 0
  in PVC down 0            out PVC down 0           pkt too big 0
  shaping Q full 0         pkt above DE 0           policing drop 0
  pvc create time 05:23:14, last time pvc status changed 01:39:39

DLCI = 212, DLCI USAGE = SWITCHED, PVC STATUS = ACTIVE, INTERFACE =
Serial0/0/1

  input pkts 18            output pkts 243          in bytes 3536
  out bytes 20168          dropped pkts 0           in pkts dropped 0
  out pkts dropped 0                 out bytes dropped 0
  in FECN pkts 0           in BECN pkts 0           out FECN pkts 0
  out BECN pkts 0          in DE pkts 0             out DE pkts 0
  out bcast pkts 0         out bcast bytes 0
  30 second input rate 0 bits/sec, 0 packets/sec
  30 second output rate 0 bits/sec, 0 packets/sec
  switched pkts 18
  Detailed packet drop counters:
  no out intf 0            out intf down 0          no out PVC 0
  in PVC down 0            out PVC down 0           pkt too big 0
  shaping Q full 0         pkt above DE 0           policing drop 0
  pvc create time 00:21:36, last time pvc status changed 00:21:20
```

**R1:**

```
R1#show frame-relay map
Serial0/0/1 (up): ip 10.1.1.2 dlci 102(0x66,0x1860), static,
              broadcast,
              CISCO, status defined, active
Serial0/0/1.112 (up): point-to-point dlci, dlci 112(0x70,0x1C00),
broadcast
          status defined, active
```

**R2:**

```
R2#show frame-relay map
Serial0/0/1 (up): ip 10.1.1.1 dlci 201(0xC9,0x3090), static,
              broadcast,
              CISCO, status defined, active
```

 

```
Serial0/0/1.212 (up): point-to-point dlci, dlci 212(0xD4,0x3440),
broadcast
          status defined, active
```

**FR Switch:**

```
FR-Switch#show frame-relay route
```

| Input Intf | Input Dlci | Output Intf | Output Dlci | Status |
|---|---|---|---|---|
| Serial0/0/0 | 102 | Serial0/0/1 | 201 | active |
| Serial0/0/0 | 112 | Serial0/0/1 | 212 | active |
| Serial0/0/1 | 201 | Serial0/0/0 | 102 | active |
| Serial0/0/1 | 212 | Serial0/0/0 | 112 | active |

Now debug the Frame Relay LMI.

```
R1#debug frame-relay lmi
```

```
*Aug 25 05:58:50.902: Serial0/0/1(out): StEnq, myseq 136, yourseen 135,
DTE up
*Aug 25 05:58:50.902: datagramstart = 0xE7000354, datagramsize = 13
*Aug 25 05:58:50.902: FR encap = 0xFCF10309
*Aug 25 05:58:50.902: 00 75 01 01 00 03 02 88 87
*Aug 25 05:58:50.902:
*Aug 25 05:58:50.906: Serial0/0/1(in): Status, myseq 136, pak size 29
*Aug 25 05:58:50.906: RT IE 1, length 1, type 0
*Aug 25 05:58:50.906: KA IE 3, length 2, yourseq 136, myseq 136
*Aug 25 05:58:50.906: PVC IE 0x7 , length 0x6 , dlci 102, status 0x2 ,
bw 0
*Aug 25 05:58:50.906: PVC IE 0x7 , length 0x6 , dlci 112, status 0x2 ,
bw 0
```

Note that two DLCIs are listed in the LMI message from FR Switch to R1.

```
R2#debug frame-relay lmi
```

```
*Aug 25 06:08:35.774: Serial0/0/1(out):StEnq, myseq 7,yourseen 4,DTE up
*Aug 25 06:08:35.774: datagramstart = 0xE73F28B4, datagramsize = 13
*Aug 25 06:08:35.774: FR encap = 0xFCF10309
*Aug 25 06:08:35.774: 00 75 01 01 00 03 02 07 04
*Aug 25 06:08:35.774:
*Aug 25 06:08:35.778: Serial0/0/1(in): Status, myseq 7, pak size 29
*Aug 25 06:08:35.778: RT IE 1, length 1, type 0
*Aug 25 06:08:35.778: KA IE 3, length 2, yourseq 5 , myseq 7
*Aug 25 06:08:35.778: PVC IE 0x7,length 0x6, dlci 201, status 0x2, bw 0
*Aug 25 06:08:35.778: PVC IE 0x7,length 0x6, dlci 212, status 0x2, bw 0
```

 