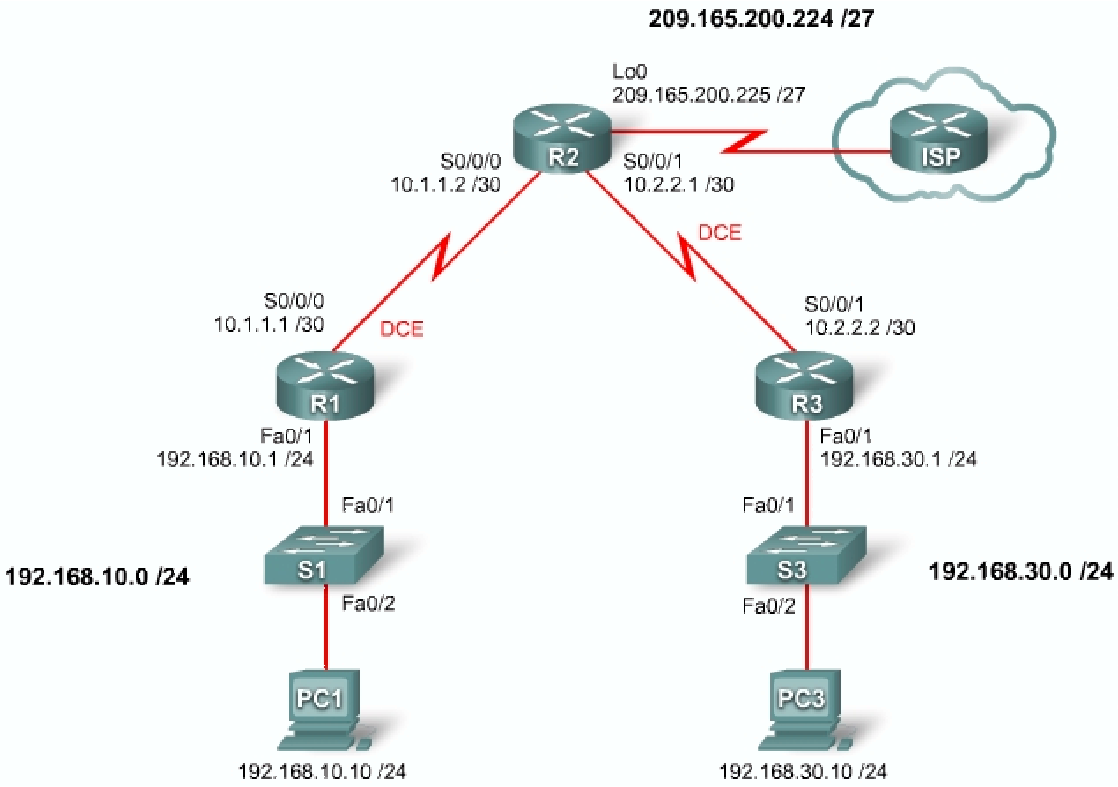
Lab 2.5.1: Basic PPP Configuration Lab

Topology Diagram



Addressing Table

Device	Interface	IP Address	Subnet Mask	Default Gateway
R1	**Fa0/1**	192.168.10.1	255.255.255.0	N/A
	S0/0/0	10.1.1.1	255.255.255.252	N/A
R2	**Lo0**	209.165.200.225	255.255.255.224	N/A
	S0/0/0	10.1.1.2	255.255.255.252	N/A
	S0/0/1	10.2.2.1	255.255.255.252	N/A
R3	**Fa0/1**	192.168.30.1	255.255.255.0	N/A
	S0/0/1	10.2.2.2	255.255.255.252	N/A
PC1	**NIC**	192.168.10.10	255.255.255.0	192.168.10.1
PC3	**NIC**	192.168.30.10	255.255.255.0	192.168.30.1

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 OSPF routing on all routers.
- Configure PPP encapsulation on all serial interfaces.
- Learn about the **debug ppp negotiation** and **debug ppp packet** commands.
- Learn how to change the encapsulation on the serial interfaces from PPP to HDLC.
- Intentionally break and restore PPP encapsulation.
- Configure PPP PAP and CHAP authentication.
- Intentionally break and restore PPP PAP and CHAP authentication.

Scenario

In this lab, you will learn how to configure PPP encapsulation on serial links using the network shown in the topology diagram. You will also learn how to restore serial links to their default HDLC encapsulation. Pay special attention to what the output of the router looks like when you intentionally break PPP encapsulation. This will assist you in the Troubleshooting lab associated with this chapter. Finally, you will configure PPP PAP authentication and PPP CHAP authentication.

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 diagram.

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

Step 2: Clear any existing configurations on the routers.

Task 2: Perform Basic Router Configuration

Configure the R1, R2, and R3 routers 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 synchronous logging.
- Configure a password for vty connections.

Task 3: Configure and Activate Serial and Ethernet Addresses

Step 1: Configure interfaces on R1, R2, and R3.

Configure the interfaces on the R1, R2, and R3 routers with the IP addresses from the addressing table at the beginning of the lab. Be sure to include the clock rate on the serial DCE interfaces.

Step 2: Verify IP addressing and interfaces.

Use the **show ip interface brief** command to verify that the IP addressing is correct and that the interfaces are active.

When you have finished, be sure to save the running configuration to the NVRAM of the router.

Step 3: Configure the Ethernet interfaces of PC1 and PC3.

Configure the Ethernet interfaces of PC1 and PC3 with the IP addresses and default gateways from the addressing table.

Step 4: Test the configuration by pinging the default gateway from the PC.

Task 4: Configure OSPF on the Routers

If you need to review the OSPF commands, see Exploration 2, module 11.

Step 1: Enable OSPF routing on R1, R2, and R3.

Use the **router ospf** command with a process ID of 1. Be sure to advertise the networks.

```
R1(config)#router ospf 1
R1(config-router)#network 192.168.10.0 0.0.0.255 area 0
R1(config-router)#network 10.1.1.0 0.0.0.3 area 0
*Aug 17 17:49:14.689: %OSPF-5-ADJCHG: Process 1, Nbr 209.165.200.225 on
Serial0/0/0 from LOADING to FULL, Loading Done
R1(config-router)#

R2(config)#router ospf 1
R2(config-router)#network 10.1.1.0 0.0.0.3 area 0
*Aug 17 17:48:40.645: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.10.1 on
Serial0/0/0 from LOADING to FULL, Loading Done
R2(config-router)#network 10.2.2.0 0.0.0.3 area 0
R2(config-router)#network 209.165.200.224 0.0.0.31 area 0
R2(config-router)#
*Aug 17 17:57:44.729: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.30.1 on
Serial0/0/1 from LOADING to FULL, Loading Done
R2(config-router)#

R3(config)#router ospf 1
R3(config-router)#network 10.2.2.0 0.0.0.3 area 0
*Aug 17 17:58:02.017: %OSPF-5-ADJCHG: Process 1, Nbr 209.165.200.225 on
Serial0/0/1 from LOADING to FULL, Loading Done
R3(config-router)#network 192.168.30.0 0.0.0.255 area 0
R3(config-router)#
```


Step 2: Verify that you have full network connectivity.

Use the **show ip route** and **ping** commands to verify connectivity.

```
R1#show ip route

<output omitted>

O    192.168.30.0/24 [110/1563] via 10.1.1.2, 00:33:56, Serial0/0/0
C    192.168.10.0/24 is directly connected, FastEthernet0/1
     209.165.200.0/27 is subnetted, 1 subnets
O       209.165.200.225 [110/782] via 10.1.1.2, 00:33:56, Serial0/0/0
     10.0.0.0/8 is variably subnetted, 3 subnets, 2 masks
O       10.2.2.0/30 [110/1562] via 10.1.1.2, 00:33:56, Serial0/0/0
C       10.1.1.0/30 is directly connected, Serial0/0/0

R1#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 = 32/32/32 ms
R1#

R2#show ip route

<output omitted>

O    192.168.30.0/24 [110/782] via 10.2.2.2, 00:33:04, Serial0/0/1
O    192.168.10.0/24 [110/782] via 10.1.1.1, 00:33:04, Serial0/0/0
     209.165.200.0/27 is subnetted, 1 subnets
C       209.165.200.224 is directly connected, Loopback0
     10.0.0.0/8 is variably subnetted, 4 subnets, 2 masks
C       10.2.2.0/30 is directly connected, Serial0/0/1
C       10.1.1.0/30 is directly connected, Serial0/0/0

R2#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 = 16/16/16 ms
R2#ping 192.168.10.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.10.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 16/16/16 ms
R2#

R3#show ip route

<output omitted>

C    192.168.30.0/24 is directly connected, FastEthernet0/1
O    192.168.10.0/24 [110/1563] via 10.2.2.1, 00:32:01, Serial0/0/1
     209.165.200.0/27 is subnetted, 1 subnets
```



```
O       209.165.200.225 [110/782] via 10.2.2.1, 00:32:01, Serial0/0/1
     10.0.0.0/8 is variably subnetted, 3 subnets, 2 masks
C       10.2.2.0/30 is directly connected, Serial0/0/1
O       10.1.1.0/30 [110/1562] via 10.2.2.1, 00:32:01, Serial0/0/1

R3#ping 209.165.200.225

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 209.165.200.225, timeout is 2
seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 16/16/16 ms
R3#ping 192.168.10.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.10.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 32/32/32 ms
R3#
```

Task 5: Configure PPP Encapsulation on Serial Interfaces

Step 1: Use the show interface command to check whether HDLC is the default serial encapsulation.

```
R1#show interface serial0/0/0
Serial0/0/0 is up, line protocol is up
  Hardware is GT96K Serial
  Internet address is 10.1.1.1/30
  MTU 1500 bytes, BW 128 Kbit, DLY 20000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation HDLC, loopback not set

<output omitted>

R2#show interface serial 0/0/0
Serial0/0/0 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 HDLC, loopback not set

<output omitted>

R2#show interface serial 0/0/1
Serial0/0/1 is up, line protocol is up
  Hardware is GT96K Serial
  Internet address is 10.2.2.1/30
  MTU 1500 bytes, BW 128 Kbit, DLY 20000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation HDLC, loopback not set

<output omitted>
```



```
R3#show interface serial 0/0/1
Serial0/0/1 is up, line protocol is up
  Hardware is GT96K Serial
  Internet address is 10.2.2.2/30
  MTU 1500 bytes, BW 128 Kbit, DLY 20000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation HDLC, loopback not set

<output omitted>
```

Step 2: Use debug commands on R1 and R2 to see the effects of configuring PPP.

```
R1#debug ppp negotiation
PPP protocol negotiation debugging is on
R1#debug ppp packet
PPP packet display debugging is on
R1#

R2#debug ppp negotiation
PPP protocol negotiation debugging is on
R2#debug ppp packet
PPP packet display debugging is on
R2#
```

Step 3: Change the encapsulation of the serial interfaces from HDLC to PPP.

Change the encapsulation type on the link between R1 and R2, and observe the effects. If you start to receive too much debug data, use the **undebug all** command to turn debugging off.

```
R1(config)#interface serial 0/0/0
R1(config-if)#encapsulation ppp
R1(config-if)#
*Aug 17 19:02:53.412: %OSPF-5-ADJCHG: Process 1, Nbr 209.165.200.225 on
Serial0/0/0 from FULL to DOWN, Neighbor Down: Interface down or
detached
R1(config-if)#
*Aug 17 19:02:53.416: Se0/0/0 PPP: Phase is DOWN, Setup
*Aug 17 19:02:53.416: Se0/0/0 PPP: Using default call direction
*Aug 17 19:02:53.416: Se0/0/0 PPP: Treating connection as a dedicated
line
*Aug 17 19:02:53.416: Se0/0/0 PPP: Session handle[E4000001] Session
id[0]
*Aug 17 19:02:53.416: Se0/0/0 PPP: Phase is ESTABLISHING, Active Open
*Aug 17 19:02:53.424: Se0/0/0 LCP: O CONFREQ [Closed] id 1 len 10
*Aug 17 19:02:53.424: Se0/0/0 LCP:    MagicNumber 0x63B994DE
(0x050663B994DE)
R1(config-if)#
*Aug 17 19:02:55.412: Se0/0/0 PPP: Outbound cdp packet dropped
*Aug 17 19:02:55.432: Se0/0/0 LCP: TIMEout: State REQsent
*Aug 17 19:02:55.432: Se0/0/0 LCP: O CONFREQ [REQsent] id 2 len 10
*Aug 17 19:02:55.432: Se0/0/0 LCP:    MagicNumber 0x63B994DE
(0x050663B994DE)
*Aug 17 19:02:56.024: Se0/0/0 PPP: I pkt type 0x008F, datagramsize 24
link[illegal]
*Aug 17 19:02:56.024: Se0/0/0 UNKNOWN(0x008F): Non-NCP packet,
discarding
R1(config-if)#
```



```
*Aug 17 19:02:57.252: Se0/0/0 PPP: I pkt type 0x000F, datagramsize 84
link[illegal]
*Aug 17 19:02:57.252: Se0/0/0 UNKNOWN(0x000F): Non-NCP packet,
discarding
*Aug 17 19:02:57.448: Se0/0/0 LCP: TIMEout: State REQsent
*Aug 17 19:02:57.448: Se0/0/0 LCP: O CONFREQ [REQsent] id 3 len 10
*Aug 17 19:02:57.448: Se0/0/0 LCP:    MagicNumber 0x63B994DE
(0x050663B994DE)
R1(config-if)#
*Aug 17 19:02:58.412: %LINEPROTO-5-UPDOWN: Line protocol on Interface
Serial0/0/0, changed state to down

R2(config)#interface serial 0/0/0
R2(config-if)#encapsulation ppp
R2(config-if)#
*Aug 17 19:06:48.848: Se0/0/0 PPP: Phase is DOWN, Setup
*Aug 17 19:06:48.848: Se0/0/0 PPP: Using default call direction
*Aug 17 19:06:48.848: Se0/0/0 PPP: Treating connection as a dedicated
line
*Aug 17 19:06:48.848: Se0/0/0 PPP: Session handle[C6000001] Session
id[0]
*Aug 17 19:06:48.848: Se0/0/0 PPP: Phase is ESTABLISHING, Active Open
*Aug 17 19:06:48.856: Se0/0/0 LCP: O CONFREQ [Closed] id 1 len 10
*Aug 17 19:06:48.856: Se0/0/0 LCP:    MagicNumber 0x63BD388C
(0x050663BD388C)
*Aug 17 19:06:48.860: Se0/0/0 PPP: I pkt type 0xC021, datagramsize 14
link[ppp]
*Aug 17 19:06:48.860: Se0/0/0 LCP: I CONFACK [REQsent] id 1 len 10
R2(config-if)#
*Aug 17 19:06:48.860: Se0/0/0 LCP:    MagicNumber 0x63BD388C
(0x050663BD388C)
R2(config-if)#
*Aug 17 19:06:50.864: Se0/0/0 LCP: TIMEout: State ACKrcvd
*Aug 17 19:06:50.864: Se0/0/0 LCP: O CONFREQ [ACKrcvd] id 2 len 10
*Aug 17 19:06:50.864: Se0/0/0 LCP:    MagicNumber 0x63BD388C
(0x050663BD388C)
*Aug 17 19:06:50.868: Se0/0/0 PPP: I pkt type 0xC021, datagramsize 14
link[ppp]
*Aug 17 19:06:50.868: Se0/0/0 LCP: I CONFREQ [REQsent] id 61 len 10
*Aug 17 19:06:50.868: Se0/0/0 LCP:    MagicNumber 0x63BDB9A8
(0x050663BDB9A8)
*Aug 17 19:06:50.868: Se0/0/0 LCP: O CONFACK [REQsent] id 61 len 10
*Aug 17 19:06:50.868: Se0/0/0 LCP:    MagicNumber 0x63BDB9A8
(0x050663BDB9A8)
*Aug 17 19:06:50.868: Se0/0/0 PPP: I pkt type 0xC021, datagramsize 14
link[ppp]
*Aug 17 19:06:50.868: Se0/0/0 LCP: I CONFACK [ACKsent] id 2 len 10
*Aug 17 19:06:50.868: Se0/0/0 LCP:    MagicNumber 0x63BD388C
(0x050663BD388C)
*Aug 17 19:06:50.868: Se0/0/0 LCP: State is Open
*Aug 17 19:06:50.872: Se0/0/0 PPP: Phase is FORWARDING, Attempting
Forward
*Aug 17 19:06:50.872: Se0/0/0 PPP: Phase is ESTABLISHING, Finish LCP
*Aug 17 19:06:50.872: Se0/0/0 PPP: Phase is UP
*Aug 17 19:06:50.872: Se0/0/0 IPCP: O CONFREQ [Closed] id 1 len 10
*Aug 17 19:06:50.872: Se0/0/0 IPCP:    Address 10.1.1.2
```



```
(0x03060A010102)
*Aug 17 19:06:50.872: Se0/0/0 CDPCP: O CONFREQ [Closed] id 1 len 4
*Aug 17 19:06:50.872: Se0/0/0 PPP: Process pending ncp packets
*Aug 17 19:06:50.876: Se0/0/0 PPP: I pkt type 0x8021, datagramsize 14
link[ip]
*Aug 17 19:06:50.876: Se0/0/0 IPCP: I CONFREQ [REQsent] id 1 len 10
*Aug 17 19:06:50.876: Se0/0/0 IPCP:    Address 10.1.1.1
(0x03060A010101)
*Aug 17 19:06:50.876: Se0/0/0 PPP: I pkt type 0x8207, datagramsize 8
link[cdp]
*Aug 17 19:06:50.876: Se0/0/0 IPCP: O CONFACK [REQsent] id 1 len 10
*Aug 17 19:06:50.876: Se0/0/0 IPCP:    Address 10.1.1.1
(0x03060A010101)
*Aug 17 19:06:50.876: Se0/0/0 CDPCP: I CONFREQ [REQsent] id 1 len 4
*Aug 17 19:06:50.876: Se0/0/0 CDPCP: O CONFACK [REQsent] id 1 len 4
*Aug 17 19:06:50.876: Se0/0/0 PPP: I pkt type 0x8021, datagramsize 14
link[ip]
*Aug 17 19:06:50.876: Se0/0/0 IPCP: I CONFACK [ACKse
R2(config-if)#nt] id 1 len 10
*Aug 17 19:06:50.876: Se0/0/0 IPCP:    Address 10.1.1.2
(0x03060A010102)
*Aug 17 19:06:50.876: Se0/0/0 IPCP: State is Open
*Aug 17 19:06:50.876: Se0/0/0 PPP: I pkt type 0x8207, datagramsize 8
link[cdp]
*Aug 17 19:06:50.876: Se0/0/0 IPCP: Install route to 10.1.1.1
*Aug 17 19:06:50.880: Se0/0/0 CDPCP: I CONFACK [ACKsent] id 1 len 4
*Aug 17 19:06:50.880: Se0/0/0 CDPCP: State is Open
*Aug 17 19:06:50.880: Se0/0/0 PPP: O pkt type 0x0021, datagramsize 80
*Aug 17 19:06:50.880: Se0/0/0 IPCP: Add link info for cef entry
10.1.1.1
*Aug 17 19:06:50.884: Se0/0/0 PPP: I pkt type 0x0021, datagramsize 80
link[ip]
*Aug 17 19:06:51.848: %LINEPROTO-5-UPDOWN: Line protocol on Interface
Serial0/0/0, changed state to up
R2(config-if)#
*Aug 17 19:06:51.888: Se0/0/0 LCP-FS: I ECHOREQ [Open] id 1 len 12
magic 0x63BDB9A8
*Aug 17 19:06:51.888: Se0/0/0 LCP-FS: O ECHOREP [Open] id 1 len 12
magic 0x63BD388C

<output omitted>

*Aug 17 19:07:00.936: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.10.1 on
Serial0/0/0 from LOADING to FULL, Loading Done
```

What happens when one end of the serial link is encapsulated with PPP and the other end of the link is encapsulated with HDLC?

_____

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What steps does PPP go through when the other end of the serial link on R2 is configured with PPP encapsulation?

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What happens when PPP encapsulation is configured on each end of the serial link?

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Step 4: Turn off debugging.

Turn off debugging if you have not already used the **undebug all** command.

```
R1#undebug all
Port Statistics for unclassified packets is not turned on.

All possible debugging has been turned off
R1#

R2#undebug all
Port Statistics for unclassified packets is not turned on.

All possible debugging has been turned off
R2#
```

Step 5: Change the encapsulation from HDLC to PPP on both ends of the serial link between R2 and R3.

```
R2(config)#interface serial0/0/1
R2(config-if)#encapsulation ppp
R2(config-if)#
*Aug 17 20:02:08.080: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.30.1 on
Serial0/0/1 from FULL to DOWN, Neighbor Down: Interface down or
detached
R2(config-if)#
*Aug 17 20:02:13.080: %LINEPROTO-5-UPDOWN: Line protocol on Interface
Serial0/0/1, changed state to down
R2(config-if)#
*Aug 17 20:02:58.564: %LINEPROTO-5-UPDOWN: Line protocol on Interface
Serial0/0/1, changed state to up
R2(config-if)#
*Aug 17 20:03:03.644: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.30.1 on
Serial0/0/1 from LOADING to FULL, Loading Done
```



```
R2(config-if)#

*Aug 17 20:03:46.988: %LINEPROTO-5-UPDOWN: Line protocol on Interface
Serial0/0/1, changed state to down
R3(config)#interface serial 0/0/1
R3(config-if)#encapsulation ppp
R3(config-if)#
*Aug 17 20:04:27.152: %LINEPROTO-5-UPDOWN: Line protocol on Interface
Serial0/0/1, changed state to up
*Aug 17 20:04:30.952: %OSPF-5-ADJCHG: Process 1, Nbr 209.165.200.225 on
Serial0/0/1 from LOADING to FULL, Loading Done
```

When does the line protocol on the serial link come up and the OSPF adjacency is restored?

_____

_____

Step 6: Verify that PPP is now the encapsulation on the serial interfaces.

```
R1#show interface serial0/0/0
Serial0/0/0 is up, line protocol is up
  Hardware is GT96K Serial
  Internet address is 10.1.1.1/30
  MTU 1500 bytes, BW 128 Kbit, DLY 20000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation PPP, LCP Open
  Open: CDPCP, IPCP, loopback not set

<output omitted>

R2#show interface serial 0/0/0
Serial0/0/0 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 PPP, LCP Open
  Open: CDPCP, IPCP, loopback not set

<output omitted>

R2#show interface serial 0/0/1
Serial0/0/1 is up, line protocol is up
  Hardware is GT96K Serial
  Internet address is 10.2.2.1/30
  MTU 1500 bytes, BW 128 Kbit, DLY 20000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation PPP, LCP Open
  Open: CDPCP, IPCP, loopback not set

<output omitted>
R3#show interface serial 0/0/1
Serial0/0/1 is up, line protocol is up
```



```
  Hardware is GT96K Serial
  Internet address is 10.2.2.2/30
  MTU 1500 bytes, BW 128 Kbit, DLY 20000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation PPP, LCP Open
  Open: CDPCP, IPCP, loopback not set

<output omitted>
```

Task 6: Break and Restore PPP Encapsulation

By intentionally breaking PPP encapsulation, you will learn about the error messages that are generated. This will help you later in the Troubleshooting lab.

Step 1: Return both serial interfaces on R2 to their default HDLC encapsulation.

```
R2(config)#interface serial 0/0/0
R2(config-if)#encapsulation hdlc
R2(config-if)#
*Aug 17 20:36:48.432: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.10.1 on
Serial0/0/0 from FULL to DOWN, Neighbor Down: Interface down or
detached
*Aug 17 20:36:49.432: %LINEPROTO-5-UPDOWN: Line protocol on Interface
Serial0/0/0, changed state to down
R2(config-if)#
*Aug 17 20:36:51.432: %LINEPROTO-5-UPDOWN: Line protocol on Interface
Serial0/0/0, changed state to up
R2(config-if)#interface serial 0/0/1
*Aug 17 20:37:14.080: %LINEPROTO-5-UPDOWN: Line protocol on Interface
Serial0/0/0, changed state to down
R2(config-if)#encapsulation hdlc
R2(config-if)#
*Aug 17 20:37:17.368: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.30.1 on
Serial0/0/1 from FULL to DOWN, Neighbor Down: Interface down or
detached
*Aug 17 20:37:18.368: %LINEPROTO-5-UPDOWN: Line protocol on Interface
Serial0/0/1, changed state to down
R2(config-if)#
*Aug 17 20:37:20.368: %LINEPROTO-5-UPDOWN: Line protocol on Interface
Serial0/0/1, changed state to up
R2(config-if)#
*Aug 17 20:37:44.080: %LINEPROTO-5-UPDOWN: Line protocol on Interface
Serial0/0/1, changed state to down
R2(config-if)#
```

Why is it useful to intentionally break a configuration?

_____

_____

_____

Why do both serial interfaces go down, come back up, and then go back down?

_____

_____

_____

Can you think of another way to change the encapsulation of a serial interface from PPP to the default HDLC encapsulation other than using the **encapsulation hdlc** command? (Hint: It has to do with the **no** command.)

_____

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_____

Step 2: Return both serial interfaces on R2 to PPP encapsulation.

```
R2(config)#interface s0/0/0
R2(config-if)#encapsulation ppp
*Aug 17 20:53:06.612: %LINEPROTO-5-UPDOWN: Line protocol on Interface
Serial0/0/0, changed state to up
R2(config-if)#interface s0/0/1
*Aug 17 20:53:10.856: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.10.1 on
Serial0/0/0 from LOADING to FULL, Loading Done
R2(config-if)#encapsulation ppp
*Aug 17 20:53:23.332: %LINEPROTO-5-UPDOWN: Line protocol on Interface
Serial0/0/1, changed state to up
R2(config-if)#
*Aug 17 20:53:24.916: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.30.1 on
Serial0/0/1 from LOADING to FULL, Loading Done
R2(config-if)#
```

Task 7: Configure PPP Authentication

Step 1: Configure PPP PAP authentication on the serial link between R1 and R2.

```
R1(config)#username R1 password cisco
R1(config)#int s0/0/0
R1(config-if)#ppp authentication pap
R1(config-if)#
*Aug 22 18:58:57.367: %LINEPROTO-5-UPDOWN: Line protocol on Interface
Serial0/0/0, changed state to down
R1(config-if)#
*Aug 22 18:58:58.423: %OSPF-5-ADJCHG: Process 1, Nbr 209.165.200.225 on
Serial0/0/0 from FULL to DOWN, Neighbor Down: Interface down or
detached
R1(config-if)#ppp pap sent-username R2 password cisco
```


What happens when PPP PAP authentication is only configured on one end of the serial link?

_____

_____

```
R2(config)#username R2 password cisco
R2(config)#interface Serial0/0/0
R2(config-if)#ppp authentication pap
R2(config-if)#ppp pap sent-username R1 password cisco
R2(config-if)#
*Aug 23 16:30:33.771: %LINEPROTO-5-UPDOWN: Line protocol on Interface
Serial0/0/0, changed state to up
R2(config-if)#
*Aug 23 16:30:40.815: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.10.1 on
Serial0/0/0 from LOADING to FULL, Loading Done
R2(config-if)#
```

What happens when PPP PAP authentication is configured on both ends of the serial link?

_____

_____

Step 2: Configure PPP CHAP authentication on the serial link between R2 and R3.

In PAP authentication, the password is not encrypted. While this is certainly better than no authentication at all, it is still highly preferable to encrypt the password that is being sent across the link. CHAP encrypts the password.

```
R2(config)#username R3 password cisco
R2(config)#int s0/0/1
R2(config-if)#ppp authentication chap
R2(config-if)#
*Aug 23 18:06:00.935: %LINEPROTO-5-UPDOWN: Line protocol on Interface
Serial0/0/1, changed state to down
R2(config-if)#
*Aug 23 18:06:01.947: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.30.1 on
Serial0/0/1 from FULL to DOWN, Neighbor Down: Interface down or
detached
R2(config-if)#

R3(config)#username R2 password cisco
*Aug 23 18:07:13.074: %LINEPROTO-5-UPDOWN: Line protocol on Interface
Serial0/0/1, changed state to up
R3(config)#int s0/0/1
R3(config-if)#
*Aug 23 18:07:22.174: %OSPF-5-ADJCHG: Process 1, Nbr 209.165.200.225 on
Serial0/0/1 from LOADING to FULL, Loading Done
R3(config-if)#ppp authentication chap
R3(config-if)#
```


Notice that the line protocol on interface serial 0/0/1 changes state to UP even before the interface is configured for CHAP authentication. Can you guess why this is the case?

_____

_____

_____

Step 3: Review the debug output.

To better understand the CHAP process, view the output of the **debug ppp authentication** command on R2 and R3. Then shut down interface serial 0/0/1 on R2, and issue the **no shutdown** command on interface serial 0/0/1 on R2.

```
R2#debug ppp authentication
PPP authentication debugging is on
R2#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R2(config)#int s0/0/1
R2(config-if)#shutdown
R2(config-if)#
*Aug 23 18:19:21.059: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.30.1 on
Serial0/0/1 from FULL to DOWN, Neighbor Down: Interface down or
detached
R2(config-if)#
*Aug 23 18:19:23.059: %LINK-5-CHANGED: Interface Serial0/0/1, changed
state to administratively down
*Aug 23 18:19:24.059: %LINEPROTO-5-UPDOWN: Line protocol on Interface
Serial0/0/1, changed state to down
R2(config-if)#no shutdown

*Aug 23 18:19:55.059: Se0/0/1 PPP: Using default call direction
*Aug 23 18:19:55.059: Se0/0/1 PPP: Treating connection as a dedicated
line
*Aug 23 18:19:55.059: Se0/0/1 PPP: Session handle[5B000005] Session
id[49]
*Aug 23 18:19:55.059: Se0/0/1 PPP: Authorization required
*Aug 23 18:19:55.063: %LINK-3-UPDOWN: Interface Serial0/0/1, changed
state to up
*Aug 23 18:19:55.063: Se0/0/1 CHAP: O CHALLENGE id 48 len 23 from "R2"
*Aug 23 18:19:55.067: Se0/0/1 CHAP: I CHALLENGE id 2 len 23 from "R3"
*Aug 23 18:19:55.067: Se0/0/1 CHAP: Using hostname from unknown source
*Aug 23 18:19:55.067: Se0/0/1 CHAP: Using password from AAA
*Aug 23 18:19:55.067: Se0/0/1 CHAP: O RESPONSE id 2 len 23 from "R2"
*Aug 23 18:19:55.071: Se0/0/1 CHAP: I RESPONSE id 48 len 23 from "R3"
*Aug 23 18:19:55.071: Se0/0/1 PPP: Sent CHAP LOGIN Request
*Aug 23 18:19:55.071: Se0/0/1 PPP: Received LOGIN Response PASS
*Aug 23 18:19:55.071: Se0/0/1 PPP: Sent LCP AUTHOR Request
*Aug 23 18:19:55.075: Se0/0/1 PPP: Sent IPCP AUTHOR Request
*Aug 23 18:19:55.075: Se0/0/1 LCP: Received AAA AUTHOR Response PASS
*Aug 23 18:19:55.075: Se0/0/1 IPCP: Received AAA AUTHOR Response PASS
```



```
*Aug 23 18:19:55.075: Se0/0/1 CHAP: O SUCCESS id 48 len 4
*Aug 23 18:19:55.075: Se0/0/1 CHAP: I SUCCESS id 2 len 4
*Aug 23 18:19:55.075: Se0/0/1 PPP: Sent CDPCP AUTHOR Request
*Aug 23 18:19:55.075: Se0/0/1 CDPCP: Received AAA AUTHOR Response PASS
*Aug 23 18:19:55.079: Se0/0/1 PPP: Sent IPCP AUTHOR Request
*Aug 23 18:19:56.075: %LINEPROTO-5-UPDOWN: Line protocol on Interface
Serial0/0/1, changed state to up
R2(config-if)#
*Aug 23 18:20:05.135: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.30.1 on
Serial0/0/1 from LOADING to FULL, Loading Done

R3#debug ppp authentication
PPP authentication debugging is on
R3#
*Aug 23 18:19:04.494: %LINK-3-UPDOWN: Interface Serial0/0/1, changed
state to down
R3#
*Aug 23 18:19:04.494: %OSPF-5-ADJCHG: Process 1, Nbr 209.165.200.225 on
Serial0/0/1 from FULL to DOWN, Neighbor Down: Interface down or
detached
*Aug 23 18:19:05.494: %LINEPROTO-5-UPDOWN: Line protocol on Interface
Serial0/0/1, changed state to down
R3#
*Aug 23 18:19:36.494: %LINK-3-UPDOWN: Interface Serial0/0/1, changed
state to up
*Aug 23 18:19:36.494: Se0/0/1 PPP: Using default call direction
*Aug 23 18:19:36.494: Se0/0/1 PPP: Treating connection as a dedicated
line
*Aug 23 18:19:36.494: Se0/0/1 PPP: Session handle[3C000034] Session
id[52]
*Aug 23 18:19:36.494: Se0/0/1 PPP: Authorization required
*Aug 23 18:19:36.498: Se0/0/1 CHAP: O CHALLENGE id 2 len 23 from "R3"
*Aug 23 18:19:36.502: Se0/0/1 CHAP: I CHALLENGE id 48 len 23 from "R2"
*Aug 23 18:19:36.502: Se0/0/1 CHAP: Using hostname from unknown source
*Aug 23 18:19:36.506: Se0/0/1 CHAP: Using password from AAA
*Aug 23 18:19:36.506: Se0/0/1 CHAP: O RESPONSE id 48 len 23 from "R3"
*Aug 23 18:19:36.506: Se0/0/1 CHAP: I RESPONSE id 2 len 23 from "R2"
R3#
*Aug 23 18:19:36.506: Se0/0/1 PPP: Sent CHAP LOGIN Request
*Aug 23 18:19:36.506: Se0/0/1 PPP: Received LOGIN Response PASS
*Aug 23 18:19:36.510: Se0/0/1 PPP: Sent LCP AUTHOR Request
*Aug 23 18:19:36.510: Se0/0/1 PPP: Sent IPCP AUTHOR Request
*Aug 23 18:19:36.510: Se0/0/1 LCP: Received AAA AUTHOR Response PASS
*Aug 23 18:19:36.510: Se0/0/1 IPCP: Received AAA AUTHOR Response PASS
*Aug 23 18:19:36.510: Se0/0/1 CHAP: O SUCCESS id 2 len 4
*Aug 23 18:19:36.510: Se0/0/1 CHAP: I SUCCESS id 48 len 4
*Aug 23 18:19:36.514: Se0/0/1 PPP: Sent CDPCP AUTHOR Request
*Aug 23 18:19:36.514: Se0/0/1 PPP: Sent IPCP AUTHOR Request
*Aug 23 18:19:36.514: Se0/0/1 CDPCP: Received AAA AUTHOR Response PASS
R3#
*Aug 23 18:19:37.510: %LINEPROTO-5-UPDOWN: Line protocol on Interface
Serial0/0/1, changed state to up
R3#
*Aug 23 18:19:46.570: %OSPF-5-ADJCHG: Process 1, Nbr 209.165.200.225 on
Serial0/0/1 from LOADING to FULL, Loading Done
R3#
```


Task 8: Intentionally Break and Restore PPP CHAP Authentication

Step 1: Break PPP CHAP authentication.

On the serial link between R2 and R3, change the authentication protocol on interface serial 0/0/1 to PAP.

```
R2#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R2(config)#int s0/0/1
R2(config-if)#ppp authentication pap
R2(config-if)#^Z
R2#
*Aug 24 15:45:47.039: %SYS-5-CONFIG_I: Configured from console by
console
R2#copy run start
Destination filename [startup-config]?
Building configuration...
[OK]
R2#reload
```

Does changing the authentication protocol to PAP on interface serial 0/0/1 break authentication between R2 and R3?

_____

_____

_____

Step 2: Restore PPP CHAP authentication on the serial link.

Notice that it is not necessary to reload the router for this change to take effect.

```
R2#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R2(config)#int s0/0/1
R2(config-if)#ppp authentication chap
R2(config-if)#
*Aug 24 15:50:00.419: %LINEPROTO-5-UPDOWN: Line protocol on Interface
Serial0/0/1, changed state to up
R2(config-if)#
*Aug 24 15:50:07.467: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.30.1 on
Serial0/0/1 from LOADING to FULL, Loading Done
R2(config-if)#
```

Step 3: Intentionally Break PPP CHAP authentication by changing the password on R3.

```
R3#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R3(config)#username R2 password ciisco
R3(config)#^Z
R3#
*Aug 24 15:54:17.215: %SYS-5-CONFIG_I: Configured from console by
console
R3#copy run start
Destination filename [startup-config]?
```



```
Building configuration...
[OK]
R3#reload
```

After reloading, what is the status of the line protocol on serial 0/0/1?

_____

_____

Step 4: Restore PPP CHAP authentication by changing the password on R3.

```
R3#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R3(config)#username R2 password cisco
R3(config)#
*Aug 24 16:11:10.679: %LINEPROTO-5-UPDOWN: Line protocol on Interface
Serial0/0/1, changed state to up
R3(config)#
*Aug 24 16:11:19.739: %OSPF-5-ADJCHG: Process 1, Nbr 209.165.200.225 on
Serial0/0/1 from LOADING to FULL, Loading Done
R3(config)#
```

Task 9: Document the Router Configurations

On each router, issue the **show run** command and capture the configurations.

```
R1#show run
!<output omitted>
!
hostname R1
!
!
enable secret class
!
!
!
no ip domain lookup
!
username R1 password 0 cisco
!
!
!
interface FastEthernet0/1
 ip address 192.168.10.1 255.255.255.0
 no shutdown
!
!
interface Serial0/0/0
 ip address 10.1.1.1 255.255.255.252
 encapsulation ppp
 clockrate 64000
 ppp authentication pap
 ppp pap sent-username R2 password 0 cisco
 no shutdown
```



```
!
!
!
router ospf 1
 network 10.1.1.0 0.0.0.3 area 0
 network 192.168.10.0 0.0.0.255 area 0
!
!
banner motd ^CCUnauthorized access strictly prohibited and prosecuted
to the full extent of the law^C
!
line con 0
 exec-timeout 0 0
 password cisco
 logging synchronous
 login
line aux 0
line vty 0 4
 password cisco
 login
!
end

R2#show run
!<output omitted>

!
hostname R2
!
!
enable secret class
!
!
no ip domain lookup
!
username R3 password 0 cisco
username R2 password 0 cisco
!
!
!
interface Loopback0
 ip address 209.165.200.225 255.255.255.224
!
!
!
interface Serial0/0/0
 ip address 10.1.1.2 255.255.255.252
 encapsulation ppp
 ppp authentication pap
 ppp pap sent-username R1 password 0 cisco
 no shutdown
!
interface Serial0/0/1
 ip address 10.2.2.1 255.255.255.252
 encapsulation ppp
 clockrate 64000
```



```
 ppp authentication chap
 no shutdown
!
!
router ospf 1
 network 10.1.1.0 0.0.0.3 area 0
 network 10.2.2.0 0.0.0.3 area 0
 network 209.165.200.224 0.0.0.31 area 0
!
!
banner motd ^CUnauthorized access strictly prohibited and prosecuted to
the full extent of the law^C
!
line con 0
 exec-timeout 0 0
 password cisco
 logging synchronous
 login
line aux 0
line vty 0 4
 password cisco
 login
!
end

R3#show run
!<output omitted>

!
hostname R3
!
!
enable secret class
!
!
!
no ip domain lookup
!
username R2 password 0 cisco
!
!
!
interface FastEthernet0/1
 ip address 192.168.30.1 255.255.255.0
 no shutdown
!
!
interface Serial0/0/1
 ip address 10.2.2.2 255.255.255.252
 encapsulation ppp
 ppp authentication chap
 no shutdown
!
router ospf 1
 network 10.2.2.0 0.0.0.3 area 0
 network 192.168.30.0 0.0.0.255 area 0
```



```
!
!
banner motd ^CUnauthorized access strictly prohibited and prosecuted to
the full extent of the law^C
!
line con 0
 exec-timeout 0 0
 password cisco
 logging synchronous
 login
line aux 0
line vty 0 4
 password cisco
 login
!
end
```

Task 10: Clean Up

Erase the configurations and reload the routers. Disconnect and store the cabling. For PC hosts that are normally connected to other networks, such as the school LAN or the Internet, reconnect the appropriate cabling and restore the TCP/IP settings.

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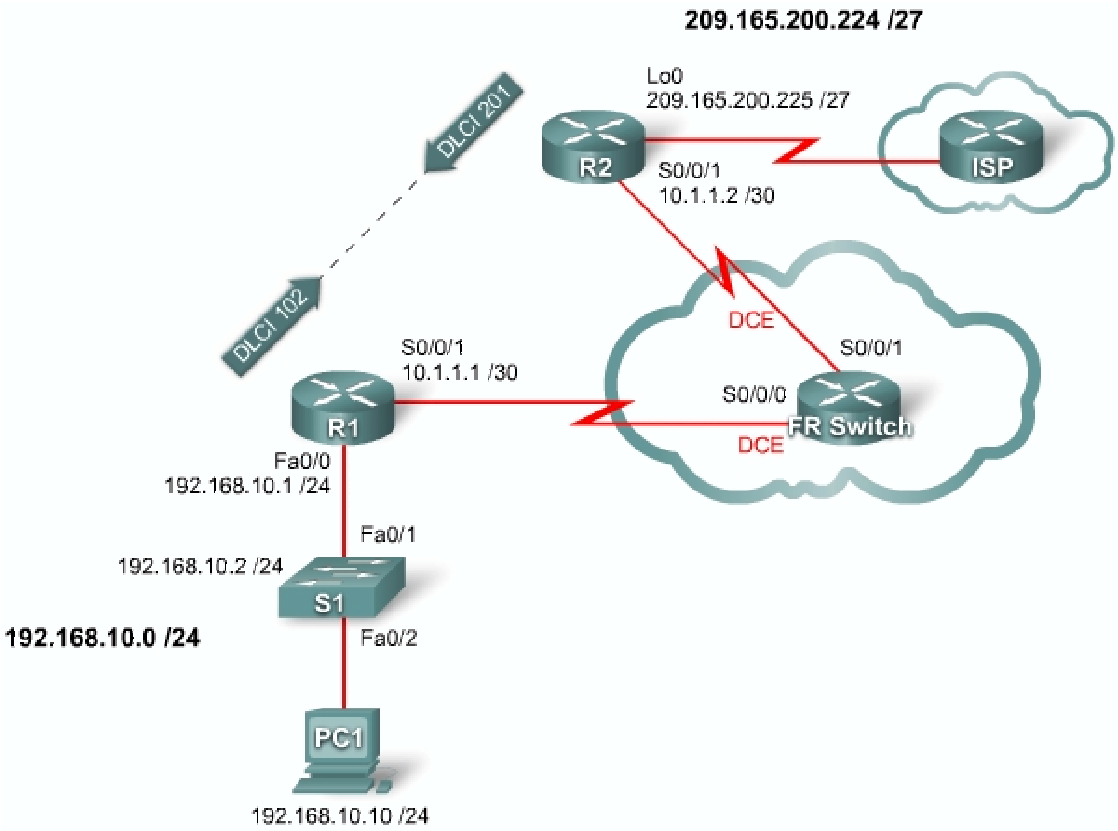
Lab 3.5.1: Basic Frame Relay

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.

Basic configurations for all routers

```
enable
configure terminal
hostname [R1, R2, FR-Switch]
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
```

Basic configurations for switch

```
enable
configure terminal
hostname [S1]
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 15
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?

_____

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 be 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
```

In order for the router to be able to ping its own interface, a second map must be created to map the DLCI to the local interface.

```
R1(config-if)#frame-relay map ip 10.1.1.1 102
```

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
```

In order for the router to be able to ping its own interface, a second map must be created to map the DLCI to the local interface.

```
R2(config-if)#frame-relay map ip 10.1.1.2 201
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, broadcast,
              CISCO, 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
```

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 Cisco 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 5: 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 6: 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
```

Final Configurations

```
R1#show run
<output omitted>
!
hostname R1

enable secret class
no ip domain lookup
!
interface FastEthernet0/0
 ip address 192.168.10.1 255.255.255.0
 no shutdown
!
interface Serial0/0/1
 ip address 10.1.1.1 255.255.255.252
 encapsulation frame-relay
 frame-relay map ip 10.1.1.2 102 broadcast
 no frame-relay inverse-arp
 no shutdown
```



```
!
interface Serial0/0/1.112 point-to-point
 ip address 10.1.1.5 255.255.255.252
 frame-relay interface-dlci 112
!
router eigrp 1
 network 10.0.0.0
 network 192.168.10.0
 no auto-summary
!
!
banner motd ^CUnauthorized access prohibited, violators will be
prosecuted to the full extent of the law.^C
!
line con 0
 password cisco
 logging synchronous
 login
line aux 0
line vty 0 4
 login
 password cisco
!
end


R2#show run
<output omitted>
!
hostname R2
!
!
enable secret class
!
!
no ip domain lookup
!
!
interface Loopback0
 ip address 209.165.200.225 255.255.255.224
!
!
interface Serial0/0/1
 ip address 10.1.1.2 255.255.255.252
 encapsulation frame-relay
 frame-relay map ip 10.1.1.1 201 broadcast
 no frame-relay inverse-arp
 frame-relay lmi-type cisco
 no shutdown
!
interface Serial0/0/1.212 point-to-point
 ip address 10.1.1.6 255.255.255.252
 frame-relay interface-dlci 212
!
router eigrp 1
 network 10.0.0.0
```



```
 network 209.165.200.0
 no auto-summary
!
!
line con 0
 password cisco
 logging synchronous
 login
line aux 0
line vty 0 4
 password cisco
 login
!
end

FR-Switch#show run
<output omitted>
!
hostname FR-Switch
!
enable secret class
!
no ip domain lookup
frame-relay switching
!
!
!
!
interface Serial0/0/0
 no ip address
 encapsulation frame-relay
 clockrate 64000
 frame-relay intf-type dce
 frame-relay route 102 interface Serial0/0/1 201
 frame-relay route 112 interface Serial0/0/1 212
 no shutdown
!
interface Serial0/0/1
 no ip address
 encapsulation frame-relay
 clock rate 64000
 frame-relay intf-type dce
 frame-relay route 201 interface Serial0/0/0 102
 frame-relay route 212 interface Serial0/0/0 112
 no shutdown
!
!
line con 0
 password cisco
 login
line aux 0
line vty 0 4
 password cisco
 login
!
end
```

