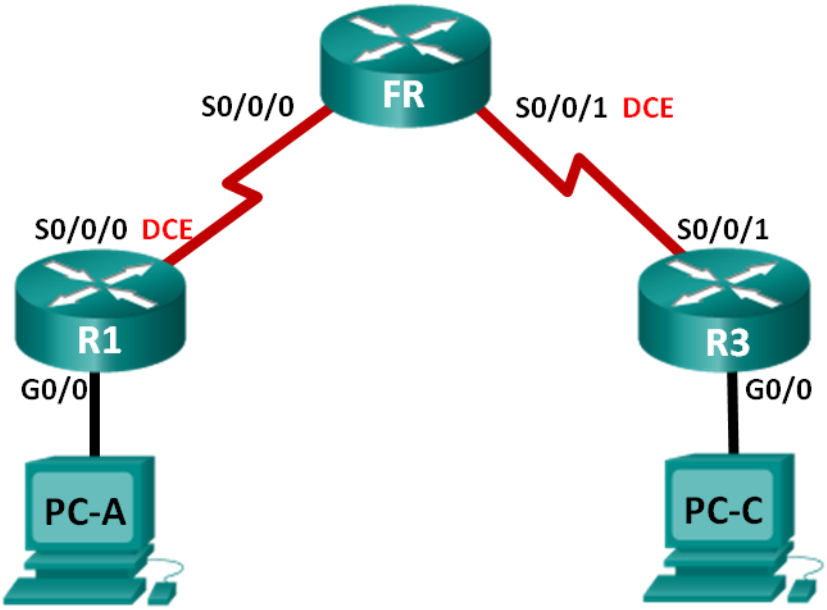
Lab – Configuring Frame Relay and Subinterfaces (Instructor Version)

Instructor Note: Red font color or Gray highlights indicate text that appears in the instructor copy only.

Topology



Addressing Table

Device	Interface	IPv4 and IPv6 Address	Default Gateway
R1	G0/0	192.168.1.1/24 2001:DB8:ACAD:A::1/64 FE80::1 link-local	N/A
	S0/0/0 (DCE)	10.1.1.1/30 2001:DB8:ACAD:B::1/64 FE80::1 link-local	N/A
FR	S0/0/0	N/A	N/A
	S0/0/1 (DCE)	N/A	N/A
R3	G0/0	192.168.3.1/24 2001:DB8:ACAD:C::3/64 FE80::3 link-local	N/A
	S0/0/1	10.1.1.2/30 2001:DB8:ACAD:B::3/64 FE80::3 link-local	N/A
PC-A	NIC	192.168.1.3/24 2001:DB8:ACAD:A::A/64	192.168.1.1 FE80::1
PC-C	NIC	192.168.3.3/24 2001:DB8:ACAD:C::C/64	192.168.3.1 FE80::3

Objectives

Part 1: Build the Network and Configure Basic Device Settings

Part 2: Configure a Frame Relay Switch

Part 3: Configure Basic Frame Relay

Part 4: Troubleshoot Frame Relay

Part 5: Configure a Frame Relay Subinterface

Background / Scenario

Frame Relay is a high-performance WAN protocol that operates at the physical and data link layers of the OSI reference model. Unlike leased lines, Frame Relay requires only a single access circuit to the Frame Relay provider to communicate with multiple sites that are connected to the same provider.

Frame Relay was one of the most extensively used WAN protocols, primarily because it was relatively inexpensive compared to dedicated lines. In addition, configuring user equipment in a Frame Relay network is fairly simple. With the advent of broadband services such as DSL and cable modem, GigaMAN (point-to-point Ethernet service over fiber-optic cable), VPN, and Multiprotocol Label Switching (MPLS), Frame Relay has become a less desirable solution for accessing the WAN. However, some rural areas do not have access to these alternative solutions and still rely on Frame Relay for connectivity to the WAN.

In this lab, you will configure Frame Relay encapsulation on serial links. You will also configure a router to simulate a Frame Relay switch. You will review Cisco standards and open standards that apply to Frame Relay. You will also configure Frame Relay point-to-point subinterfaces.

Note: The routers used with CCNA hands-on labs are Cisco 1941 Integrated Services Routers (ISRs) with Cisco IOS Release 15.2(4)M3 (universalk9 image). Other routers and Cisco IOS versions can be used. Depending on the model and Cisco IOS version, the commands available and output produced might vary from what is shown in the labs. Refer to the Router Interface Summary Table at the end of this lab for the correct interface identifiers.

Note: Make sure that the routers have been erased and have no startup configurations. If you are unsure, contact your instructor.

Instructor Note: Refer to the Instructor Lab Manual for the procedures to initialize and reload devices.

Required Resources

- 3 Routers (Cisco 1941 with Cisco IOS Release 15.2(4)M3 universal image or comparable)
- 2 PCs (Windows 7, Vista, or XP with terminal emulation program, such as Tera Term)
- Console cables to configure the Cisco IOS devices via the console ports
- Ethernet and serial cables as shown in the topology

Part 1: Build the Network and Configure Basic Device Settings

In Part 1, you will set up the network topology and configure basic settings on the PC hosts and routers.

Step 1: Cable the network as shown in the topology.

Step 2: Initialize and reload the routers as necessary.

Step 3: Configure basic settings for each router.

a. Disable DNS lookup.

b. Configure device names as shown in the topology.

c. Assign **class** as the privileged EXEC mode password.

d. Assign **cisco** as the console and vty passwords and enable login.

e. Configure **logging synchronous** for the console line.

f. Encrypt the plain text passwords.

g. Configure a MOTD banner to warn users that unauthorized access is prohibited.

h. Set the clocking rate for all DCE serial interfaces to **128000**.

i. Configure the IPv4 and IPv6 addresses listed in the Addressing Table for all interfaces. Do not activate the serial interfaces at this time.

j. Copy the running configuration to the startup configuration.

Step 4: Configure PC hosts.

Refer to the Addressing Table for PC host address information.

Step 5: Test connectivity.

At this point, the PCs will not be able to ping each other, but they should be able to ping their default gateway. Test both protocols, IPv4 and IPv6. Verify and troubleshoot if necessary.

Part 2: Configure a Frame Relay Switch

In Part 2, you will configure a Frame Relay switch. You will create permanent virtual circuits (PVCs) and assign Data Link Connection Identifiers (DLCIs). This configuration creates two PVCs: one from R1 to R3 (DLCI 103), and one from R3 to R1 (DLCI 301).

Step 1: Configure the FR router as a Frame Relay switch.

The **frame-relay switching** command enables Frame Relay switching globally on a router, allowing it to forward frames based on the incoming DLCI rather than an IP address.

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

Step 2: Change the interface encapsulation on S0/0/0.

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(config)# interface s0/0/0
FR(config-if)# encapsulation frame-relay
```

Step 3: Change the interface type to DCE.

Changing the interface type to DCE tells the router to send Local Management Interface (LMI) keepalives and allows Frame Relay route statements to be applied.

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.

```
FR(config)# interface s0/0/0
FR(config-if)# frame-relay intf-type dce
```

Step 4: Configure DLCI.

Configure the router to forward incoming traffic on interface S0/0/0 with DLCI 103 to S0/0/1 with an output of DLCI of 301.

```
FR(config-if)# frame-relay route 103 interface s0/0/1 301
FR(config-if)# no shutdown
```

Step 5: Configure Frame Relay on S0/0/1.

```
FR(config)# interface s0/0/1
FR(config-if)# encapsulation frame-relay
FR(config-if)# frame-relay intf-type dce
FR(config-if)# frame-relay route 301 interface s0/0/0 103
FR(config-if)# no shutdown
```

Step 6: Verify Frame Relay configuration.

a. Use the **show frame-relay pvc** command to verify that Frame Relay is configured correctly.

```
FR# 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 = 103, 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
  connected to interface Serial0/0/1 301
  pvc create time 00:00:53, last time pvc status changed 00:00:53

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 = 301, 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
  connected to interface Serial0/0/0 103
  pvc create time 00:00:16, last time pvc status changed 00:00:16
```

b. Issue the **show frame-relay route** command. This is the Layer 2 route that Frame Relay traffic takes through the network. (Do not confuse this with Layer 3 IP routing.)

```
FR# show frame-relay route
Input Intf      Input Dlci      Output Intf     Output Dlci     Status
Serial0/0/0     103             Serial0/0/1     301             inactive
Serial0/0/1     301             Serial0/0/0     103             inactive
```

Part 3: Configure Basic Frame Relay

In Part 3, you will configure Frame Relay on routers R1 and R3. After Frame Relay is configured, you will enable the EIGRP routing protocol to provide end-to-end connectivity.

Step 1: Configure R1 for Frame Relay.

Inverse ARP allows distant ends of a Frame Relay link to discover each other dynamically, 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 map IP addresses to DLCIs statically and disable Inverse ARP.

a. Change the encapsulation on S0/0/0 to Frame Relay.

```
R1(config)# interface s0/0/0
R1(config-if)# encapsulation frame-relay
```

b. Use the **no frame-relay inverse-arp** command to disable Inverse ARP.

```
R1(config)# interface s0/0/0
R1(config-if)# no frame-relay inverse-arp
```

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

Note: The IPv6 Frame Relay map to a global unicast address does not include the **broadcast** keyword. However, the **broadcast** keyword is used in the mapping to the link-local address. IPv6 routing protocols use link-local addresses for multicast routing updates; therefore, only the link-local address map requires the **broadcast** keyword to forward multicast packets.

```
R1(config)# interface s0/0/0
R1(config-if)# frame-relay map ip 10.1.1.2 103 broadcast
R1(config-if)# frame-relay map ipv6 2001:db8:acad:b::3 103
R1(config-if)# frame-relay map ipv6 fe80::3 103 broadcast
```

d. For the router to ping its own interface, the DLCI must be created to map to the local interface.

```
R1(config)# interface s0/0/0
R1(config-if)# frame-relay map ip 10.1.1.1 103
R1(config-if)# frame-relay map ipv6 2001:db8:acad:b::1 103
```

e. Use the **no shutdown** command to activate S0/0/0.

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

Step 2: Configure R3 for Frame Relay.

```
R3(config)# interface s0/0/1
R3(config-if)# encapsulation frame-relay
R3(config-if)# no frame-relay inverse-arp
```

```
R3(config-if)# frame-relay map ip 10.1.1.1 301 broadcast
R3(config-if)# frame-relay map ipv6 2001:db8:acad:b::1 301
R3(config-if)# frame-relay map ipv6 fe80::1 301 broadcast
R3(config-if)# frame-relay map ip 10.1.1.2 301
R3(config-if)# frame-relay map ipv6 2001:db8:acad:b::3 301
R3(config-if)# no shutdown
```

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

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If you type the **no shutdown** command first, Inverse ARP may cause Frame Relay to learn Layer 2 to Layer 3 mappings that you may not want. By turning off the Frame Relay Inverse ARP before issuing the **no shutdown** command, you ensure that only the statically mapped connections that you want are part of the Frame Relay maps.

Step 3: Verify that Frame Relay is active.

a. You should now be able to ping R3 from R1. It may take several seconds after bringing up the interfaces for the PVCs to become active.

```
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 = 28/30/40 ms
R1# ping 2001:db8:acad:b::3
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:B::3, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 28/28/28 ms
```

b. Ping R1 from R3.

```
R3# 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 = 28/28/28 ms
R3# ping 2001:db8:acad:b::1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:B::1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 24/26/28 ms
```

c. Issue the **show frame-relay pvc** command to display PVC status information on R1 and R3.

```
R1# show frame-relay pvc

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

                Active     Inactive      Deleted       Static
```

```
  Local          1            0            0            0
  Switched       0            0            0            0
  Unused         0            0            0            0

DLCI = 103, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE = Serial0/0/0

  input pkts 22            output pkts 154          in bytes 2240
  out bytes 10860          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 134       out bcast bytes 8780
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
  pvc create time 01:59:40, last time pvc status changed 01:55:14

R3# 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 = 301, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE = Serial0/0/1

  input pkts 158           output pkts 22           in bytes 11156
  out bytes 2240           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 2         out bcast bytes 160
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
  pvc create time 01:57:20, last time pvc status changed 01:56:19
```

d. Issue the **show frame-relay route** command on FR to verify that status of the Frame Relay map statements.

```
FR# show frame-relay route
Input Intf      Input Dlci      Output Intf     Output Dlci     Status
Serial0/0/0     103             Serial0/0/1     301             active
Serial0/0/1     301             Serial0/0/0     103             active
```

e. Issue the **show frame-relay map** command on R1 and R3 to display a summary of the static and dynamic mappings of Layer 3 addresses to DLCIs. Because Inverse ARP has been turned off, there are only static maps.

```
R1# show frame-relay map
Serial0/0/0 (up): ipv6 FE80::3 dlci 103(0x67,0x1870), static,
              broadcast,
```

```
              CISCO, status defined, active
Serial0/0/0 (up): ipv6 2001:DB8:ACAD:B::1 dlci 103(0x67,0x1870), static,
              CISCO, status defined, active
Serial0/0/0 (up): ip 10.1.1.1 dlci 103(0x67,0x1870), static,
              CISCO, status defined, active
Serial0/0/0 (up): ipv6 2001:DB8:ACAD:B::3 dlci 103(0x67,0x1870), static,
              CISCO, status defined, active
Serial0/0/0 (up): ip 10.1.1.2 dlci 103(0x67,0x1870), static,
              broadcast,
              CISCO, status defined, active

R3# show frame-relay map
Serial0/0/1 (up): ipv6 FE80::1 dlci 301(0x12D,0x48D0), static,
              broadcast,
              CISCO, status defined, active
Serial0/0/1 (up): ipv6 2001:DB8:ACAD:B::3 dlci 301(0x12D,0x48D0), static,
              CISCO, status defined, active
Serial0/0/1 (up): ip 10.1.1.2 dlci 301(0x12D,0x48D0), static,
              CISCO, status defined, active
Serial0/0/1 (up): ipv6 2001:DB8:ACAD:B::1 dlci 301(0x12D,0x48D0), static,
              CISCO, status defined, active
Serial0/0/1 (up): ip 10.1.1.1 dlci 301(0x12D,0x48D0), static,
              broadcast,
              CISCO, status defined, active
```

Note: The FR router acts as a Layer 2 device, so there is no need to map Layer 3 addresses to Layer 2 DLCIs.

Step 4: Configure EIGRP on R1 and R3.

a. Enable IPv6 routing on R1 and R3.

```
R1(config)# ipv6 unicast-routing

R3(config)# ipv6 unicast-routing
```

b. Using AS 1, enable EIGRP for IPv4 and IPv6 on R1 and R3 for all networks. Set the router ID for R1 as 1.1.1.1 and 3.3.3.3 for R3.

```
R1(config)# router eigrp 1
R1(config-router)# no auto-summary
R1(config-router)# eigrp router-id 1.1.1.1
R1(config-router)# network 10.1.1.0 0.0.0.3
R1(config-router)# network 192.168.1.0
R1(config-rtr)# no shutdown

R1(config-router)# ipv6 router eigrp 1
R1(config-rtr)# router-id 1.1.1.1
R1(config-rtr)# interface g0/0
R1(config-if)# ipv6 eigrp 1
R1(config-if)# interface s0/0/0
```

```
R1(config-if)# ipv6 eigrp 1

R3(config)# router eigrp 1
R3(config-router)# no auto-summary
R3(config-router)# eigrp router-id 3.3.3.3
R3(config-router)# network 10.1.1.0 0.0.0.3
R3(config-router)# network 192.168.3.0
R3(config-router)# ipv6 router eigrp 1
R3(config-rtr)# router-id 3.3.3.3
R3(config-rtr)# no shutdown
R3(config-rtr)# interface g0/0
R3(config-if)# ipv6 eigrp 1
R3(config-if)# interface s0/0/1
R3(config-if)# ipv6 eigrp 1
```

Step 5: Verify end-to-end connectivity.

Ping PC-C from PC-A. If your pings were unsuccessful, troubleshoot until you have end-to-end connectivity.

Note: It may be necessary to disable the PC firewall for pings to be successful.

Part 4: Troubleshoot Frame Relay

In Part 4, you will break the Frame Relay connection established earlier and use some tools to troubleshoot Frame Relay. A variety of tools are available for troubleshooting Frame Relay connectivity issues.

Step 1: Debug Local Management Interface (LMI).

a. Issue the **debug frame-relay lmi** command on R1. The output gives detailed information on all LMI data. Keepalives are sent every 10 seconds by default, so you may have to wait until you see any output. The output shows an outgoing LMI packet with a sequence number of 50. The last LMI message received from FR had a sequence number of 49. The output is also showing an incoming LMI message from FR to R1 with a sequence number of 50. DLCI 103 is the only DLCI on this link, and it is currently active.

```
R1# debug frame-relay lmi
Frame Relay LMI debugging is on
Displaying all Frame Relay LMI data
R1#
*Jun 26 18:28:45.922: Serial0/0/0(out): StEnq, myseq 50, yourseen 49, DTE up
*Jun 26 18:28:45.922: datagramstart = 0xC318D54, datagramsize = 13
*Jun 26 18:28:45.922: FR encap = 0xFCF10309
*Jun 26 18:28:45.922: 00 75 01 01 01 03 02 32 31
*Jun 26 18:28:45.922:
*Jun 26 18:28:45.922: Serial0/0/0(in): Status, myseq 50, pak size 13
*Jun 26 18:28:45.922: RT IE 1, length 1, type 1
*Jun 26 18:28:45.922: KA IE 3, length 2, yourseq 50, myseq 50
*Jun 26 18:28:45.922: PVC IE 0x7 , length 0x6 , dlci 103 , status 0x2 , bw 0
```

b. Issue the **undebug all** command to turn off debugging.

Note: This command can be abbreviated to **u all**. This is useful to know when debug information is flooding the screen.

```
R1# undebug all
All possible debugging has been turned off
```

Step 2: Remove the IPv4 frame map from R1.

a. Issue the **no frame-relay map** command to remove the IPv4 frame map on R1.

```
R1(config)# interface s0/0/0
R1(config-if)# no frame-relay map ip 10.1.1.2 103 broadcast
```

b. Issue the **debug ip icmp** command on R1.

```
R1# debug ip icmp
ICMP packet debugging is on
```

c. Ping R1 from R3. Pings should not be successful. However, debug messages on R1 show that the ICMP packets from R3 are reaching R1.

Note: You should see console messages reporting the EIGRP adjacency going up and down. This is sometimes called flapping.

```
R3# 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#
*Jun 26 20:12:35.693: ICMP: echo reply sent, src 10.1.1.1, dst 10.1.1.2, topology
BASE, dscp 0 topoid 0
R1#
*Jun 26 20:12:37.689: ICMP: echo reply sent, src 10.1.1.1, dst 10.1.1.2, topology
BASE, dscp 0 topoid 0
R1#
*Jun 26 20:12:39.689: ICMP: echo reply sent, src 10.1.1.1, dst 10.1.1.2, topology
BASE, dscp 0 topoid 0
R1#
*Jun 26 20:12:41.689: ICMP: echo reply sent, src 10.1.1.1, dst 10.1.1.2, topology
BASE, dscp 0 topoid 0
R1#
*Jun 26 20:12:43.689: ICMP: echo reply sent, src 10.1.1.1, dst 10.1.1.2, topology
BASE, dscp 0 topoid 0
```

Why does the ping fail?

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The ping fails because R1 has no way to reply. With no way to map the IP address of R3 to a Layer 2 DLCI, it cannot route the response and drops the packet.

d. Issue the **show frame-relay map** command on R1. The IPv4 map for R3 is missing from the list.

```
R1# show frame-relay map
Serial0/0/0 (up): ipv6 FE80::3 dlci 103(0x67,0x1870), static,
              broadcast,
              CISCO, status defined, active
Serial0/0/0 (up): ipv6 2001:DB8:ACAD:B::1 dlci 103(0x67,0x1870), static,
```

```
              CISCO, status defined, active
Serial0/0/0 (up): ip 10.1.1.1 dlci 103(0x67,0x1870), static,
              CISCO, status defined, active
Serial0/0/0 (up): ipv6 2001:DB8:ACAD:B::3 dlci 103(0x67,0x1870), static,
              CISCO, status defined, active
```

e. Issue the **undebug all** command to turn off debugging on R1.

```
R1# undebug all
All possible debugging has been turned off
```

f. Re-apply the **frame-relay map ip** command to S0/0/0 on R1, but without using the **broadcast** keyword.

```
R1(config)# interface s0/0/0
R1(config-if)# frame-relay map ip 10.1.1.2 103
```

g. Ping R1 from R3. Pings should be successful, but the EIGRP adjacency continues to flap. It may take a few minutes between each message because of the EIGRP timers.

```
R3# 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 = 28/28/28 ms


R1(config-if)#
*Jun 26 20:25:10.871: %DUAL-5-NBRCHANGE: EIGRP-IPv4 1: Neighbor 10.1.1.2 (Serial0/0/0)
is down: Interface PEER-TERMINATION received
*Jun 26 20:28:13.673: %DUAL-5-NBRCHANGE: EIGRP-IPv4 1: Neighbor 10.1.1.2 (Serial0/0/0)
is up: new adjacency
R1(config-if)#
*Jun 26 20:31:18.185: %DUAL-5-NBRCHANGE: EIGRP-IPv4 1: Neighbor 10.1.1.2 (Serial0/0/0)
is down: retry limit exceeded
R1(config-if)#
*Jun 26 20:32:00.977: %DUAL-5-NBRCHANGE: EIGRP-IPv4 1: Neighbor 10.1.1.2 (Serial0/0/0)
is up: new adjacency
R1(config-if)#
*Jun 26 20:35:05.489: %DUAL-5-NBRCHANGE: EIGRP-IPv4 1: Neighbor 10.1.1.2 (Serial0/0/0)
is down: retry limit exceeded
```

Why does the EIGRP adjacency continue to flap?

_____

Without the **broadcast** keyword, multicast traffic is not being forwarded over the DLCI specified in the frame map statement.

h. Replace the Frame Relay map statement and include the **broadcast** keyword this time.

```
R1(config-if)# frame-relay map ip 10.1.1.2 103 broadcast
```

i. Verify that the full routing table is restored and that you have end-to-end connectivity.

```
R1# show ip route
Codes: L - local, 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, H - NHRP, l - LISP
        + - replicated route, % - next hop override

Gateway of last resort is not set

      10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C        10.1.1.0/30 is directly connected, Serial0/0/0
L        10.1.1.1/32 is directly connected, Serial0/0/0
      192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.1.0/24 is directly connected, GigabitEthernet0/0
L        192.168.1.1/32 is directly connected, GigabitEthernet0/0
D     192.168.3.0/24 [90/2172416] via 10.1.1.2, 00:01:54, Serial0/0/0
```

Step 3: 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.

a. Change the Frame Relay encapsulation on S0/0/1 on R3 to IETF.

```
R3(config)# interface s0/0/1
R3(config-if)# encapsulation frame-relay ietf
```

b. Issue the **show interfaces s0/0/1** command on R3 and FR. Even though the encapsulation is different on each interface, the link is still active. This is because Cisco routers understand both types of incoming frames. However, if you have routers from different vendors and you are using Frame Relay, then the IETF standard must be used.

```
R3# show interfaces s0/0/1
Serial0/0/1 is up, line protocol is up
  Hardware is WIC MBRD Serial
  Internet address is 10.1.1.2/30
  MTU 1500 bytes, BW 1544 Kbit/sec, DLY 20000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation FRAME-RELAY IETF, loopback not set
  Keepalive set (10 sec)
  LMI enq sent  1898, LMI stat recvd 1900, LMI upd recvd 0, DTE LMI up
<output omitted>

FR# show interfaces s0/0/1
Serial0/0/1 is up, line protocol is up
  Hardware is WIC MBRD Serial
  MTU 1500 bytes, BW 1544 Kbit/sec, DLY 20000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation FRAME-RELAY, loopback not set
  Keepalive set (10 sec)
  LMI enq sent  0, LMI stat recvd 0, LMI upd recvd 0
```

c. Reset the R3 Frame Relay encapsulation back to Cisco (the default).

```
R3(config)# interface s0/0/1
R3(config-if)# encapsulation frame-relay
```

Step 4: Change the LMI type.

a. Issue the **frame-relay lmi-type ansi** command on interface S0/0/1 on R3.

```
R3(config-if)# frame-relay lmi-type ansi
```

b. After at least 60 seconds, issue the **show interfaces s0/0/1** command on R3. When 60 seconds have passed, the interface changes its state to up, then down, because R3 is expecting ANSI LMI, and FR is sending Cisco LMI.

```
R3# show interfaces s0/0/1
Serial0/0/1 is up, line protocol is down
  Hardware is WIC MBRD Serial
  Internet address is 10.1.1.2/30
  MTU 1500 bytes, BW 1544 Kbit/sec, DLY 20000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation FRAME-RELAY, loopback not set
  Keepalive set (10 sec)
  LMI enq sent  2157, LMI stat recvd 2136, LMI upd recvd 0, DTE LMI down
  LMI enq recvd 0, LMI stat sent  0, LMI upd sent  0
  LMI DLCI 0  LMI type is ANSI Annex D  frame relay DTE  segmentation inactive
  FR SVC disabled, LAPF state down
  Broadcast queue 0/64, broadcasts sent/dropped 733/0, interface broadcast
<output omitted>
```

c. On R3, issue the **show frame-relay lmi** command to display LMI information, including LMI type, number of timeouts, and the amount of time since the last full update.

```
R3# 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 2158             Num Status msgs Rcvd 2136
  Num Update Status Rcvd 0              Num Status Timeouts 23
  Last Full Status Req 00:00:05         Last Full Status Rcvd 00:04:35
```

d. On R3, issue the **debug frame-relay lmi** command. The LMI packets no longer display in pairs. While all outgoing LMI messages are logged, no incoming messages display because R3 is expecting ANSI LMI, and FR is sending Cisco LMI.

```
R3# debug frame-relay lmi
Frame Relay LMI debugging is on
Displaying all Frame Relay LMI data
R3#
*Jun 26 21:49:10.829: Serial0/0/1(out): StEnq, myseq 104, yourseen 0, DTE down
*Jun 26 21:49:10.829: datagramstart = 0xC313554, datagramsize = 14
*Jun 26 21:49:10.829: FR encap = 0x00010308
*Jun 26 21:49:10.829: 00 75 95 01 01 00 03 02 68 00
*Jun 26 21:49:10.829:
R3#
*Jun 26 21:49:20.829: Serial0/0/1(out): StEnq, myseq 105, yourseen 0, DTE down
```

```
*Jun 26 21:49:20.829: datagramstart = 0xC317554, datagramsize = 14
*Jun 26 21:49:20.829: FR encap = 0x00010308
*Jun 26 21:49:20.829: 00 75 95 01 01 00 03 02 69 00
*Jun 26 21:49:20.829:
```

e. Restore the LMI type back to Cisco on R3. Notice that the debug messages change after you issue this command. The LMI sequence number has been reset to 1. R3 began to understand the LMI messages coming in from FR. After R3 and FR have successfully exchanged LMI messages, the interface changed state to up.

```
R3(config)# interface s0/0/1
R3(config-if)# frame-relay lmi-type cisco
R3(config-if)#
*Jun 26 21:51:20.829: Serial0/0/1(out): StEnq, myseq 117, yourseen 0, DTE down
*Jun 26 21:51:20.829: datagramstart = 0xC31F254, datagramsize = 14
*Jun 26 21:51:20.829: FR encap = 0x00010308
*Jun 26 21:51:20.829: 00 75 95 01 01 00 03 02 75 00
*Jun 26 21:51:20.829:
R3(config-if)#
*Jun 26 21:51:30.829: Serial0/0/1(out): StEnq, myseq 1, yourseen 0, DTE down
*Jun 26 21:51:30.829: datagramstart = 0xC31F3D4, datagramsize = 13
*Jun 26 21:51:30.829: FR encap = 0xFCF10309
*Jun 26 21:51:30.829: 00 75 01 01 00 03 02 01 00
*Jun 26 21:51:30.829:
*Jun 26 21:51:30.829: Serial0/0/1(in): Status, myseq 1, pak size 21
*Jun 26 21:51:30.829: RT IE 1, length 1, type 0
*Jun 26 21:51:30.829: KA IE 3, length 2, yourseq 1 , myseq 1
*Jun 26 21:51:30.829: PVC IE 0x7 , length 0x6 , dlci 301, stat
R3(config-if)#us 0x2 , bw 0
R3(config-if)#
*Jun 26 21:51:40.829: Serial0/0/1(out): StEnq, myseq 2, yourseen 1, DTE down
*Jun 26 21:51:40.829: datagramstart = 0xC313B54, datagramsize = 13
*Jun 26 21:51:40.829: FR encap = 0xFCF10309
*Jun 26 21:51:40.829: 00 75 01 01 01 03 02 02 01
*Jun 26 21:51:40.829:
*Jun 26 21:51:40.829: Serial0/0/1(in): Status, myseq 2, pak size 21
*Jun 26 21:51:40.829: RT IE 1, length 1, type 0
*Jun 26 21:51:40.829: KA IE 3, length 2, yourseq 2 , myseq 2
*Jun 26 21:51:40.829: PVC IE 0x7 , length 0x6 , dlci 301, stat
R3(config-if)#us 0x2 , bw 0
*Jun 26 21:51:51.829: %LINEPROTO-5-UPDOWN: Line protocol on Interface
Serial0/0/1, changed state to up
R3(config-if)#
```

f. Issue the **undebug all** command to end debugging.

```
R3# undebug all
All possible debugging has been turned off
```

Part 5: Configure a Frame Relay Subinterface

Frame Relay supports two types of subinterfaces: point-to-point and point-to-multipoint. Point-to-multipoint subinterfaces support non-broadcast multiaccess topologies. For example, a hub and spoke topology would use a point-to-multipoint subinterface. In Part 5, you will create a point-to-point subinterface.

Step 1: On the FR router, create new PVCs between R1 and R3.

```
FR(config)# interface s0/0/0
FR(config-if)# frame-relay route 113 interface s0/0/1 311
FR(config-if)# interface s0/0/1
FR(config-if)# frame-relay route 311 interface s0/0/0 113
```

Step 2: Create and configure a point-to-point subinterface on R1 and R3.

Note: Frame Relay encapsulation must be specified on the physical interface before subinterfaces can be created.

a. Create subinterface 113 as a point-to-point interface on R1.

```
R1(config)# interface s0/0/0.113 point-to-point
R1(config-subif)# ip address 10.1.1.5 255.255.255.252
R1(config-subif)# ipv6 address 2001:db8:acad:d::1/64
R1(config-subif)# ipv6 address fe80::1 link-local
R1(config-subif)# frame-relay interface-dlci 113
R1(config-fr-dlci)#
```

b. Create subinterface 311 as a point-to-point subinterface on R3.

```
R3(config)# interface s0/0/1.311 point-to-point
R3(config-subif)# ip address 10.1.1.6 255.255.255.252
R3(config-subif)# ipv6 address 2001:db8:acad:d::3/64
R3(config-subif)# ipv6 address fe80::3 link-local
R3(config-subif)# frame-relay interface-dlci 311
R3(config-fr-dlci)#
```

c. Verify connectivity.

```
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 = 28/28/28 ms
R1# ping 2001:db8:acad:d::3
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:D::3, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 28/28/28 ms

R3# 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 = 28/28/28 ms
R3# ping 2001:db8:acad:d::1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:D::1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 28/28/28 ms
```

d. Issue the **show frame-relay pvc** command on R1 and R3 to display the PVC status.

```
R1# show frame-relay pvc

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

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

DLCI = 103, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE = Serial0/0/0

  input pkts 1170          output pkts 1408         in bytes 92566
  out bytes 105327         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 1160      out bcast bytes 89034
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
  pvc create time 07:53:13, last time pvc status changed 00:35:58

DLCI = 113, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE = Serial0/0/0.113

  input pkts 86            output pkts 494          in bytes 20916
  out bytes 45208          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 464       out bcast bytes 42088
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
  pvc create time 00:35:58, last time pvc status changed 00:35:58

R3# 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 = 301, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE = Serial0/0/1

  input pkts 1406          output pkts 1176         in bytes 105143
  out bytes 93110          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 1038      out bcast bytes 80878
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
  pvc create time 07:51:07, last time pvc status changed 00:37:16

DLCI = 311, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE = Serial0/0/1.311

  input pkts 513           output pkts 114          in bytes 47072
  out bytes 30360          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 74        out bcast bytes 26200
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
  pvc create time 01:11:06, last time pvc status changed 00:37:16
```

e. Issue the **show frame-relay route** command on FR to verify the status of the Frame Relay map statements.

```
FR# show frame-relay route
Input Intf      Input Dlci      Output Intf     Output Dlci     Status
Serial0/0/0     103             Serial0/0/1     301             active
Serial0/0/0     113             Serial0/0/1     311             active
Serial0/0/1     301             Serial0/0/0     103             active
Serial0/0/1     311             Serial0/0/0     113             active
```

f. Issue the **show frame-relay map** command on R1 and R3 to verify the status of the Frame Relay map statements.

```
R1# show frame-relay map
Serial0/0/0 (up): ip 10.1.1.2 dlci 103(0x67,0x1870), static,
              broadcast,
              CISCO, status defined, active
Serial0/0/0 (up): ipv6 FE80::3 dlci 103(0x67,0x1870), static,
              broadcast,
              CISCO, status defined, active
Serial0/0/0 (up): ipv6 2001:DB8:ACAD:B::1 dlci 103(0x67,0x1870), static,
              CISCO, status defined, active
Serial0/0/0 (up): ip 10.1.1.1 dlci 103(0x67,0x1870), static,
              CISCO, status defined, active
Serial0/0/0 (up): ipv6 2001:DB8:ACAD:B::3 dlci 103(0x67,0x1870), static,
              CISCO, status defined, active
Serial0/0/0.113 (up): point-to-point dlci, dlci 113(0x71,0x1C10), broadcast
```

```
          status defined, active

R3# show frame-relay map
Serial0/0/1 (up): ipv6 FE80::1 dlci 301(0x12D,0x48D0), static,
              broadcast,
              CISCO, status defined, active
Serial0/0/1 (up): ipv6 2001:DB8:ACAD:B::3 dlci 301(0x12D,0x48D0), static,
              CISCO, status defined, active
Serial0/0/1 (up): ip 10.1.1.2 dlci 301(0x12D,0x48D0), static,
              CISCO, status defined, active
Serial0/0/1 (up): ipv6 2001:DB8:ACAD:B::1 dlci 301(0x12D,0x48D0), static,
              CISCO, status defined, active
Serial0/0/1 (up): ip 10.1.1.1 dlci 301(0x12D,0x48D0), static,
              broadcast,
              CISCO, status defined, active
Serial0/0/1.311 (up): point-to-point dlci, dlci 311(0x137,0x4C70), broadcast
          status defined, active
```

Reflection

1. What is a PVC and how is it used?

   _____

   _____

   _____

   A PVC is a permanent virtual circuit. This is a Layer 2 connection created between endpoints through a Frame Relay cloud. There can be multiple PVCs per physical interface, allowing multiple point-to-point connections or point-to-multipoint connections.

2. What is the purpose of a DLCI?

   _____

   A DLCI is a Layer 2 Frame Relay address that Inverse ARP uses to obtain an associated Layer 3 IP address.

3. What purpose does the Local Management Interface (LMI) serve in a Frame Relay network?

   _____

   _____

   _____

   _____

   The LMI is a signaling protocol that exchanges information between a router and a Frame Relay switch. The LMI exchanges information on keepalives, PVC status (active, inactive, deleted, unused), and IP addresses (when Inverse ARP is enabled). This information is used as a status mechanism between the router (DTE) and the Frame Relay switch (DCE).

4. Why would you use subinterfaces with Frame Relay?

   _____

   _____

   _____

   _____

Subinterfaces address the limitations of Frame Relay networks by providing a way to subdivide a partially meshed Frame Relay network into a number of smaller, fully meshed, or point-to-point subnetworks. Each subnetwork is assigned its own network number and appears to the protocols as if it were reachable through a separate interface.

Router Interface Summary Table

Router Interface Summary				
Router Model	**Ethernet Interface #1**	**Ethernet Interface #2**	**Serial Interface #1**	**Serial Interface #2**
1800	Fast Ethernet 0/0 (F0/0)	Fast Ethernet 0/1 (F0/1)	Serial 0/0/0 (S0/0/0)	Serial 0/0/1 (S0/0/1)
1900	Gigabit Ethernet 0/0 (G0/0)	Gigabit Ethernet 0/1 (G0/1)	Serial 0/0/0 (S0/0/0)	Serial 0/0/1 (S0/0/1)
2801	Fast Ethernet 0/0 (F0/0)	Fast Ethernet 0/1 (F0/1)	Serial 0/1/0 (S0/1/0)	Serial 0/1/1 (S0/1/1)
2811	Fast Ethernet 0/0 (F0/0)	Fast Ethernet 0/1 (F0/1)	Serial 0/0/0 (S0/0/0)	Serial 0/0/1 (S0/0/1)
2900	Gigabit Ethernet 0/0 (G0/0)	Gigabit Ethernet 0/1 (G0/1)	Serial 0/0/0 (S0/0/0)	Serial 0/0/1 (S0/0/1)

Note: To find out how the router is configured, look at the interfaces to identify the type of router and how many interfaces the router has. There is no way to effectively list all the combinations of configurations for each router class. This table includes identifiers for the possible combinations of Ethernet and Serial interfaces in the device. The table does not include any other type of interface, even though a specific router may contain one. An example of this might be an ISDN BRI interface. The string in parenthesis is the legal abbreviation that can be used in Cisco IOS commands to represent the interface.

Device Configs

Router R1 (After Parts 1 and 2 of this lab)

```
R1# show run
Building configuration...

Current configuration : 1606 bytes
!
version 15.2
service timestamps debug datetime msec
service timestamps log datetime msec
service password-encryption
!
hostname R1
!
boot-start-marker
boot-end-marker
!
enable secret 4 06YFDUHH61wAE/kLkDq9BGho1QM5EnRtoyr8cHAUg.2
!
```

```
no aaa new-model
memory-size iomem 15
!
ip cef
!
no ip domain lookup
no ipv6 cef
multilink bundle-name authenticated
!
interface Embedded-Service-Engine0/0
 no ip address
 shutdown
!
interface GigabitEthernet0/0
 ip address 192.168.1.1 255.255.255.0
 duplex auto
 speed auto
 ipv6 address FE80::1 link-local
 ipv6 address 2001:DB8:ACAD:A::1/64
!
interface GigabitEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/0/0
 ip address 10.1.1.1 255.255.255.252
 shutdown
 ipv6 address FE80::1 link-local
 ipv6 address 2001:DB8:ACAD:B::1/64
 clock rate 128000
!
interface Serial0/0/1
 no ip address
 shutdown
!
ip forward-protocol nd
!
no ip http server
no ip http secure-server
!
control-plane
!
banner motd ^C Unauthorized Access is Prohibited! ^C
!
line con 0
 password 7 070C285F4D06
 logging synchronous
```

```
 login
line aux 0
line 2
 no activation-character
 no exec
 transport preferred none
 transport input all
 transport output pad telnet rlogin lapb-ta mop udptn v120 ssh
 stopbits 1
line vty 0 4
 password 7 094F471A1A0A
 login
 transport input all
!
scheduler allocate 20000 1000
!
end
```

Router FR (After Parts 1 and 2 of this lab)

```
FR# show run
Building configuration...

Current configuration : 1671 bytes
!
version 15.2
service timestamps debug datetime msec
service timestamps log datetime msec
service password-encryption
!
hostname FR
!
boot-start-marker
boot-end-marker
!
enable secret 4 06YFDUHH61wAE/kLkDq9BGho1QM5EnRtoyr8cHAUg.2
!
no aaa new-model
memory-size iomem 15
!
ip cef
!
no ip domain lookup
no ipv6 cef
!
multilink bundle-name authenticated
!
frame-relay switching
!
interface Embedded-Service-Engine0/0
```

```
 no ip address
 shutdown
!
interface GigabitEthernet0/0
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface GigabitEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/0/0
 no ip address
 encapsulation frame-relay
 frame-relay intf-type dce
 frame-relay route 103 interface Serial0/0/1 301
!
interface Serial0/0/1
 no ip address
 encapsulation frame-relay
 clock rate 128000
 frame-relay intf-type dce
 frame-relay route 301 interface Serial0/0/0 103
!
ip forward-protocol nd
!
no ip http server
no ip http secure-server
!
control-plane
!
banner motd ^C Unauthorized Access is Prohibited! ^C
!
line con 0
password 7 094F471A1A0A
 logging synchronous
 login
line aux 0
line 2
 no activation-character
 no exec
 transport preferred none
 transport input all
 transport output pad telnet rlogin lapb-ta mop udptn v120 ssh
 stopbits 1
```

```
line vty 0 4
 password 7 01100F175804
 login
 transport input all
!
scheduler allocate 20000 1000
!
end
```

Router R3 (After Parts 1 and 2 of this lab)

```
R3# sh run
Building configuration...

Current configuration : 1674 bytes
!
version 15.2
service timestamps debug datetime msec
service timestamps log datetime msec
service password-encryption
!
hostname R3
!
boot-start-marker
boot-end-marker
!
enable secret 4 06YFDUHH61wAE/kLkDq9BGho1QM5EnRtoyr8cHAUg.2
!
no aaa new-model
memory-size iomem 15
!
ip cef
!
no ip domain lookup
no ipv6 cef
!
multilink bundle-name authenticated
!
interface Embedded-Service-Engine0/0
 no ip address
 shutdown
!
interface GigabitEthernet0/0
 ip address 192.168.3.1 255.255.255.0
 duplex auto
 speed auto
 ipv6 address FE80::3 link-local
 ipv6 address 2001:DB8:ACAD:C::3/64
!
interface GigabitEthernet0/1
```

```
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/0/0
 no ip address
 shutdown
 clock rate 2000000
!
interface Serial0/0/1
 ip address 10.1.1.2 255.255.255.252
 shutdown
 ipv6 address FE80::3 link-local
 ipv6 address 2001:DB8:ACAD:B::3/64
!
ip forward-protocol nd
!
no ip http server
no ip http secure-server
!
control-plane
!
banner motd ^C Unauthorized Access is Prohibited! ^C
!
line con 0
password 7 0822455D0A16
 logging synchronous
 login
line aux 0
line 2
 no activation-character
 no exec
 transport preferred none
 transport input all
 transport output pad telnet rlogin lapb-ta mop udptn v120 ssh
 stopbits 1
line vty 0 4
 password 7 070C285F4D06
 login
 transport input all
!
scheduler allocate 20000 1000
!
end
```

Router R1 (After Part 3 of this lab)

```
R1# sh run
Building configuration...
```

```
Current configuration : 2055 bytes
!
version 15.2
service timestamps debug datetime msec
service timestamps log datetime msec
service password-encryption
!
hostname R1
!
boot-start-marker
boot-end-marker
!
enable secret 4 06YFDUHH61wAE/kLkDq9BGho1QM5EnRtoyr8cHAUg.2
!
no aaa new-model
memory-size iomem 15
!
ip cef
!
no ip domain lookup
ipv6 unicast-routing
ipv6 cef
multilink bundle-name authenticated
!
interface Embedded-Service-Engine0/0
 no ip address
 shutdown
!
interface GigabitEthernet0/0
 ip address 192.168.1.1 255.255.255.0
 duplex auto
 speed auto
 ipv6 address FE80::1 link-local
 ipv6 address 2001:DB8:ACAD:A::1/64
 ipv6 eigrp 1
!
interface GigabitEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/0/0
 ip address 10.1.1.1 255.255.255.252
 encapsulation frame-relay
 ipv6 address FE80::1 link-local
 ipv6 address 2001:DB8:ACAD:B::1/64
 ipv6 eigrp 1
```

```
 clock rate 128000
 frame-relay map ipv6 2001:DB8:ACAD:B::1 103
 frame-relay map ip 10.1.1.1 103
 frame-relay map ipv6 FE80::3 103 broadcast
 frame-relay map ipv6 2001:DB8:ACAD:B::3 103
 frame-relay map ip 10.1.1.2 103 broadcast
 no frame-relay inverse-arp
!
interface Serial0/0/1
 no ip address
 shutdown
!
!
router eigrp 1
 network 10.1.1.0 0.0.0.3
 network 192.168.1.0
 eigrp router-id 1.1.1.1
!
ip forward-protocol nd
!
no ip http server
no ip http secure-server
!
ipv6 router eigrp 1
 eigrp router-id 1.1.1.1
!
control-plane
!
banner motd ^C Unauthorized Access is Prohibited! ^C
!
line con 0
 password 7 070C285F4D06
 logging synchronous
 login
line aux 0
line 2
 no activation-character
 no exec
 transport preferred none
 transport input all
 transport output pad telnet rlogin lapb-ta mop udptn v120 ssh
 stopbits 1
line vty 0 4
 password 7 094F471A1A0A
 login
 transport input all
!
scheduler allocate 20000 1000
!
```

```
end
```

Router FR (After Part 3 of this lab)

```
FR# show run
Building configuration...

Current configuration : 1671 bytes
!
version 15.2
service timestamps debug datetime msec
service timestamps log datetime msec
service password-encryption
!
hostname FR
!
boot-start-marker
boot-end-marker
!
!
enable secret 4 06YFDUHH61wAE/kLkDq9BGho1QM5EnRtoyr8cHAUg.2
!
no aaa new-model
memory-size iomem 15
!
ip cef
!
no ip domain lookup
no ipv6 cef
!
multilink bundle-name authenticated
!
frame-relay switching
!
interface Embedded-Service-Engine0/0
 no ip address
 shutdown
!
interface GigabitEthernet0/0
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface GigabitEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
```

```
interface Serial0/0/0
 no ip address
 encapsulation frame-relay
 frame-relay intf-type dce
 frame-relay route 103 interface Serial0/0/1 301
!
interface Serial0/0/1
 no ip address
 encapsulation frame-relay
 clock rate 128000
 frame-relay intf-type dce
 frame-relay route 301 interface Serial0/0/0 103
!
ip forward-protocol nd
!
no ip http server
no ip http secure-server
!
control-plane
!
banner motd ^C Unauthorized Access is Prohibited! ^C
!
line con 0
password 7 094F471A1A0A
 logging synchronous
 login
line aux 0
line 2
 no activation-character
 no exec
 transport preferred none
 transport input all
 transport output pad telnet rlogin lapb-ta mop udptn v120 ssh
 stopbits 1
line vty 0 4
 password 7 01100F175804
 login
 transport input all
!
scheduler allocate 20000 1000
!
end
```

Router R3 (After Part 3 of this lab)

```
R3# show run
Building configuration...

Current configuration : 2123 bytes
!
```

```
version 15.2
service timestamps debug datetime msec
service timestamps log datetime msec
service password-encryption
!
hostname R3
!
boot-start-marker
boot-end-marker
!
enable secret 4 06YFDUHH61wAE/kLkDq9BGho1QM5EnRtoyr8cHAUg.2
!
no aaa new-model
memory-size iomem 15
!
ip cef
!
no ip domain lookup
ipv6 unicast-routing
ipv6 cef
!
multilink bundle-name authenticated
!
interface Embedded-Service-Engine0/0
 no ip address
 shutdown
!
interface GigabitEthernet0/0
 ip address 192.168.3.1 255.255.255.0
 duplex auto
 speed auto
 ipv6 address FE80::3 link-local
 ipv6 address 2001:DB8:ACAD:C::3/64
 ipv6 eigrp 1
!
interface GigabitEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/0/0
 no ip address
 shutdown
 clock rate 2000000
!
interface Serial0/0/1
 ip address 10.1.1.2 255.255.255.252
 encapsulation frame-relay
```

```
 ipv6 address FE80::3 link-local
 ipv6 address 2001:DB8:ACAD:B::3/64
 ipv6 eigrp 1
 frame-relay map ipv6 2001:DB8:ACAD:B::3 301
 frame-relay map ip 10.1.1.2 301
 frame-relay map ipv6 FE80::1 301 broadcast
 frame-relay map ipv6 2001:DB8:ACAD:B::1 301
 frame-relay map ip 10.1.1.1 301 broadcast
 no frame-relay inverse-arp
!
router eigrp 1
 network 10.1.1.0 0.0.0.3
 network 192.168.3.0
 eigrp router-id 3.3.3.3
!
ip forward-protocol nd
!
no ip http server
no ip http secure-server
!
ipv6 router eigrp 1
 eigrp router-id 3.3.3.3
!
control-plane
!
banner motd ^C Unauthorized Access is Prohibited! ^C
!
line con 0
password 7 0822455D0A16
 logging synchronous
 login
line aux 0
line 2
 no activation-character
 no exec
 transport preferred none
 transport input all
 transport output pad telnet rlogin lapb-ta mop udptn v120 ssh
 stopbits 1
line vty 0 4
 password 7 070C285F4D06
 login
 transport input all
!
scheduler allocate 20000 1000
!
end
```

Router R1 - Final

```
R1# show run
Building configuration...

Current configuration : 2296 bytes
!
version 15.2
service timestamps debug datetime msec
service timestamps log datetime msec
service password-encryption
!
hostname R1
!
boot-start-marker
boot-end-marker
!
enable secret 4 06YFDUHH61wAE/kLkDq9BGho1QM5EnRtoyr8cHAUg.2
!
no aaa new-model
memory-size iomem 15
!
ip cef
!
no ip domain lookup
ipv6 unicast-routing
ipv6 cef
!
multilink bundle-name authenticated
!
redundancy
!
interface Embedded-Service-Engine0/0
 no ip address
 shutdown
!
interface GigabitEthernet0/0
 ip address 192.168.1.1 255.255.255.0
 duplex auto
 speed auto
 ipv6 address FE80::1 link-local
 ipv6 address 2001:DB8:ACAD:A::1/64
 ipv6 eigrp 1
!
interface GigabitEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
```

```
interface Serial0/0/0
 ip address 10.1.1.1 255.255.255.252
 encapsulation frame-relay
 ipv6 address FE80::1 link-local
 ipv6 address 2001:DB8:ACAD:B::1/64
 ipv6 eigrp 1
 clock rate 128000
 frame-relay map ip 10.1.1.2 103 broadcast
 frame-relay map ipv6 FE80::3 103 broadcast
 frame-relay map ipv6 2001:DB8:ACAD:B::1 103
 frame-relay map ip 10.1.1.1 103
 frame-relay map ipv6 2001:DB8:ACAD:B::3 103
 no frame-relay inverse-arp
!
interface Serial0/0/0.113 point-to-point
 ip address 10.1.1.5 255.255.255.252
 ipv6 address FE80::1 link-local
 ipv6 address 2001:DB8:ACAD:D::1/64
 frame-relay interface-dlci 113
!
interface Serial0/0/1
 no ip address
 shutdown
!
router eigrp 1
 network 10.0.0.0
 network 192.168.1.0
 eigrp router-id 1.1.1.1
!
ip forward-protocol nd
!
no ip http server
no ip http secure-server
!
ipv6 router eigrp 1
 eigrp router-id 1.1.1.1
!
control-plane
!
banner motd ^C Unauthorized Access is Prohibited! ^C
!
line con 0
 password 7 104D000A0618
 logging synchronous
 login
line aux 0
line 2
 no activation-character
 no exec
```

```
 transport preferred none
 transport input all
 transport output pad telnet rlogin lapb-ta mop udptn v120 ssh
 stopbits 1
line vty 0 4
 password 7 121A0C041104
 login
 transport input all
!
scheduler allocate 20000 1000
!
end
```

Router FR (Final)

```
FR# show run
Building configuration...

Current configuration : 1769 bytes
!
version 15.2
service timestamps debug datetime msec
service timestamps log datetime msec
service password-encryption
!
hostname FR
!
boot-start-marker
boot-end-marker
!
enable secret 4 06YFDUHH61wAE/kLkDq9BGho1QM5EnRtoyr8cHAUg.2
!
no aaa new-model
memory-size iomem 15
!
ip cef
!
no ip domain lookup
no ipv6 cef
!
multilink bundle-name authenticated
!
frame-relay switching
!
interface Embedded-Service-Engine0/0
 no ip address
 shutdown
!
interface GigabitEthernet0/0
 no ip address
```

```
 shutdown
 duplex auto
 speed auto
!
interface GigabitEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/0/0
 no ip address
 encapsulation frame-relay
 frame-relay intf-type dce
 frame-relay route 103 interface Serial0/0/1 301
 frame-relay route 113 interface Serial0/0/1 311
!
interface Serial0/0/1
 no ip address
 encapsulation frame-relay
 clock rate 128000
 frame-relay intf-type dce
 frame-relay route 301 interface Serial0/0/0 103
 frame-relay route 311 interface Serial0/0/0 113
!
ip forward-protocol nd
!
no ip http server
no ip http secure-server
!
control-plane
!
banner motd ^C Unauthorized Access is Prohibited! ^C
!
line con 0
password 7 0822455D0A16
 logging synchronous
 login
line aux 0
line 2
 no activation-character
 no exec
 transport preferred none
 transport input all
 transport output pad telnet rlogin lapb-ta mop udptn v120 ssh
 stopbits 1
line vty 0 4
 password 7 14141B180F0B
 login
```

```
 transport input all
!
scheduler allocate 20000 1000
!
end
```

Router R3 (Final)

```
R3# show run
Building configuration...

Current configuration : 2298 bytes
!
version 15.2
service timestamps debug datetime msec
service timestamps log datetime msec
service password-encryption
!
hostname R3
!
boot-start-marker
boot-end-marker
!
enable secret 4 06YFDUHH61wAE/kLkDq9BGho1QM5EnRtoyr8cHAUg.2
!
no aaa new-model
memory-size iomem 15
!
ip cef
!
no ip domain lookup
ipv6 unicast-routing
ipv6 cef
!
multilink bundle-name authenticated
!
interface Embedded-Service-Engine0/0
 no ip address
 shutdown
!
interface GigabitEthernet0/0
 ip address 192.168.3.1 255.255.255.0
 duplex auto
 speed auto
 ipv6 address FE80::3 link-local
 ipv6 address 2001:DB8:ACAD:C::3/64
 ipv6 eigrp 1
!
interface GigabitEthernet0/1
 no ip address
```

```
 shutdown
 duplex auto
 speed auto
!
interface Serial0/0/0
 no ip address
 shutdown
 clock rate 2000000
!
interface Serial0/0/1
 ip address 10.1.1.2 255.255.255.252
 encapsulation frame-relay
 ipv6 address FE80::3 link-local
 ipv6 address 2001:DB8:ACAD:B::3/64
 ipv6 eigrp 1
 frame-relay map ipv6 FE80::1 301 broadcast
 frame-relay map ipv6 2001:DB8:ACAD:B::3 301
 frame-relay map ip 10.1.1.2 301
 frame-relay map ipv6 2001:DB8:ACAD:B::1 301
 frame-relay map ip 10.1.1.1 301 broadcast
 no frame-relay inverse-arp
 frame-relay lmi-type cisco
!
interface Serial0/0/1.311 point-to-point
 ip address 10.1.1.6 255.255.255.252
 ipv6 address FE80::3 link-local
 ipv6 address 2001:DB8:ACAD:D::3/64
 frame-relay interface-dlci 311
!
router eigrp 1
 network 10.1.1.0 0.0.0.3
 network 192.168.3.0
 eigrp router-id 3.3.3.3
!
ip forward-protocol nd
!
no ip http server
no ip http secure-server
!
!
ipv6 router eigrp 1
 eigrp router-id 3.3.3.3
!
control-plane
!
banner motd ^C Unauthorized Access is Prohibited! ^C
!
line con 0
password 7 104D000A0618
```

```
 logging synchronous
 login
line aux 0
line 2
 no activation-character
 no exec
 transport preferred none
 transport input all
 transport output pad telnet rlogin lapb-ta mop udptn v120 ssh
 stopbits 1
line vty 0 4
 password 7 030752180500
 login
 transport input all
!
scheduler allocate 20000 1000
!
end
```