FRAME RELAY

Network Design & Simulation Lab

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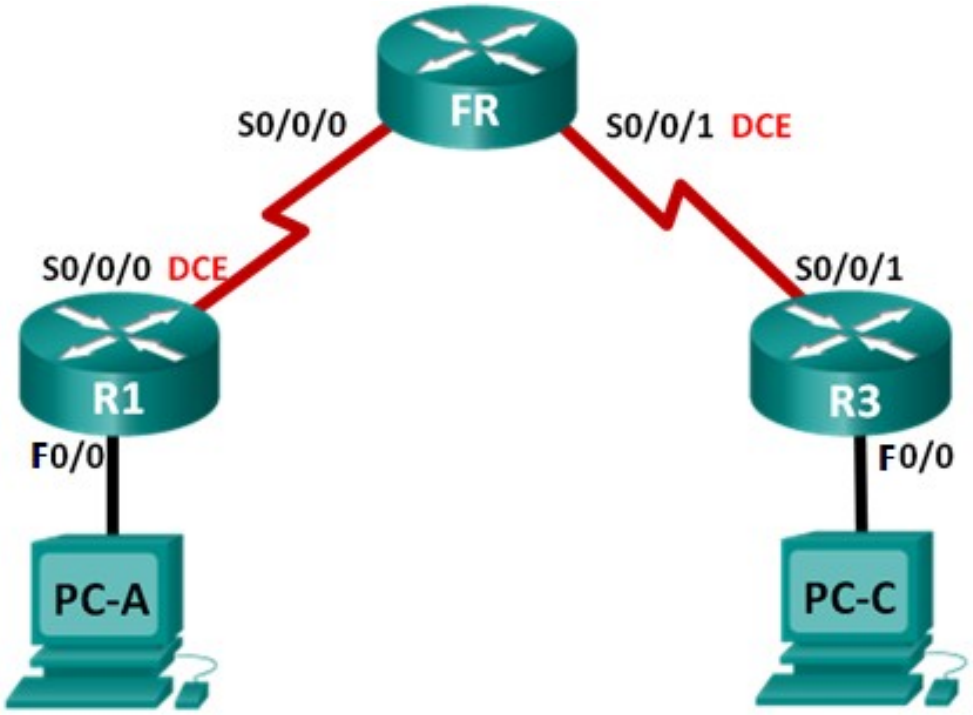
Frame Relay

Topology



Addressing Table

Device	Interface	IPv4 and IPv6 Address	Default Gateway
R1	F0/0	192.168.1.1/24	N/A
	S0/0/0 (DCE)	10.1.1.1/30	N/A
FR	S0/0/0	N/A	N/A
	S0/0/1 (DCE)	N/A	N/A
R3	F0/0	192.168.3.1/24	N/A
	S0/0/1	10.1.1.2/30	N/A
PC-A	NIC	192.168.1.3/24	192.168.1.1
PC-C	NIC	192.168.3.3/24	192.168.3.1

Introduction

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.

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 also configure Frame Relay point-to-point subinterfaces.

Note: Make sure that the routers have been erased and have no startup configurations.

Required Resources

- 3 Routers
- 2 PCs
- 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. Copy and paste the following:
enable
conf t
no ip domain-lookup
enable secret pass
line con 0
password pass
logging synchronous
login

b. Configure the IPv4 addresses listed in the Addressing Table for all interfaces. **Do not activate the serial interfaces at this time.**

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.

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)

<output omitted>

DLCI = 103, DLCI USAGE = SWITCHED, PVC STATUS = INACTIVE, INTERFACE = Serial0/0/0

<output omitted>
  connected to interface Serial0/0/1 301
```

```
<output omitted>

DLCI = 301, DLCI USAGE = SWITCHED, PVC STATUS = INACTIVE, INTERFACE = Serial0/0/1

<output omitted>
  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.

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

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 ip 10.1.1.2 301
R3(config-if)# no shutdown
```

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

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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
```

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
```

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

```
R1# show frame-relay pvc

<output omitted>

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

<output omitted>

R3# show frame-relay pvc

<output omitted>

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

<output omitted>
```

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): ip 10.1.1.1 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): ip 10.1.1.2 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. Using AS 1, enable EIGRP for IPv4 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.

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: 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 4, 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)# 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)# 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

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
```

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

<output omitted>

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

<output omitted>

R3# show frame-relay pvc

PVC Statistics for interface Serial0/0/1 (Frame Relay DTE)
 <output omitted>
DLCI = 311, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE = Serial0/0/1.311
<output omitted>
```

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
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
```

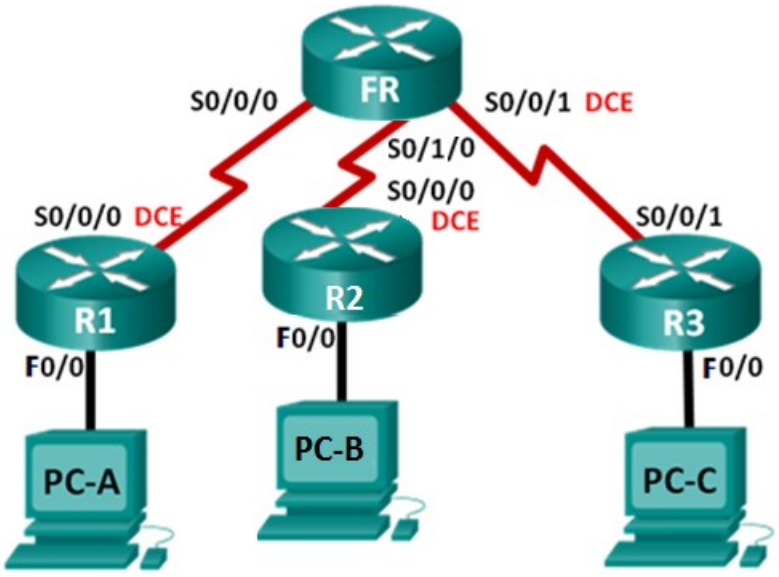
f. Issue the **show frame-relay map** command on R1 and R3 to verify the status of the Frame Relay map statements.

```
R1# show frame-relay map
<output omitted>
Serial0/0/0.113 (up): point-to-point dlci, dlci 113(0x71,0x1C10), broadcast
          status defined, active

R3# show frame-relay map
<output omitted>
Serial0/0/1.311 (up): point-to-point dlci, dlci 311(0x137,0x4C70), broadcast
          status defined, active
```

Part 5: Full Mesh

In part 5, you will add a third router to your topology:



Device	Interface	IPv4 and IPv6 Address	Default Gateway
R1	s0/0/0.102	10.1.1.9/30	N/A
R3	S0/0/1.302	10.1.1.13/30	N/A
R2	s0/0/0.201	10.1.1.10/30	N/A
	s0/0/0.203	10.1.1.14/30	N/A
	F0/0	192.168.2.1/24	N/A
PC-B	NIC	192.168.2.3/24	192.168.2.1

Step 1: Add the new PVSs to the FR switch

```
FR(config)# interface s0/0/0
FR(config-if)# frame-relay route 102 interface s0/1/0 201
FR(config-if)# interface s0/0/1
FR(config-if)# frame-relay route 302 interface s0/1/0 203
FR(config-if)# interface s0/1/0
FR(config-if)# frame-relay route 201 interface s0/0/0 102
FR(config-if)# frame-relay route 203 interface s0/0/1 302
```

Step 2: Connect the router and configure interfaces

Connect R2 as shown in the new topology and configure the interfaces and subinterfaces on all routers as shown in the addressing table above. Add the new networks to EIGRP on all routers.

How many PVCs are there in the network?

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Step 3: Test connectivity.

From PC-B ping both PCs A and C. the pings should be successful.

Reflection

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

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2. What is the purpose of a DLCI?

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