Chapter 7: Establishing a Dedicated Frame Relay Connection and Controlling Traffic Flow

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Objectives

Upon completion of this chapter, you will be able to perform the following tasks:
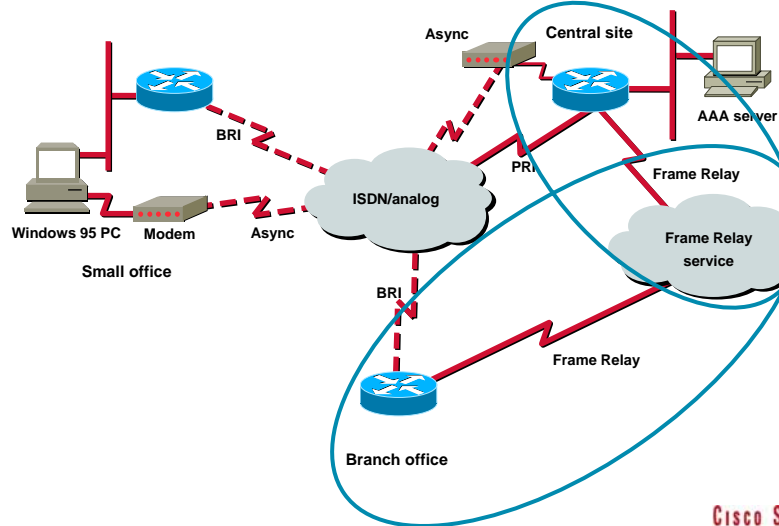
- **Configure Frame Relay**
- **Configure Frame Relay subinterfaces**
- **Configure Frame Relay traffic shaping**
- **Verify Frame Relay operation**

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Chapter Activities

Frame Relay Overview

- **Virtual circuits make connections**
- **Connection-oriented service**

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Frame Relay Operation

10.1.1.1

PVC

CSU/DSU

DLCI=500

**Inverse ARP or
Frame Relay map**

ARP

ETH	Destination MAC	Source MAC	IP

Frame Relay	Destination DLCI (500)	IP (10.1.1.1)

- **Get locally significant DLCIs from your Frame Relay provider**
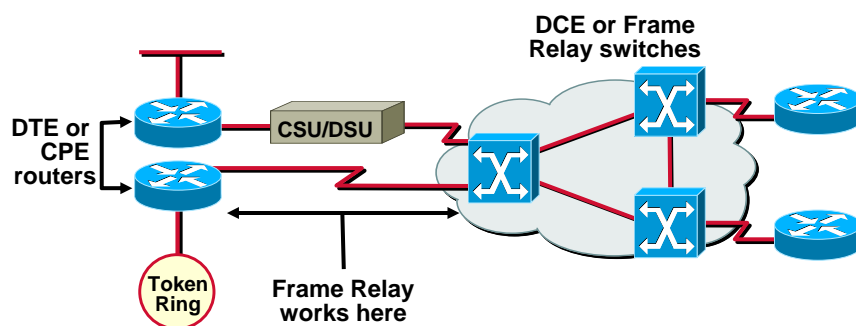- **Map your network addresses to DLCIs**

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11-5—BCRAN—Establishing a Dedicated Frame Relay Connection and Controlling Traffic Flow

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Frame Relay Signaling

**LMI
500=Active
400=Inactive**

DLCI=500   **PVC**

CSU/DSU

DLCI=400

PVC

Keepalive

Cisco supports three LMI standards:

- **ANSI T1.617 Annex D**
- **ITU-T Q.933 Annex A**
- **"The gang of four"**

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11-6—BCRAN—Establishing a Dedicated Frame Relay Connection and Controlling Traffic Flow

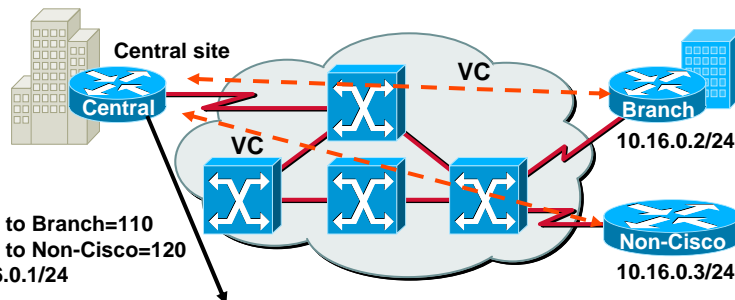Copyright © 1999, Cisco Systems, Inc.

Configuring Basic Frame Relay
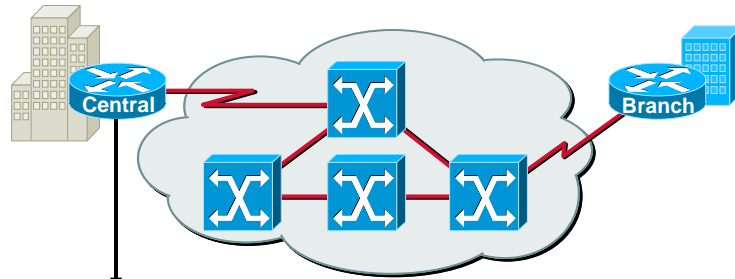

```
Central(config)#interface Serial1
Central(config-if)#ip address 10.16.0.1 255.255.255.0
Central(config-if)#encapsulation frame-relay
```

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Configuring Address Mapping

Central site

VC

VC

Branch

10.16.0.2/24

Non-Cisco

10.16.0.3/24

DLCI to Branch=110
DLCI to Non-Cisco=120
10.16.0.1/24

```
Central(config)#interface Serial1
Central(config-if)#ip address 10.16.0.1 255.255.255.0
Central(config-if)#encapsulation frame-relay
Central(config-if)#bandwidth 56
Central(config-if)#frame-relay map ip 10.16.0.2 110 broadcast
Central(config-if)#frame-relay map ip 10.16.0.3 120 broadcast ietf
```

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Verifying Frame Relay Operation

```
Router#show interface serial 0
Serial0 is up, line protocol is up
 Hardware is CD2430 in sync mode
 MTU 1500 bytes, BW 128 Kbit, DLY 20000 usec, rely 255/255, load 1/255
 Encapsulation FRAME-RELAY, loopback not set, keepalive set (10 sec)
 LMI enq sent 112971, LMI stat recvd 112971, LMI upd recvd 0, DTE LMI up
 LMI enq recvd 0, LMI stat sent 0, LMI upd sent 0
 LMI DLCI 1023 LMI type is CISCO frame relay DTE
 FR SVC disabled, LAPF state down
 Broadcast queue 0/64, broadcasts sent/dropped 32776/0, interface broadcasts 14
 Last input 00:00:00, output 00:00:03, output hang never
 Last clearing of "show interface" counters never
 Input queue: 0/75/0 (size/max/drops); Total output drops: 0
 Queueing strategy: weighted fair
 <Output Omitted>
```

- **Displays line, protocol, DLCI, and LMI information**

Verifying Frame Relay Operation (cont.)

```
Router#show frame-relay pvc 110

PVC Statistics for interface Serial0 (Frame Relay DTE)

DLCI = 110, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE = Serial0

 input pkts 14055 output pkts 32795 in bytes 1096228
 out bytes 6216155 dropped pkts 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 32795 out bcast bytes 6216155

<Output Omitted>
```

- **Displays PVC traffic statistics**

Verifying Frame Relay Operation (cont.)

```
Router#show frame-relay map
Serial0 (up): ip 10.140.2.1 dlci 120(0x78,0x1C80), dynamic,
              broadcast,, status defined, active
```

- **Displays the route maps, either static or dynamic**

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Verifying Frame Relay Operation (cont.)

```
Router#show frame-relay lmi

LMI Statistics for interface Serial0 (Frame Relay DTE) LMI TYPE = CISCO
 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 113100 Num Status msgs Rcvd 113100
 Num Update Status Rcvd 0 Num Status Timeouts 0
```

- **Displays LMI information**

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Verifying Frame Relay Operation (cont.)

```
Router#debug frame-relay lmi
Serial3/1(in): Status, myseq 214
RT IE 1, length 1, type 0
KA IE 3, length 2, yourseq 214, myseq 214
PVC IE 0x7 , length 0x6 , dlci 130, status 0x2 , bw 0
Serial3/1(out): StEnq, myseq 215, yourseen 214, DTE up
datagramstart = 0x1959DF4, datagramsize = 13
FR encap = 0xFCF10309
00 75 01 01 01 03 02 D7 D6

Serial3/1(in): Status, myseq 215
RT IE 1, length 1, type 1
KA IE 3, length 2, yourseq 215, myseq 215
Serial3/1(out): StEnq, myseq 216, yourseen 215, DTE up
datagramstart = 0x1959DF4, datagramsize = 13
FR encap = 0xFCF10309
00 75 01 01 01 03 02 D8 D7
```

• **Displays LMI debug information**

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Verifying Frame Relay Operation (cont.)

```
Router#sh frame map
Serial0 (up): ip 10.140.2.1 dlci 120(0x78,0x1C80), dynamic,
              broadcast,, status defined, active
Router#clear frame-relay-inarp
Router#sh frame map
Router#
```

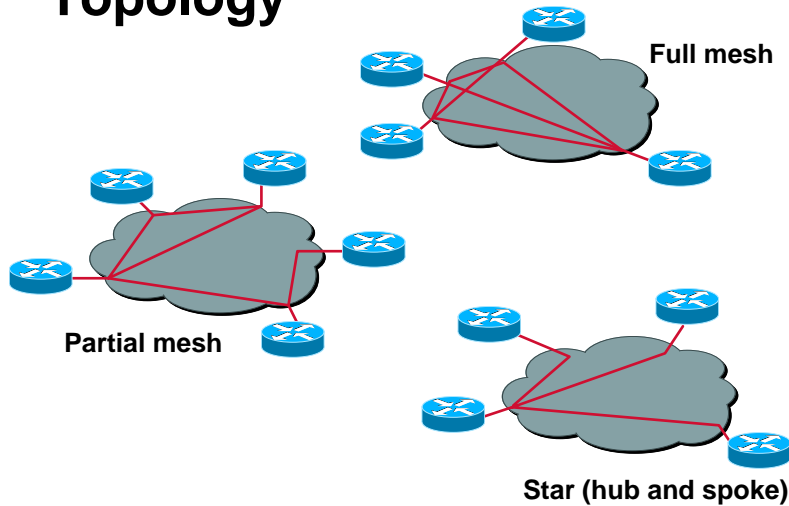• **Clears dynamically created Frame Relay maps**

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Selecting a Frame Relay Topology

Full mesh

Partial mesh

Star (hub and spoke)

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Reachability Issues with Routing Updates

Routing update

Circuit #21

Circuit #22

Circuit #23

A   B   C   D
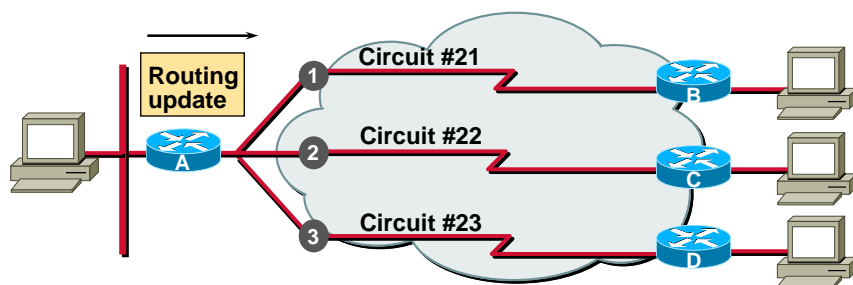
- **Broadcast traffic must be replicated for each active connection**

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Resolving Reachability Issues

- **Split horizon can cause problems in NBMA environments**

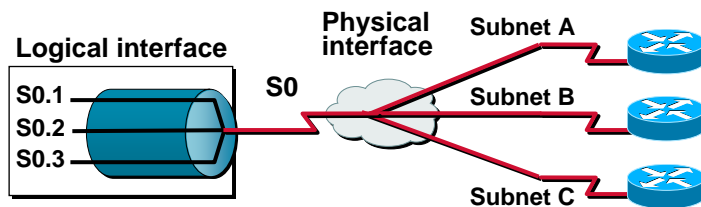- **A single physical interface simulates multiple logical interfaces**

- **Subinterfaces can resolve split horizon issues**

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Configuring Subinterfaces

- **Multipoint**

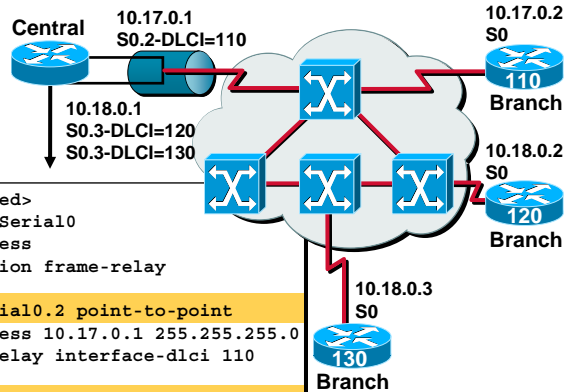 – **Subinterfaces act as default NBMA network**

  – **Can save subnets because uses single subnet**

  – **Good for full-mesh topology**

- **Point-to-point**

  – **Subinterfaces act as leased line**

  – **Each point-to-point connection requires its own subnet**

  – **Good for star or partial-mesh topologies**

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Configuring Subinterfaces Example

Central
10.17.0.1
S0.2-DLCI=110

10.18.0.1
S0.3-DLCI=120
S0.3-DLCI=130

10.17.0.2
S0
110
Branch

10.18.0.2
S0
120
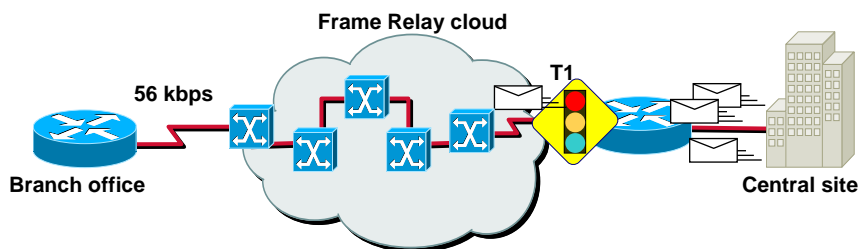**Branch**

10.18.0.3
S0
130
Branch

```
Central(config)#<Output Omitted>
Central(config-if)#interface Serial0
Central(config-if)#no ip address
Central(config-if)#encapsulation frame-relay
!
Central(config)#interface Serial0.2 point-to-point
Central(config-subif)#ip address 10.17.0.1 255.255.255.0
Central(config-subif)#frame-relay interface-dlci 110
!
Central(config)#interface Serial0.3 multipoint
Central(config-subif)#ip address 10.18.0.1 255.255.255.0
Central(config-subif)#frame-relay interface-dlci 120
Central(config-subif)#frame-relay interface-dlci 130
!
<Output Omitted>
```

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Frame Relay Traffic Shaping Overview

Frame Relay cloud

T1

56 kbps

Branch office

Central site

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Frame Relay Traffic Flow Terminology

Local access loop=T1

I am congested.

BECN

FECN

Local access loop=64 kbps

Traffic flow

B_c=64 kbps

CIR=32 kbps

T1

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Frame Relay Traffic Flow Terminology (cont.)

Discard

$B_{c + B_e}$

Discard frame

DE=1

B_c

Bits

Access rate

CIR

DE=0

Frame 1   **Frame 2**   **Frame 3**   **Frame 4**

Time (T=B_c/CIR)

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Why Use Traffic Shaping over Frame Relay?

Frame Relay cloud

56 kbps

T1

Branch office

Bottleneck

Central site

I need to reduce the pace at which I send packets.
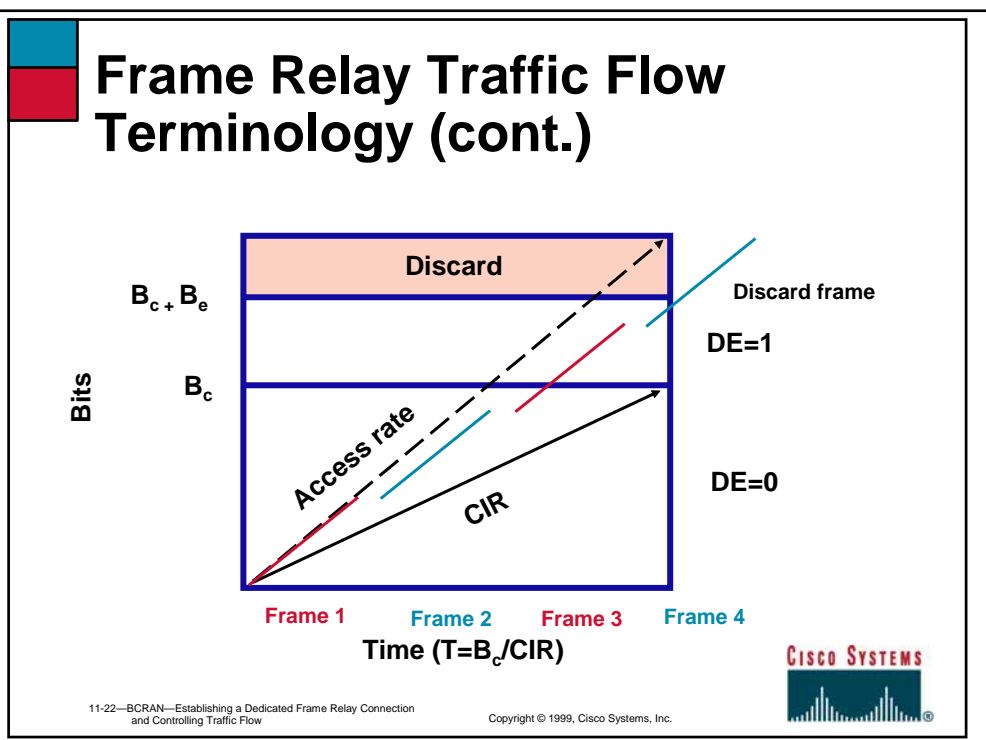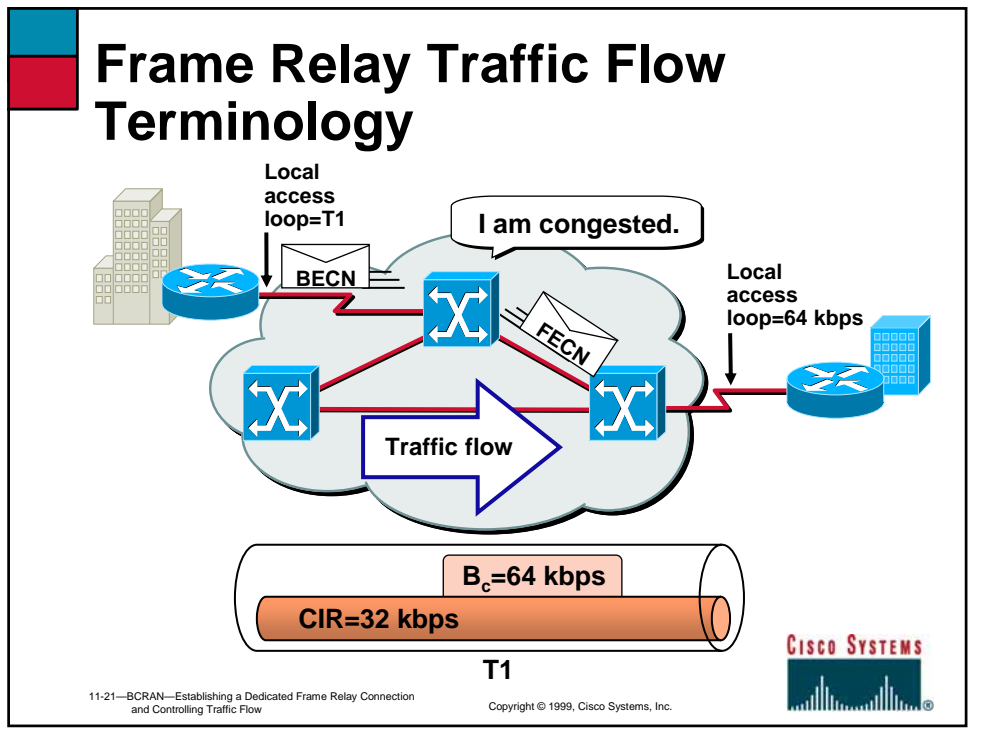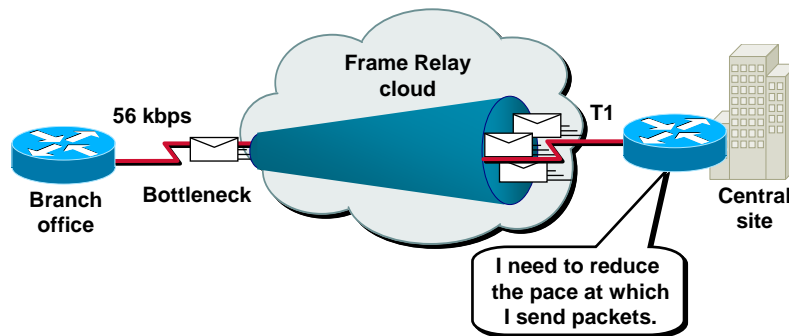
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Why use Traffic Shaping over Frame Relay? (cont.)

Frame Relay cloud

56 kbps

T1

Branch office

BECN

Central site

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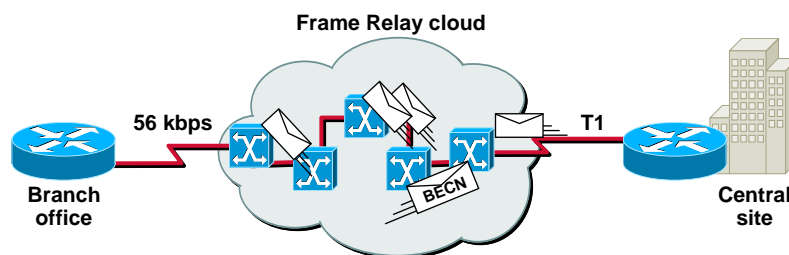
Configuring Frame Relay Traffic Shaping—Steps 1 and 2

```
Router(config)#map-class frame-relay map-class-name
```

- **Enters map class configuration mode so you can define a map class**

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Configuring Frame Relay Traffic Shaping—Step 2 (cont.)

```
Router(config-map-class)#frame-relay traffic-rate average [peak]
```

- **Defines the average and peak rates**

  or

```
Router(config-map-class)#frame-relay adaptive-shaping becn
```

- **Specifies that the router fluctuates the sending rate based on the BECNs received**

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Configuring Frame Relay Traffic Shaping—Step 2 (cont.)

or

```
Router(config-map-class)#frame-relay custom-queue-list number
```

- **Specifies a custom queue list**

or

```
Router(config-map-class)#frame-relay priority-group number
```

- **Specifies a priority group**

Configuring Frame Relay Traffic Shaping—Steps 3 to 5

Step 3

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

- **Enables Frame Relay on an interface**

Step 4

```
Router(config-if)#frame-relay traffic-shaping
```

- **Enables Frame Relay traffic shaping on an interface**

Step 5
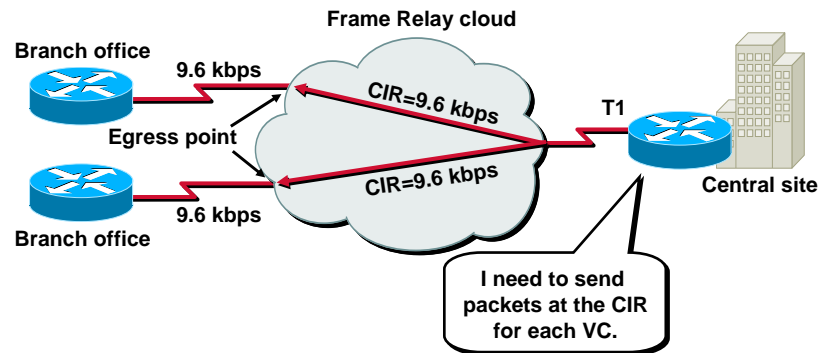
```
Router(config-if)#frame-relay class map-class-name
```

- **Maps the map class to virtual circuits on the interface**

Traffic Shaping Rate Enforcement Example

Frame Relay cloud

Branch office

9.6 kbps

CIR=9.6 kbps

Egress point

CIR=9.6 kbps

9.6 kbps

T1

Branch office

Central site

> I need to send packets at the CIR for each VC.

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Configuring Traffic Shaping Rate Enforcement Example

Frame Relay cloud

Branch office

T1

Central site

Branch office
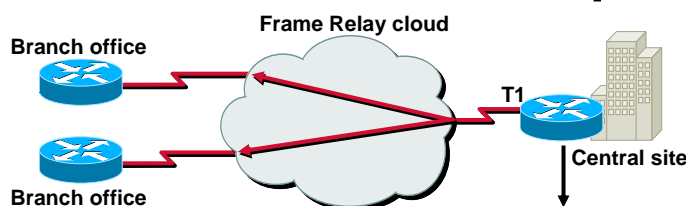
```
Central(config)#interface Serial2

Central(config-if)#no ip address
Central(config-if)#encapsulation frame-relay
Central(config-if)#frame-relay traffic-shaping
Central(config-if)#frame-relay class branch
!
…
!
Central(config)#map-class frame-relay branch
Central(config-map-class)#frame-relay traffic-rate 9600 18000
```

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Traffic Shaping BECN Support Example

Frame Relay cloud

56 kbps

Branch office

BECN
BECN
BECN
BECN

T1

Central site

I need to adjust my transmit speed because of BECNs.

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Configuring Traffic Shaping BECN Support Example

Frame Relay cloud

56 kbps

Branch office
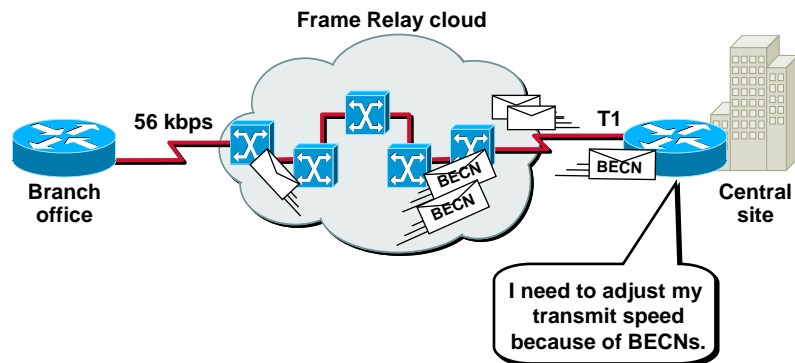
BECN
BECN
BECN

T1

Central site
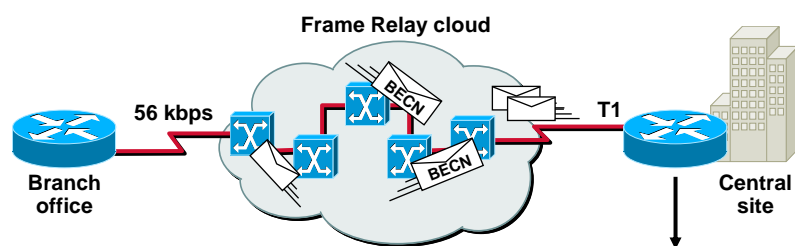
```
Central(config)#interface serial 0
Central(config-if)#no ip address
Central(config-if)#encapsulation frame-relay
Central(config-if)#frame-relay traffic-shaping
Central(config-if)#frame-relay class becnnotify
!
…
!
Central(config)#map-class frame-relay becnnotify
Central(config-map-class)#frame-relay adaptive-shaping becn
```

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Configuring Traffic Shaping Queuing Example

```
interface Serial0
 no ip address
 encapsulation frame-relay
 frame-relay lmi-type ansi
 frame-relay traffic-shaping
 frame-relay class slow_vcs
!
interface Serial0.1 point-to-point
 ip address 10.128.30.1 255.255.255.248
 ip ospf cost 200
 bandwidth 10
 frame-relay interface-dlci 101
!
interface Serial0.2 point-to-point
 ip address 10.128.30.9 255.255.255.248
 ip ospf cost 400
 bandwidth 10
 frame-relay interface-dlci 102
 class fast_vcs
!
 interface Serial0.3 point-to-point
 ip address 10.128.30.17 255.255.255.248
 ip ospf cost 200
 bandwidth 10
 frame-relay interface-dlci 103
```

```
!
map-class frame-relay slow_vcs
 frame-relay traffic-rate 4800 9600
 frame-relay custom-queue-list 1
!
map-class frame-relay fast_vcs
 frame-relay traffic-rate 16000 64000
 frame-relay priority-group 2
!
access-list 100 permit tcp any any eq 2065
access-list 115 permit tcp any any eq 256
!
priority-list 2 protocol decnet high
priority-list 2 protocol ip normal
priority-list 2 default medium
!
queue-list 1 protocol ip 1 list 100
queue-list 1 protocol ip 2 list 115
queue-list 1 default 3
queue-list 1 queue 1 byte-count 1600 limit 200
queue-list 1 queue 2 byte-count 600 limit 200
queue-list 1 queue 3 byte-count 500 limit 200
```

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Verifying Frame Relay Traffic Shaping

```
CentralA#sh frame-relay pvc

PVC Statistics for interface Serial3/1 (Frame Relay DTE)

DLCI = 110, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE = Serial3/1.1

  input pkts 35          output pkts 40          in bytes 4324
  out bytes 6684         dropped pkts 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 25      out bcast bytes 5124
  Shaping adapts to BECN
  pvc create time 00:12:55, last time pvc status changed 00:12:55
```
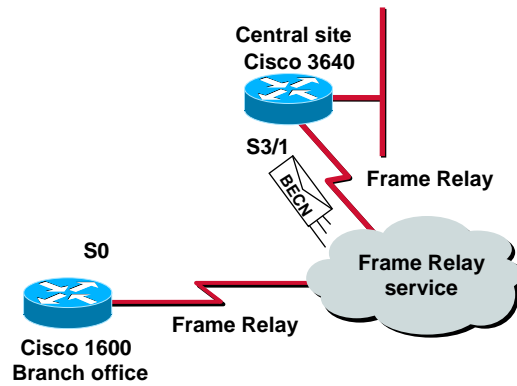
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Laboratory Exercise: Visual Objective

Central site
Cisco 3640

S3/1

BECN

Frame Relay

Frame Relay service

S0

Frame Relay

Cisco 1600
Branch office

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11-42—BCRAN—Establishing a Dedicated Frame Relay Connection and Controlling Traffic Flow

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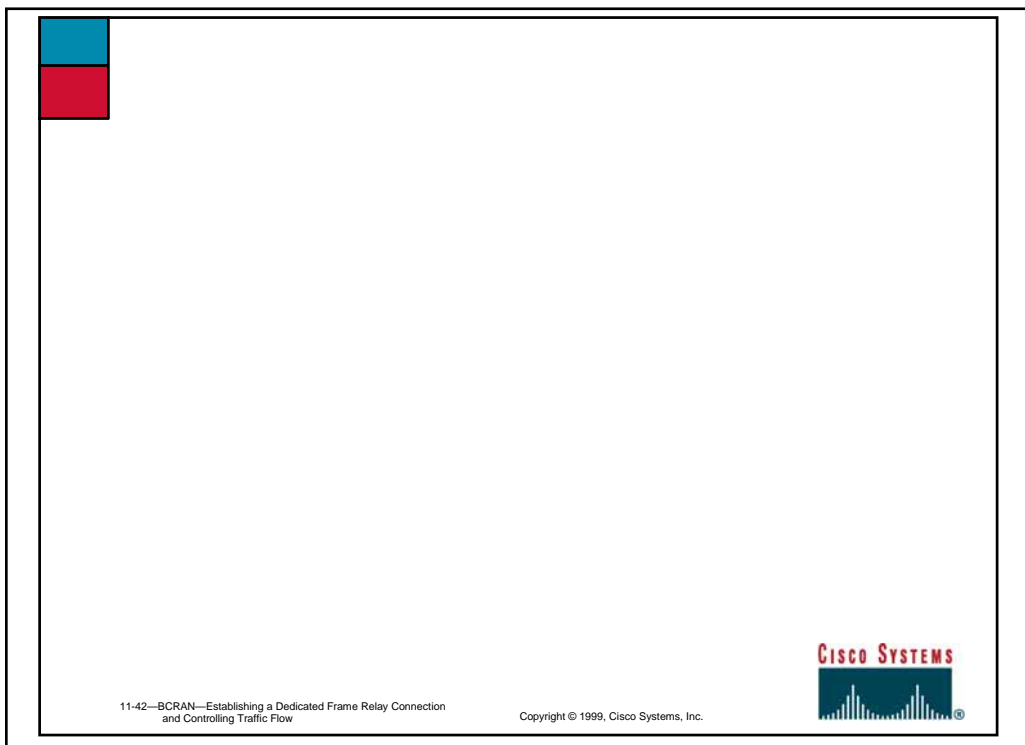**Cisco Systems Confidential**

Summary

After completing this chapter, you should be able to perform the following tasks:

- **Configure Frame Relay**
- **Configure Frame Relay subinterfaces**
- **Configure Frame Relay traffic shaping**
- **Verify Frame Relay operation**

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Review Questions

- **What is a DLCI and how is it used to route Frame Relay traffic?**
- **Why would you use Frame Relay subinterfaces?**
- **List and describe three Frame Relay traffic shaping features.**

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