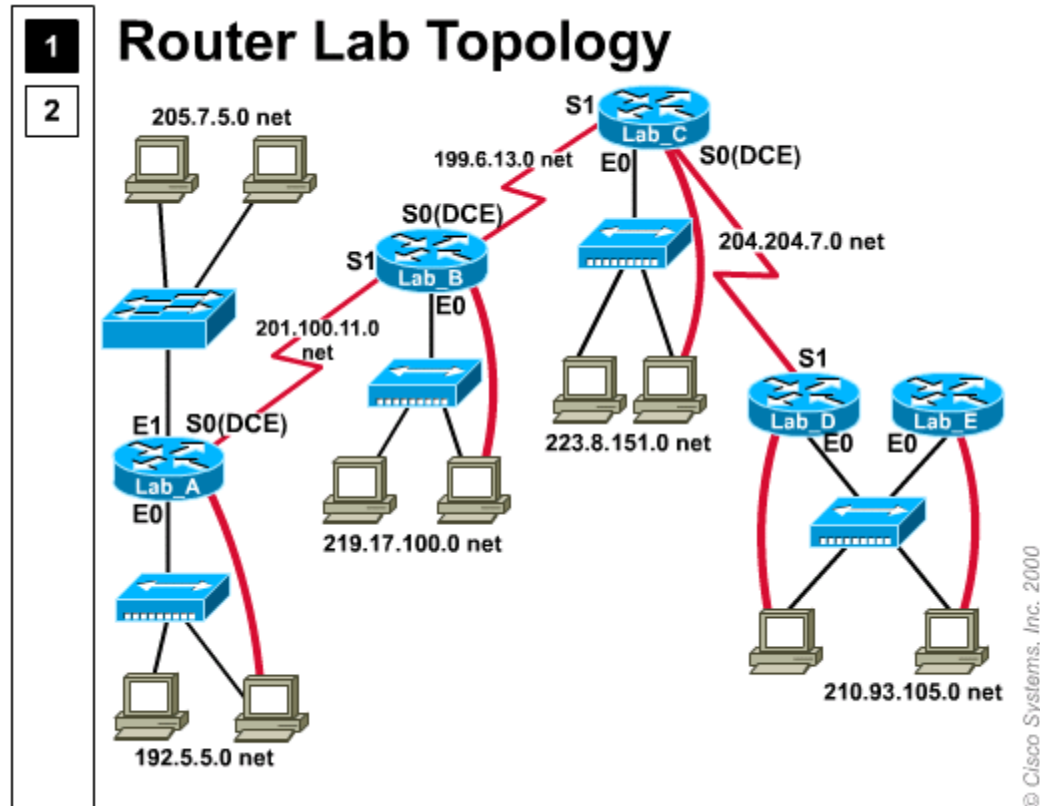◀ 🖧 Lab 6.5.9.1 Frame Relay config - overview

Estimated time: 60 min.

Objectives:

- To become familiar with Frame Relay related WAN terminology
- To understand the requirements and options for Frame Relay communications
- To simulate the configuration of a Frame Relay switch and links between two routers

Background:

This lab focuses on the Frame Relay Packet Switching Protocol for connecting devices on a Wide Area Network (WAN). Frame Relay is an industry-standard, switched data link layer protocol that handles multiple virtual circuits using HDLC encapsulation between connected devices (routers). Frame Relay is more efficient than X.25, the protocol for which it is generally considered a replacement. Frame Relay is a very widely used and important WAN communication technology. With this lab you will use a router to create a Frame Relay switch (the cloud) and connected two other routers through it to simulate a wide area link between two LANs.

Point-to-Point vs. Frame Relay
Two of the most common types of WAN communication links in use today are 1) Leased Dedicated Point-to-Point permanent circuits and 2) Frame Relay Packet-Switched circuits. The prior labs used PPP (and Cisco HDLC) over a (simulated) leased

dedicated point-to-point circuit. This assumes the organization that leased the circuit is paying for the full dedicated bandwidth (such as a T1 at 1.544 Mbps) 24 hours a day, 7 days a week whether they actually use the full bandwidth or not. Packet-switched networks enable end stations to dynamically share the network medium (sometimes referred to as "the cloud") and the available bandwidth and it is possible to only pay for the bandwidth you need. This is referred to as Committed Information Rate (CIR).

Potential Bandwidth Sharing

Frame Relay uses variable-length packets for more efficient and flexible transfers. These packets then are switched between the various network segments (usually phone company Central Offices or COs) until the destination is reached. Statistical multiplexing techniques control network access in a packet-switched network. The advantage of this technique is that it accommodates more flexibility and more efficient use of bandwidth especially between switches within the cloud. Frame Relay is a way of sharing existing T-1 and T-3 lines owned by service providers and potentially getting better use from them. Most telephone companies now provide Frame Relay service for customers who want connections at 56 Kbps to T-1 speeds.

Frame Relay Devices - DTE and DCE

Devices attached to a Frame Relay WAN fall into two general categories: Data Terminal Equipment (DTE) and Data Circuit-terminating Equipment (DCE). DTEs are typically located on the premises of and owned by a customer. Examples of DTE devices are terminals, personal computers, routers, and bridges. DCEs are usually carrier-owned (phone company) internetworking devices but can be owned by the customer. The purpose of DCE equipment is to provide clocking and switching services in a network, which are the devices that actually transmit data through the WAN cloud In most cases, these are Frame Relay packet switches themselves. CSU/DSU's are considered DCE.

The connection between a DTE device and a DCE device consists of both a physical-layer component and a Data link-layer component. The physical component defines the mechanical, electrical, functional, and procedural specifications for the connection between the devices. One of the most commonly used physical-layer interface specifications is the Recommended Standard (RS)-232 specification. The link-layer component defines the protocol that establishes the connection between the DTE device, such as a router, and the DCE device, such as a Frame Relay switch (usually at the phone company CO).

Virtual Circuits

Frame Relay provides connection-oriented data link layer communication. This means that a defined communication exists between each pair of devices and that these connections are associated with a connection identifier. This service is implemented by using a Frame Relay virtual circuit, which is a logical connection created between two data terminal equipment (DTE) devices across a Frame Relay packet-switched network (PSN). Virtual circuits provide a bi-directional communications path from one DTE device to another and are identified by a Data-Link Connection Identifier (DLCI).

A number of virtual circuits can be multiplexed into a single physical circuit for transmission across the network. This capability often can reduce the equipment and network complexity required to connect multiple DTE devices. A virtual circuit can pass

through any number of intermediate DCE devices (switches) located within the Frame Relay PSN (Packet Switched Network) or cloud. Frame Relay virtual circuits fall into two categories: Switched Virtual Circuits (SVCs) and Permanent Virtual Circuits (PVCs). PVCs are the most common.

Tools / Preparation:

Prior to starting the lab, the teacher or lab assistant should have at least 3 of the 5 routers in the standard router lab available. The middle router will act as the Frame Relay Switch and the other routers will connect through it. The middle router must have DCE clock rate and DCE cable ends on both serial ports (S0 and S1). Before beginning this lab you should read the Networking Academy Second Year Companion Guide, Chapter 12 - Frame Relay. You should also review the Semester 4 On-line chapter on Frame Relay.

NOTE:

This is a simulated lab since there will not likely be a real circuit with a Frame Relay cloud available for attachment and testing of the configuration changes made to the routers. The purpose of this lab is to practice the process of configuring the routers to connect to a frame relay WAN link.

The following is a list of resources required.

- 3 Cisco routers with the IOS 11.2 or later
- Middle router serial ports connected to DCE serial cables
- Hubs and/or switch attached to the end routers
- Workstation connected to each router's console port

Web Site Resources:

- Routing basics
- General information on routers
- 2500 series routers
- 1600 series routers
- Terms and acronyms
- IP routing protocol IOS command summary
- Introduction to WAN technologies

Notes:

Select 3 routers which have WAN serial links between them. The middle router will simulate a Frar

Relay switch and the end routers will simulate geographically separate sites connected through the Frame Relay "cloud". This lab worksheet uses routers Lab-A, Lab-B and Lab-C. You will configure two remote routers (Lab-A and Lab-C) first and then the middle Frame Relay router (Lab B).

Step 1 - Configure the physical 3-router setup

The two cables connected to the middle router (Lab-B) should both be DCE in order to have this router simulate the Frame Relay switch (The DCE cables are labeled on one end). On router Lab-B, connect one of the DCE cables to Serial 0 and the other to Serial 1. The DCE cable from Lab-B serial 1 will connect to a DTE cable going to router Lab-A serial 0 and the Lab-B serial 1 cable will go to the router Lab-C DTE cable on serial 1. Use the tables below for cabling and interfaces.

Router Frame Relay switch	From Serial Intfc # & Type (DCE / DTE)	To Remote Router Name	To Serial Intf # & Type (DCE / DTE)
Lab-B	Serial 0 / DCE	Lab-C	Serial 1 / DTE
Lab-B	Serial 1 / DCE	Lab-A	Serial 0 / DTE

Use the `show controller` command to check the DCE/DTE connections.

        `Lab-A#show controller S 0`

1. What does the `show controller` command for S0 indicate?

_____

Router	Interface Ethernet 0	Interface Serial 0	Interface Serial 1	Subnet Mask
Lab-A (remote)	192.5.5.1	201.100.11.1	Not used	255.255.255.0
Lab-B (switch)	Not used	DLCI 21	DLCI 20	N/A
Lab-C (remote)	223.8.151.1	Not used	201.100.11.2	255.255.255.0

2. Draw the 3 router set up showing cabling, interfaces, IP addresses and DLCIs. (Hint: use the table above for the diagram)

Step 2 - Check the WAN Interface on remote router Lab-A

Connect your workstation to the console port connection on Router Lab-A and use **show interface** command to answer the following questions:

Lab-A# show interface serial 0

3. What is the IP address and number of subnet bits for this interface?

4. What is the status of the interface and the Line protocol?

5. What is the encapsulation currently set to?

Step 3 - Configure the Serial Interface on Lab-A for a Frame Relay Connection

Connect your workstation to the console port connection on Router Lab-A and use the following commands to set up Frame Relay on interface Serial 0. Note that if your are using Cisco IOS version 11.2 or newer the Frame Relay DLCI and LMI type can be detected automatically and will not need to be configured manually.

Lab-A - Remote Router Frame Relay Configuration

Prompt and Command	Purpose
*** Configure Interface S0 ***	
Lab-A#config t	Configure from terminal
Lab-A(config)# interface Serial0	Select interface S0 to configure
Lab-A(config-if)# ip address 201.100.11.1 255.255.255.0	Set the IP address and subnet mask for S0 (use the standard router lab IP)
Lab-A(config-if)# encapsulation frame-relay	Change the data link encapsulation from HDLC to Frame Relay. Use IETF if connecting to non-Cisco router. Default is Cisco encapsulation.
Lab-A(config-if)# no shutdown	Bring up interface S0
exit	
*** Configure Interface E0 ***	
Lab-A(config)# interface Ethernet0	Select interface E0

Prompt and Command	Purpose
`Lab-A(config-if)# ip address 192.5.5.1 255.255.255.0`	Set the IP address and subnet mask for E0 (use the standard router lab IP)
`Lab-A(config-if)# no shutdown`	Bring up interface E0
`exit`	
*** Configure IGRP Routing Protocol ***	
`Lab-A(config)# router igrp 100`	Enables IGRP routing protocol process
`Lab-A(config-router)# network 201.100.11.0`	Selects network 210.100.11.0 to broadcast and receive IGRP updates
`Lab-A(config-router)# network 192.5.5.0`	Selects network 192.5.5.0 to broadcast and receive IGRP updates
`Control Z and Copy run start`	

Step 4 - Use the show running-config interface command to verify the configuration of S0

Lab-A#sh run

6. What information was displayed about Lab-A interface S0? _____

Step 5 - Check the WAN Interface on remote router Lab-C

Connect your workstation to the console port connection on Router Lab-C and use **show interface** command to answer the following questions:

Lab-C# show interface serial 1

7. What is the IP address and number of subnet bits for this interface? _____

8. What is the status of the interface and the Line protocol? _____

9. What is the encapsulation currently set to? _____

Step 6 - Configure the Serial Interface on Lab-C for a Frame Relay Connection

Connect your workstation to the console port connection on Router Lab-C and use the following commands to set up Frame Relay on interface Serial 1. Note that if you are using Cisco IOS version 11.2 or newer the Frame Relay DLCI and LMI type can be detected automatically.

Lab-C - Remote Router Frame Relay Configuration

Prompt and Command	Purpose

*** Configure Interface S1 ***	
`Lab-C#config t`	Configure from terminal
`Lab-C(config)# interface Serial1`	Select interface S1 to configure
`Lab-C(config-if)# ip address 201.100.11.2 255.255.255.0`	Set the IP address and subnet mask for S1 (use the standard router lab IP)
`Lab-C(config-if)# encapsulation frame-relay`	Change the data link encapsulation from HDLC to Frame Relay. Use IETF if connecting to non-Cisco router. Default is Cisco encapsulation.
`Lab-C(config-if)# no shutdown`	Bring up interface S1
`exit`	
*** Configure Interface E0 ***	
`Lab-C(config)# interface Ethernet0`	Select interface E0
`Lab-C(config-if)# ip address 223.8.151.1 255.255.255.0`	Set the IP address and subnet mask for E0 (use the standard router lab IP)
`Lab-C(config-if)# no shutdown`	Bring up interface E0
`exit`	
*** Configure IGRP Routing Protocol ***	
`Lab-C(config)# router igrp 100`	Enables IGRP routing protocol process
`Lab-C(config-router)# network 201.100.11.0`	Selects network 201.100.11.0 to broadcast and receive IGRP updates
`Lab-C(config-router)# network 223.8.151.0`	Selects network 223.8.151.0 to broadcast and receive IGRP updates
`Control Z and Copy run start`	

Step 7 - Use the show running-config interface command to verify the configuration of S1

> `Lab-C#sh run`

10. What information was displayed about Lab-C interface S1? _____

Step 8 - Configure Lab-B as a Frame Relay Switch

Connect your workstation to the console port on Router Lab-B and use the following commands to enable Frame Relay switching and define interfaces Serial 0 and Serial 1 as DCE.

Lab-B - Frame Relay Switch configuration

Prompt and Command	Purpose
*** Enable Frame Relay Switching ***	

`Lab-B#config t`	Configure from terminal
`Lab-B(config)# frame-relay switching`	Starts the frame relay switching process
*** Configure Interface S0 ***	
`Lab-B(config)# interface Serial0`	Select interface E0
`Lab-B(config-if)# no ip address`	Specify no IP address for S0
`Lab-B(config-if)# encapsulation frame-relay`	Change the Layer 2 data link encapsulation from HDLC to Frame Relay.
`Lab-B(config-if)# clock rate 56000`	Specify the synchronous clock rate for the DCE side of the interface
`Lab-B(config-if)# frame-relay intf-type dce`	Specify the interface as a DCE device
`Lab-B(config-if)# frame-relay route 21 interface serial 1 20`	Define frame route so packets coming in on S0 DLCI 21 should go to S1 DLCI 20
`Lab-B(config-if)# no shutdown`	Bring up interface S0
*** Configure Interface S1 ***	
`Lab-B(config)# interface Serial1`	Select interface S1
`Lab-B(config-if)# no ip address`	Specify no IP address for S1
`Lab-B(config-if)# encapsulation frame-relay`	Change the Layer 2 data link encapsulation from HDLC to Frame Relay.
`Lab-B(config-if)# clock rate 56000`	Specify the synchronous clock rate for the DCE side of the interface
`Lab-B(config-if)# frame-relay intf-type dce`	Specify the interface as a DCE device
`Lab-B(config-if)# frame-relay route 20 interface serial 0 21`	Define frame route so packets coming in on S1 DLCI 20 should go to S0 DLCI 21
`Lab-B(config-if)# no shutdown`	Bring up interface S0
`Control Z and Copy run start`	

Step 9 - Use the show running-config interface command to verify the configuration of S0 and S1.

Note that there are several commands added by the router.

Lab-B#sh run

11. What information was displayed about Lab-B interface S0? _____

12. What information was displayed about Lab-B interface S1? _____

Step 10 - Confirm that the Line Is Up by entering the show interface serial 0 command:

Lab-A# show interface serial 0

13. What is the status of the Serial frame link? _____

14. How many LMI messages were sent and received? _____

15. What does this mean? _____

16. What is the LMI type? _____

Step 11 - Verify the Frame Relay PVC status for router Lab-A (remote router)

Lab-A# show frame pvc

17. What is the DLCI number of the connection? (DLCI=) _____

18. What is the status of the PVC? (PVC Status =) _____

Step 12 - Check the Frame Relay map for router Lab-A (remote router)

Lab-A# show frame map

19. What is local interface number, IP address of the switch interface and the DLCI of the connection? _____

20. What is the status of the PVC? _____

Step 13 - Check the LMI status for router Lab-A (remote router)

Lab-A# show frame lmi

21. What is local interface number and is it DCE or DTE? _____

Step 14 - Verify the Frame Relay PVC status for router Lab-B (the switch)

Lab-B# show frame pvc

22. What are the DLCI numbers of the connections? _____

23. What is the status of the PVCs? _____

Step 15 - Verify the Frame Relay routing table for router Lab-B (the switch)

Lab-B# show frame route

24. What information is shown? Input intf, Input DLCI, Output Intf, Output DLCI, Status
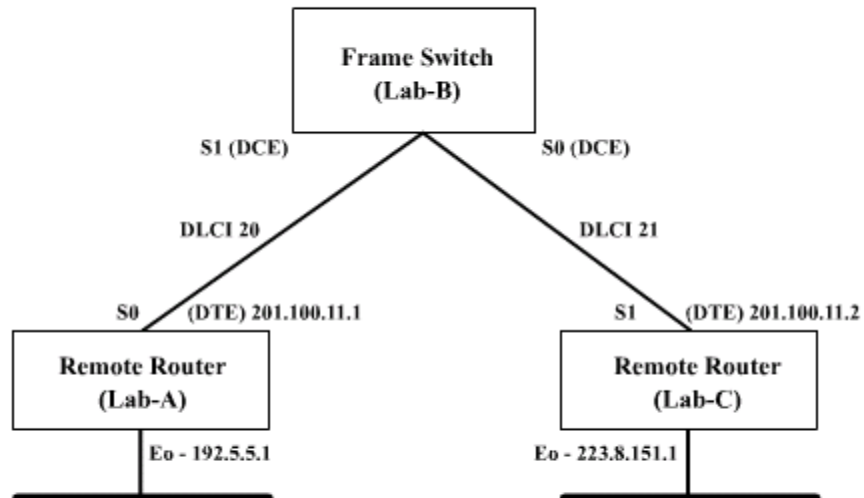
Step 16 - Verify the Frame Relay PVC status for router Lab-B (the switch)

Lab-A# ping 201.100.11.2

25. What was the result? _____

Lab 6.5.9.1 Frame Relay config - Answers

1. What does the show controller command for S0 indicate? V.35 DTE cable

2. Draw the 3 router set up showing cabling, interfaces, IP addresses and DLCIs.

Lab-A# show interface serial 0

3. What is the IP address and number of subnet bits for this interface? 201.100.11.1 / 24
4. What is the status of the interface and the Line protocol? Serial0 is up, line protocol is up
5. What is the encapsulation currently set to? Encapsulation HDLC

Lab-A#sh run

6. What information was displayed about Lab-A interface S0?
interface Serial0
ip address 201.100.11.1 255.255.255.0
encapsulation frame-relay

Lab-C# show interface serial 1

7. What is the IP address and number of subnet bits for this interface? 201.100.11.2 / 24

8. What is the status of the interface and the Line protocol? <u>Serial1 is up, line protocol is up</u>

9. What is the encapsulation currently set to? <u>Encapsulation HDLC</u>

`Lab-C#sh run`

10. What information was displayed about Lab-C interface S1?
<u>interface Serial1</u>
<u>ip address 201.100.11.2 255.255.255.0</u>
<u>encapsulation frame-relay</u>

`Lab-B#sh run`

11. What information was displayed about Lab-B interface S0?
<u>interface Serial0</u>
<u>no ip address</u>
<u>no ip directed-broadcast</u>
<u>encapsulation frame-relay</u>
<u>no ip route-cache</u>
<u>no ip mroute-cache</u>
<u>no fair-queue</u>
<u>clockrate 56000</u>
<u>frame-relay intf-type dce</u>
<u>frame-relay route 21 interface Serial1 20</u>

12. What information was displayed about Lab-B interface S1?
<u>interface Serial1</u>
<u>no ip address</u>
<u>no ip directed-broadcast</u>
<u>encapsulation frame-relay</u>
<u>no ip route-cache</u>
<u>no fair-queue</u>
<u>clockrate 56000</u>
<u>frame-relay intf-type dce</u>
<u>frame-relay route 20 interface Serial0 21</u>

`Lab-A# show interface serial 0`

Confirm that the following information appears in the command output. Write the message that relates to each question.

13. What is the status of the Serial frame link? <u>Serial0 is up, line protocol is up - The Frame Relay connection is active</u>

14. How many LMI messages were sent and received? <u>LMI enq sent 1477, LMI stat recvd 1458</u> What does this mean? <u>The connection is sending and receiving data.</u>

15. What is the LMI type? <u>"LMI type is CISCO"--The Local Management Interface (LMI) type is configured correctly for the router.</u>

```
Serial0 is up, line protocol is up
Hardware is HD64570
Internet address is 201.100.11.1/24
MTU 1500 bytes, BW 1544 Kbit, DLY 20000 usec, rely 255/255, load 1/255
Encapsulation FRAME-RELAY, loopback not set, keepalive set (10 sec)
LMI enq sent 1477, LMI stat recvd 1458, 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
Broadcast queue 0/64, broadcasts sent/dropped 190/0, interface broadcasts 185
Last input 00:00:09, output 00:00:09, output hang never
Last clearing of "show interface" counters never
Input queue: 0 Queueing strategy: weighted fair
Output queue: 0/1000 Conversations 0/1/256 (active/max active/max total)
Reserved Conversations 0/0 (allocated/max allocated)
5 minute input rate 0 bits/sec, 0 packets/sec
5 minute output rate 0 bits/sec, 0 packets/sec
1925 packets input, 49357 bytes, 0 no buffer
Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
1697 packets output, 33272 bytes, 0 underruns
0 output errors, 0 collisions, 9 interface resets
0 output buffer failures, 0 output buffers swapped out
23 carrier transitions
DCD=up DSR=up DTR=up RTS=up CTS=up
```

Lab-A# show frame pvc

16. What is the DLCI number of the connection? <u>20</u>

17. What is the status of the PVC? <u>Active</u>

```
PVC Statistics for interface Serial0 (Frame Relay DTE)

DLCI = 20, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE = Serial0

input pkts 55              output pkts 41              in bytes 3317
out bytes 2570             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 31          out bcast bytes 1530

pvc create time 00:40:27, last time pvc status changed 00:40:27
```

Lab-A# show frame map

18. What is local interface number, IP address of the switch interface and the DLCI of the connection? <u>Serial 0, 201.100.11.2, DLCI 20</u>

19. What is the status of the PVC? <u>Defined, Active</u>

Serial0 (up): ip 201.100.11.2 dlci 20(0x14,0x440), dynamic, broadcast, status defined, active
(note that IP address 201.100.11.2 is the other router)

`Lab-A# show frame lmi`

20. What is local interface number and is it DCE or DTE? <u>Serial 0, DTE</u>

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 1496	Num Status msgs Rcvd 1477
Num Update Status Rcvd 0	Num Status Timeouts 19

`Lab-B# show frame pvc for Lab-B`

21. What Are the DLCI numbers of the connections? <u>20 and 21</u>
22. What is the status of the PVCs? <u>Active on both</u>

PVC Statistics for interface Serial0 (Frame Relay DCE)		
DLCI = 21, DLCI USAGE = SWITCHED, PVC STATUS = ACTIVE, INTERFACE = Serial0		
input pkts 399	output pkts 186	in bytes 22016
out bytes 10010	dropped pkts 1	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	Num Pkts Switched 399
pvc create time 03:45:00, last time pvc status changed 03:44:38		
PVC Statistics for interface Serial1 (Frame Relay DCE)		
DLCI = 20, DLCI USAGE = SWITCHED, PVC STATUS = ACTIVE, INTERFACE = Serial1		
input pkts 188	output pkts 399	in bytes 10090
out bytes 22016	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 0	out bcast bytes 0	Num Pkts Switched 187
pvc create time 03:45:04, last time pvc status changed 03:44:52		

`Lab-B# show frame route`

23. What information is shown? <u>Input / Output interfaces, DLCIs and status</u>

Input Intf	Input Dlci	Output Intf	Output Dlci	Status
Serial0	21	Serial1	20	active

Serial1	20	Serial0	21	active

Lab-A# ping 201.100.11.2

24. What was the result? <u>Success</u>

Sending 5, 100-byte ICMP Echos to 201.100.11.2, timeout is 2 seconds: !!!!! Success rate is 100 percent (5/5), round-trip min/avg/max = 68/68/72 ms