Frame Relay

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These slides are available at
http://www.cis.ohio-state.edu/~jain/cis777-00/

What is Frame Relay?

Why not leased lines or X.25?

Frame formats and protocols

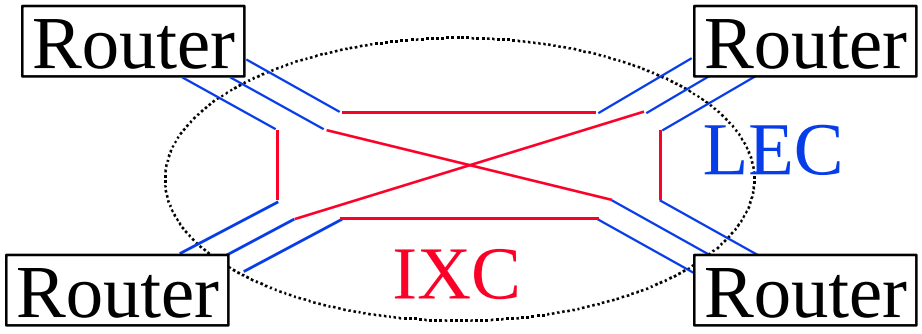
Signaling

Problems with Leased Lines

Multiple logical links ⇒ Multiple connections

Four nodes ⇒ 12 ports,
12 local exchange carrier (LEC) access lines,
6 inter-exchange carrier (IXC) connections

One more node ⇒ 8 more ports, 8 more LEC lines, 4 more IXC circuits

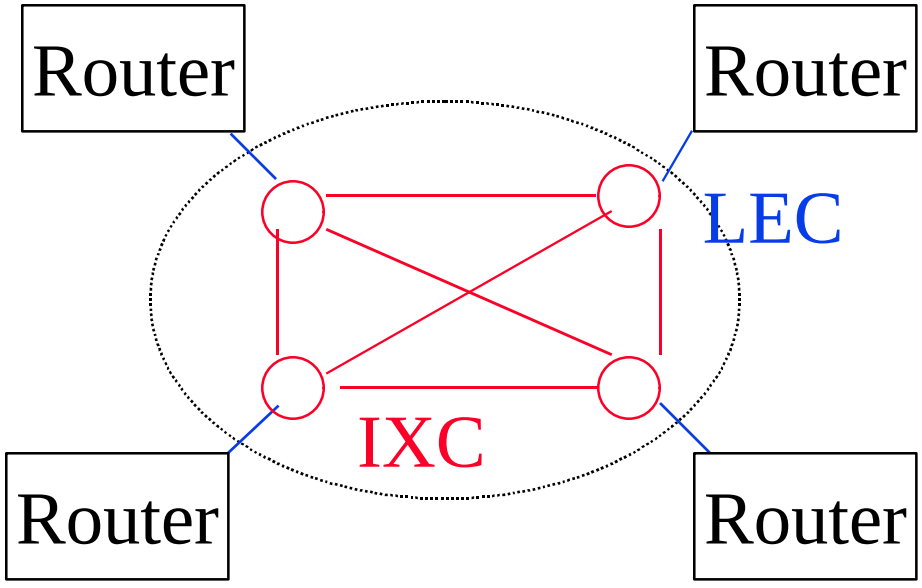


Solution: X.25/Frame Relay

Four nodes: 4 ports, 4 LEC access lines,
6 IXC circuits

One more node: 1 more port,
1 more access line, 4 more IXC circuits

Share leased lines ⇒ Virtual Private Networks



X.25

n-band signaling. VC setup and clearing
nessages in the same channel as data.

Three layer protocol. Third layer for multiplexing.

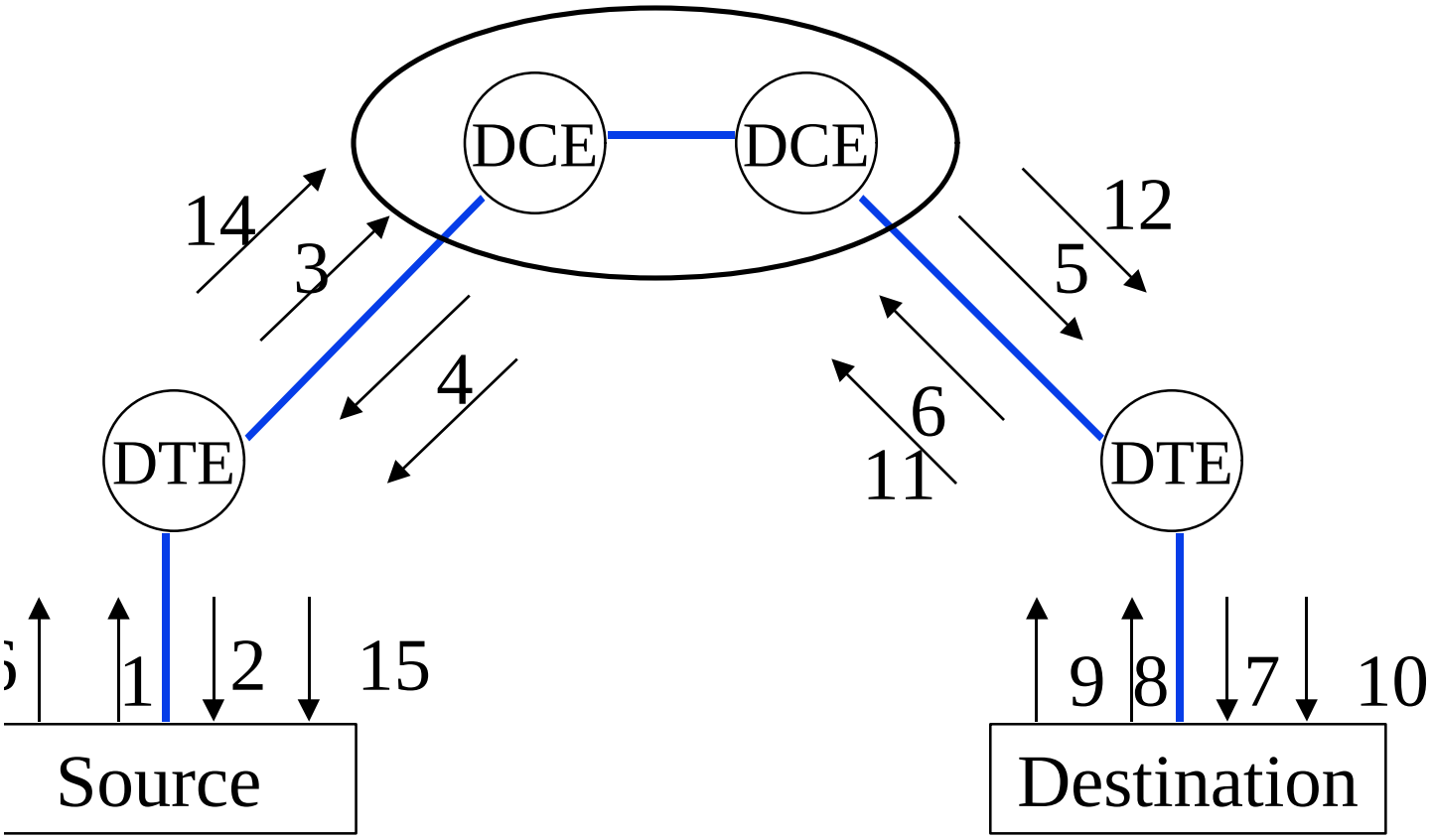
Flow control

Error control

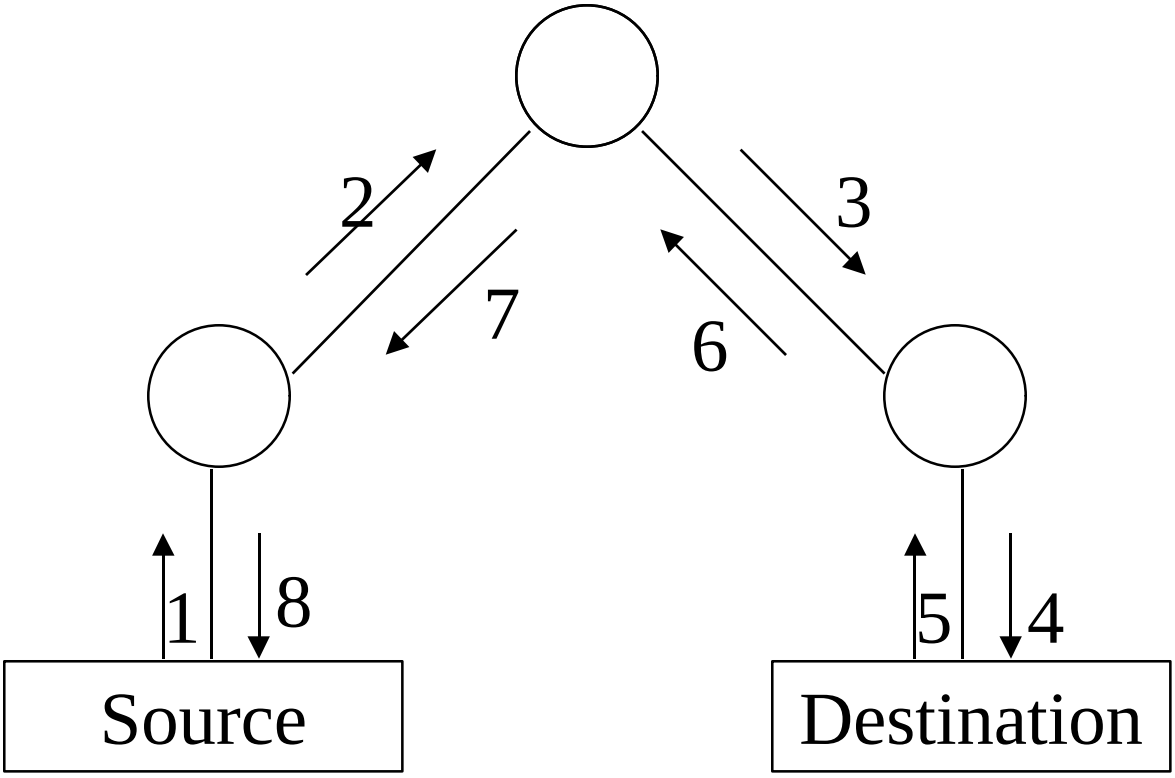
16 messages for one packet transfer

ly 8 messages without flow control and error contro

X.25 Exchange



Frame Relay Exchange



Frame Relay: Key Features

- X.25 simplified
- No flow and error control
- Out-of-band signaling
- Two layers
- Protocol multiplexing in the second layer
- Congestion control added
- Higher speed possible.

X.25 suitable to 200 kbps. Frame relay to 2.048 Mbp

Relay vs Switching

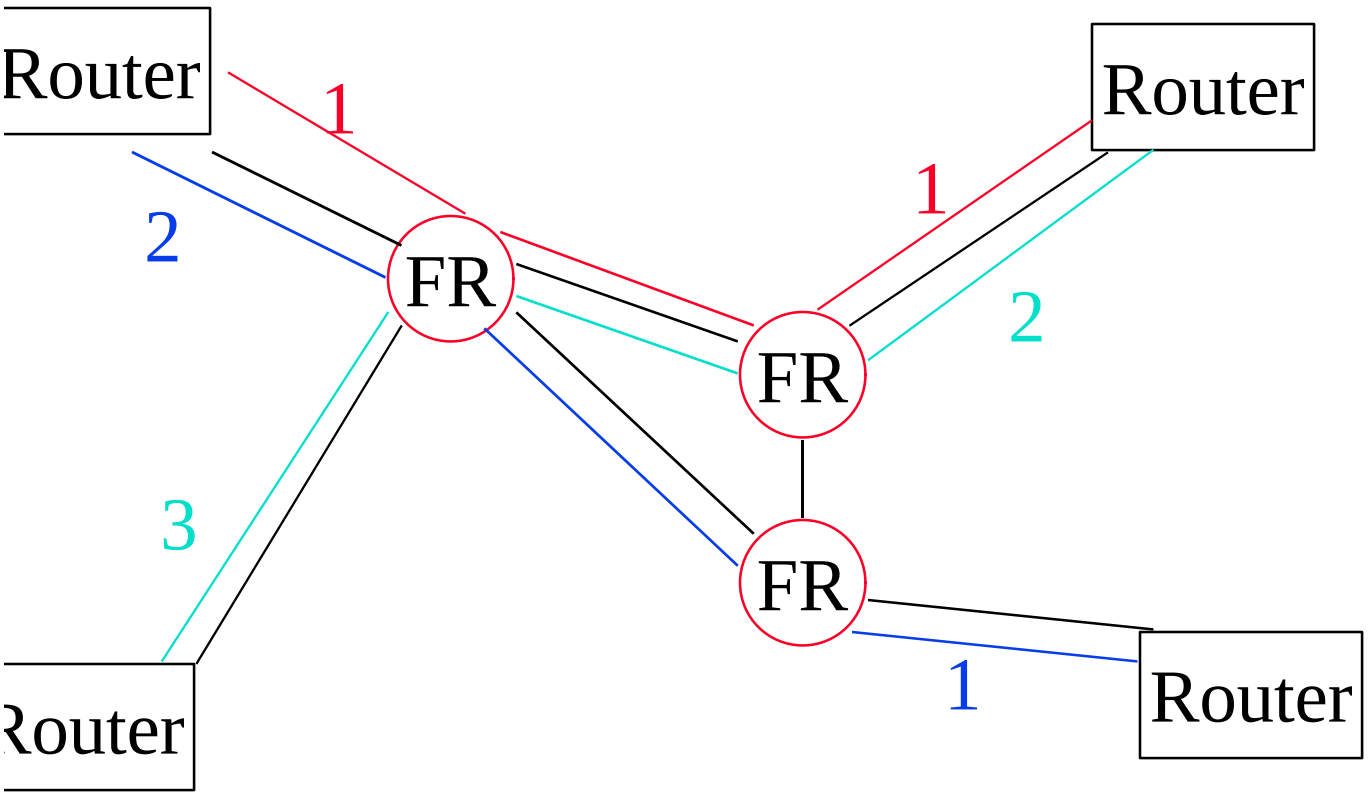
Switching = Relaying + Ack +
Flow control + Error recovery +
oss recovery

Switching = X.25

Relay = Unreliable multiplexing service

Datalink Control Identifiers

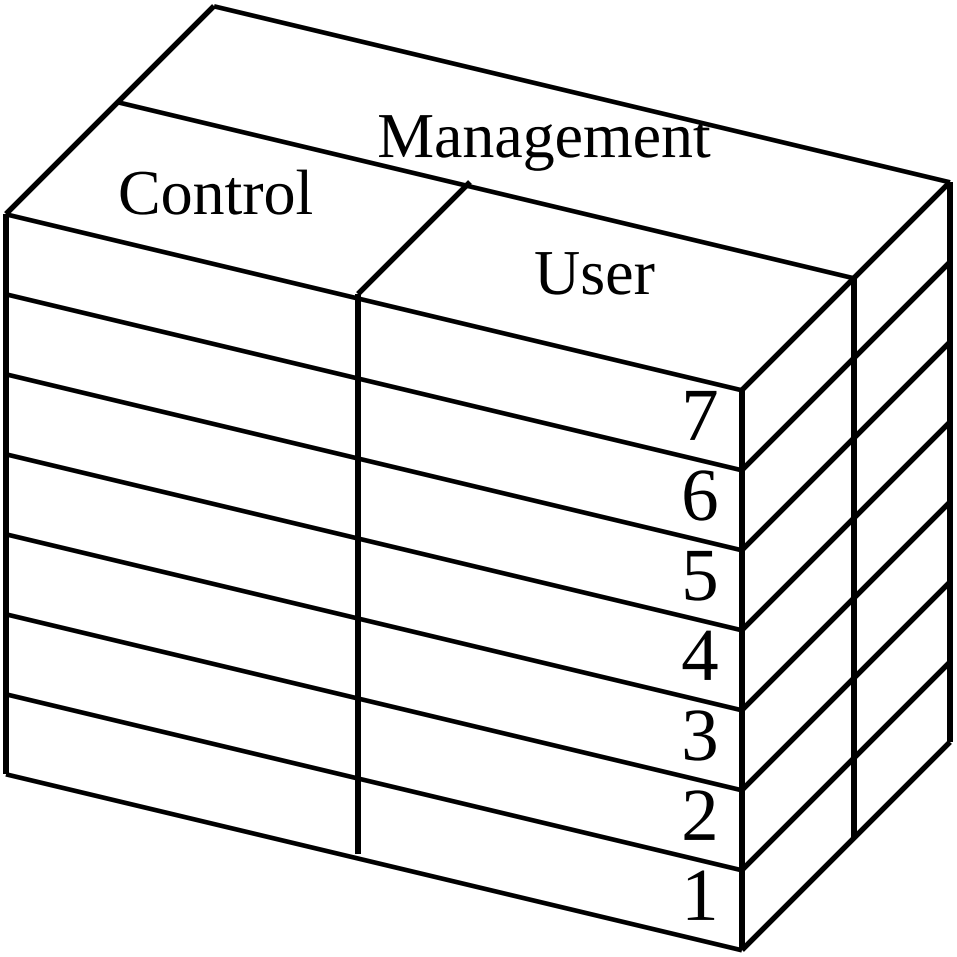
DLCI: Similar to Logical Channel Numbers in X.25



Data Link Control Identifier

- Only local significance
- Allows multiple logical connections over one circuit
- Some ranges preassigned
- DLCI = 0 is used for signaling

ISDN Reference Model

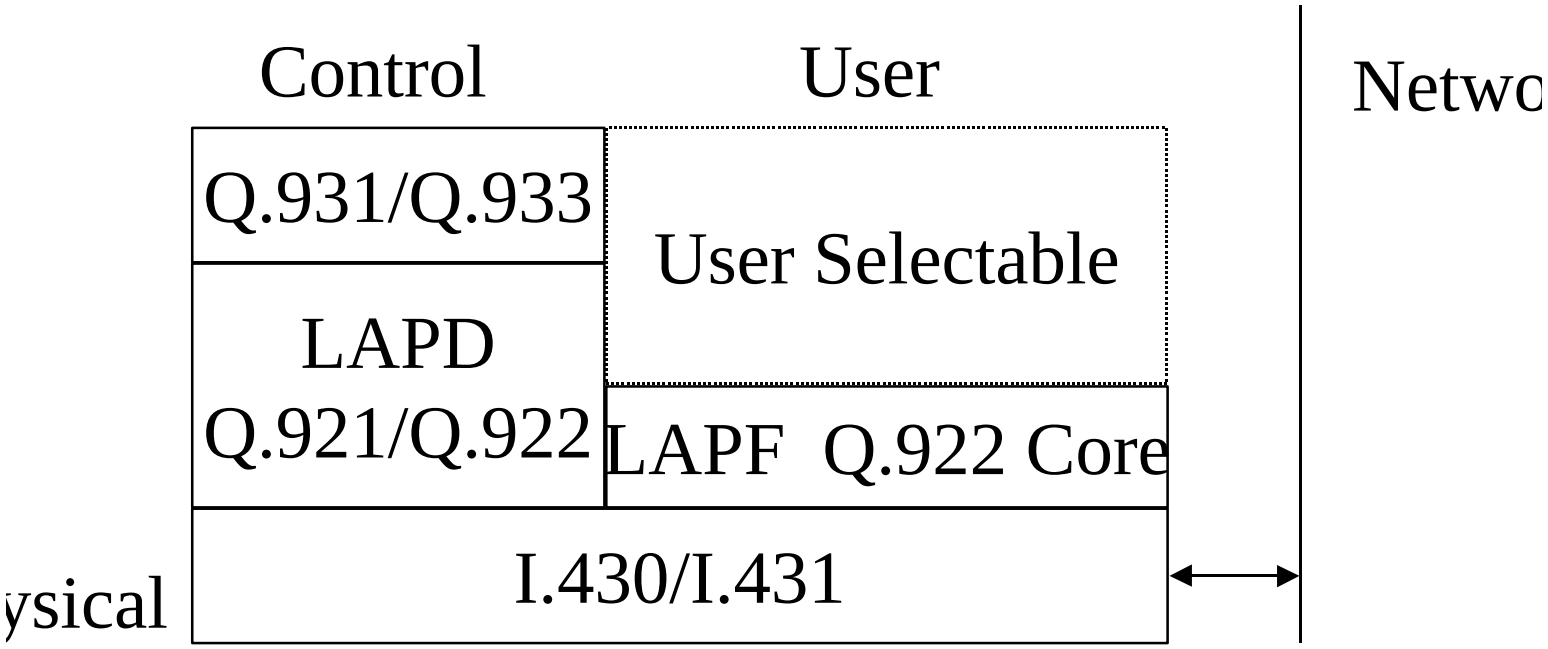


Frame Relay UNI Architecture

JNI = User-network Interface

LAPF = Link Access Protocol - Frame Mode Servic

LAPD = Link Access Protocol - D Channel



Control Plane

- Signaling over D channel (D = Delta = Signaling)
- Data transfer over B, D, or H (B = Bearer)
- LAPD used for reliable signaling
- ISDN Signaling Q.933 + Q.931 used for signaling messages
- Service Access Point Identifier (SAPI) in LAPD = 0
  ⇒ Q.933 + Q.931 Frame relay message

User Plane

Link Access Procedure for Frame-Mode bearer services (LAPF)

Q.922 = Enhanced LAPD (Q.921)
= LAPD + Congestion

LAPF defined in Q.922

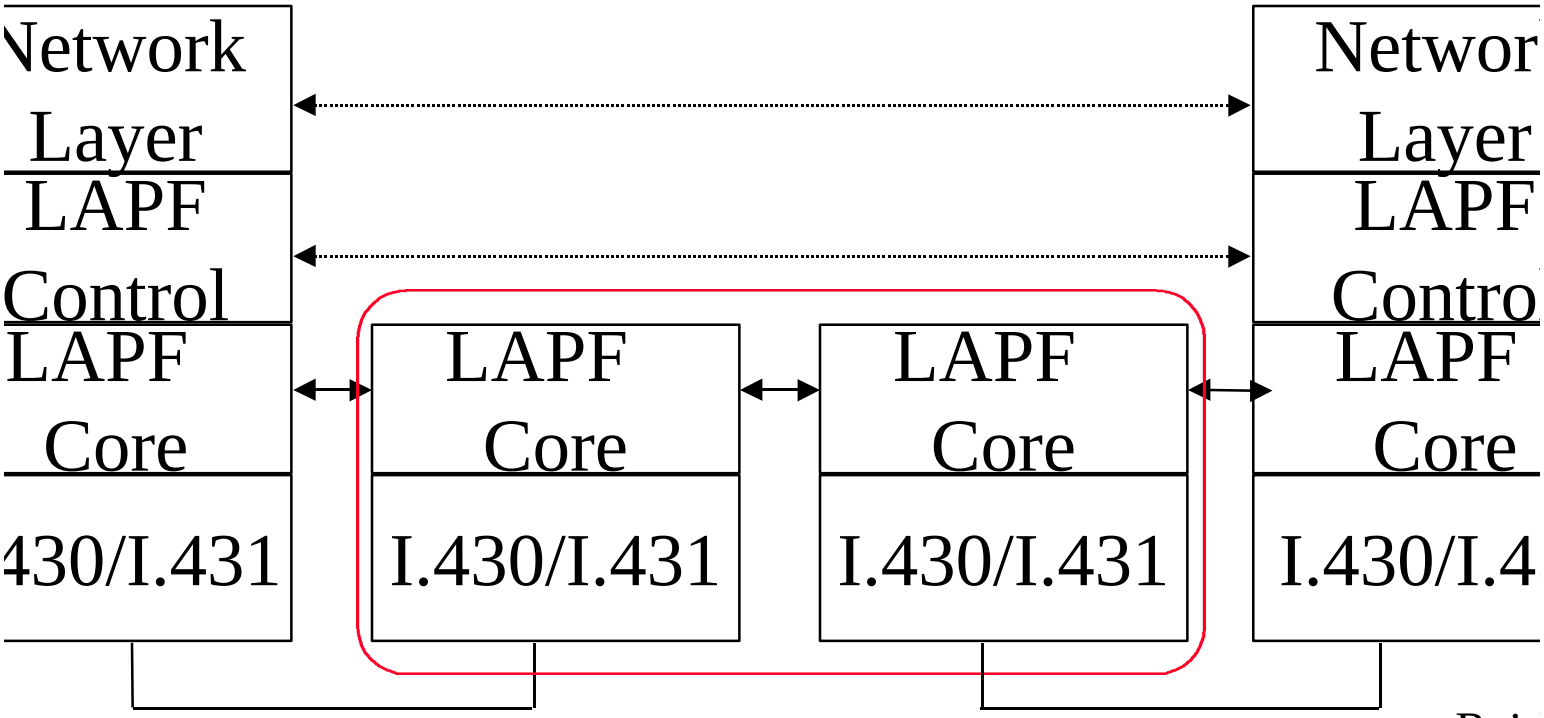
Core functions defined in Q.922 appendix:

- Frame delimiting, alignment, and flag transparenc
- Virtual circuit multiplexing and demultiplexing
- Octet alignment ⇒ Integer number of octets befo zero-bit insertion
- Checking min and max frame sizes

User Plane (Cont)

- Error detection, Sequence and non-duplication
- Congestion control

LAPF control may be used for end-to-end signaling



LAPF-Core Frame Format

- LAPF is similar to LAPD: Flag, bit stuffing, FCS
- No control frames in LAPF-Core ⇒ No control field
- No inband signaling
- No flow control, no error control, no sequence numbers
- Logical Link Control (LLC) may be used on the top of LAPF core

Flag 01111110	Address	Information	FCS	Flag 01111110
1B	2-4B		2B	2B

LAPF Address Field

	8	7	6	5	4	3	2	1
2 Octet:	Upper DLCI						C/R	EA 0
	Lower DLCI				FECN	BECN	DE	EA 1
3 Octet:	Upper DLCI						C/R	EA 0
	DLCI				FECN	BECN	DE	EA 0
	Lower DLCI or DL-Core control						D/C	EA 1
4 Octet:	Upper DLCI						C/R	EA 0
	DLCI				FECN	BECN	DE	EA 0
	DLCI							EA 0
	Lower DLCI or DL-Core control						D/C	EA 1

LAPF Address Field

Address length = 2, 3, or 4 bytes

Data Link Control Identifier (DLCI) = 10, 16, 17, or 23 bits

Address Extension (EA) bits: 0 ⇒ More bytes

D/C = Remaining bits for DLCI or for core control protocol (No use for core control has been defined)

C/R = Command/response (not used)

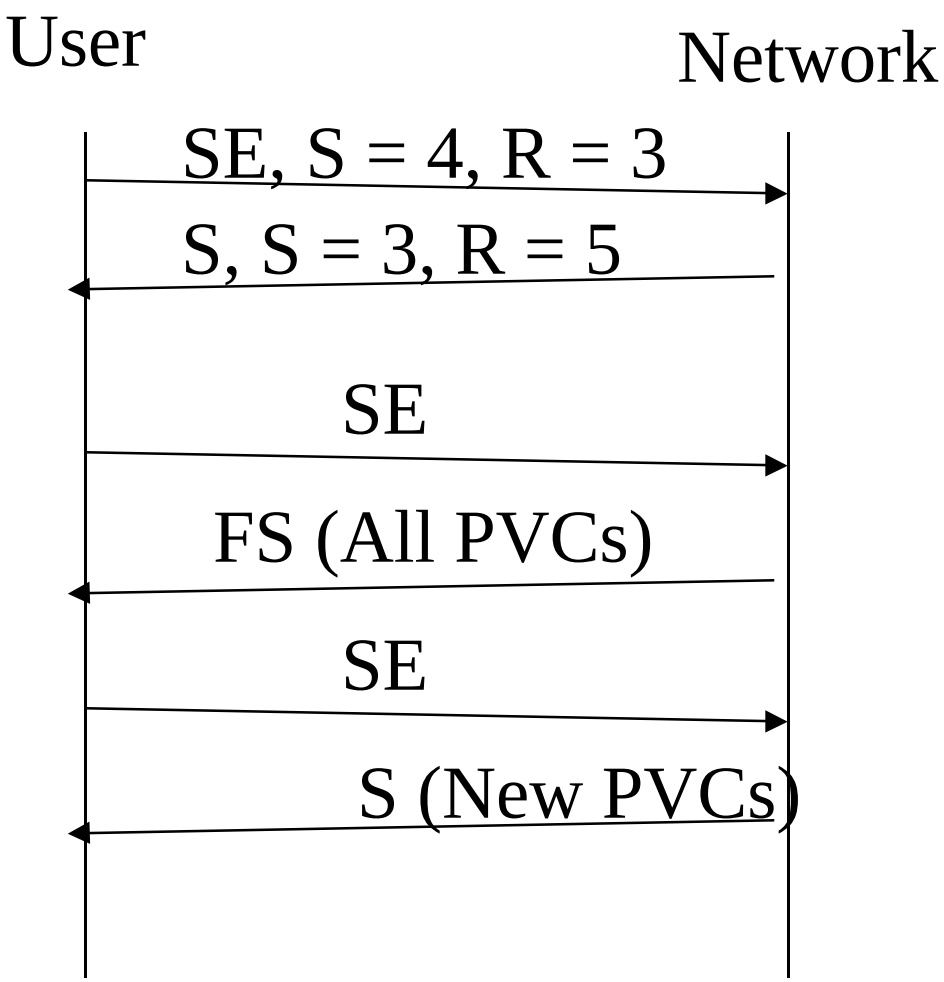
FECN = Forward Explicit Congestion Indication

BECN = Backward Explicit Congestion Indication

Local Management Interface (LMI)

- Extension designed by a group of vendors
- To overcome problems observed in early implementations
- May be standardized by both ANSI and ITU-T
- Status Enquiry (SE) message from user to network
- Status (S) message from network to user
- Uses HDLC UI frames (with sequence numbers)
- Uses protocol ID=00001001, DLCI=1023

LMI Operation



DLCI Extensions

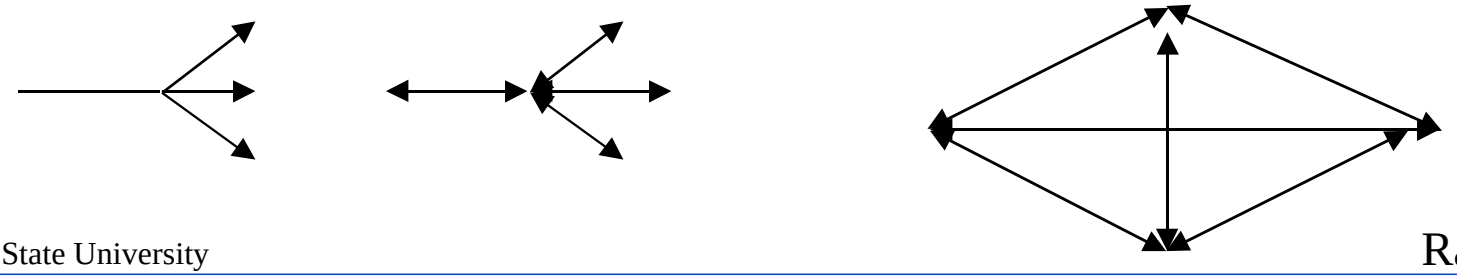
Global DLCI

⇒ DLCI points to the same destination at all time and points

(OK for small networks)

Multicasting

- One-way multicasting: 1 to N
- Two-way multicasting: 1 to N and N to 1
- N-way Multicasting: N to N



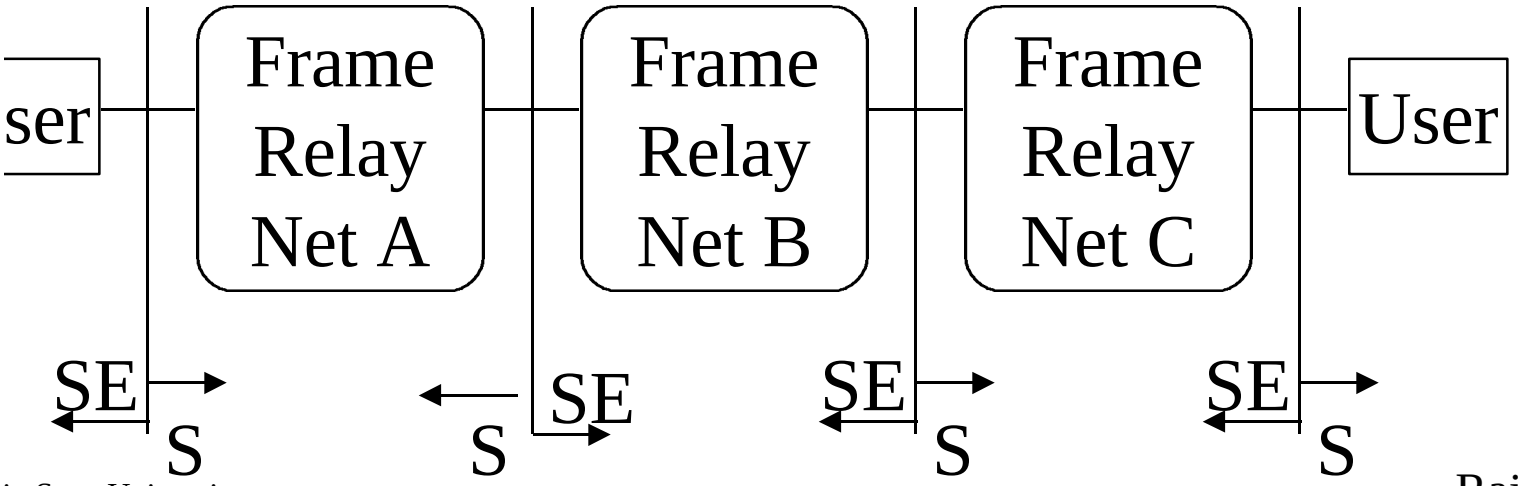
Network-to-Network Interface (NNI)

Developed by frame relay forum: FRF 92.08R1, FRF 92.62

Working draft of ANSI T1S1.2

Adding/deleting PVCs between networks

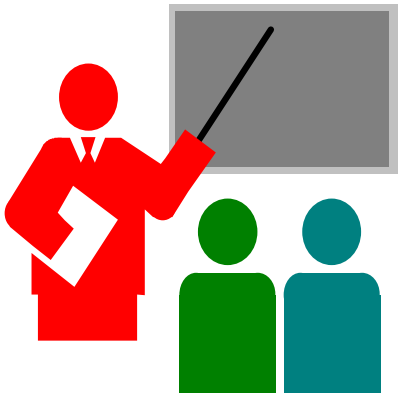
Diagnosing PVC failures



Major NNI Operations

- Notification of adding a PVC
- Notification of deleting a PVC
- Notification of UNI or NNI failures
- Notification of a PVC segment availability or unavailability
- Verification of links between frame relay nodes
- Verification of frame relay nodes

Summary



- X.25 designed for unintelligent devices over error-prone networks ⇒ Slow
- Frame relay = Simplified X.25
- Higher data rates than X.25
- Developed for ISDN but runs in non-ISDN environments
- Two layer protocol architecture

Homework

Read Section 7.2 of McDysan's book

Additional References

Chapter 11 of Stallings' "ISDN and Broadband ISD with Frame Relay and ATM"

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J. Black, "Frame Relay Networks," 2nd Ed., McGraw-Hill, 1995

C. A. Heckart, "The Guide to Frame Relay Networking," Flatiron Publishing, 1994

Frame Relay Forum, http://www.frforum.com