Frame Relay

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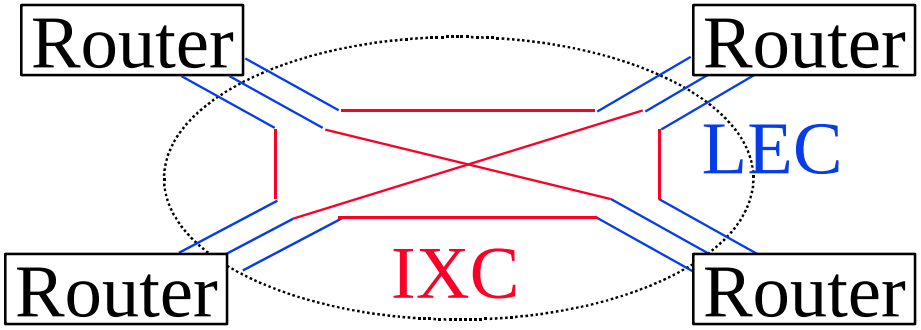
Overview

- What is Frame Relay?
- Why not leased lines or X.25?
- Frame formats and protocols
- Signaling

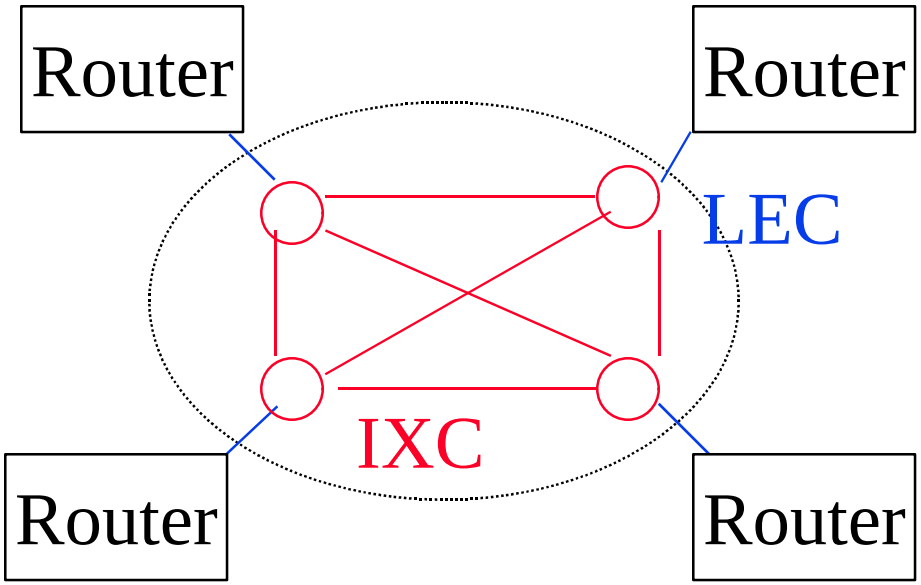
Problems with Leased Lines

- No user-to-user end-to-end signaling
- 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

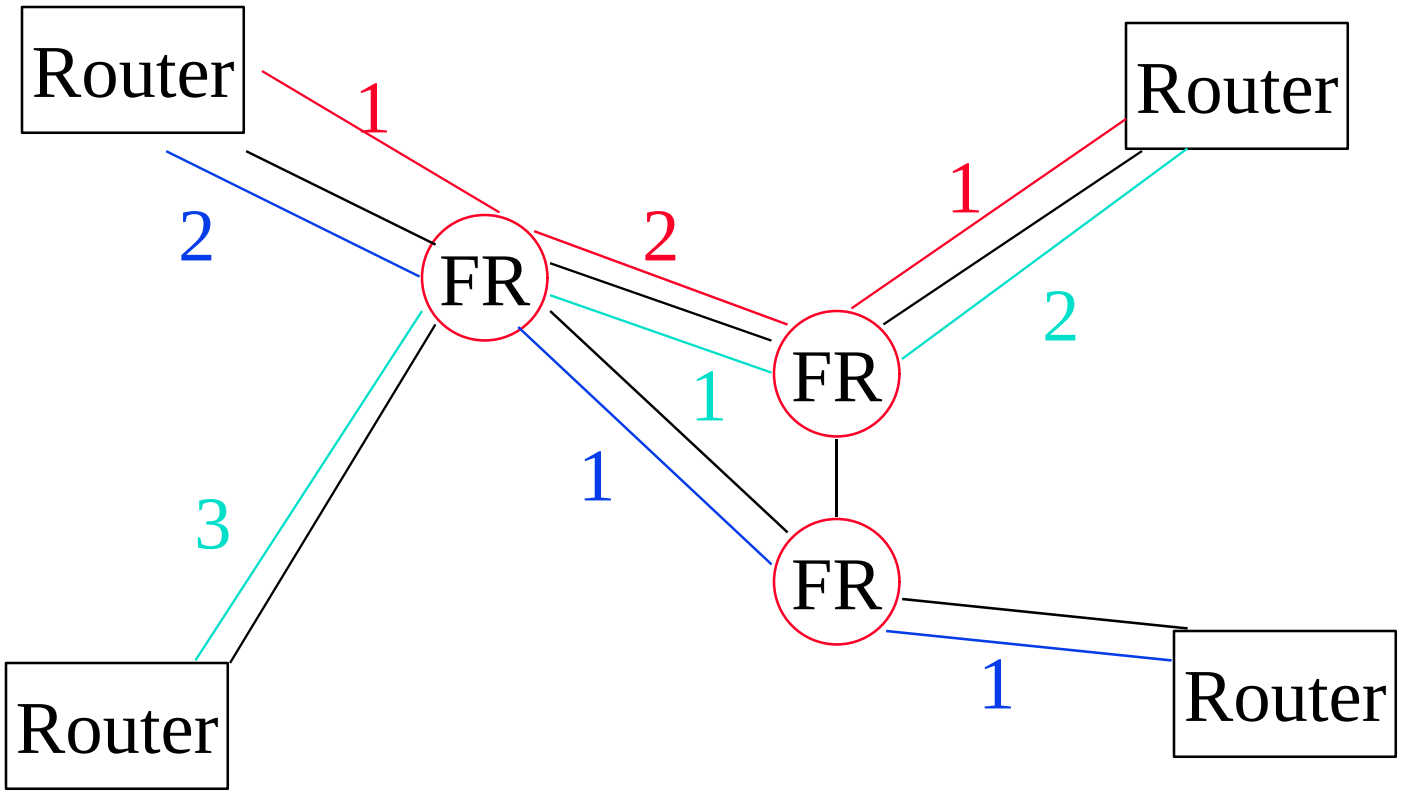


Solution: Frame Relay

- 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



Data Link Control Identifiers (DLCI)



Data Link Control Identifier

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

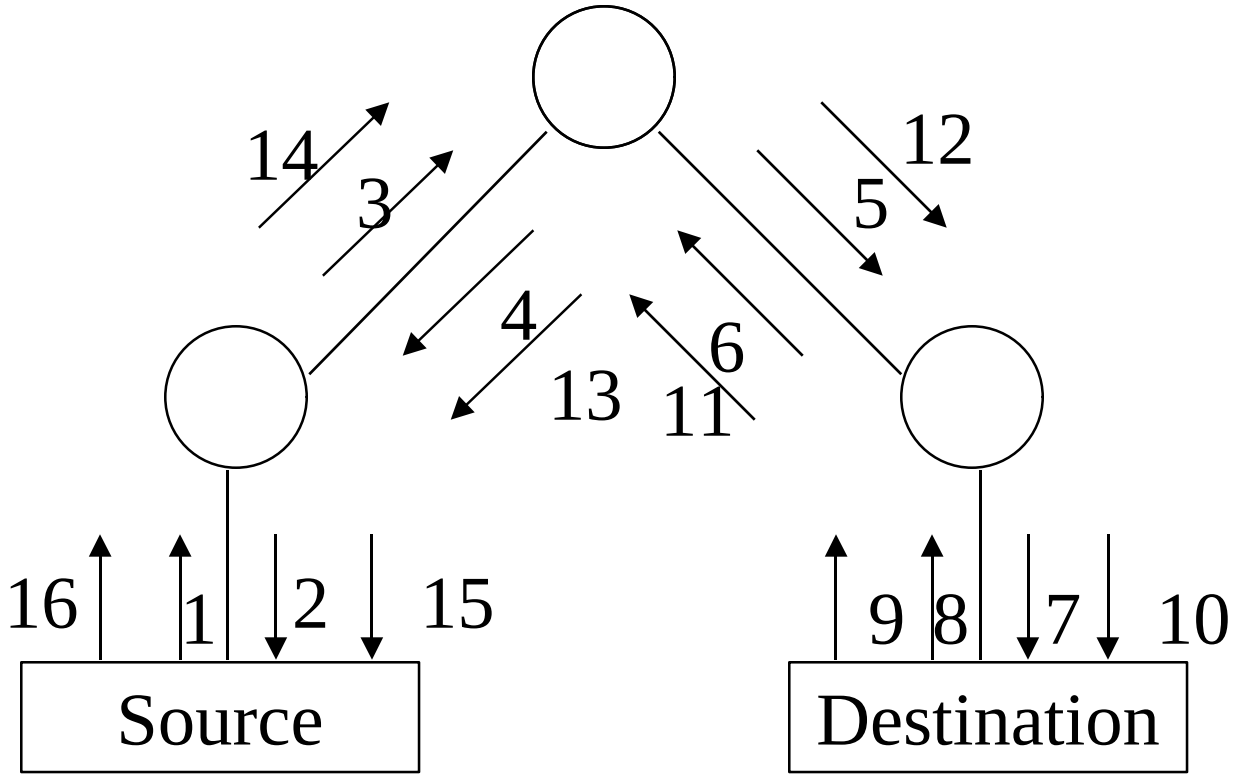
X.25

- In-band signaling. VC setup and clearing messages in the same channel as data.
- Three layer protocol. Third layer for multiplexing.
- Flow control
- Error control

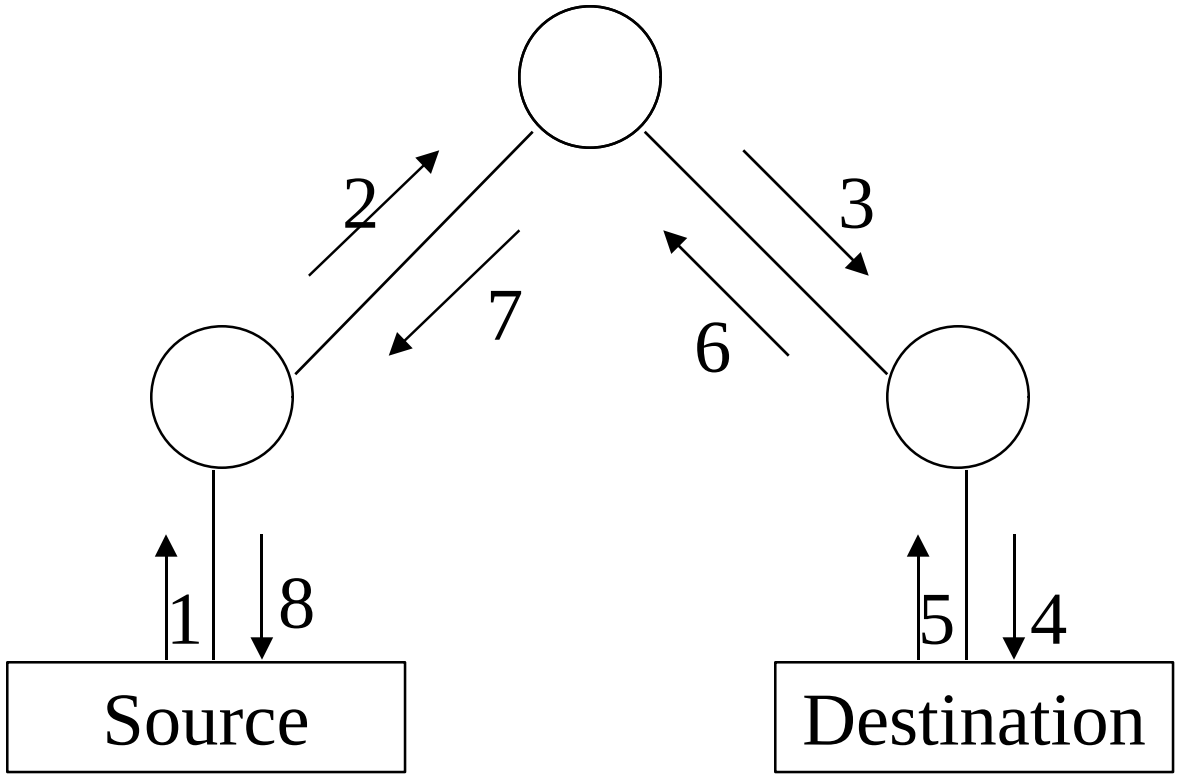
$\Rightarrow$ 12 messages for one packet transfer

Only 6 messages without flow control and error control

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

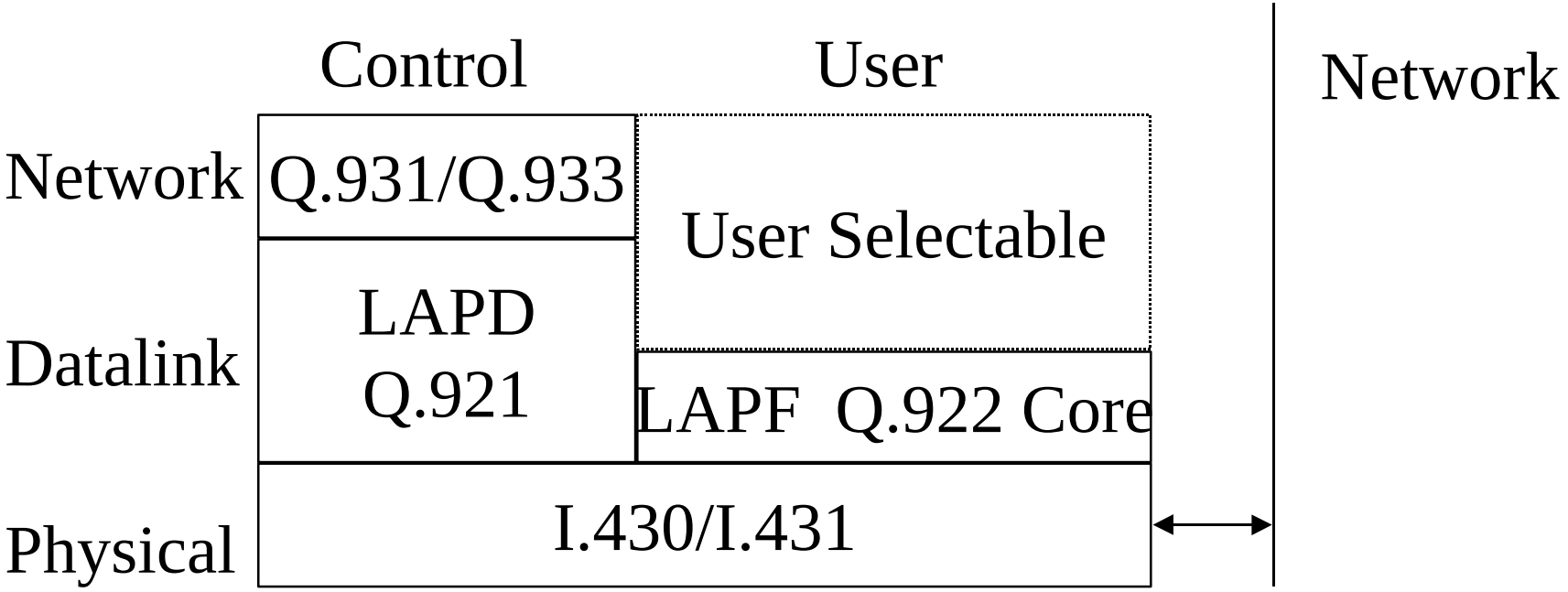
$\Rightarrow$ Higher speed possible.
X.25 suitable to 200 kbps. Frame relay to 2.048 Mbps.

Relay vs Switching

- Switching = Relaying + Ack +
  Flow control + Error recovery +
  loss recovery
- Switching = X.25
- Relay = Unreliable multiplexing service

Frame Relay UNI Architecture

- UNI = User-network Interface
- LAPF = Link Access Procedure - Frame Relay
- LAPD = Link Access Procedure for D Channel



Control Plane

- Signaling over D channel
- Data transfer over B, D, or H
- LAPD used for reliable signaling
- ISDN Signaling Q.933 + Q.931 used for signaling messages
- SAPI = 0 in LAPD
  $\Rightarrow$ Q.933 + Q.931 Frame relay message

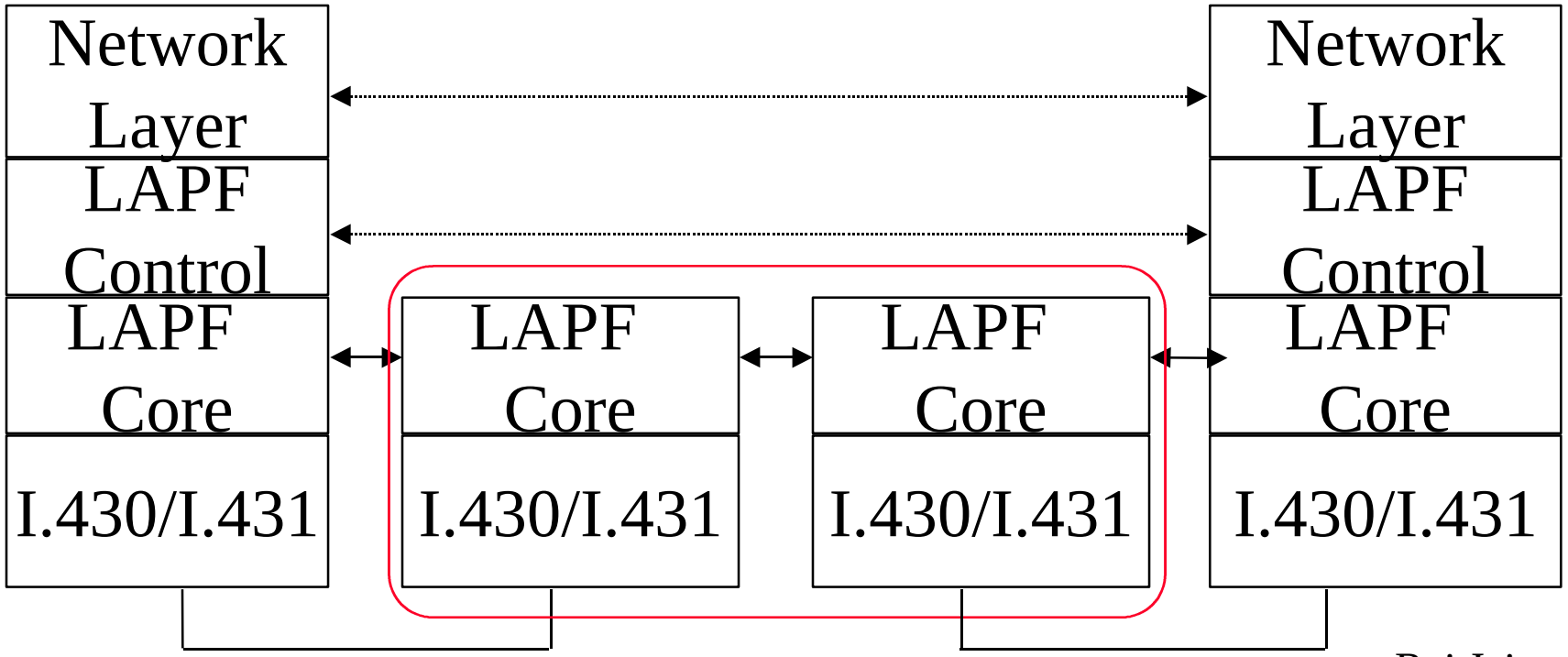
User Plane

- 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 transparency
  - Virtual circuit multiplexing and demultiplexing
  - Octet alignment ⇒ Integer number of octets before 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



Signaling

- Permanent Virtual Circuit (PVC)
- Switched Virtual Circuit (SVC)
- Q.933 used for FR connections over PVC or SVC
  $\Rightarrow$ Q.933 is a subset of Q.931
- Message Types: Alerting, call proceeding, connect, connect ack, progress, setup, disconnect, release, release complete, status, status inquiry
- Frame relay forum has proposed to simplify Q.933 by deleting progress, connect ack, and alerting.
  Also delete many information element.
  Add SVC.

Connection Control Msgs

- **Call establishment**
  1. Alerting
  2. Call proceeding
  3. Connect
  4. Connect Acknowledge
  5. Progress
  6. Setup
- **Call clearing**
  7. Disconnect
  8. Release
  9. Release Complete

- **Miscellaneous**
  10. Status
  11. Status Enquiry

Signaling Example

D-Channel Q.931 exchange to establish B-Channel Circuit switched Connection

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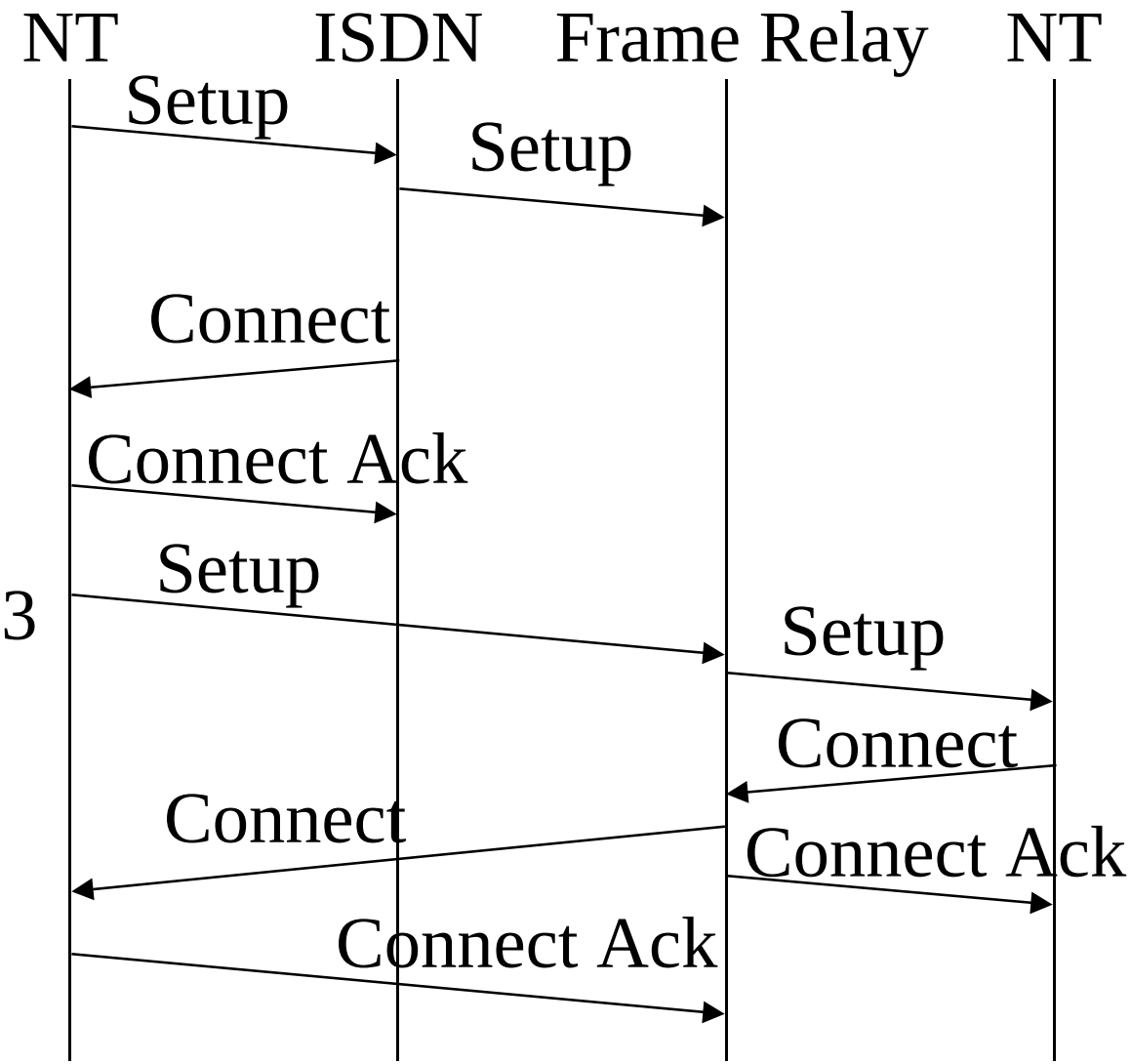
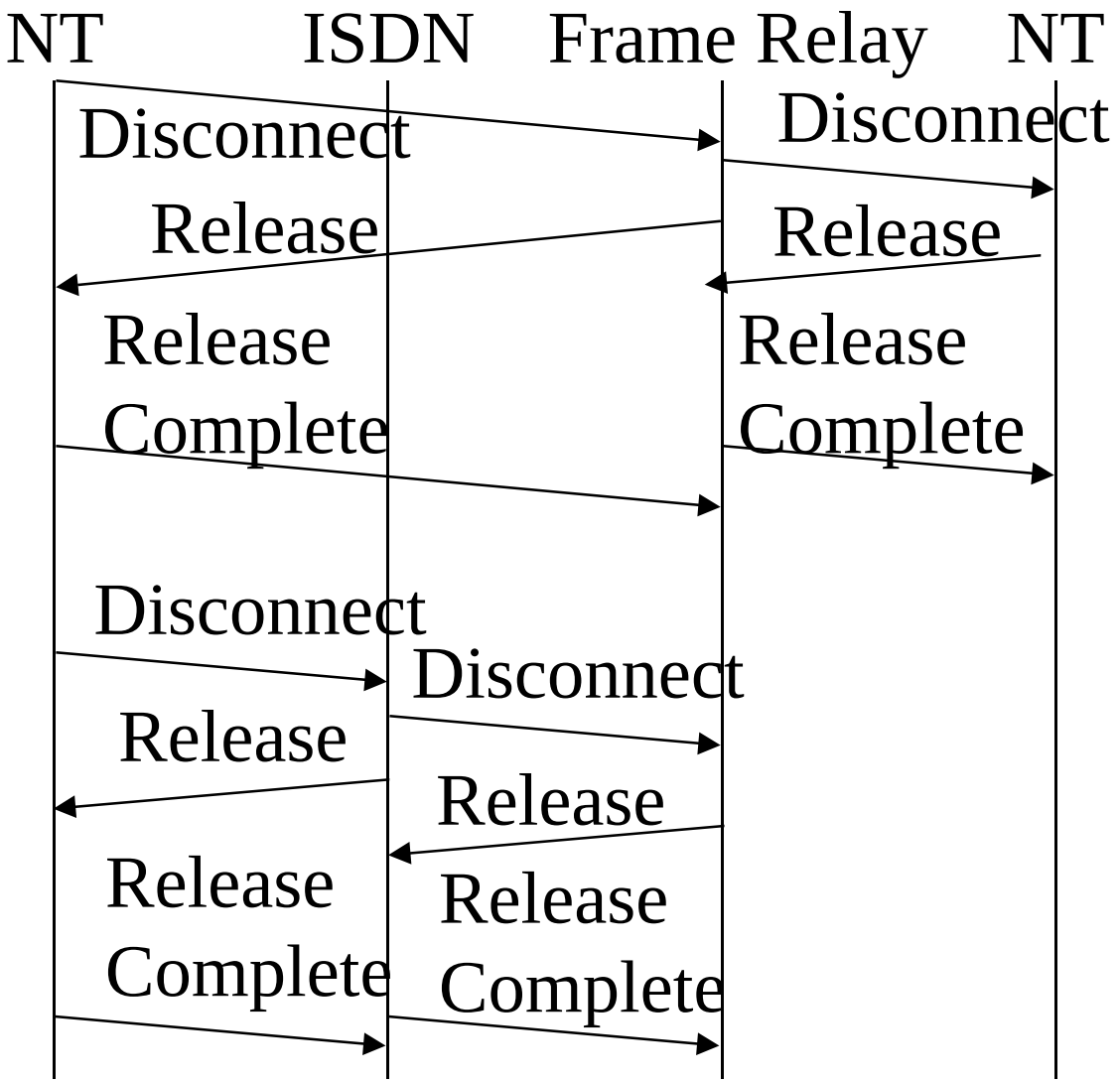
B-Channel Q.933 exchange to establish B-Channel frame-mode connection



Signaling Example (cont)

B-Channel Q.933 exchange to release B-Channel frame-mode connection

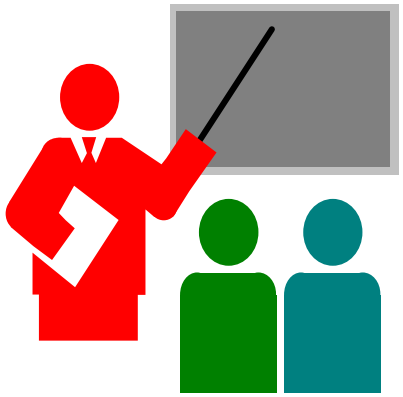
D-Channel Q.931 exchange to release B-Channel Circuit switched Connection



Physical Layer Options

- Both ANSI and ITU-T define frame relay on ISDN
- Frame relay forum's implementation agreements:
  - Metallic interface at DS1 1.544 Mbps (ANSI T1.403)
  - Leased lines at 56 kbps (V.35)
  - Metallic interface at E1 2.048 Mbps (G.703)
  - Synchronous interface at E1 2.048 Mbps (G.704)
  - X.21 interface for synchronous transmission
- MCI offers frame relay at 56 kbps, 64 kbps, fractional T1, N × 56 or N × 64 kbps.

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 Chapter 11 of Stallings' ISDN book

Frame Relay Standards

ITU:

- I.122, Framework for Frame Mode Bearer Services, 1993.
- I.223, Frame Mode Bearer Services, 1992.
- I.370, Congestion management for the ISDN Frame Relaying Bearer Service, 1991.
- I.372, Frame Relay Bearer Service Network-to-network Interface Requirements, 1993.
- I.555, Frame Mode Bearer Services Interworking, 1992.

Standards (Cont)

- Q.922, ISDN Data Link Layer Specification for Frame Mode Bearer Services, 1992.
- Q.933, Signaling Specifications for Frame Mode Call Control, 1992.

ANSI:

- T1.606, Architectural Framework and Service Description for Frame-Relaying Bearer Service, 1990.
- T1.617, Signaling Specification for Frame Relay Bearer Service for DSS1, 1991.
- T1.618, Core Aspects of Frame Protocol for Use with Frame Relay Bearer Service, 1991.

Implementation Agreements

- FRF.1, The User-Network Interface (UNI)
- FRF.2, The network-to-network interface (NNI)
- FRF.3, Multiprotocol encaptulation
- FRF.4, Switched virtual circuit (SVC)
- FRF.5, Frame relay/ATM network interworking
- FRF.6, Frame relay service customer network management

Available from Frame Relay Forum, http://frame-relay.indiana.edu/

RFCs

- RFC 2115, “MIB for Frame Relay DTEs Using SMIv2,” Sept 1997.
- RFC 1973, “PPP in Frame Relay,” June 1996.
- RFC1604, "Definitions of Managed Objects for Frame Relay Service" by T. Brown, 03/25/1994, 46 pp.
- RFC1586 "Guidelines for Running OSPF Over Frame Relay Networks" by O. deSouza, M. Rodrigues, 03/24/1994, 6 pp.
- RFC1490, "Multiprotocol Interconnect over Frame Relay" by T. Bradley, C. Brown, A. Malis, 07/26/1993, 35 pp.