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 $\Rightarrow$ Multiple connections
- Four nodes $\Rightarrow$ 12 ports,
  12 local exchange carrier (LEC) access lines,
  6 inter-exchange carrier (IXC) connections
- One more node $\Rightarrow$ 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 $\implies$ 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

⇒ 12 messages for one packet transfer
Only 6 messages without flow control and error control
X.25 Exchange

Source

Destination
Frame Relay Exchange

Source

Destination
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 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

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- **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
  => 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 \( \Rightarrow \) Integer number of octets before zero-bit insertion
  - Checking min and max frame sizes
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
  ⇒ 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

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

NT Setup ISDN Setup Frame Relay Setup NT

Connect
Connect Ack
Setup
Connect
Connect Ack
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

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NT  ISDN  Frame  Relay  NT
  Disconnect  Release  Release  Disconnect
  Release  Complete  Release  Release
  Complete  Release  Release  Complete
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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:

Standards (Cont)

- Q.933, Signaling Specifications for Frame Mode Call Control, 1992.

ANSI:

Implementation Agreements

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

RFCs