Fast Networking Technologies

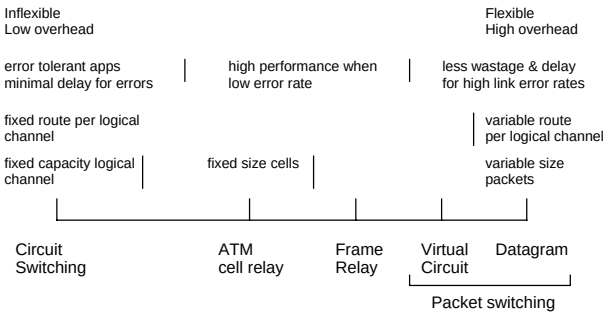
Traditional technologies (revision):

- Circuit switching
  - pre allocated fixed channel capacity
  - transparent, fixed delay (no jitter)

- Packet switching (1970s)
  - Efficient use of network
  - dynamically variable capacity
  - multiplexing of many channels on single physical link
  - buffering delays in network
  - delivery order not guaranteed
  - causes jitter

Frame relay and Cell relay bridge the gap between these extremes

Network technologies



Varying data characteristics. Consider:
Voice
Block interactive data (eg. web)
File Transfer
Multiplexed low bit rate (eg. terminal)
Compressed video

Packet Switching Overview

- Originated in 1970's
- Best known standard is X.25 Approved in 1976
- Revised several times - last time in 1993

- Includes 3 layers
  - physical layer X.21 (alternatives eg EIA.232)
  - link layer - LAPB
  - network layer X.25

- Designed to improve the inefficient utilisation of circuits when the circuit switched approach is used for many data (non voice) transmissions.

Packet switching operation overview

- All data sent in small blocks - *packets.*
- Long messages split into pieces.
- Each packet contains control information (address) and possibly some user data.
- Each packet is passed around the network (store and forward) until it reaches its destination.
- The network has *routing* strategies to attempt to get packets to their destination efficiently. - a complex task
- The network may need *congestion* control strategies to avoid catastrophe when overloads occur.

Packet Switching Characteristics

- Several *logical connections* may exist on a single interface - multiplexing.
- Flexible transmission rates - allowing data rate conversion

- Congestion may build up in the network - worst case packet loss
- Packets may take different routes between the same host - even packets belonging to the same message - causing arrival in the wrong order.
- Some overhead in transmitting header of packet
- Greater delay than circuit switched connection as messages are passed around inside the network.

Virtual Circuits

Rather than using the *datagram* approach some packet switched networks use *virtual circuits*

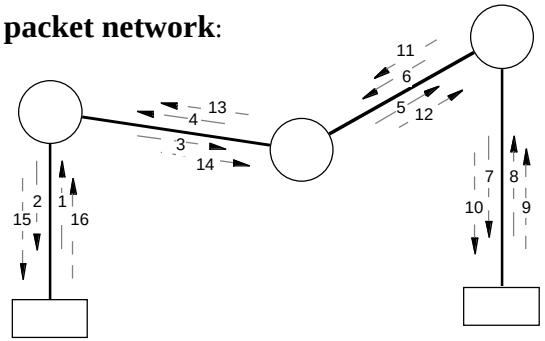
- All packets follow the same route once a virtual circuit is established.
- Each node holds routing information for established virtual circuits (logical connection) -allowing simple lookup.
- Many virtual circuits may share a single physical link.
- Guaranteed delivery order for packets.
- Delay overhead in establishing the virtual circuit. cf.. circuit switching.
- Packets ‘held up’ by errors causing retransmissions on a link.

Frame Relay- Outline

- Latest networks are very fast
- Latest networks have very low error rates.

- implications ?

packet network:

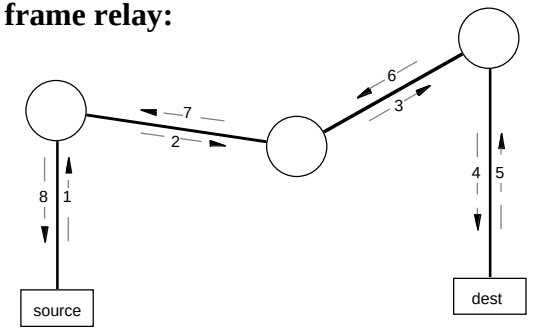


Frame relay removes this data link protocol overhead because it assumes a relatively low probability of error in any transmitted packet

Frame relay / packet switched comparison

- Call control signalling is on a separate logical connection
- multiplexing and switching at layer 2 rather than layer 3
- NO hop by hop error or flow control
- 2Mbit / s (ITU-T Recommendation I.233)

frame relay:



Frame Mode Bearer Service Architecture

A connection oriented link layer service which preserves frame order and has a small probability of frame loss

- Control plane
  - provides control signalling
  - separate logical channel
  - Q.933 messages (subset of Q.931 ISDN common channel signalling) used ensure reliable control signalling.
- User plane
  - framing
  - detection (only) of transmission errors
  - congestion control
  - known as LAPF

Frame relay connection

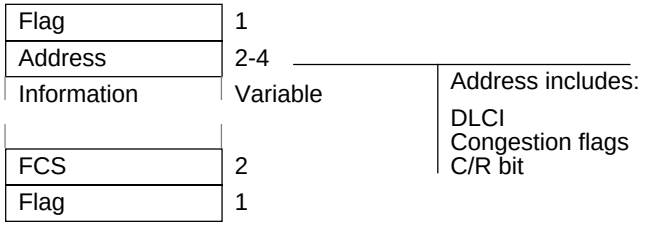
Assuming user is connected to a frame relay handler then to send data:

- Establish a logical connection between two endpoints
- Exchange data
- Release logical connection

- Each connection has a unique Data Link Connection Identifier (DLCI)
- DLCI =0 is used only for call control
- minimum set of control messages SETUP, CONNECT, RELEASE, RELEASE COMPLETE (Q.933 includes these plus others)

User data transfer

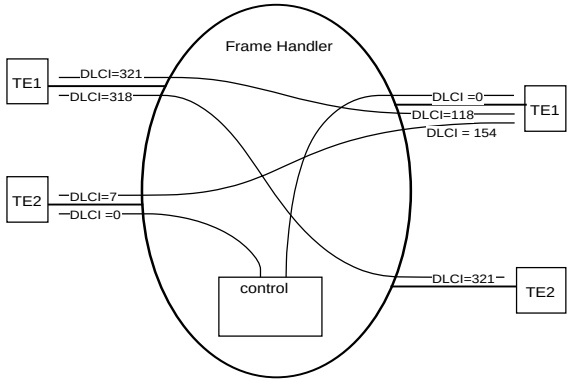
LAPF core protocol frame format:



- LAPF frame format is similar to LAPD but no control field.
- this implies:
  - only one frame type
  - no inband signalling (only user data carried by a logical connection)
  - no sequence numbers

The frame relay network -function outline

- routing based on DLCI values
- frame handlers exist at network nodes
- frame handler holds a *connection table* for each virtual connection
- translates each DLCI before forwarding
- corrupted frames lost (not forwarded)
- messages on DLCI=0 used for call control



Access to a frame relay network

- Switched Access
  - user connects to a frame handler via switched network eg. ISDN
  - ISDN access via B or H channel
- Integrated Access
  - user connected directly to frame relay network
  - OR user connected to local exchange which provides frame handling.

Congestion

- Queues building inside the network
- Delays increase
- Frames get discarded as buffers fill up
- Higher level protocols have to re send
- Ultimately useful throughput actually drops.

Solution requires co-operation between network and users

- Congestion Avoidance
- Congestion Recovery
- Discard Strategy