

High speed computer networks

Frame relay

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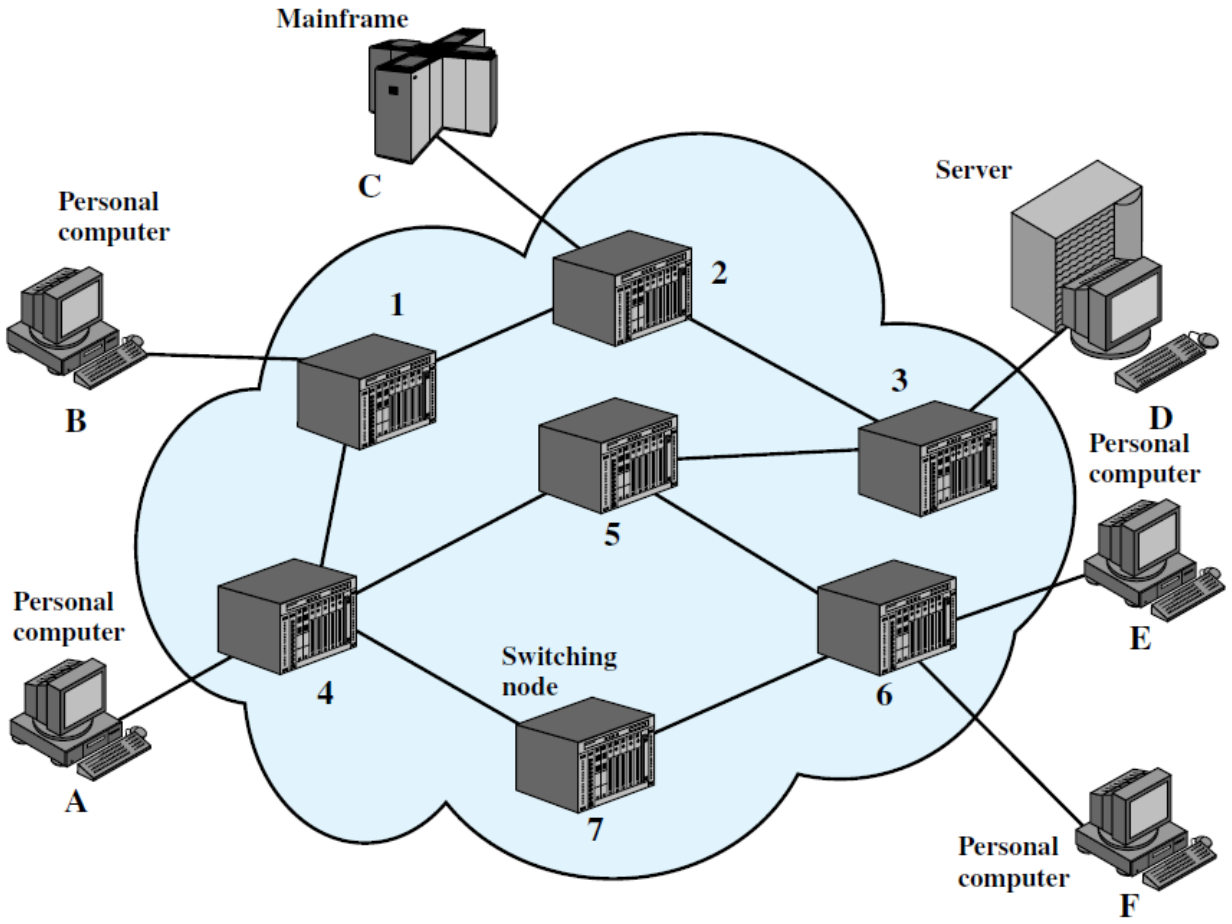
Introduction

- Switching
  - ✓Circuit switching
  - ✓Packet switching
    - Virtual circuit
    - Datagram
- X.25
- Frame relay networks
  - ✓Architecture

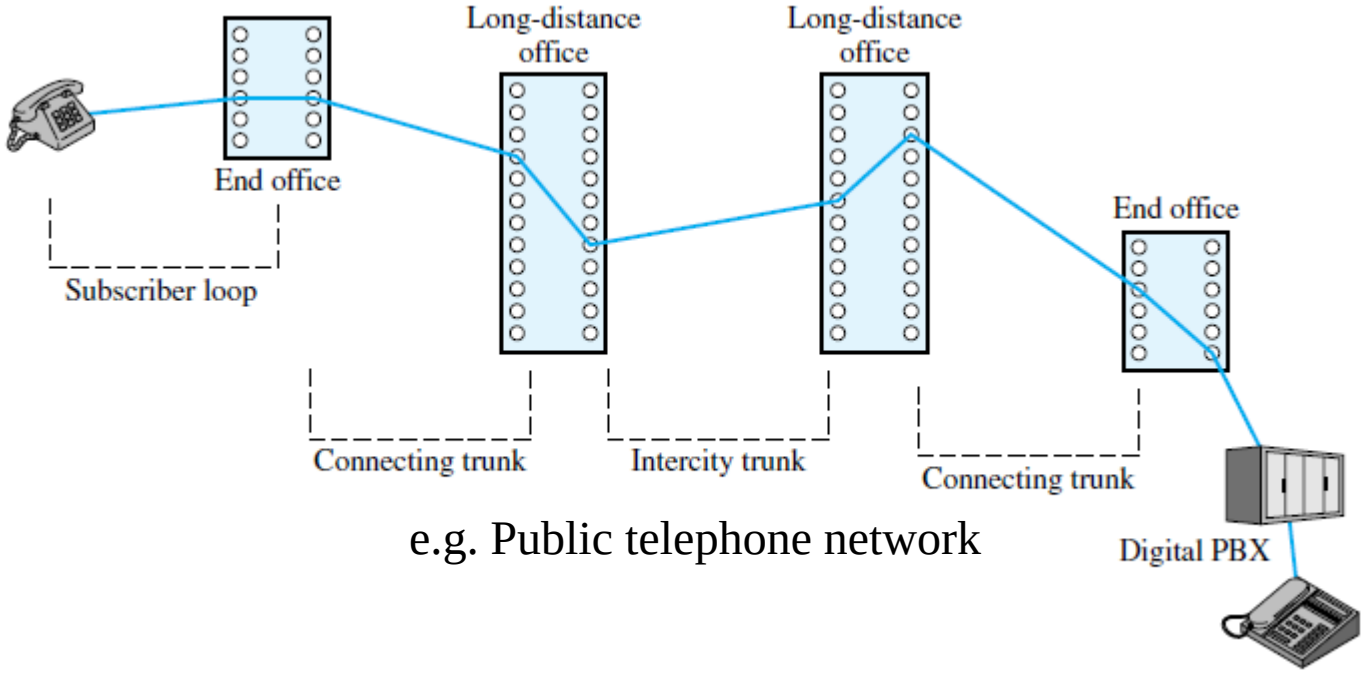
Switched communication network

- Transmitting data through a network of intermediate switching nodes



Circuit-Switching

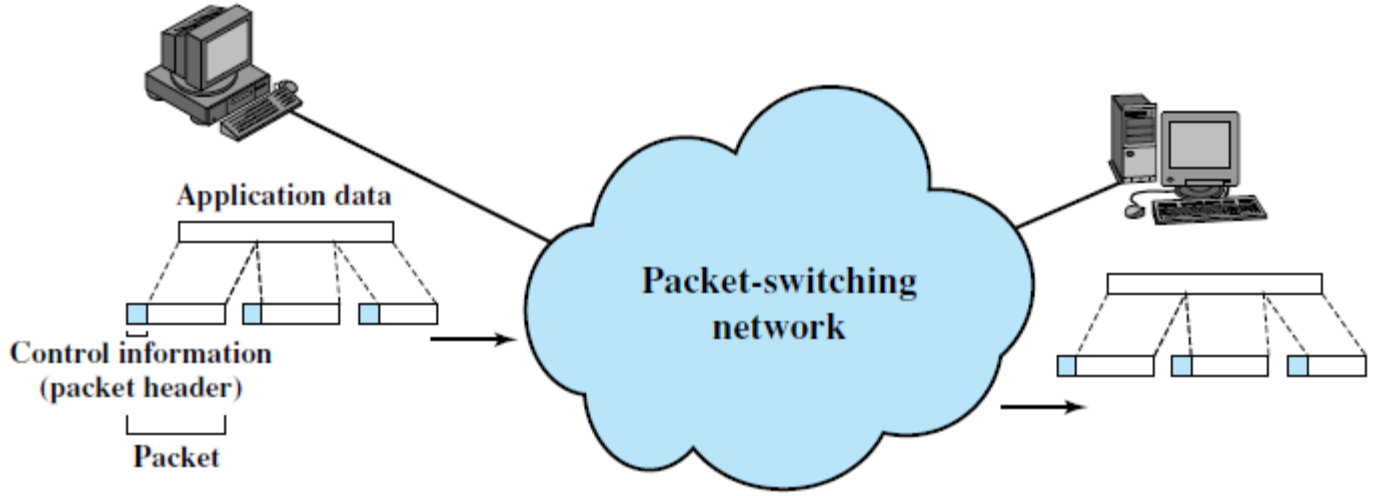
- Designed to handle voice traffic
- Process
  - ✓End-to-end circuit establishmen
  - ✓Data transfer
  - ✓Circuit disconnect
- Advantage
  - ✓No variation of delay
- Shortcomings
  - ✓Inefficient
    - high idle time
  - ✓Constant data rate
    - devices must transmit and receive at the same data rate



e.g. Public telephone network

Packet switching

- Used extensively for computer communications
- Data transmitted in short blocks, or packets
  - ✓Packet length < 1000 octets
  - ✓Each packet contains user data plus control info (routing)
  - ✓Store and forward



Packet switching

- Path selection- considering the state of the network

- Advantages
  - ✓Link can be shared dynamically by many packets
  - ✓Different data rate can be used
    - A packet-switching network can perform data-rate conversion
  - ✓When congestion occurs, packets can be still accepted
    - But, delay time increases
  - ✓Priority can be used

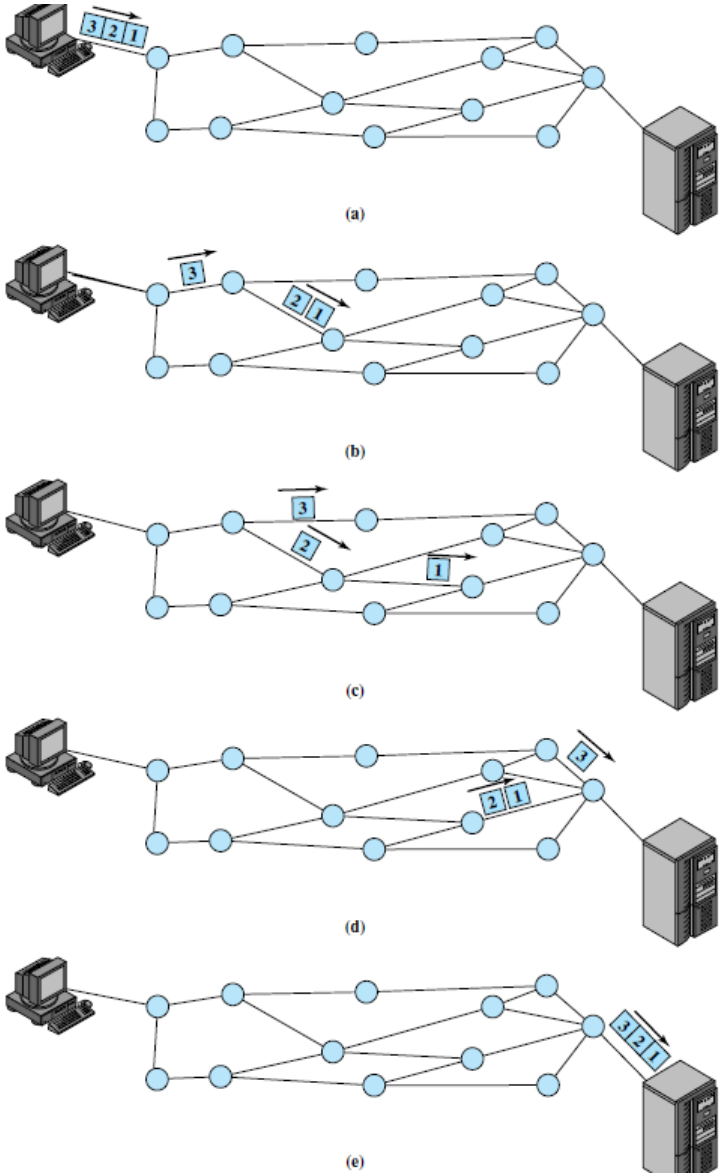
Packet switching

- Disadvantages
  - ✓Packets incur additional delay with every node they pass through
  - ✓Jitter: variation in packet delay
  - ✓Data overhead in every packet for routing information
  - ✓Processing overhead for every packet at every node traversed

Packet switching : switching Technique

- How the network will handle this stream of packets ?

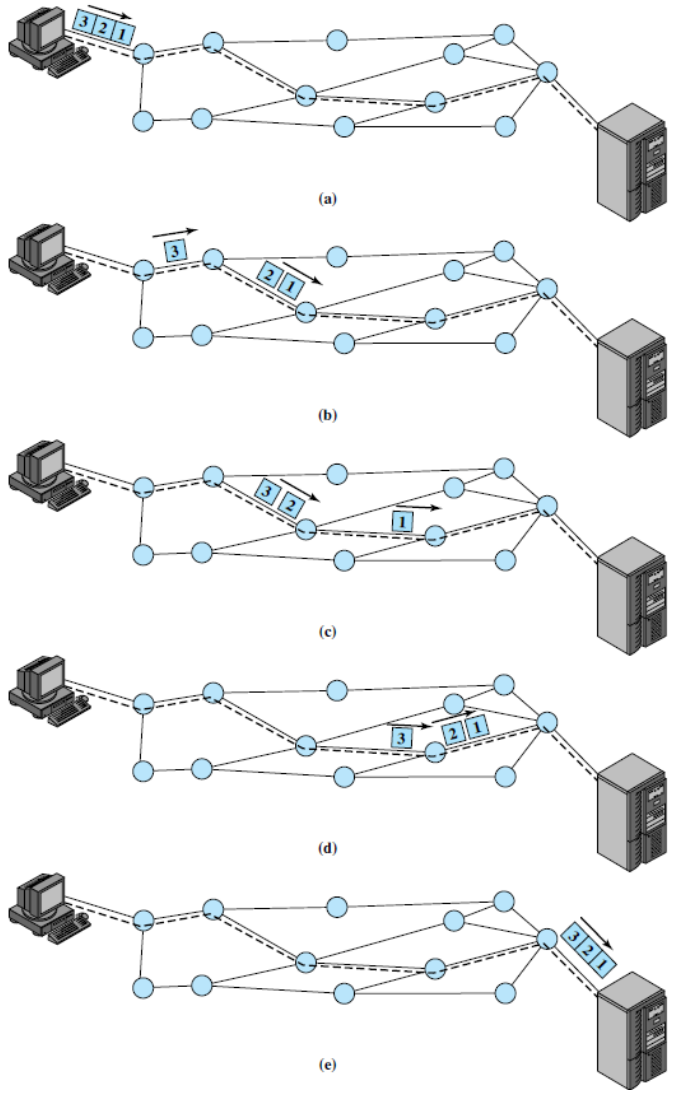
- **Datagram approach (connectionless)**
  - ✓Each packet is treated independently
  - ✓The packets do not all follow the same route
  - ✓The exit node or the destination node restores the packets to their original order
- Each packet must contain a destination address and possibly a source address
  - ✓Efficient for fairly long packets



Virtual circuit approach

- Connection-oriented
  - ✓Pre-defined route is established
  - ✓Exchange of control packets prior to the transfer of traffic
  - ✓All packets follow the same route
  - ✓Each packet contains data plus a virtual circuit identifier
  - ✓No routing decision

- **Any difference with circuit switching?**



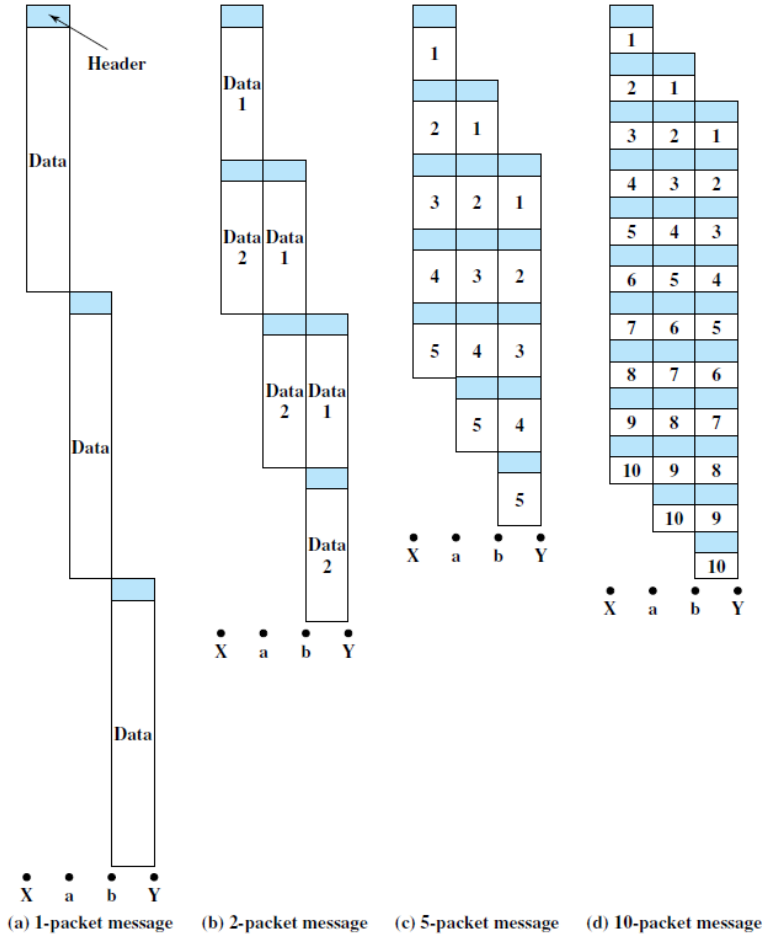
Virtual circuit approach

- If two stations wish to exchange **data over an extended period of time**, there are certain advantages to virtual circuits
  - ✓The network may provide services such as sequencing and error control
  - ✓Fast packet transfer

- But, datagram is preferred for exchanging only a few packets
  - ✓No call set up phase
  - ✓Also flexible and reliable

Packet size and transmission time

- Relation between packet size and transmission time
- E.g., assume a virtual circuit from station X to Y
  - ✓ Message to be sent 40 byte and 3 bytes control information
  - ✓ Break the message into two packet blocks
  - ✓ Continue decreasing the block size ?



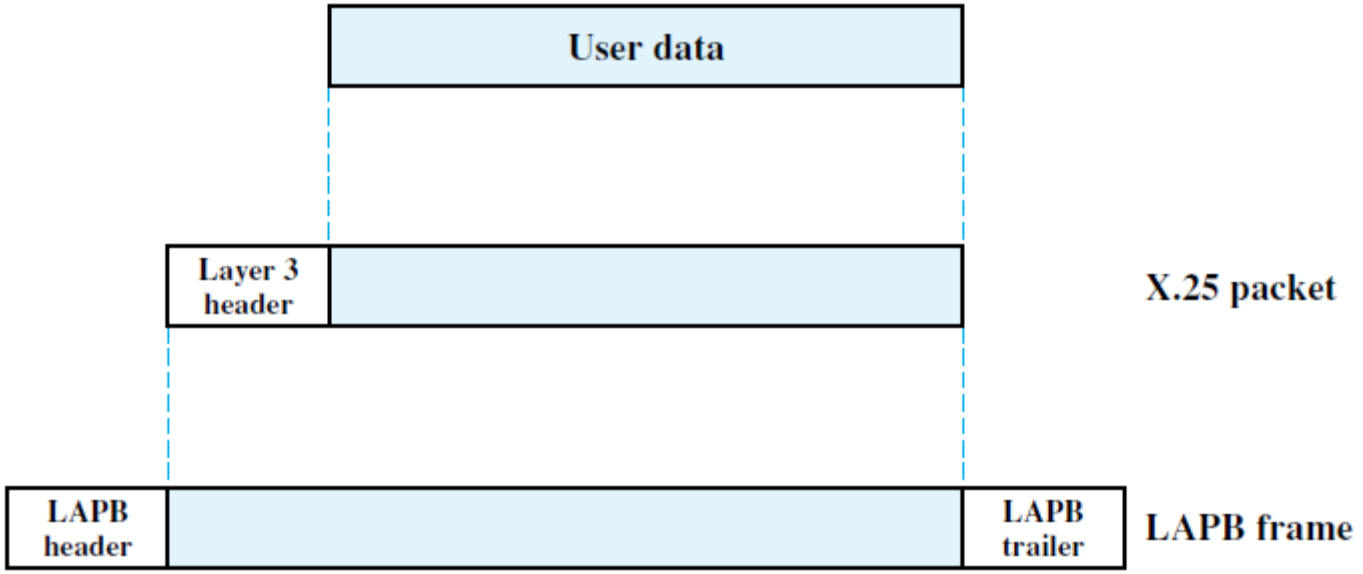
X.25

- A standard (ITU-T) used for traditional packet switching networks
- Specifies an interface between a host system and a packet switching network
  - ✓Set of protocols corresponding to the first three layers of OSI

- Physical layer
  - ✓Interface between stations and packet-switching network
  - ✓Use Physical layer specifications in X.25
- Link layer
  - ✓Reliable transmission of data between packet switches (link access protocol-balanced LAP-B)
- Packet layer
  - ✓Packet formats, control procedures to setup a call and exchange information
  - ✓logical connection between two stations through the network

X.25

- X.25 protocol control information



Frame relay networks: high speed networking

- Designed to provide a more efficient transmission scheme than X.25

- Key features of X.25
  - ✓ Call control packets are carried on the same channel and virtual circuit as data packet
  - ✓ Multiplexing of virtual circuits takes place at layer 3
  - ✓ Both layer 2 and layer 3 include flow control and error control mechanisms
    - Large overhead and slow down transmission

Great improvement on the reliability of physical circuits (e.g. bit error rate of a typical optical link is 10^{-8})

➢ **Remove unnecessary overhead**

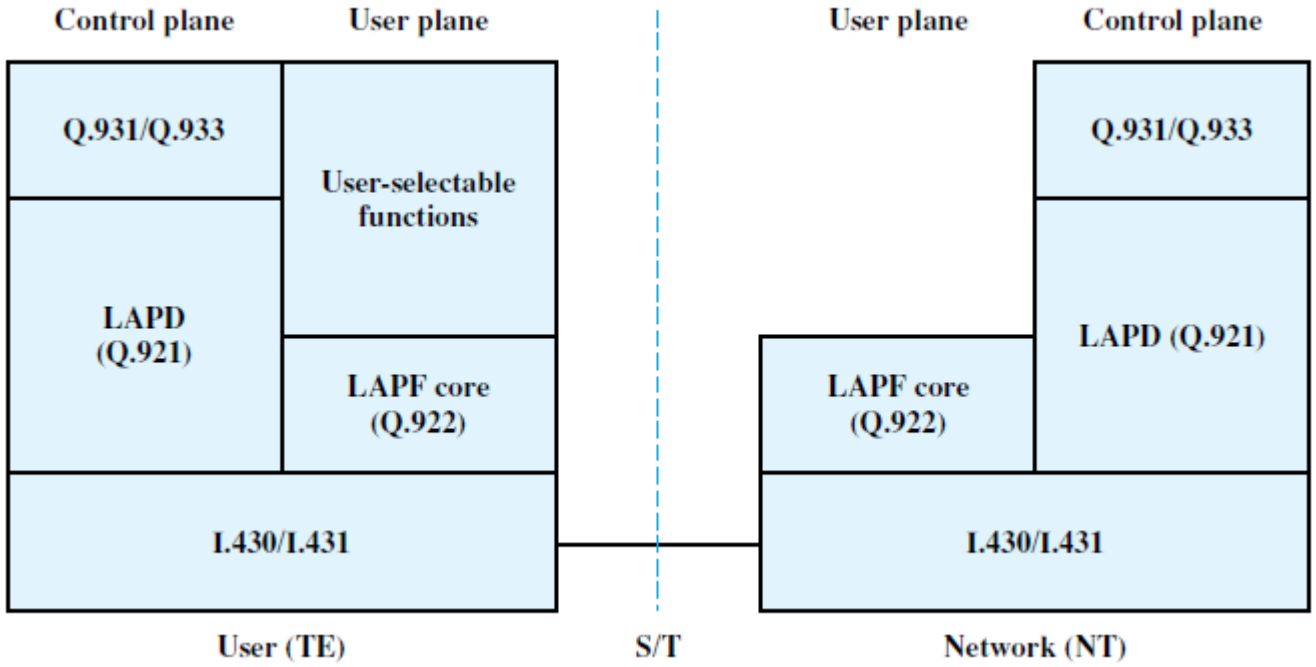
Frame relay

- Removes overhead that X.25 imposes and takes advantage of the improvement in transmission link

- Key differences
  - ✓Call control signaling on separate logical connection from user data
  - ✓Multiplexing/switching of logical connections at layer 2 (not layer 3)
  - ✓No hop-by-hop flow control and error control
    - Flow and error control are the responsibility of higher layers
  - ✓Throughput an order of magnitude higher than X.25

Protocol architecture

- Frame Relay has 2 layers: physical and data link (or LAPF)



Protocol architecture

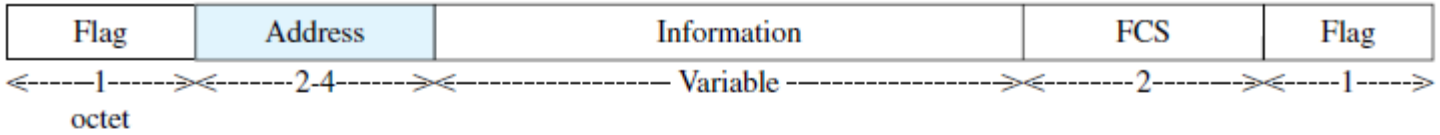
- Control plane
  - ✓Signaling over D channel
  - ✓Separate channel for control information
  - ✓At the data link layer LAPD (link access control –D channel) is used –for reliable data link control

- User plane
  - ✓For actual transfer of information
  - ✓LAPF(link access procedure for frame mode bearer service)
    - Detection of transmission errors
    - Virtual circuit multiplexing/demultiplexing
    - Frame delimiting, alignment and transparency
    - Congestion control function

Also functions of LAPD

User data transfer

- LAPF core protocol
  - ✓Similar to LAPD



(a) Frame format

8	7	6	5	4	3	2	1
Upper DLCI						C/R	EA 0
Lower DLCI				FECN	BECN	DE	EA 1

(b) Address field—2 octets (default)

8	7	6	5	4	3	2	1
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

(d) Address field—4 octets

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

(c) Address field—3 octets

EA	Address field extension bit
C/R	Command/response bit
FECN	Forward explicit congestion notification
BECN	Backward explicit congestion notification
DLCI	Data link connection identifier
D/C	DLCI or DL-CORE control indicator
DE	Discard eligibility

User data transfer

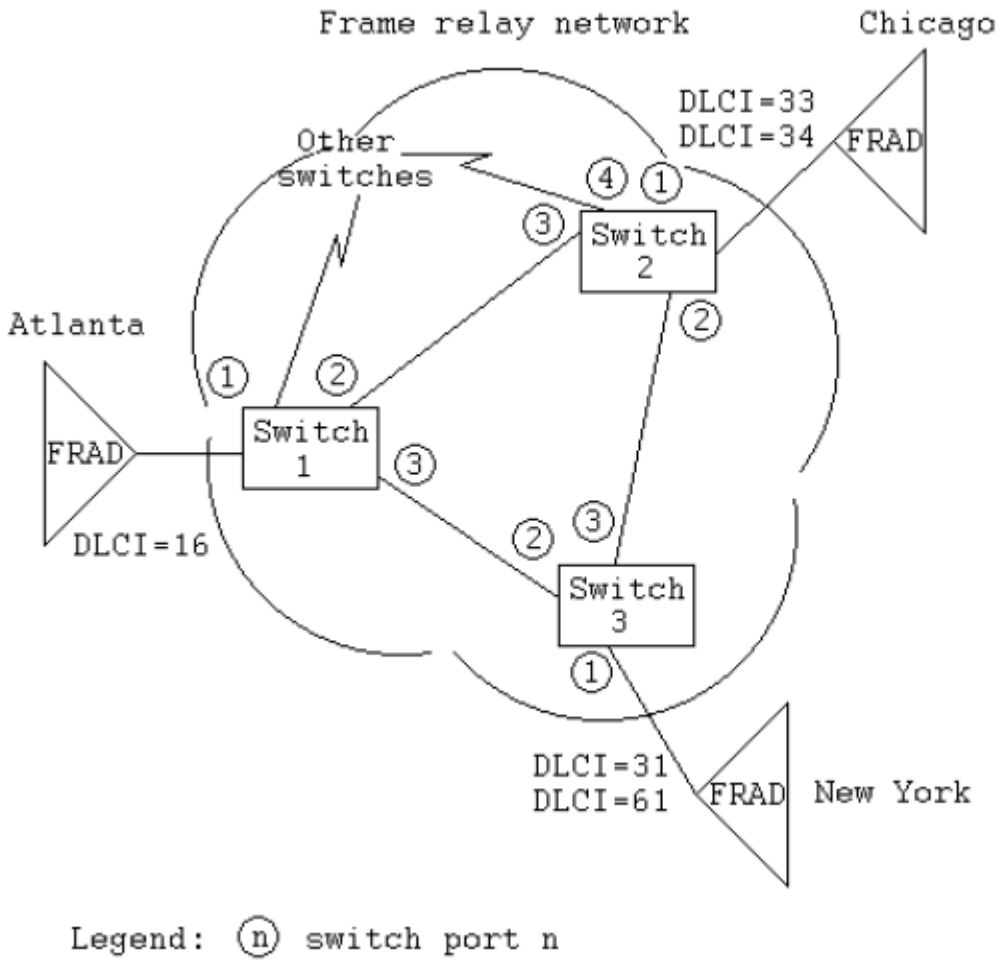
- No control field, which is normally used for
  - ✓Identify frame type (data or control)
  - ✓Sequence numbers
- Implication:
  - ✓Connection setup/teardown carried on separate channel
  - ✓Cannot do flow and error control

- Flags – mark the beginning and end of frame
- Address – 2 bytes (can be extended to 3 or 4 bytes)
  - ✓DLCI – same as the virtual circuit number
  - ✓Forward explicit congestion notification (FECN) and backward explicit congestion notification (BECN) – used as part of frame relay congestion control process

Congestion control

- Discard control (DE)
  - ✓When set, indicates that a frame should be discarded in preference to other
  - ✓Part of traffic management procedures
    - Committed burst size – the maximum amount of data that a network agrees to transfer under normal circumstance
    - Based on Committed information rate (CIR) – in the event of CIR being exceeded
      - Take no action, set the DE field, discard the frame immediately
- BECN
  - ✓Informs the sender that congestion has occurred
  - ✓The source - slow down to prevent the loss of packets
- FECN
  - ✓Congestion control in the direction of the data transmission
  - ✓The forward explicit congestion notification (FECN) bit can be set by any switch to indicate that traffic is congested
  - ✓The destination knows that it should expect delay or a loss of packets

DLCI



Input		Output	
Port	DLCI	Port	DLCI
1	16	3	xyz
3	abc	1	16

Frame relay call control

- Data transfer involves:
  - ✓Establish logical connection and DLCI
  - ✓Exchange data frames
  - ✓Release logical connection

- 4 message types needed
  - ✓SETUP
  - ✓CONNECT
  - ✓RELEASE
  - ✓RELEASE COMPLETE

Virtual circuit

- Permanent virtual circuit
  - ✓Permanently established connection
  - ✓No call setup and termination
  - ✓For frequent and consistent data transfers
- Switched virtual circuit
  - ✓Creates temporary short connection
  - ✓Establishing by sending signaling messages to the network