SET 4573: Data Communication and Switching System

Chapter 6: Wide Area Network

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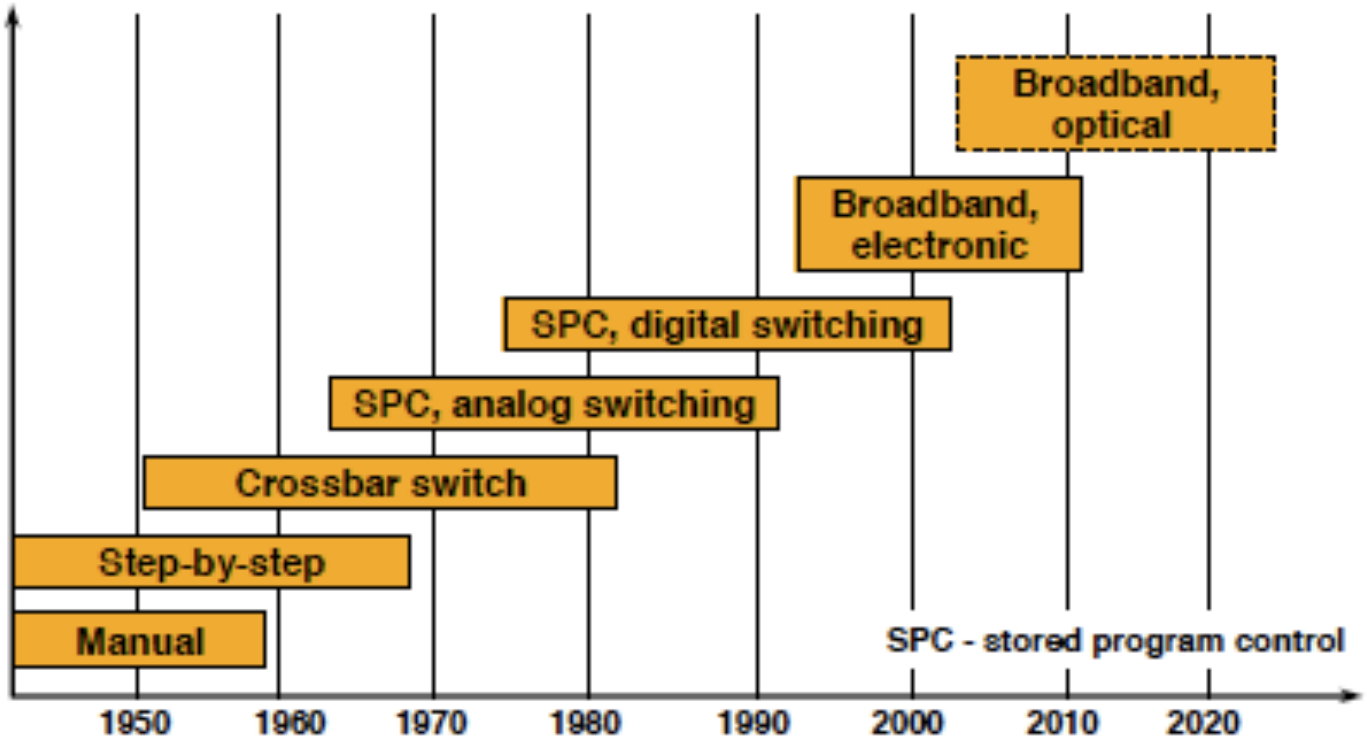
Wide Area Network (WAN)

- WAN is a network that cover broad area including regional or national boundaries consisting of private and public Service Providers.
- A good example is Internet which cover the whole world that works based on TCP/IP protocols
- WAN uses X.25, Frame Relay, ATM etc. for connectivity over longer distance
- WAN works based on two different switching technologies
  - circuit switching
  - packet switching

Circuit Switching

- Uses a dedicated path between two stations
- Designed for voice communication
- Utilizes 3-phases connection
  - Link establishment or link setup
  - Data transfer
  - Link disconnection
- Disadvantages
  - channel capacity is dedicated for duration of connection
  - if no data is to be transmitted, capacity wasted due to non-sharing link
- Link set up (connection) takes time and increases the latency

Development of switching technologies



Source: *Understanding Telecommunications* 1, Ericsson & Telia, Studentlitteratur, 2001.

Packet Switching

- Packet Switching was designed for data communication
- Messages are transmitted in small packets
- Packets contains user data and control info
  - user data may be part of a larger message
  - control info includes routing (addressing) info, error checking, etc.
- packets are received, stored briefly (buffered) and past on to the next node (store and forward)

Advantages of Packet Switching

- Good line efficiency
  - single link shared by many packets from different users
  - packets queued and transmitted as fast as possible
- Multiplexing is possible for both slow and high data rate transmission
- Priorities can be used for different kind of traffics

Packet Switching Techniques

- Large and long messages are broken into smaller packets
- Packets can be transmitted in two ways in packet-switched network
  - virtual circuit
    - Frames follow dedicated path setup before transmission
    - The path can be shared
  - Datagram
    - No dedicated path established

Virtual Circuits vs Datagram

Virtual Circuits

- network can provide sequencing and error control
- a dedicated path is established before packet transmission
- more reliable due to dedicated path

- Datagram
  - dedicated path is not established prior the transmission
  - more flexible as the packet travel on its independent route
  - less reliable due to no error and flow control

Examples of Packet Switching Protocol and Technologies

- Among the technologies used in Packet Switching
  - TCP/IP
  - X.25
  - Frame Relay
  - ATM

TCP/IP

- TCP/IP is the basis of Internet which has 2 main protocols
  - TCP/UDP
  - IP
- TCP/IP is described in detail in Chapter 7 and 8

X.25

- ITU-T standard for interface between host and packet switched network
- An universal on packet switched networks and packet switching in ISDN
- Defines three layers (in OSI model)
  - Physical
  - Data Link
  - Packet

X.25 - Physical

- Interface between station node link covering
  - Data Terminal Equipment DTE (user equipment)
  - Data Circuit-terminating Equipment DCE (node)
- Physical layer specification is X.21 (CCITT)

X.25 – Data Link

- Link Access Protocol Balanced (LAPB)
  - Subset of HDLC
- Provides reliable transfer of data over link

X.25 – Packet

- Provides a logical connections (virtual circuit) between users
- Is implementing network layer, Layer 3 of OSI
- Established on demand

Issues with X.25

- Key features include:
  - call control packets, in band signaling
  - multiplexing of virtual circuits at layer 3
  - layers 2 and 3 include flow and error control, thus redundancy
  - hence have considerable overhead
  - not appropriate for modern digital systems with high reliability

Frame Relay

- Uses the frame structure similar to LAPD
- The frame header contains DLCI field- destination address of the frame
- Uses VC
  - Permanent VC (PVC)
  - Switched VC (SVC)
- Designed to eliminate most X.25 overhead
- Key differences:
  - call control carried in separate logical connection
  - multiplexing and switching done at layer 2
  - no error or flow control at layer 2:
    - flow and error control (if used) are done by higher layer

Frame Relay-frame format

Flag	Frame Relay Header (2-octet)	Information	FCS	Flag

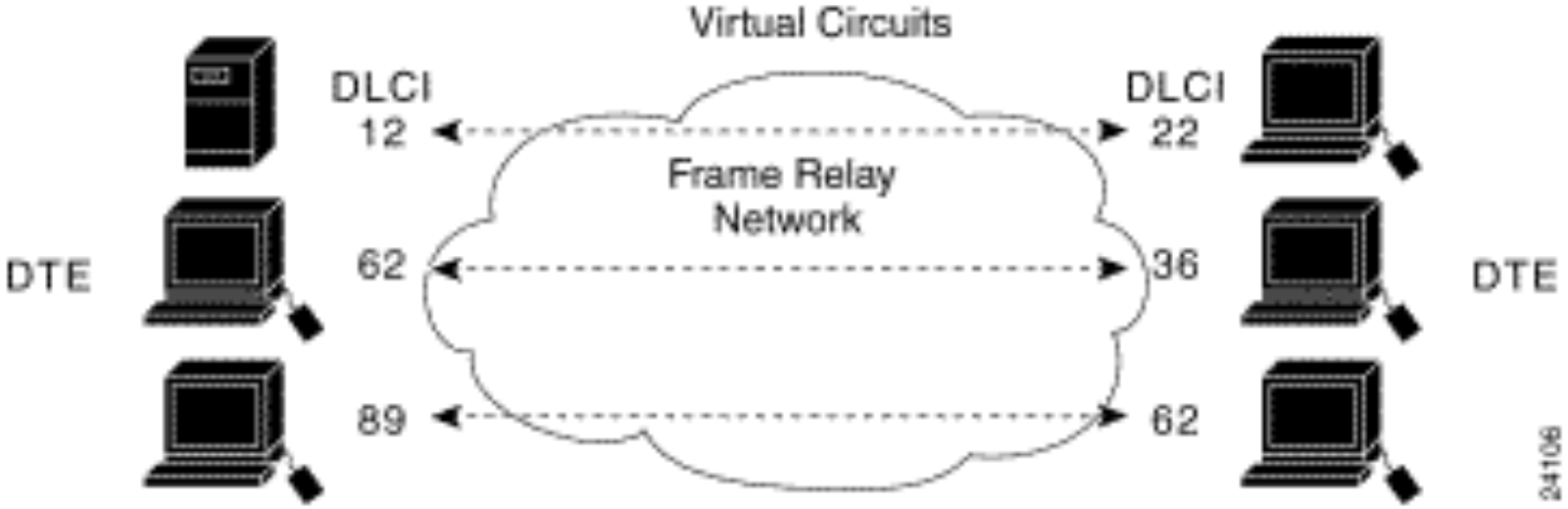
Frame Relay Header

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

Frame Relay header

- DLCI (Data Link Connection Identifier)
  - 10-bit DLCI field represents the address of the frame and the corresponds PVC
- FECN
  - Forward Explicit Congestion Notification (ECN)
- BECN
  - Backward ECN
- ECN bit
  - Frames get discarded when congested
  - FECN is changed to 1 as a frame is sent toward destination when congestion occur
    - To inform destination about the congestion
  - BECN is change to 1 as the frame is travelling back to sender when congestion occur
    - Source will slow down sending frame

Data Link Connection Identifier



Advantages and Disadvantages

- Advantages
  - increased reliability
  - lower delay-no flow control
  - higher throughput-no error checking field
- Disadvantage
  - lost link by link error and flow control-due to no error and flow control

Frame Relay vs. X.25

- Call Control
  - X.25 connection establishment and release (call control) use in-band signaling within the same virtual channel used for user data transmission causing additional overhead.
  - Frame Relay call control uses separate virtual channels identified by reserved DLCI
- Routing vs. Switching
  - X.25 performs packet switching on OSI layer 3 (network layer)
  - Frame Relay performs packet switching on OSI layer 2 (data-link). Frame Relay does not use any layer 3 protocol.
- Flow Control
  - Frame Relay doesn't perform flow control between frame handlers
  - X.25 routers have to acknowledge each frame; in case of frame errors frames have to be retransmitted and acknowledged.
  - Frame Relay relies on flow control performed by higher layer protocols.