جامعة الأهرام الكندية
AHRAM CANADIAN UNIVERSITY

Lecture (5)
Packet switching & Frame Relay techniques (II)

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Agenda

- Packet switching protocol layers (X.25)
- Frame Relay

Packet switching protocol layers (X.25)

- Circuit switching network provides a transparent communications path for attached devices that makes it appear that the two communicating stations have a direct link.
- packet-switching networks, the attached stations must organize their data into packets for transmission.
- This requires a certain level of cooperation between the network and the attached stations
- The standard used for traditional packet-switching networks is X.25, which is an ITU-T standard

- The functionality of X.25 is specified on three levels:
  - Physical layer,
  - Link layer, and
  - Packet layer.

1. The Physical layer

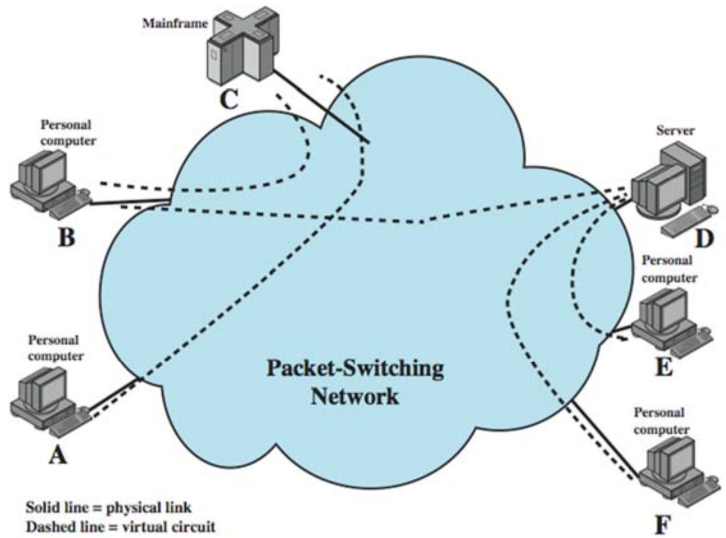
- interface between station node link
- two ends are distinct
  - Data Terminal Equipment DTE (user equipment)
  - Data Circuit-terminating Equipment DCE (node)
- physical layer specification is X.21
- can substitute alternative such as EIA-232

2. The link layer (link control layer)

- referred to as LAPB (Link Access Protocol - Balanced).
- sending data as a sequence of frames.
- provides reliable (error control) transfer of data over link.

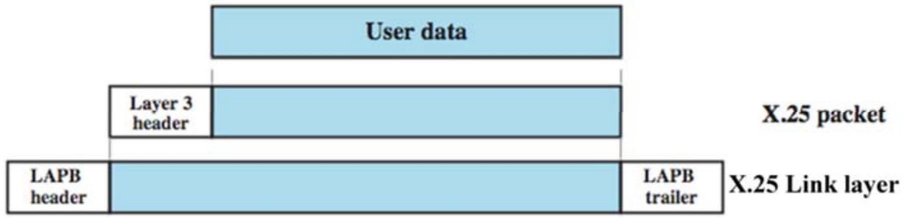
3. The packet layer

- provides a External virtual circuit service, enabling any subscriber to the network to set up logical connections, called virtual circuits, to other subscribers.
- “virtual circuit“ refers to the logical connection between two stations through the network;
- X.25 can transfer datagrams, through the virtual circuit (data associated with that logical channel), after its establishment



- Last figure shows an example of X.25 virtual circuits
- station A has a virtual circuit connection to C; station B has two virtual circuits established, one to C and one to D; and stations E and F each have a virtual circuit connection to D.
- As an example of how these external virtual circuits are used, station D keeps track of data packets arriving from three different workstations (B, E, F) on the basis of the virtual circuit number associated with each incoming packet.

X.25 packet



Steps

- User data are passed down to X.25 level 3, which appends control information as a header, creating a packet.
- This control information do
  - identifying by number a particular virtual circuit with its associated data,
  - providing sequence numbers that can be used for flow and error control on a virtual circuit basis.
- X.25 packet is then passed down to the LAPB entity, which appends control information at the front and back of the packet the control information in the frame is needed for the operation of the LAPB protocol.

- Each X.25 data packet includes send and receive sequence numbers.
- The send sequence number, P(S), for all outgoing data packets on a particular virtual circuit.
- The receive sequence number, P(R), is an acknowledgment of packets received on that virtual circuit.
- Packets then delivered to physical layer to be transferred through terminals.

key features of the X.25

The following are key features of the X.25 approach:

1. Call control packets, used for setting up and clearing virtual circuits, are carried on the same channel and same virtual circuit as data packets.
2. Multiplexing of virtual circuits takes place at layer 3.
3. Both layer 2 and layer 3 include flow control and error control mechanisms.

Conclusions

- The X.25 approach results in considerable overhead.
- At each hop through the network, the data link control protocol (layer 2) involves the exchange of a data frame and an acknowledgment frame.
- At each intermediate node, state tables must be maintained for each virtual circuit to deal with the call management and flow control/error control aspects of the X.25 protocol.
- All of this overhead may be justified when there is a significant probability of error on any of the links in the network.
- This approach is not suitable for modern digital communication facilities.

Summary

1. Layer 1: physical layer
2. Layer 2: link layer
   - Error checking @ intermediate nodes.
3. Layer 3: packet layer
   - Virtual circuit identification (multiplexing) (Addressing)
   - Reliability using sequencing and acknowledgment packet (end2end)

- All the three layers implemented in all intermediate nodes and end user equipments
- Data and control share same logical path

Frame relay

- The modern transmission technology are able (ex: fiber optics) are
  - Reliable
  - high quality
  - High data rate
- the overhead of X.25 is not only unnecessary but degrades the effective utilization of the available high data rates
- Frame relay is designed to eliminate much of the overhead that X.25 imposes on end user systems and on the packet-switching network.

Differences between frame relay and a conventional X.25 packet-switching service are:

- Call control signaling, (needed to set up and manage a connection), is carried on a separate logical connection from user data.
- Thus, intermediate nodes need not maintain state tables or process messages relating to call control on an individual per-connection basis.
- Multiplexing and switching of logical connections takes place at layer 2 instead of layer 3, eliminating one entire layer of processing.

- There is no hop-by-hop flow control and error control.
- End-to-end flow control and error control are the responsibility of a higher layer, if they are employed at all (layer 3 in not implemented in switched nodes only layer 2 which speed up switching node).

- with frame relay, a single user data frame is sent from source to destination, and an acknowledgment, generated at a higher layer, may be carried back in a frame.
- There are no hop-by-hop exchanges of data frames and acknowledgments.

Disadvantage

Doesn't provide link-by-link flow and error control

Solved by

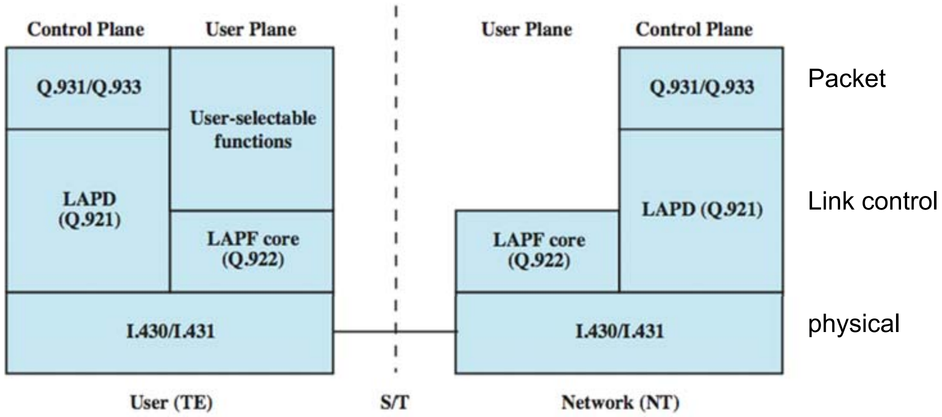
- increasing reliability of transmission and switching facilities,
- Flow and error control provided by higher layer

Advantage

- Reduced control functionality of in user network interface, and in internal network.
- Lower delay
- higher throughput

- frame relay achieved an access speeds up to 2 Mbps.
- frame relay service at even higher data rates is now available.

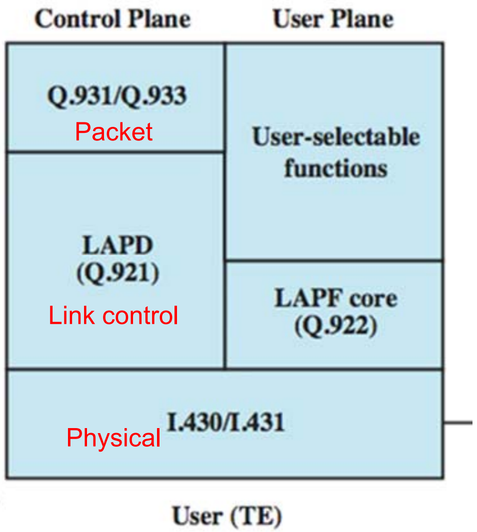
Frame relay Protocol Architecture



- Protocol contains two separate planes of operation:
  - control (C) plane,
    - between a subscriber and the network
    - Responsible of establishment and termination of logical connections,
  - user (U) plane,
    - end-to end functionality
    - which is responsible for the transfer of user data between subscribers.
- That means, a separate logical channel is used for control information.

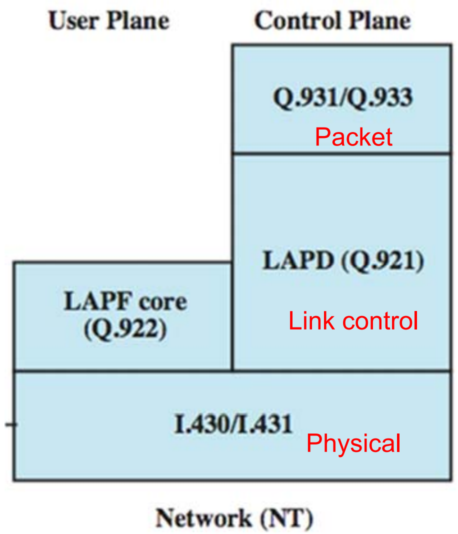
User& network/Control plane:

- Packet layer: Uses Q.933 control signaling messages for actual transfer of information between end users (end2end sequencing and error recovery)
- In link control layer LAPD (Q.921) is used to provide a reliable data link control service, with error control and flow control, between user (TE) and network (NT).
- Physical layer uses I.430/I431 signaling



Network/ User Plane:

- Physical layer uses: I.430/I431 signaling
- Link control layer: uses LAPF (Link Access Procedure for Frame) known as Q.22 protocol to
  - ensure frame is neither too long nor short
  - detection of transmission errors

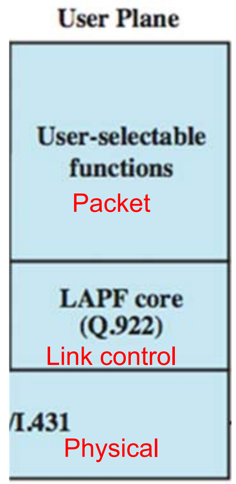


– congestion control functions
– frame mux and demux using addressing field
– ensure frame is integral number of octets

- The core functions of LAPF in the user/network plane constitute a sub-layer of the link layer.
- This provides the bare service of transferring data link
- frames from one subscriber to another, with no flow control or error control.

User/ user plan:

- the user may choose to select additional data link or network-layer end-to-end functions.
- These are not part of the frame relay service. Based on the core functions, a network offers frame relay as a connection-oriented link layer service with the following properties:
  – Preservation of the order of frame transfer from one edge of the network to the other
  – A small probability of frame loss

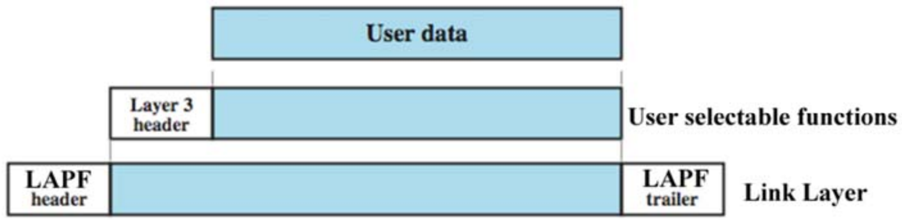


data link connections

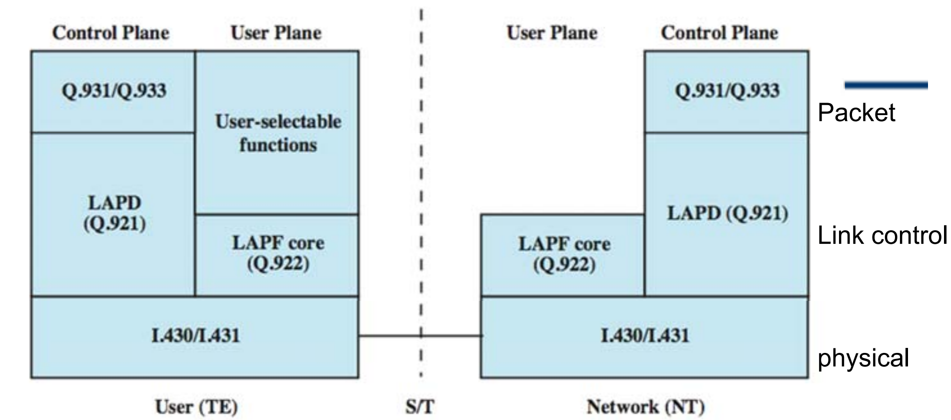
- Frame relay uses data link connections rather than virtual circuits which used by X.25
- data transferred over them
- not protected by flow or error control
- uses separate connection for call control (unlike x.25)

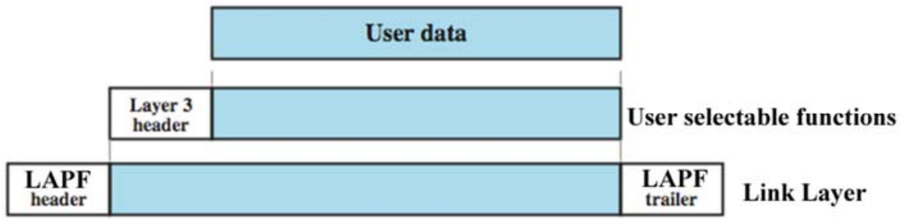
frame format

- LAPF header, doesn’t contain Control field, which means there is only one frame type, used for carrying user data.
- no sequence numbers.
- Contains
  – Flag and Frame Check Sequence (FCS) fields



- The information field carries higher-layer data.
- The address field has a default length of 2 octets and may be extended to 3 or 4 octets.
- It carries a data link connection identifier (DLCI) of 10, 16, or 23 bits.
- The DLCI serves the same function as the virtual circuit number in X.25.
- As in X.25, the connection identifier has only local significance: Each end of the logical connection assigns its own DLCI from the pool of locally unused numbers, and the network must map from one to the other.





Summary

1. Layer 1: physical layer (link between intermediate nodes)
2. Layer 2: link layer (intermediate nodes & end user terminal)
   - Error checking
   - logical data link connection identifier (DLCI) (multiplexing)
3. Layer 3: packet layer (end user only for data , intermediate nodes & end user terminal for control)
   - User defined function (for data)
   - Acknowledgement & sequencing & error recovery (for control) (per hop)

Thanks,…