

Connection-mode service

✍ Services primitives:

» RESET:

- DL-RESET.request
- DL-RESET.indication
- DL-RESET.response
- DL-RESET.confirm

✍ Flow control

- » Provides locally by each LLC entity

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Acknowledged Connectionless Service

- ✍ A mechanism by which a user can send a unit of data and receive an acknowledgement of successful delivery
- ✍ Still, no connection set up

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Services primitives

✎ Primitives:

- » DL-DATA-ACK (includes Request & indication)
- » DL-DATA-ACK-STATUS-indication
 - provides acknowledgement to the sender whether the data unit was received successfully
- » DL-REPLY
 - a poll of guaranteed response
 - provide a data exchange service (returned from remote station, or to be exchanged with a remote station)
- » DL-REPLY-UPDATE

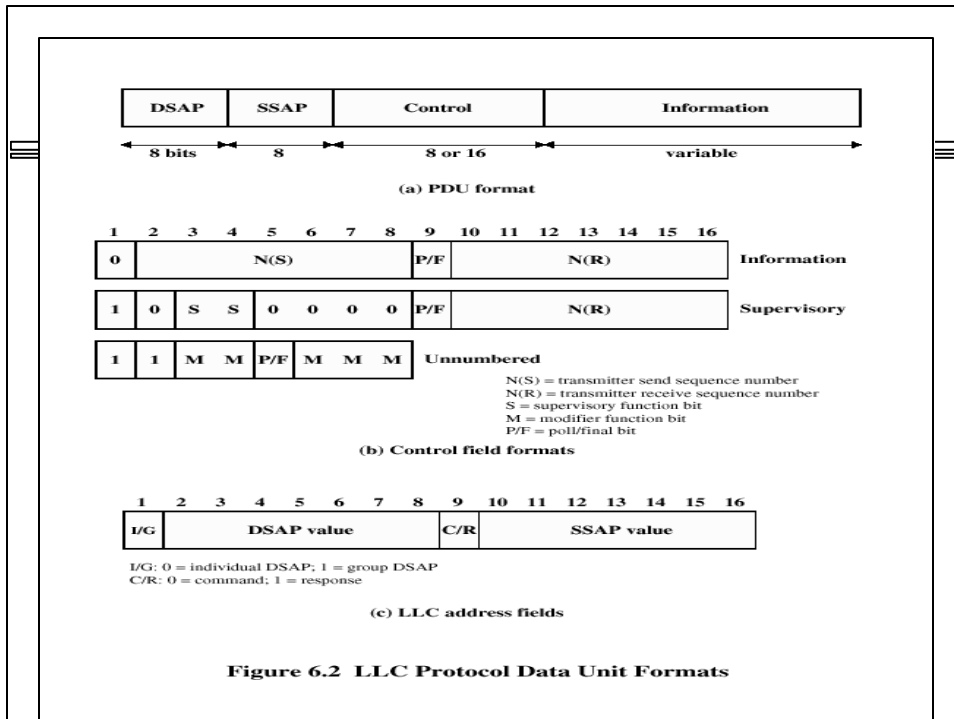
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LLC Protocols (Types)

- ✎ Type 1 operation
 - » Supports unacknowledged connectionless services
- ✎ Type 2 operation
 - » Supports connection-mode service
- ✎ Type 3 operation
 - » Support acknowledged connectionless service
- ✎ A station on LAN may support more than one type of operation

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Type of LLC	LLC Classes			
	I	II	III	IV
1	X	X	X	X
2		X		X
3			X	X



Control field

Information

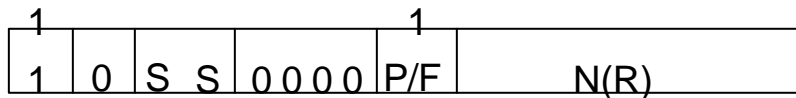


- ✎ N(S): source's PDU sequence number
- ✎ N(R): piggybacked acknowledgment sequence number
- ✎ P/F: command/response

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Control field

Supervisory:

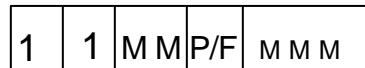


- ✎ Flow and error control
- ✎ 2-bit S field to distinguish three PDUs:
 - » Receive Ready (RR)
 - » Receive Not Ready (RNR)
 - » Reject (REJ)

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Control field

✍ Unnumbered



✍ Various protocol control PDUs

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Type 1 Operation

✍ UI (unnumbered I nformation)

✍ Management functions

» XID (exchange information; type of operation, window size)

- If DSAP & SSAP are null, it indicates the LLC entity's type of operation

- If DSAP & SSAP exist, then it is specific for that SAP

» TEST

- To test the transmission path between two LLC entities

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Type 2 Operation: Connection establishment

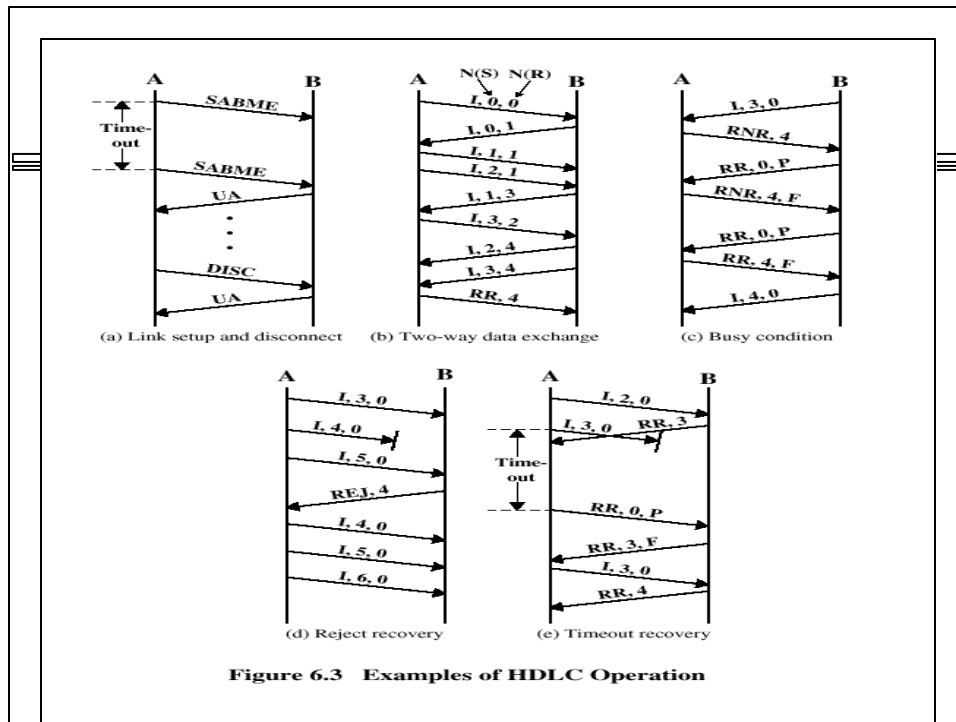
- ✎ The user send a Set Asynchronous Balanced Mode Extended (SABME) PDU
- ✎ If it is accepted, the destination sends Unnumbered Acknowledgment (UA) PDU
 - » The logical connection is uniquely identified by the pair of user SAPs
- ✎ If it is rejected, the destination sends a Disconnect Mode (DM) PDU

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Type 2 Operation: Data Transfer

- ✎ The user send a Set Asynchronous Balanced Mode Extended (SABME) PDU
- ✎ If it is accepted, the destination sends Unnumbered Acknowledgment (UA) PDU
 - » The logical connection is uniquely identified by the pair of user SAPs
- ✎ If it is rejected, the destination sends a Disconnect Mode (DM) PDU

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Type 3 Operation

- ✧ Acknowledged Connectionless
- ✧ Operation:
 - » User data sent using AC command PDU
 - » Must be acknowledged using AC response PDU
 - » A 1-bit sequence number is used to guard against lost PDU
 - » Sender alternates in using this 1-bit (0 or 1)
 - » Receiver uses the opposite (1 or 0)
 - » Only one outstanding PDU in each direction

Summary of Flow Control

- ✍ A technique for assuring that a transmitting entity does not overwhelm a receiving entity
- ✍ Used in both Connection-Oriented and Acknowledged Connectionless services
- ✍ Stop-and-Wait flow control
- ✍ sliding-Window Flow control

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Stop-and-Wait

- ✍ The simplest form of flow control
- ✍ Supports Acknowledged Connectionless LLC service
- ✍ Operation:
 - » a transmitting entity sends its PDU
 - » an acknowledgment is sent by the receiving entity to indicate its willingness to receive another PDU
- ✍ it works fine
- ✍ Major design issue:
 - » the ratio between the link-bit length and PDU length

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Sliding-Window

- ✎ The receiving entity (B) allocates buffer space for W PDUs
- ✎ The transmitting entity (A) is allowed to send W PDUs without waiting for acknowledgment
- ✎ Each frame is labeled with a sequence number
- ✎ B sends an acknowledgment announcing the next expected PDU

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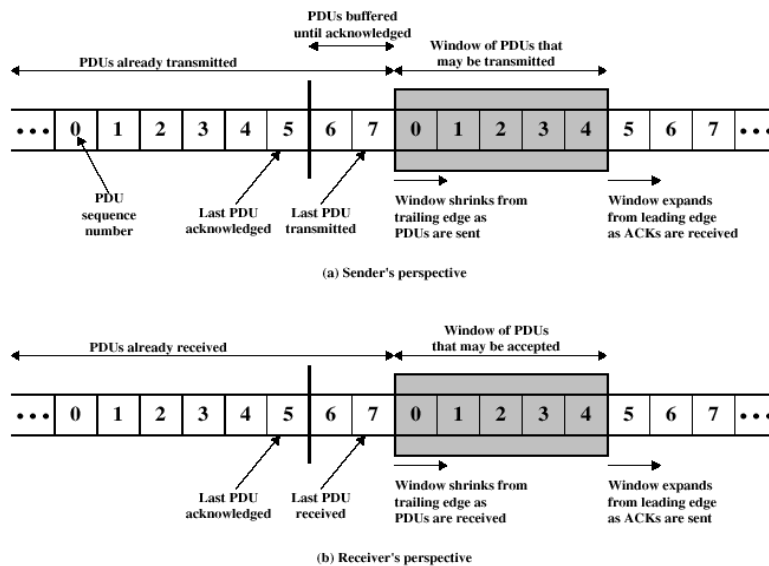


Figure 6.7 Sliding-Window Depiction

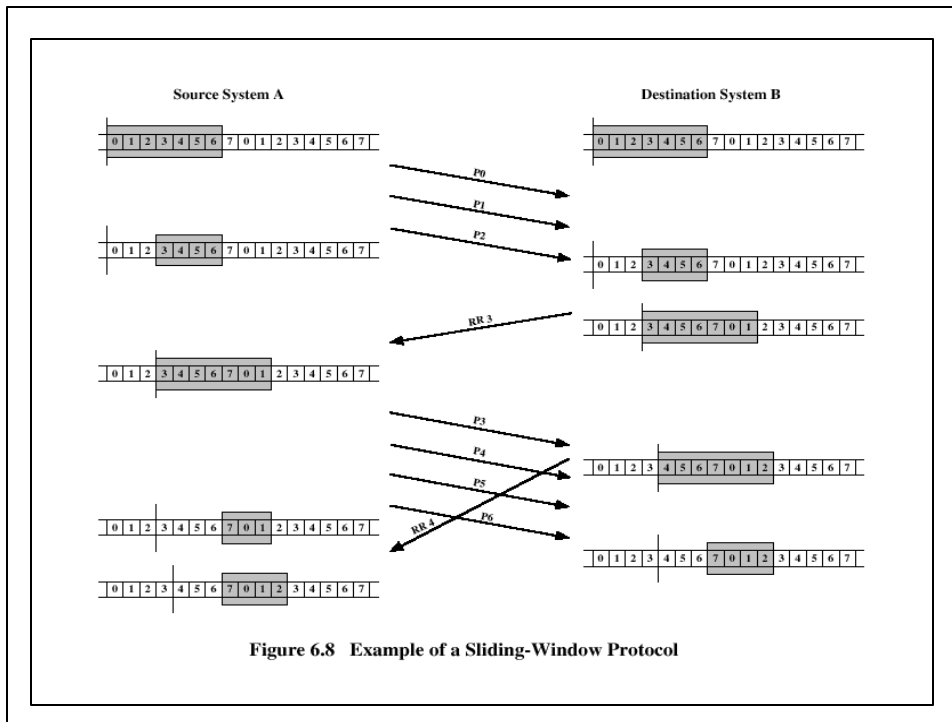


Figure 6.8 Example of a Sliding-Window Protocol

Error Control

- ✍ Mechanisms to detect and correct error in the transmitted PDUs
- ✍ Lost PDU
 - » Fails to arrive
- ✍ Damaged PDU
 - » Arrived at the other end but some bits are in error

Error Control (Cont.)

- ✎ The receiving end feedback
 - » Positive acknowledgment
 - » Retransmission after timeout
 - » Negative acknowledgement and retransmission
- ✎ Automatic Repeat Request (ARQ)
 - » It turns an reliable data link into a reliable one
- ✎ LLC standard supports:
 - » Stop-and-wait ARQ
 - » Go-back-N ARQ

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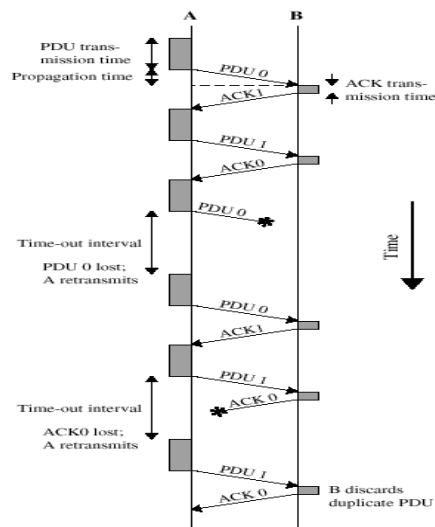
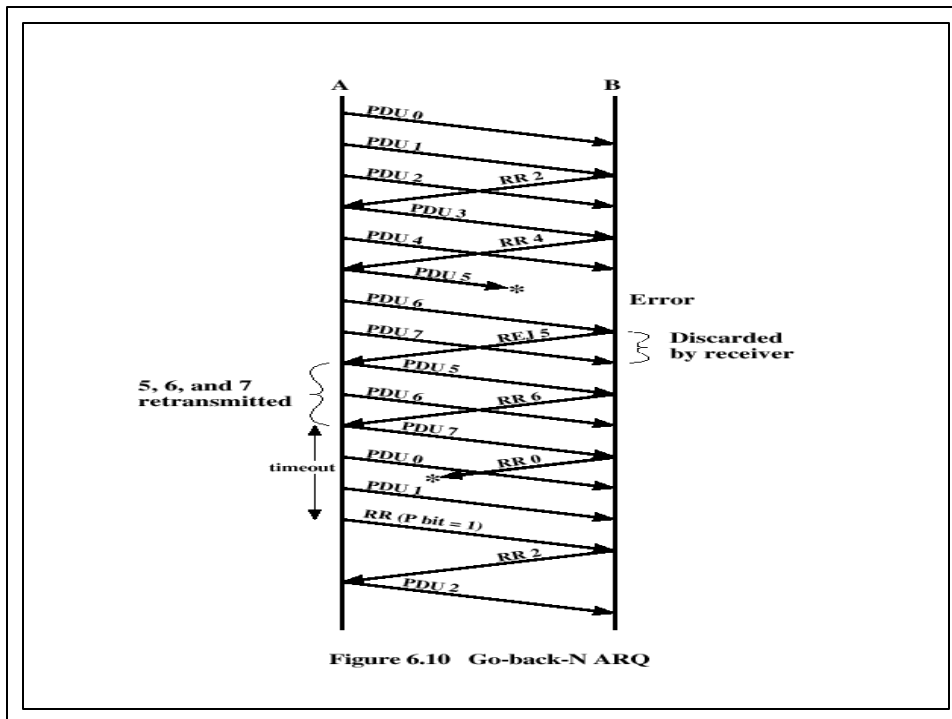


Figure 6.9 Stop-and-Wait ARQ



Assignment # 3

- ✍ Chapter 6:
- ✍ Problems: 1, 2, 3, 4
- ✍ Due date: Sunday 24/01/14 23 H
- ✍ Quiz on the same day

Chapter 7: LAN/MAN Systems

- ✍ Ethernet
- ✍ Token Ring
- ✍ Fiber channel
- ✍ Wireless LANs
- ✍ ATM LANs