Data Communication (CSX-208)

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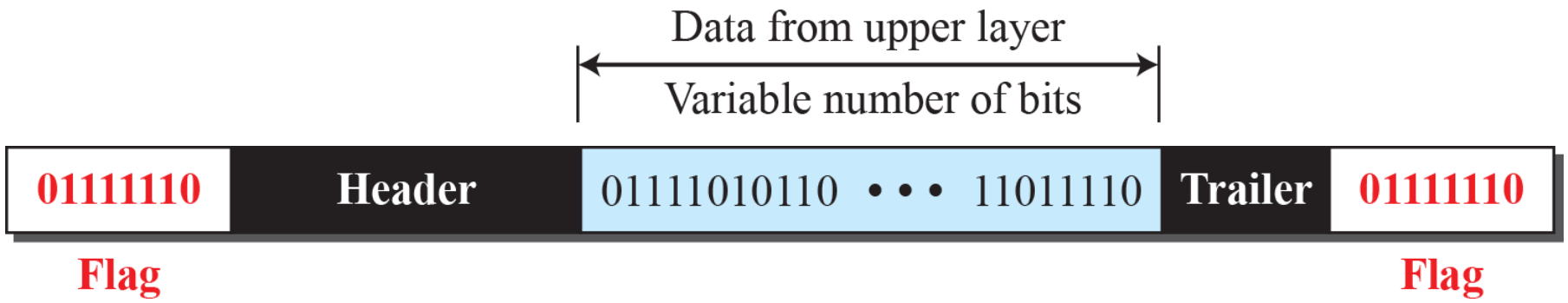
Data Link Layer

Framing, Flow Control

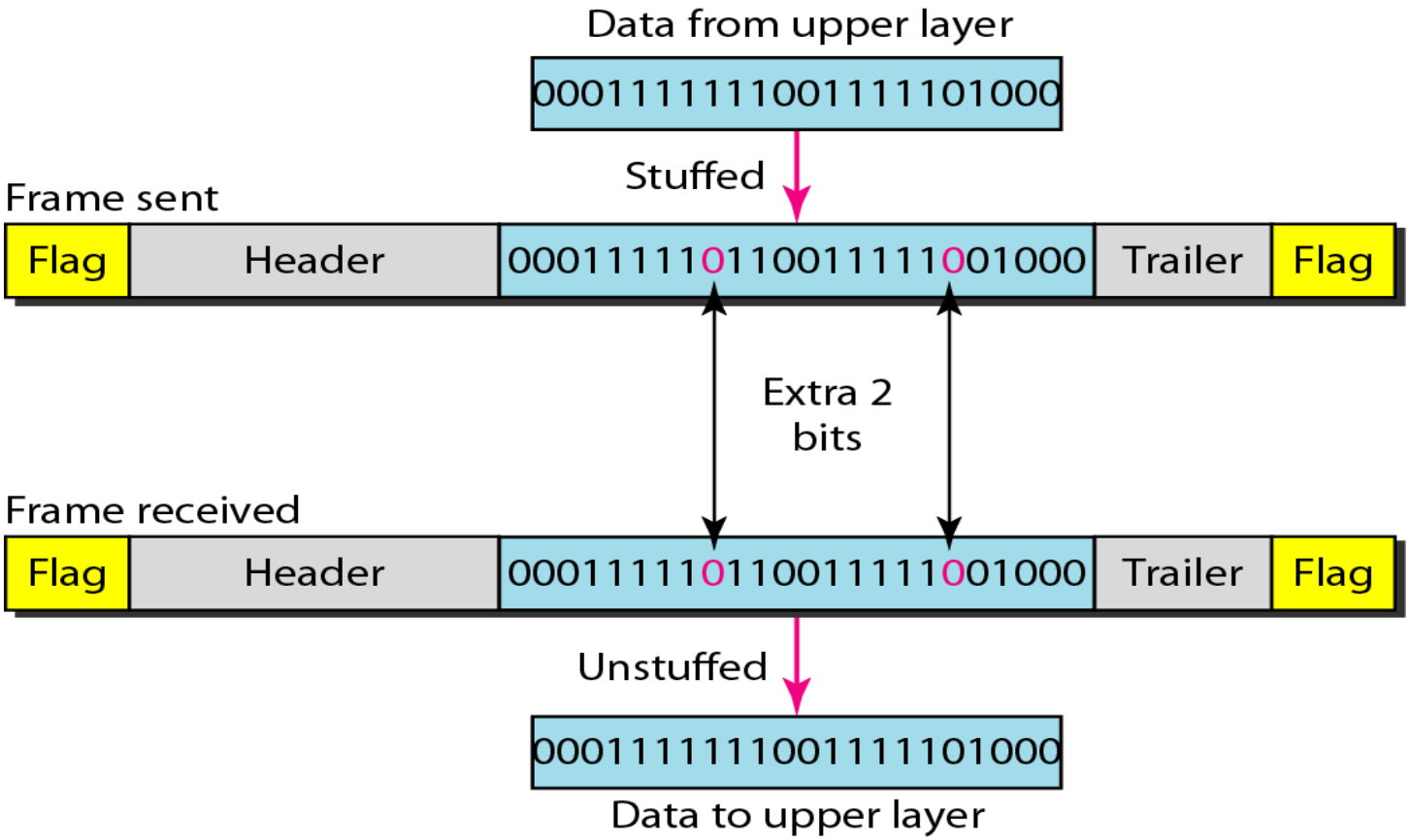
Data Link Layer

- Data link layer is divided into two sub-layers: Data Link Control (DLC) and Multiple Access Control (MAC).
- The data link control needs to pack bits into frames, so that each frame is distinguishable from another.
- Our postal system practices a type of framing. The simple act of inserting a letter into an envelope separates one piece of information from another; the envelope serves as the delimiter.
- Types of framing:
  - Fixed-Size Framing
  - Variable-Size Framing

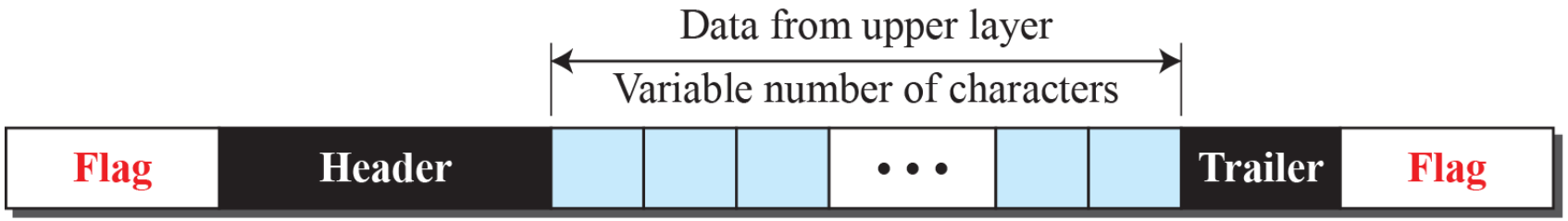
A frame in a bit-oriented protocol



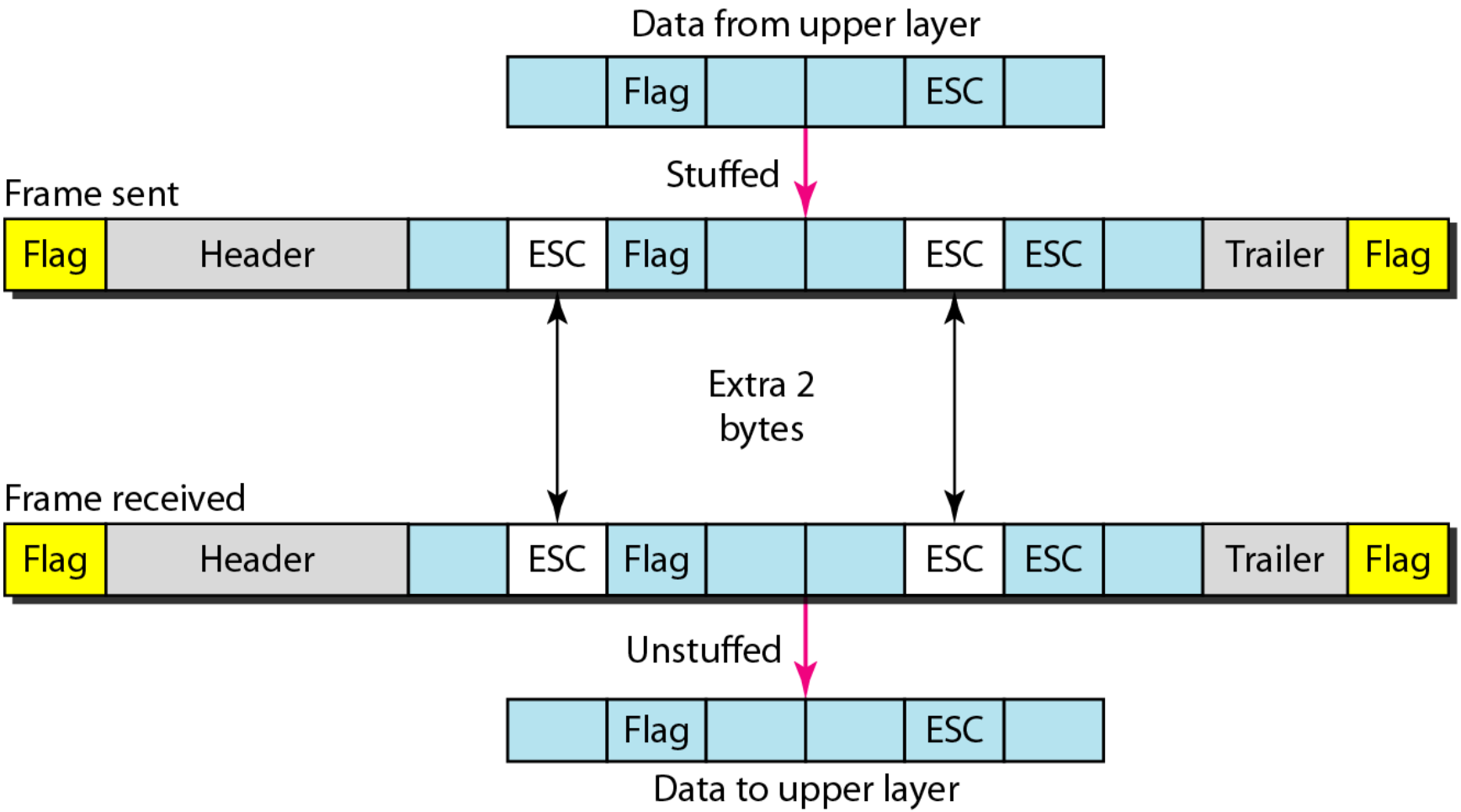
Variable-Size Framing: Bit Stuffing and Unstuffing



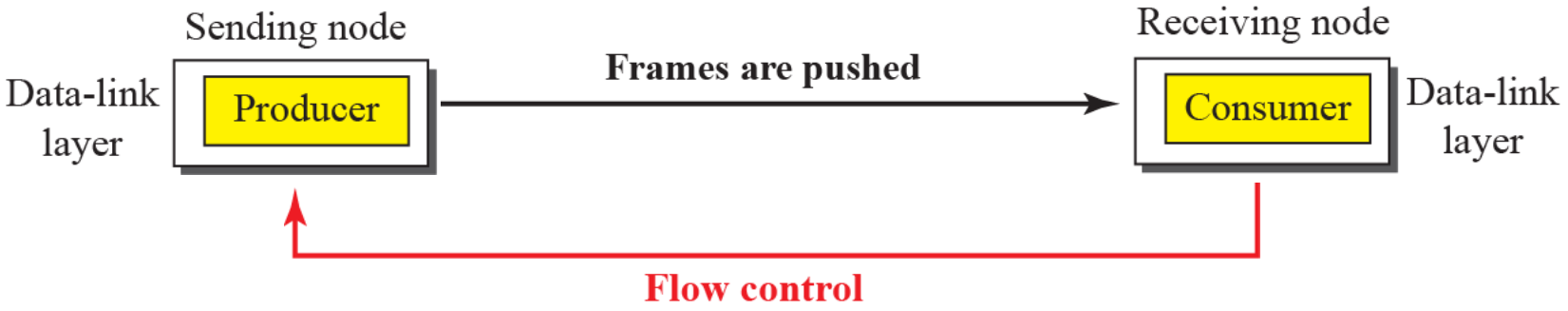
A frame in a character-oriented protocol



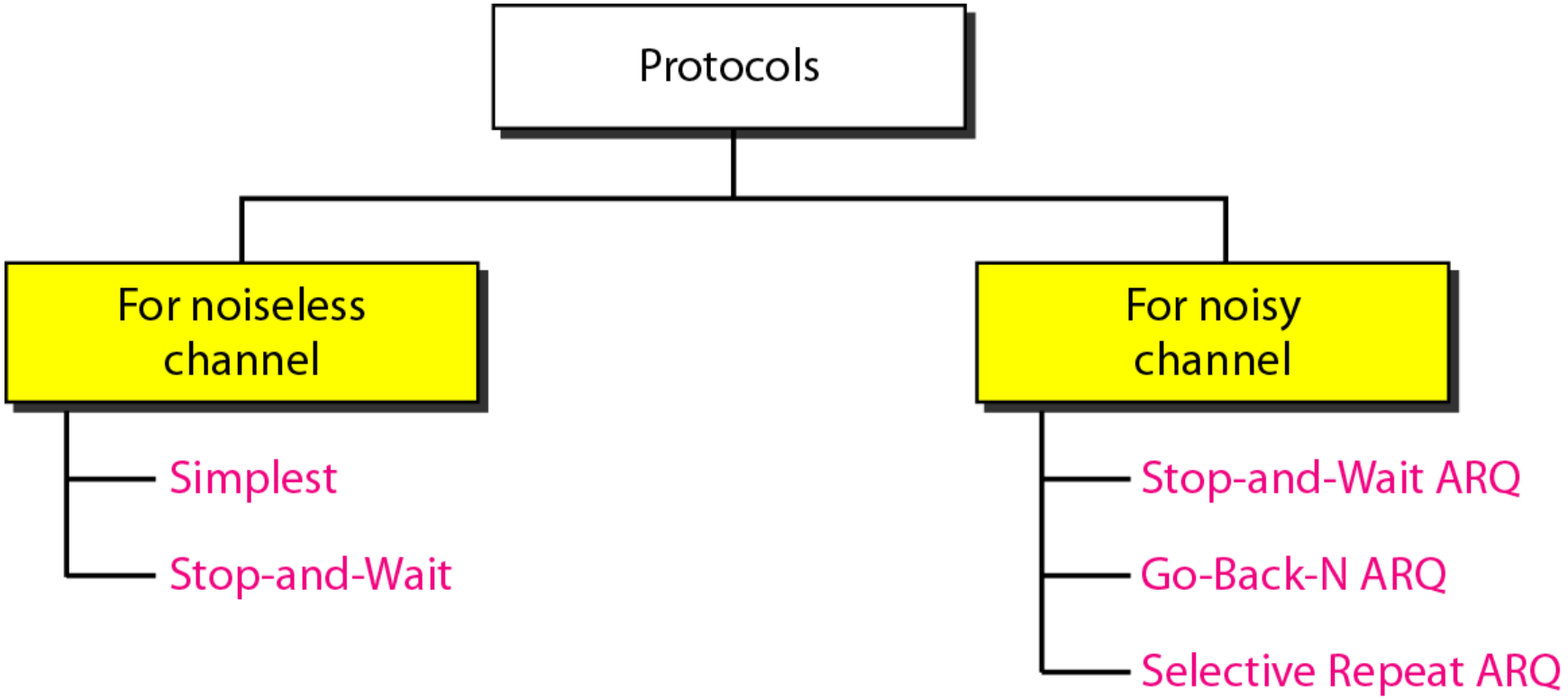
Variable-Size Framing: Byte Stuffing and Unstuffing



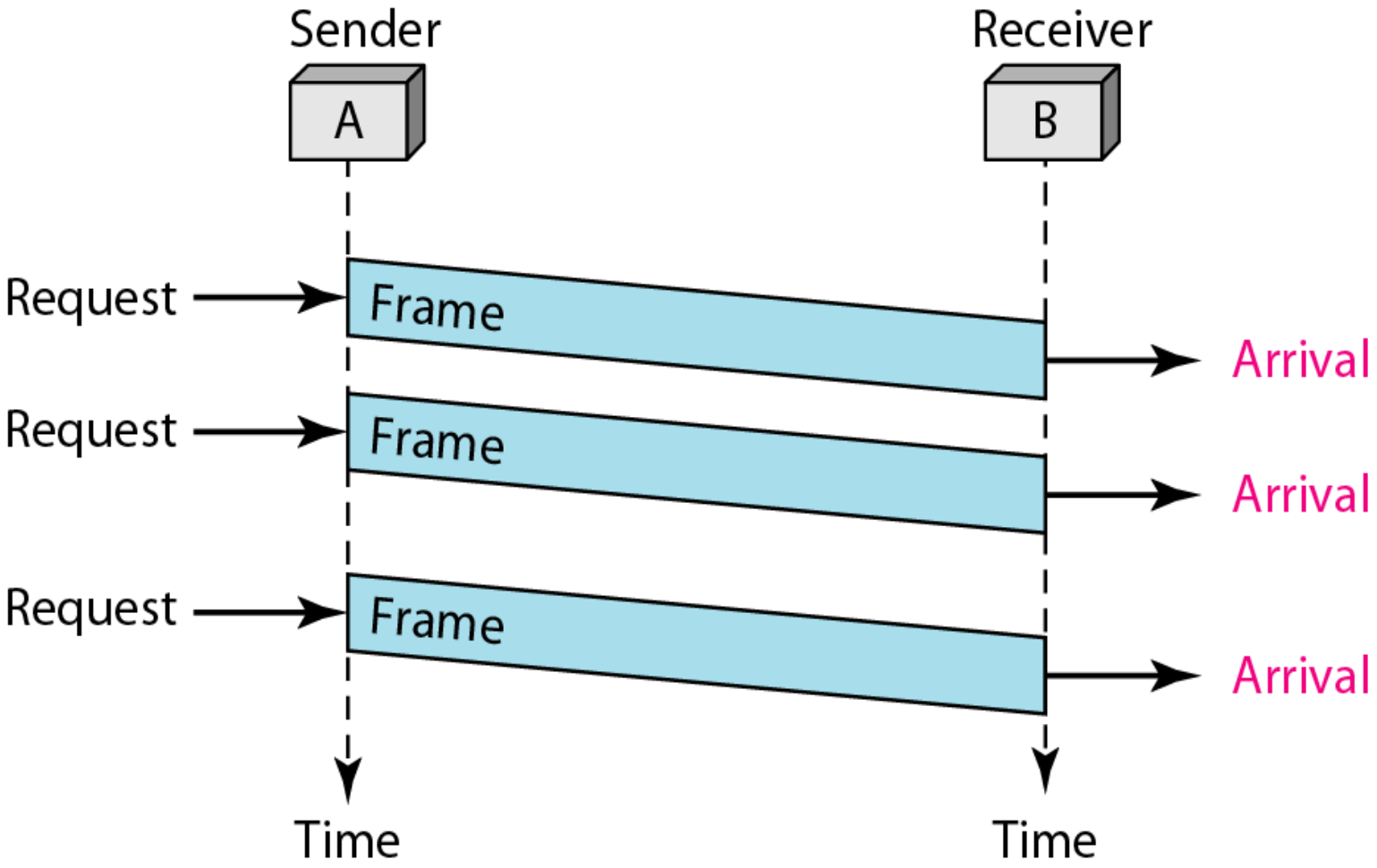
Flow control at the data link layer



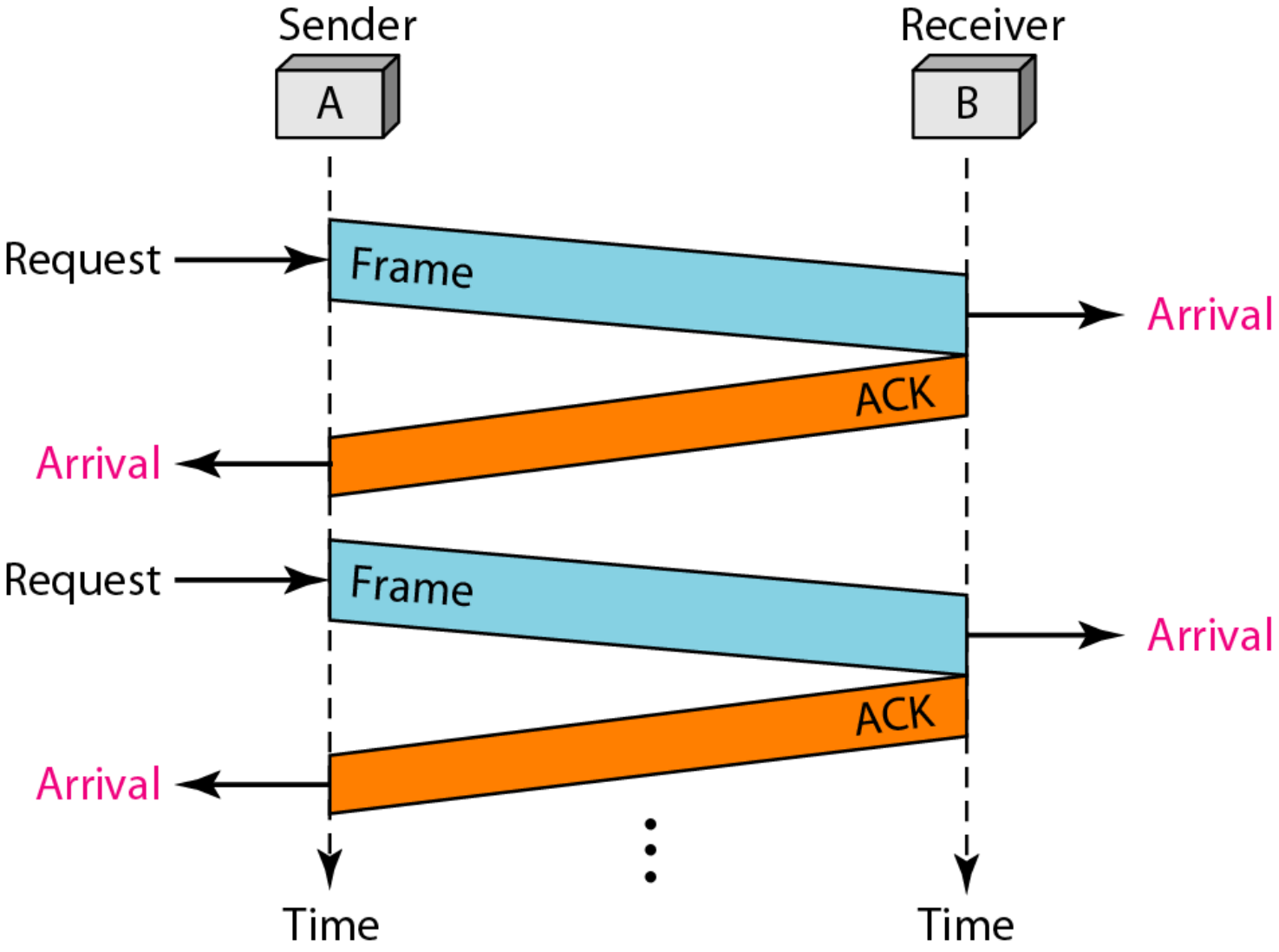
Data Link Layer protocols



Simplest Protocol



Stop-and-Wait Protocol



Stop-and-Wait Automatic Repeat Request

- The sender will not send the next frame until it is sure that the current one is correctly receive
- Sequence number is necessary to check for duplicated frames

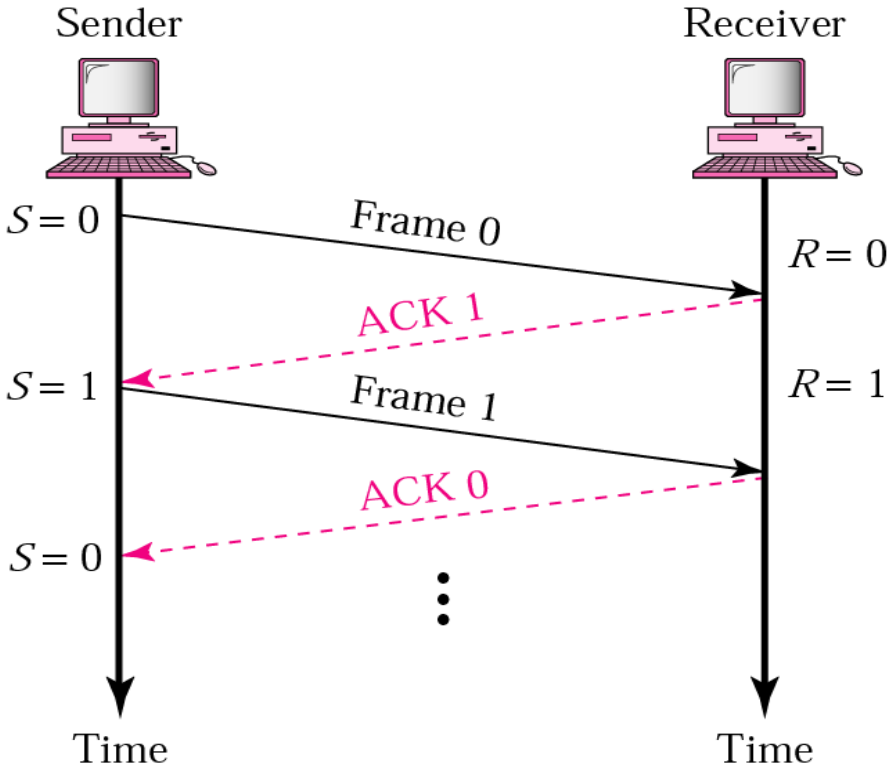


Figure: Normal Operation

Stop-and-Wait ARQ

- A damage or lost frame treated by the same manner by the receiver.

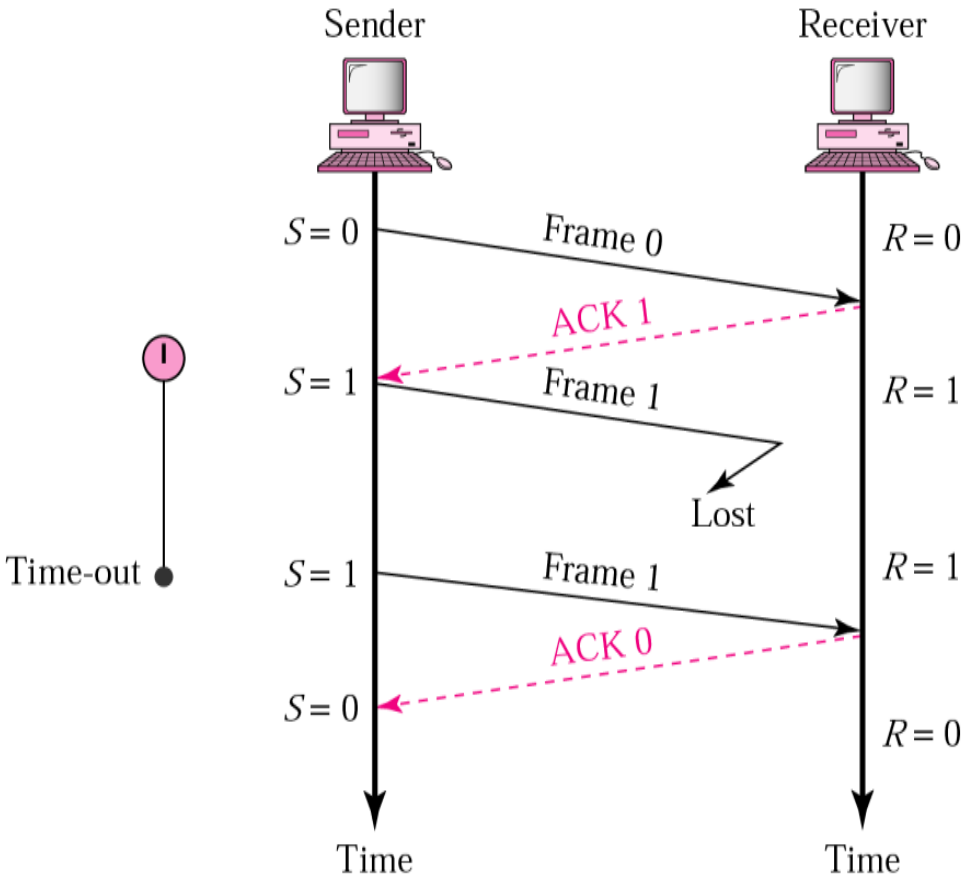


Figure: Stop-and-Wait ARQ, lost or damaged frame

Stop-and-Wait ARQ

- Importance of frame numbering: ***prevents retaining of duplicate frames.***

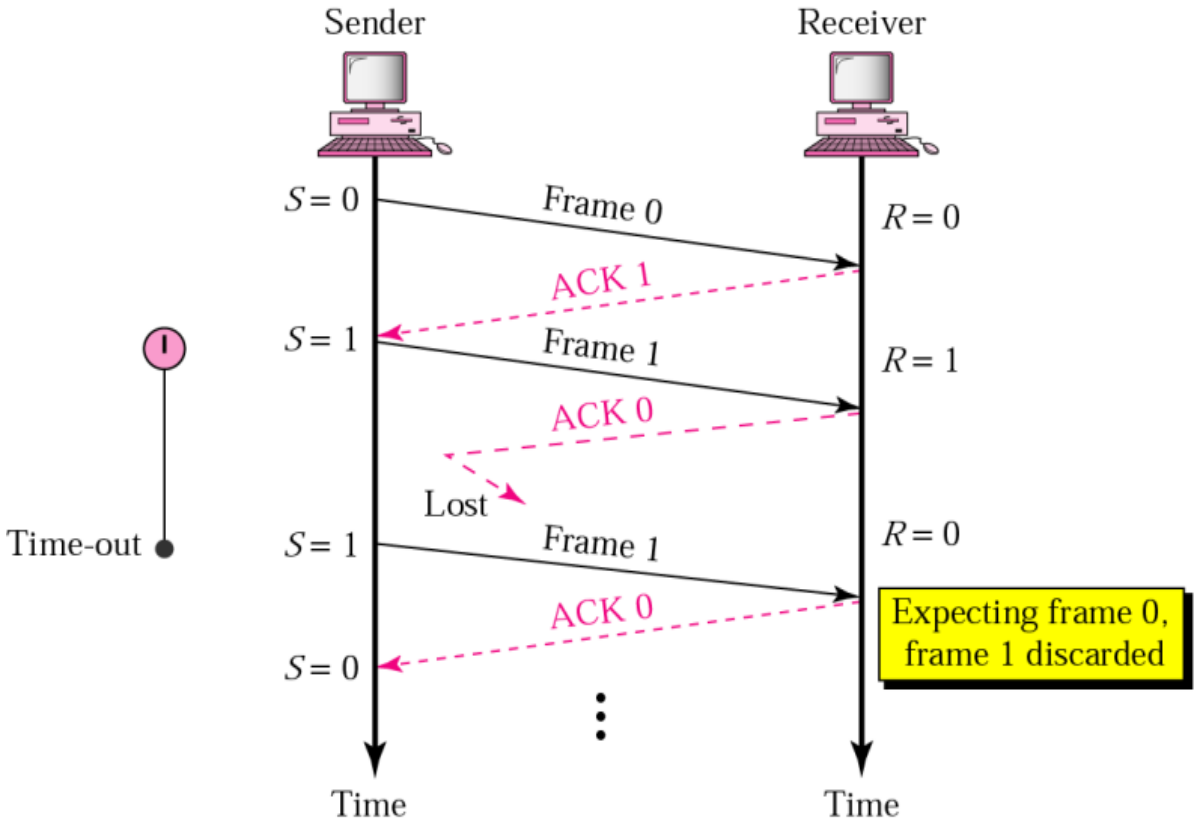


Figure: Stop-and-Wait ARQ, lost ACK frame

Stop-and-Wait ARQ

- Numbered acknowledgments are needed if an acknowledgment is delayed and the next frame is lost.

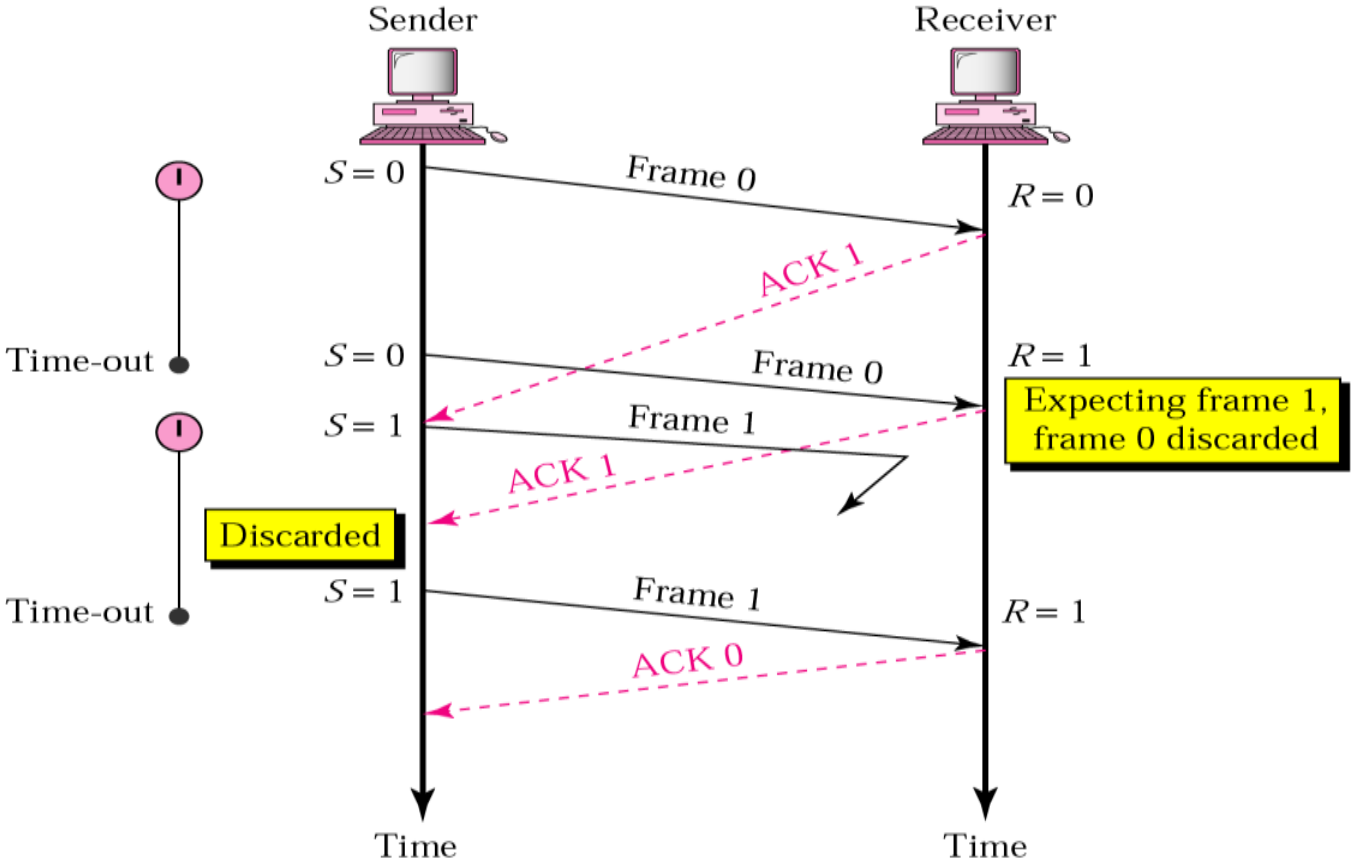
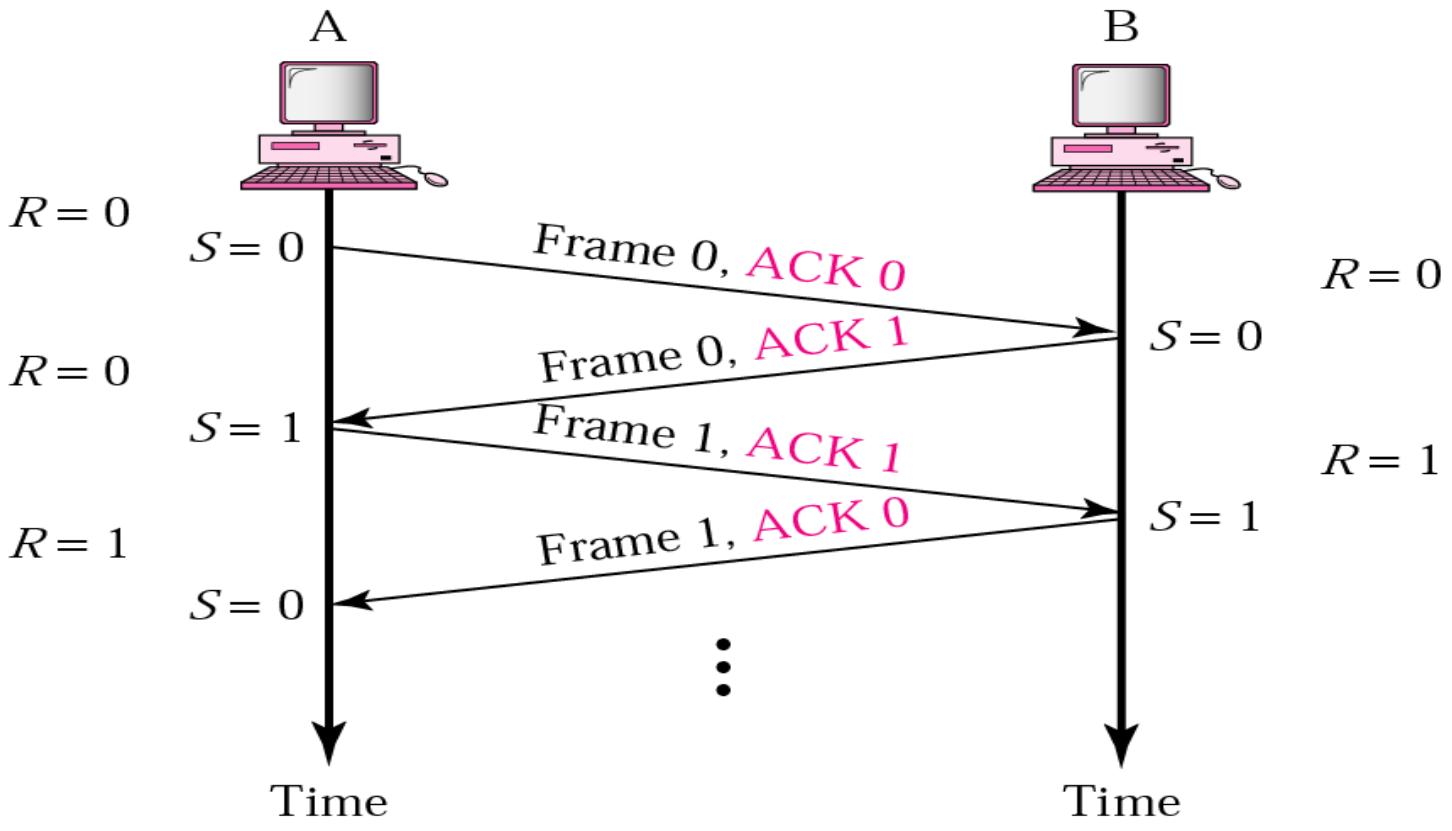


Figure: Stop-and-Wait ARQ, delayed ACK and lost frame

Piggybacking (Bidirectional transmission)

- It is a method to combine a data frame with an acknowledgment.
- It can save bandwidth because data frame and an ACK frame can combined into just one frame



Go-Back-N Automatic Repeat Request

- ACK1 is not necessary if ACK2 is sent: Cumulative ACK

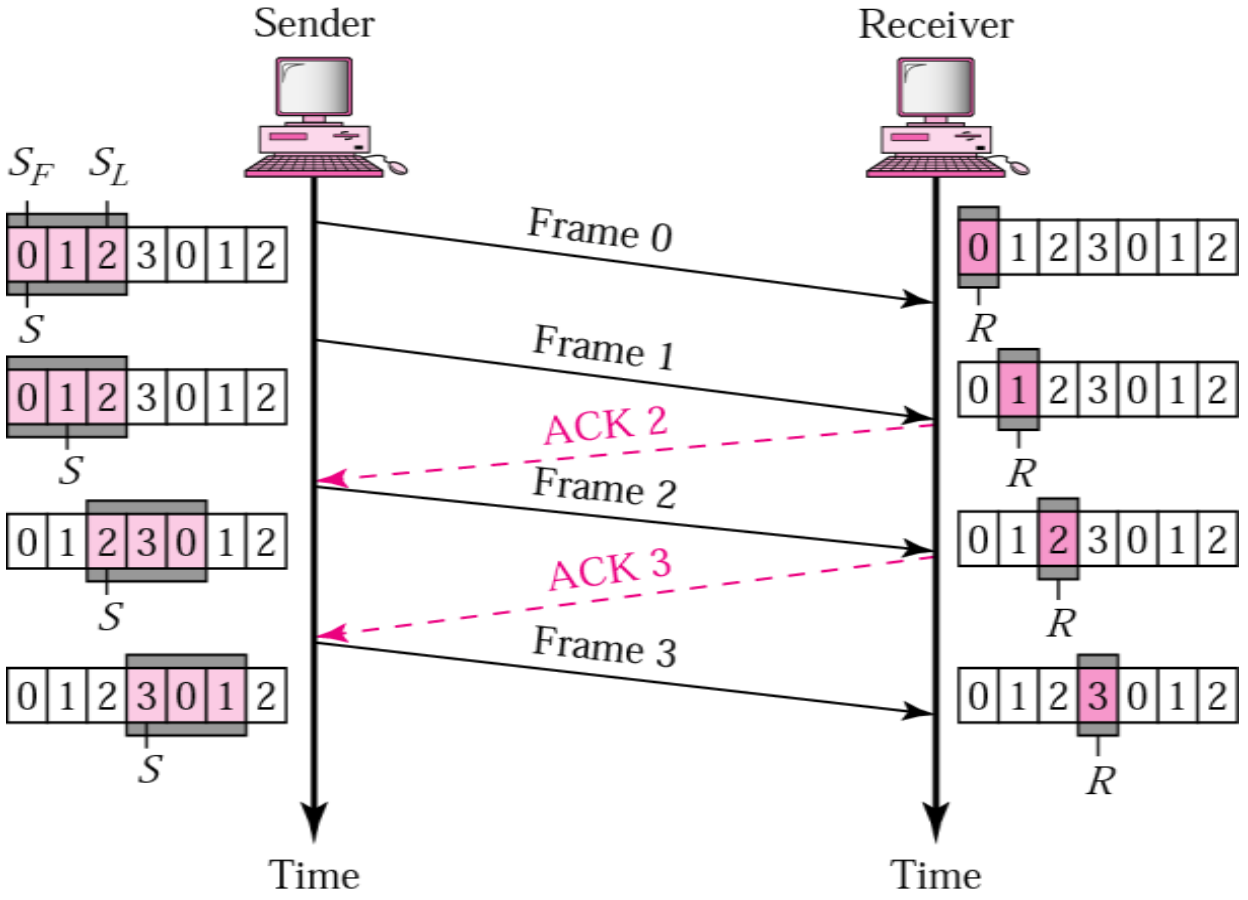


Figure: Normal operation

Go-Back-N Automatic Repeat Request

- Correctly received out of order packets are not Buffered

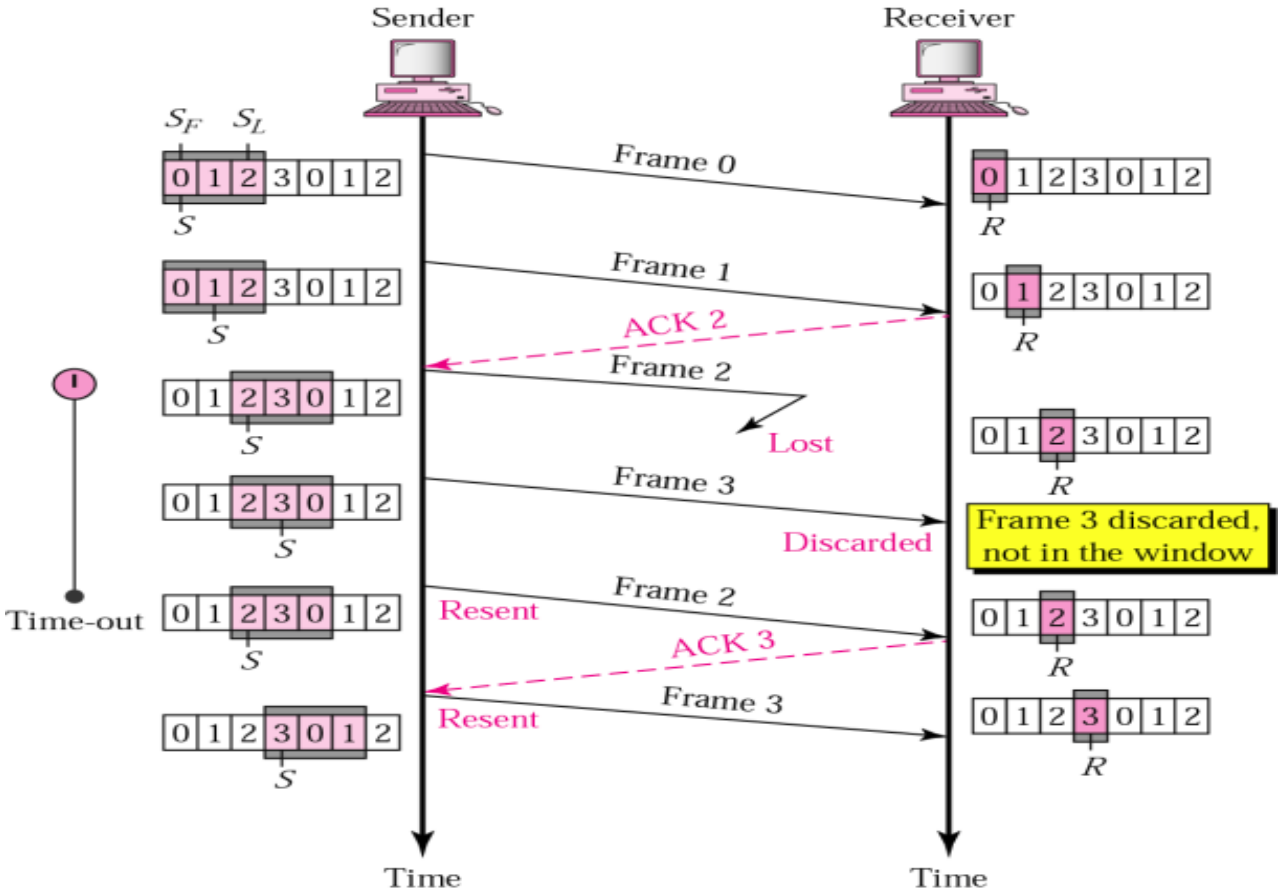


Figure: Damage or Lost Frame

Go-Back-N Automatic Repeat Request

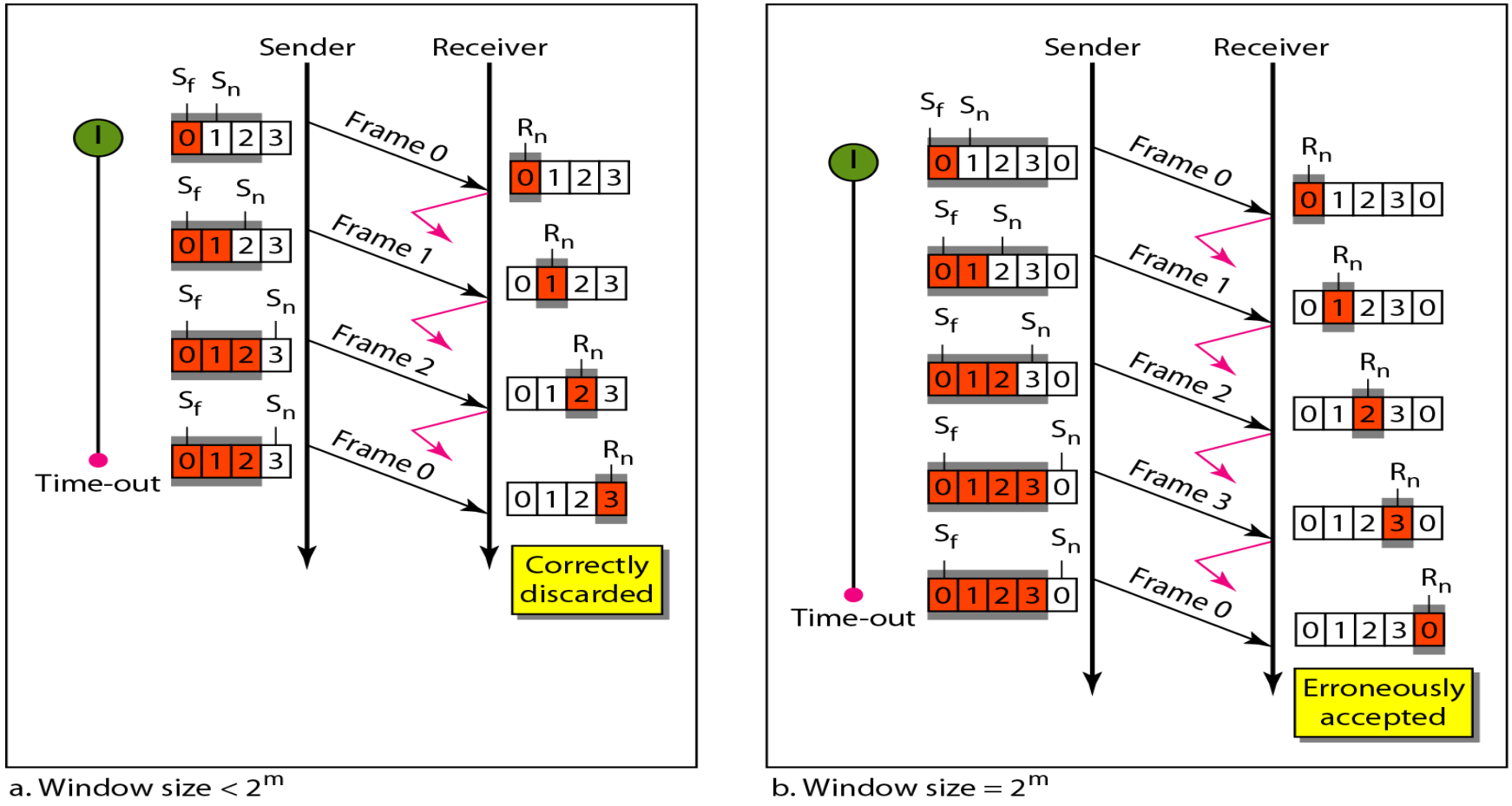


Figure: Window Size

Selective Repeat Automatic Repeat Request

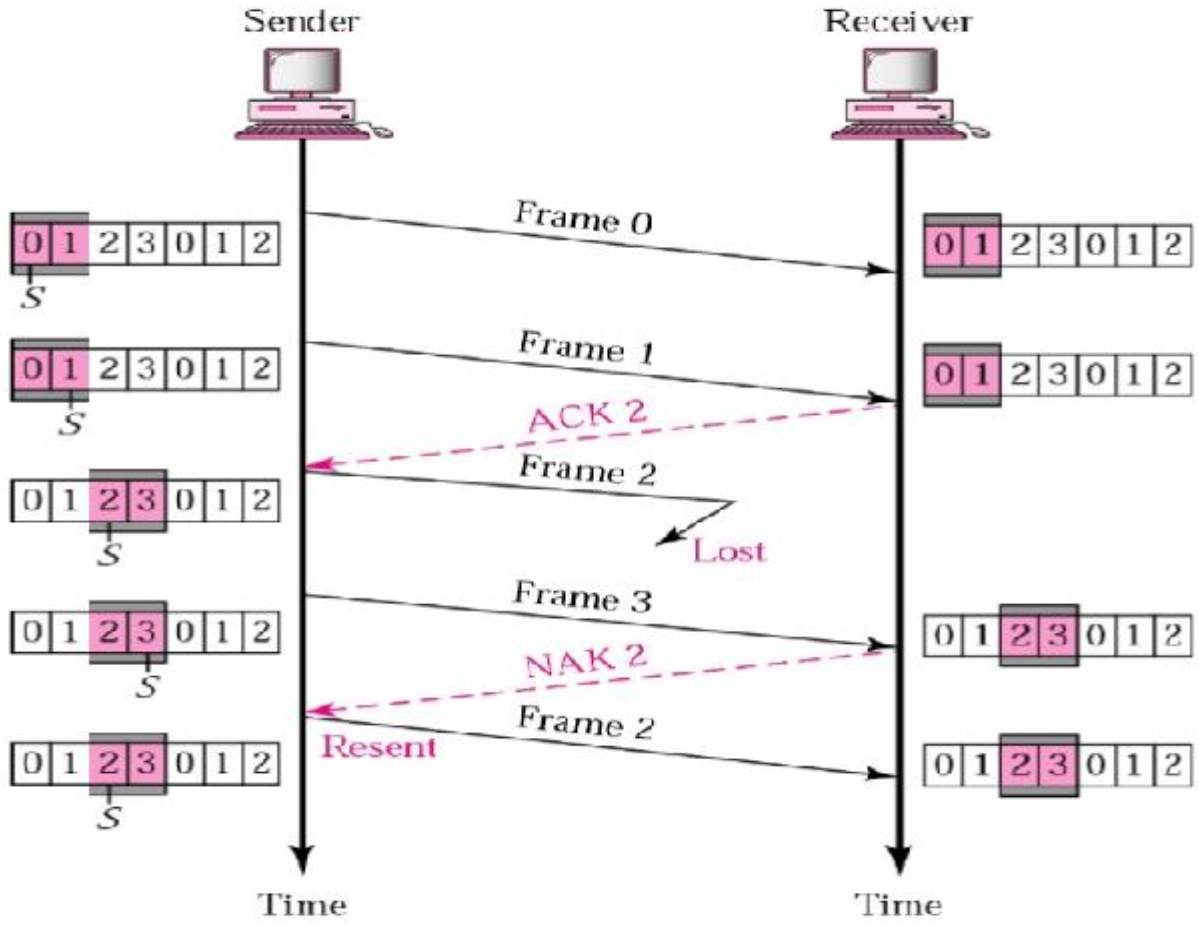


Figure: Selective Repeat ARQ, lost frame

Selective Repeat Automatic Repeat Request

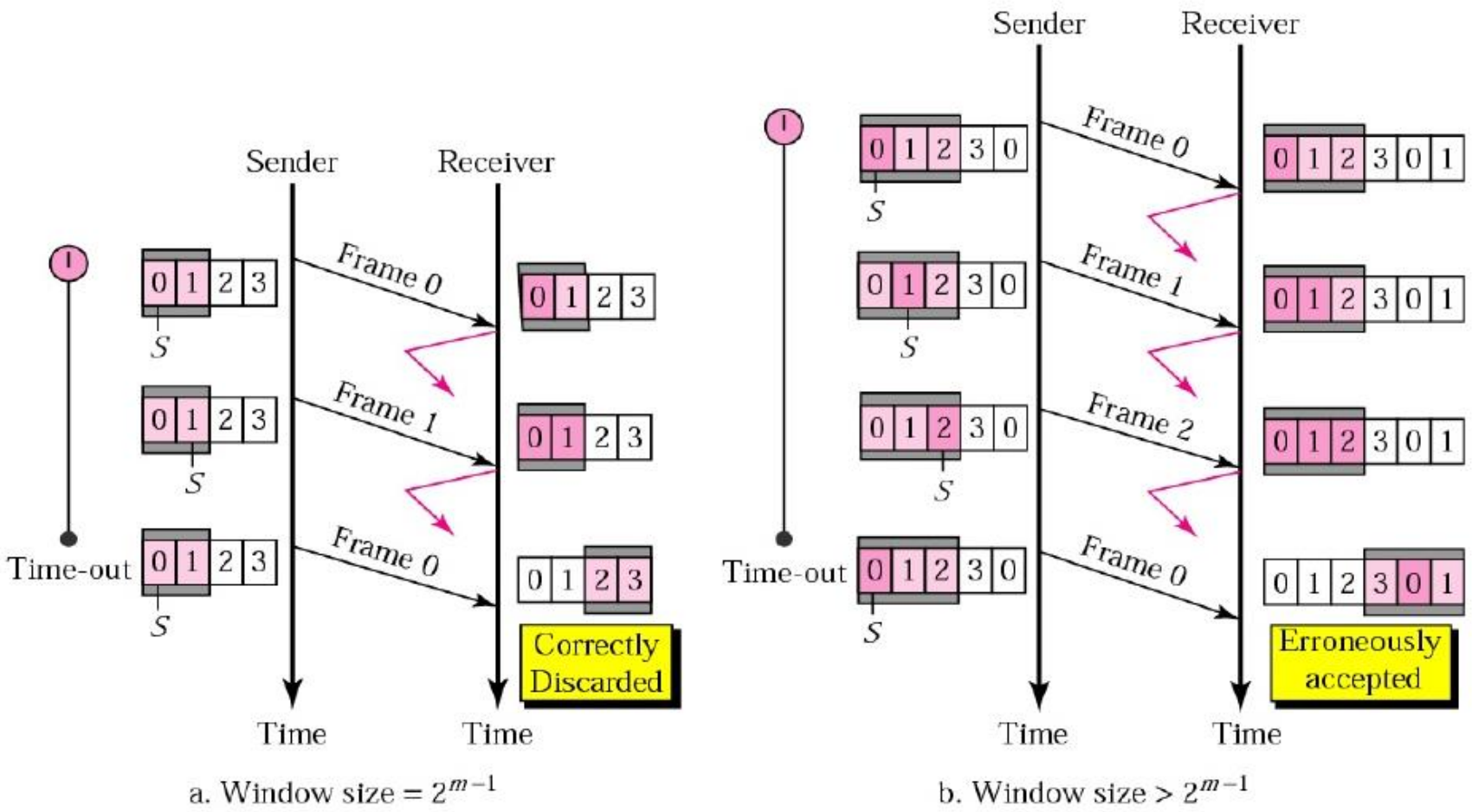


Figure: Selective Repeat ARQ, sender window size

High-level Data Link Control (HDLC)

- HDLC is a bit-oriented protocol for communication over point-to-point and multi-point links. It implements the ARQ mechanisms
- Two modes
  - Normal mode (NRM)
    - Primary station can send commands and secondary stations can only respond
  - Asynchronous balanced mode (ABM)
    - The link is point-to-point i.e each station can function as primary and secondary station

HDLC transfer modes

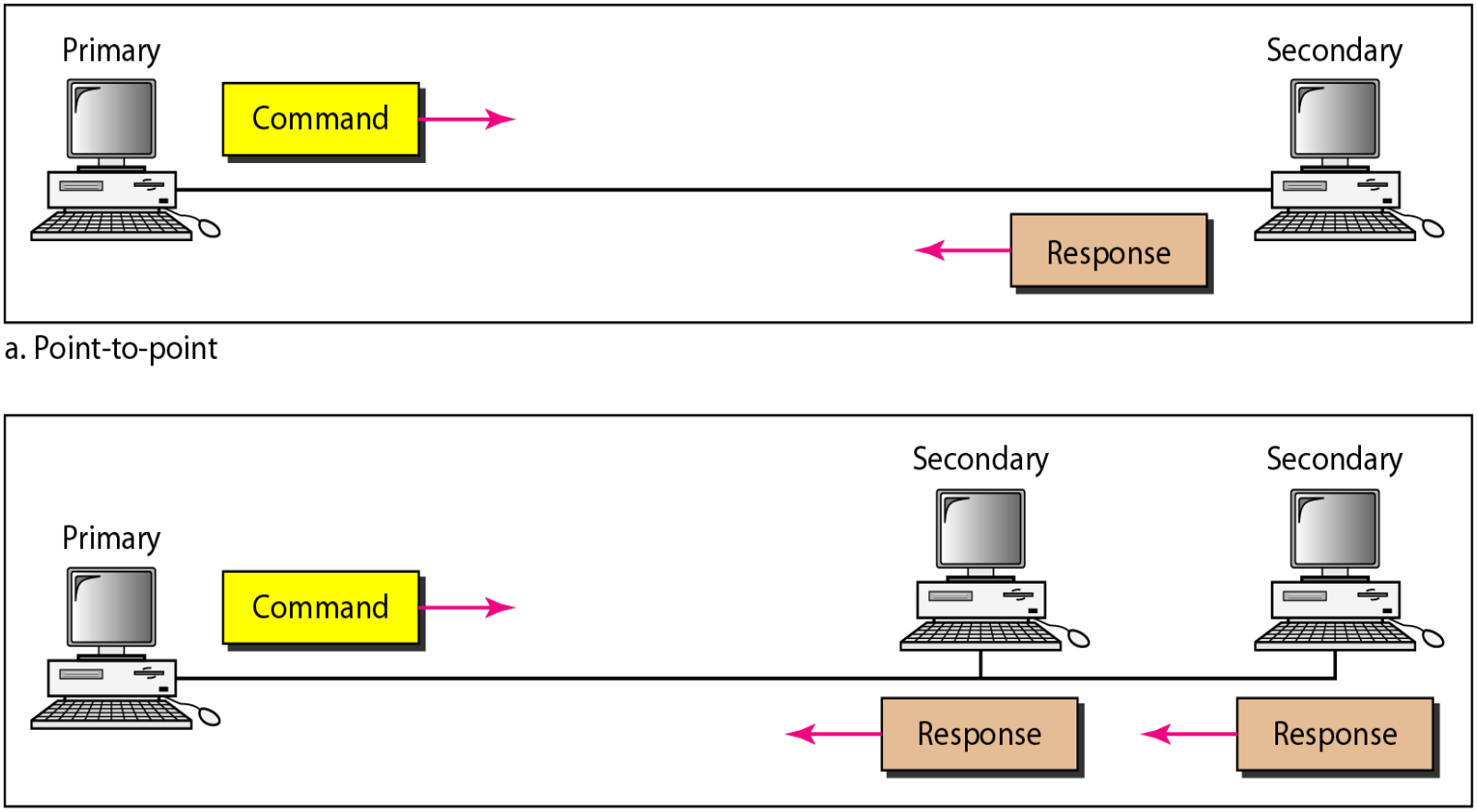


Figure: HDLC in point to point and multi-point scenario in NRM

HDLC transfer modes

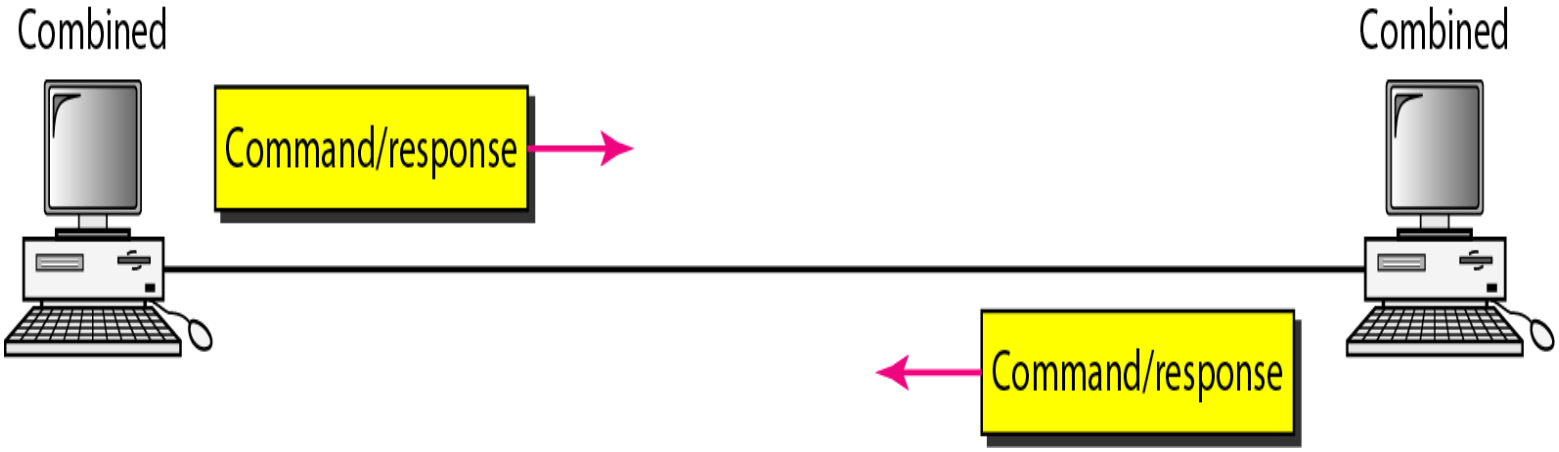
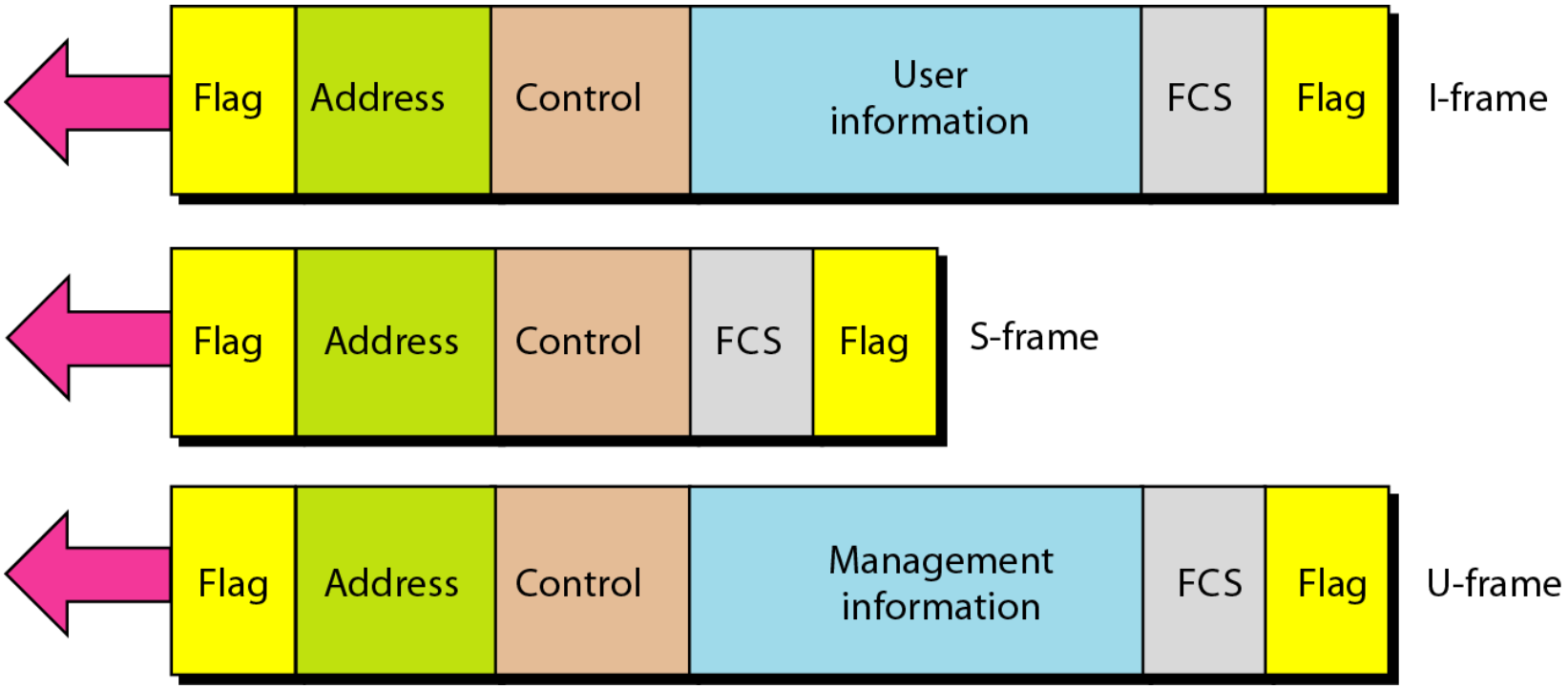


Figure: HDLC in point to point and multi-point scenario in ABM

HDLC frames

- Information frames (I-frame)
- Supervisory frames (S-frame)
- Unnumbered frames (U-frame)



Point-to-Point Protocol (PPP)

- Mostly used on internet communication at data-link layer
- It is byte oriented protocol

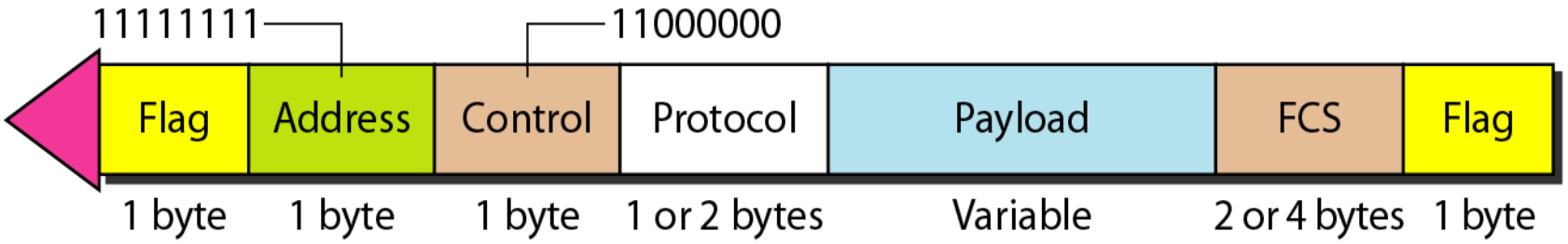


Figure: PPP frame