



Chapter 7

Data Link Control Protocols



Reading Materials

- **Data and Computer Communications,**
William Stallings
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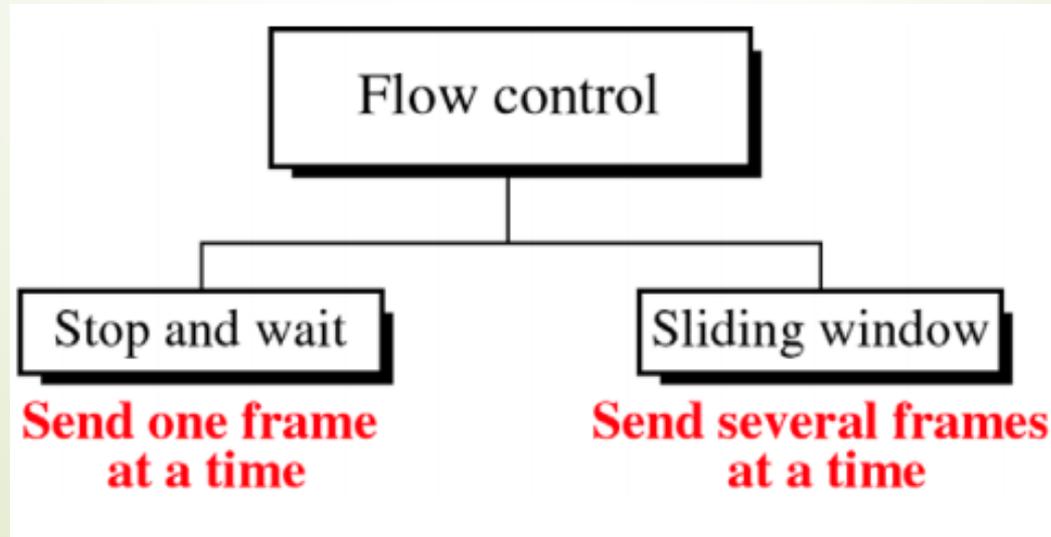


Contents

- Flow control
 - Error control
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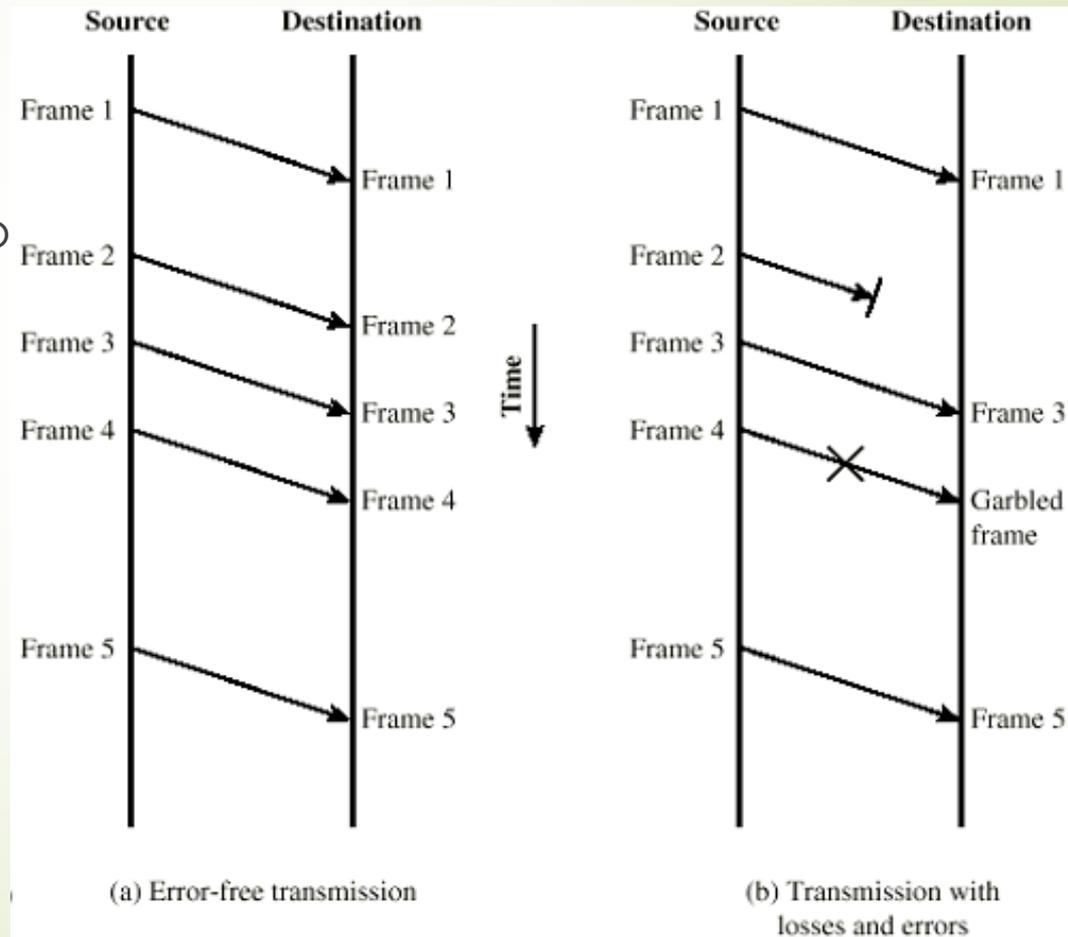
Flow Control

- Ensuring the sending entity does not overwhelm the receiving entity
 - Preventing buffer overflow.
- Referring to a set of procedures used to restrict the amount of data that the sender can send before waiting for acknowledgement.



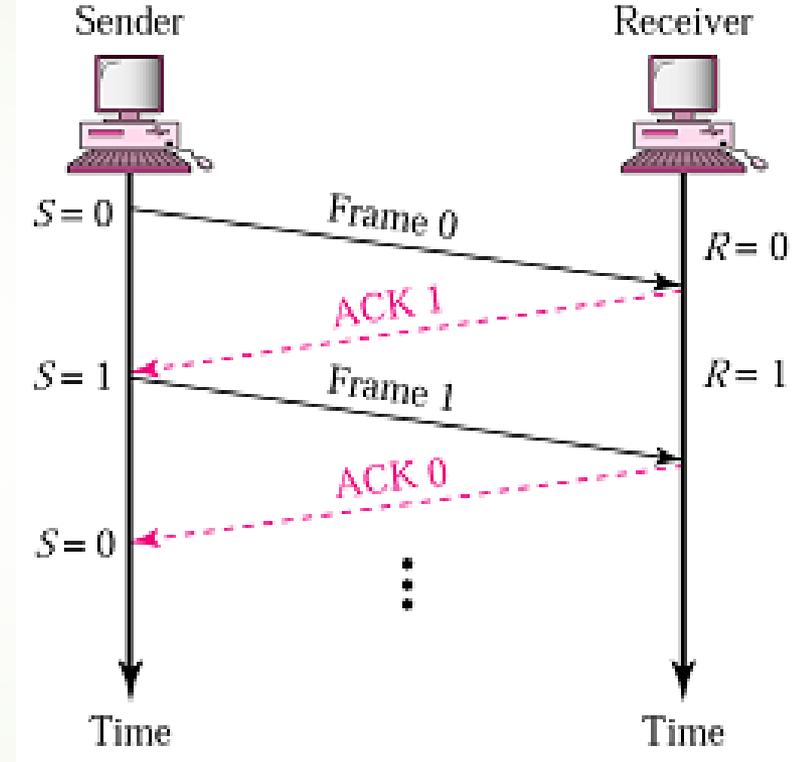
Model of Frame Transmission

- ▶ The data are sent in a sequence of frames, with each frame containing a portion of the data and some control information.
- ▶ The time it takes for a station to emit all of the bits of a frame onto the medium is the transmission time; this is proportional to the length of the frame.
- ▶ The propagation time is the time it takes for a bit to traverse the link between source and destination.



Stop and Wait

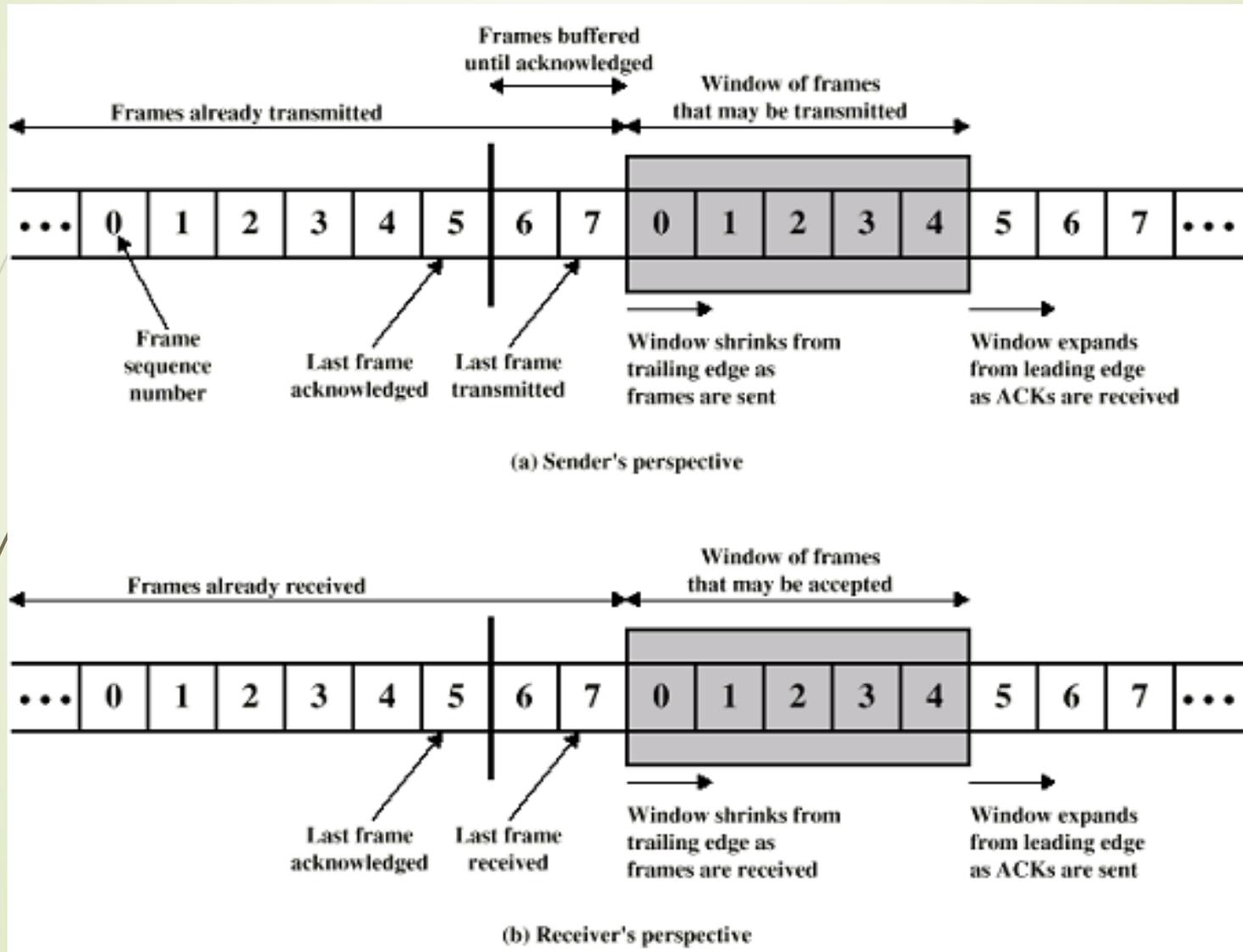
- Source transmits frame
- Destination receives frame and replies with acknowledgement
- Source waits for ACK before sending next frame
- Destination can stop flow by not sending ACK



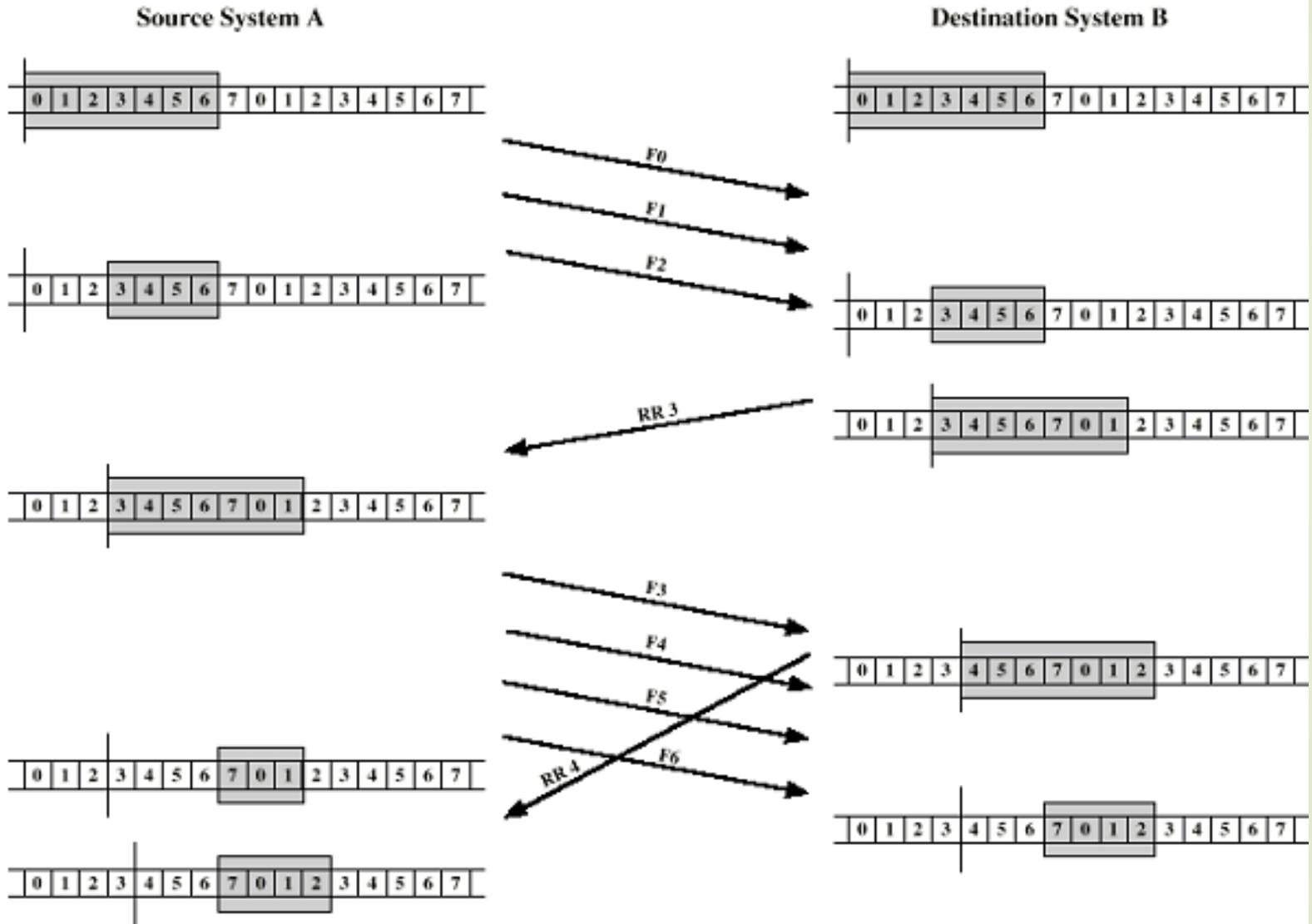
Sliding Windows Flow Control

- Allow multiple frames to be in transit
- Receiver has buffer for W frames
- Transmitter can send up to W frames without ACK
- Each frame is numbered
- ACK includes number of next frame expected
- Sequence number bounded by size of sequence number field (k)
 - Frames are numbered modulo 2^k

Sliding Window Diagram



Example Sliding Window

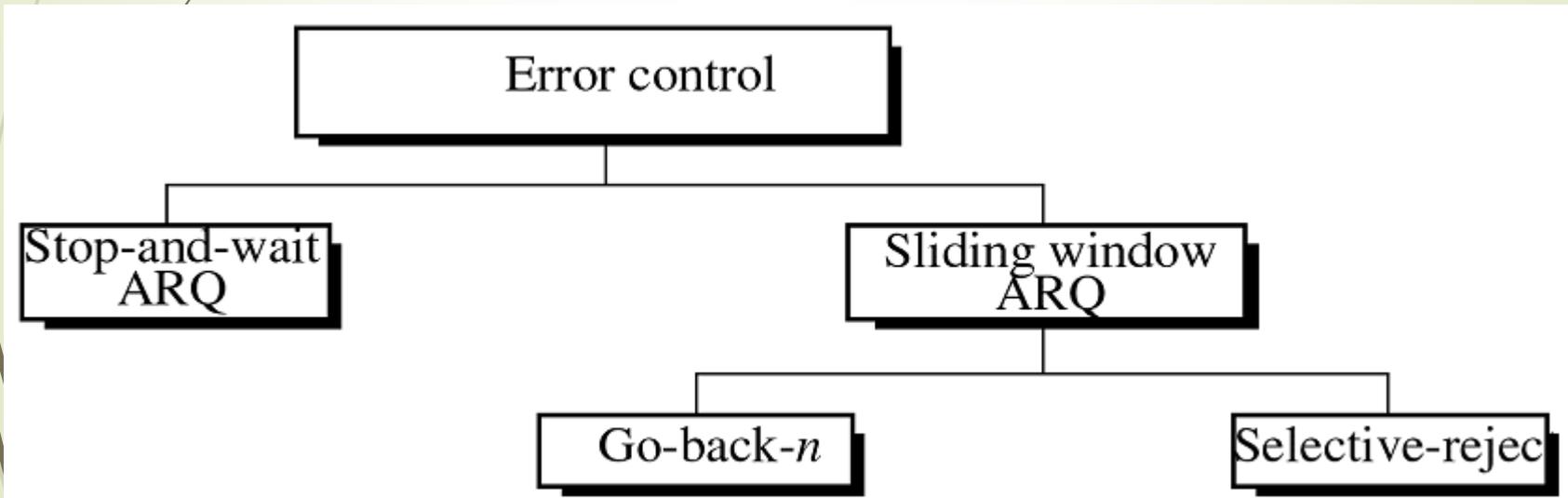


Error Control

- Detection and correction of errors while transmission
- Lost frames
- Damaged frames
- Automatic repeat request (ARQ)
 - Error detection
 - Positive acknowledgment
 - Retransmission after timeout
 - Negative acknowledgement and retransmission

Automatic Repeat Request (ARQ)

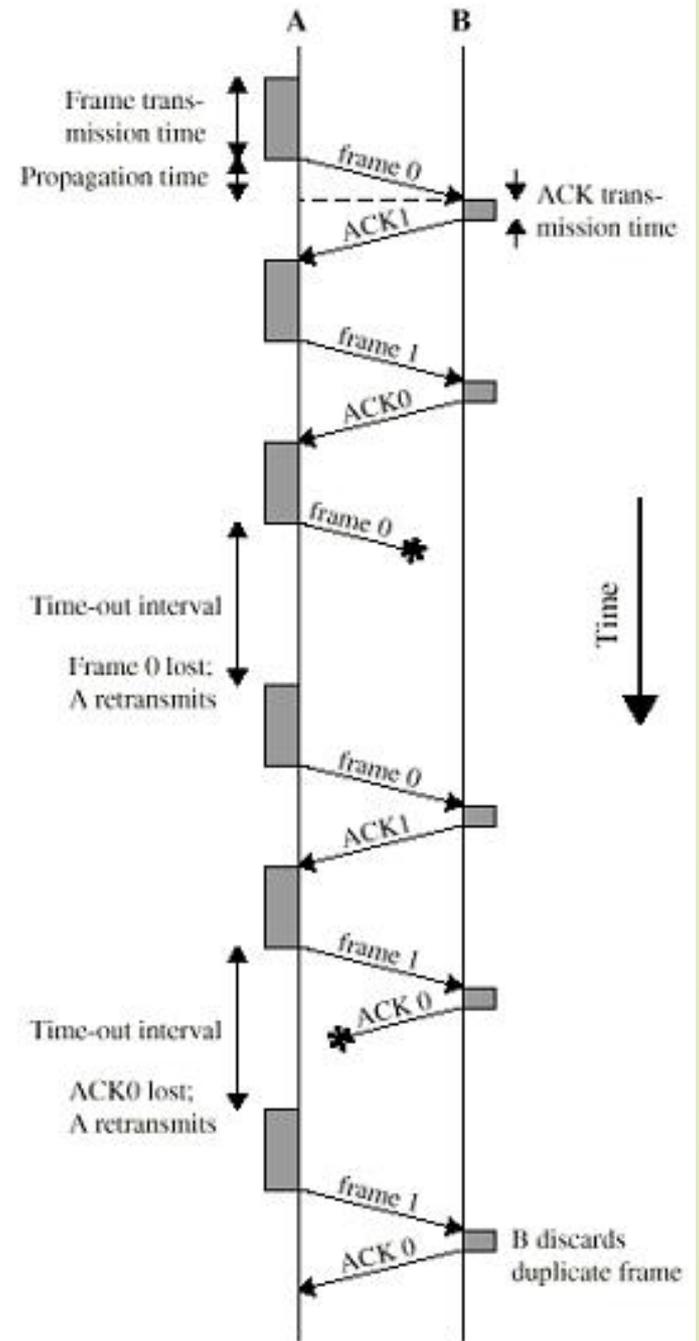
- Stop and wait
- Go back N
- Selective reject (selective retransmission)



Stop and Wait

- ▶ Source transmits single frame
- ▶ Wait for ACK
- ▶ If received frame damaged, discard it
 - ▶ Transmitter has timeout
 - ▶ If no ACK within timeout, retransmit
- ▶ If ACK damaged, transmitter will not recognize it
 - ▶ Transmitter will retransmit
 - ▶ Receiver gets two copies of frame
 - ▶ Use ACK0 and ACK1
- ▶ Pros and cons:
 - ▶ Simple
 - ▶ Inefficient

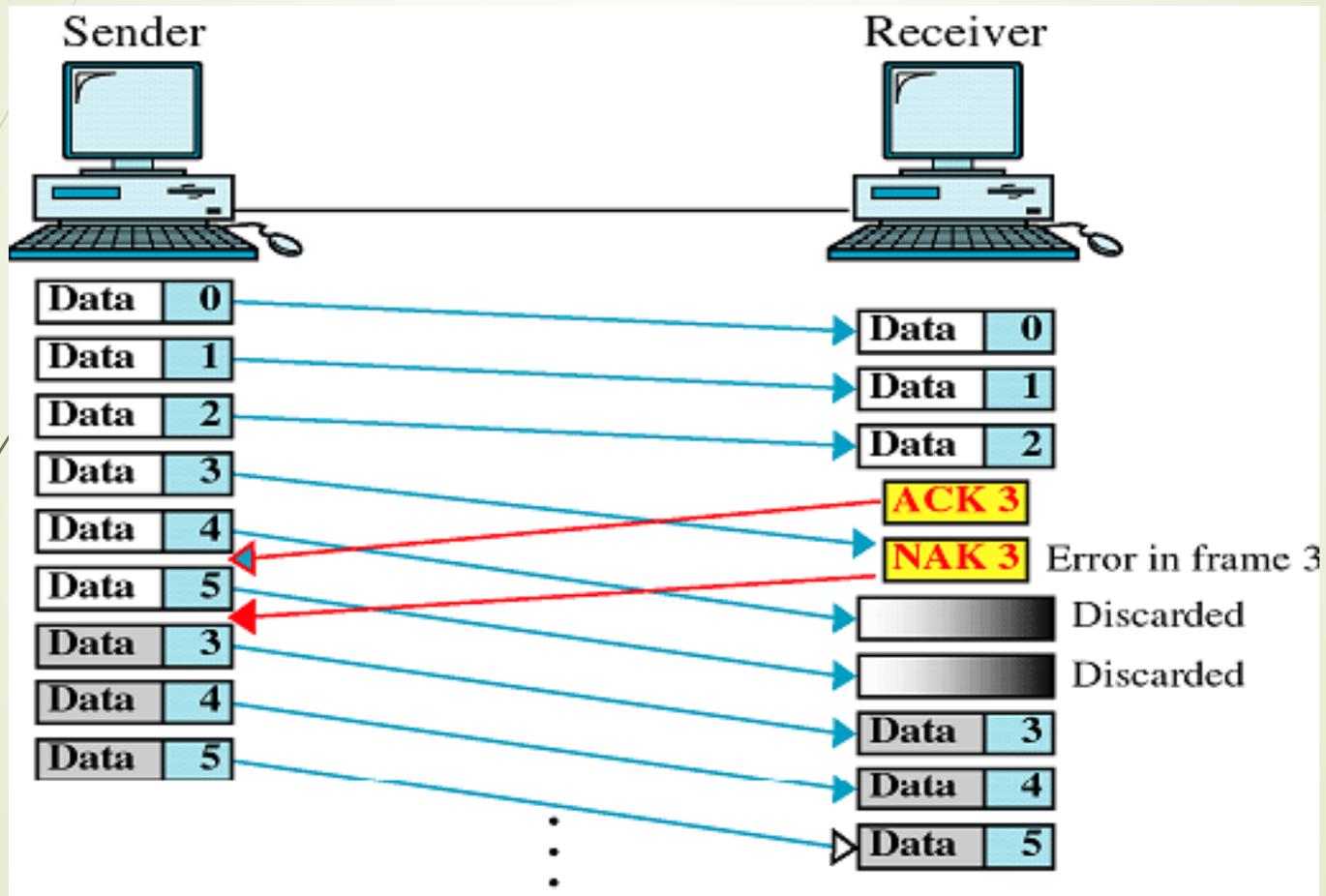
Stop-and-Wait Diagram



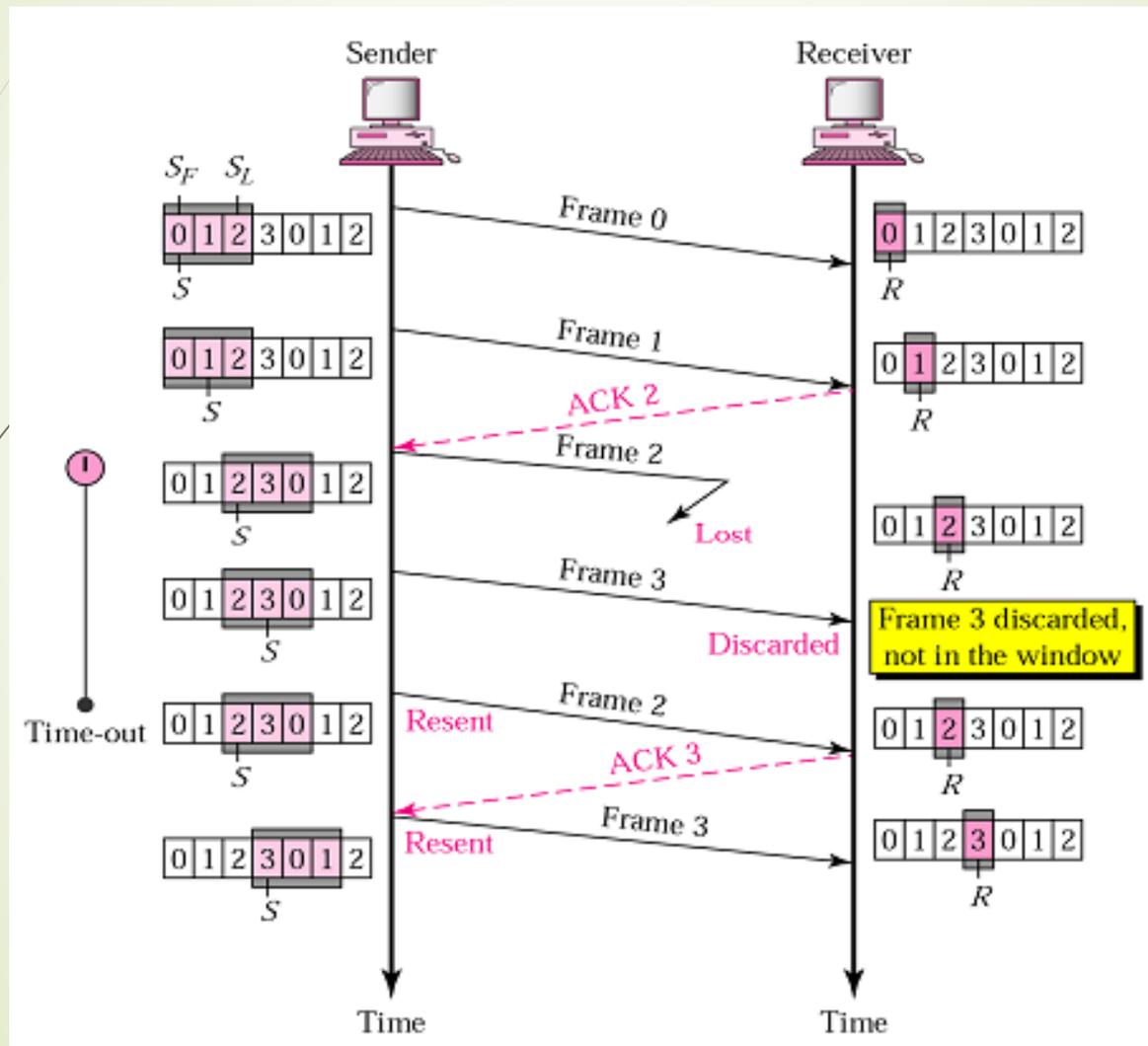
Go Back N

- Based on sliding window
- If no error, ACK as usual with next frame expected
- If error, reply with rejection
 - Discard that frame and all future frames until error frame received correctly
 - Transmitter must go back and retransmit that frame and all subsequent frames

Go Back N - Damaged Frame

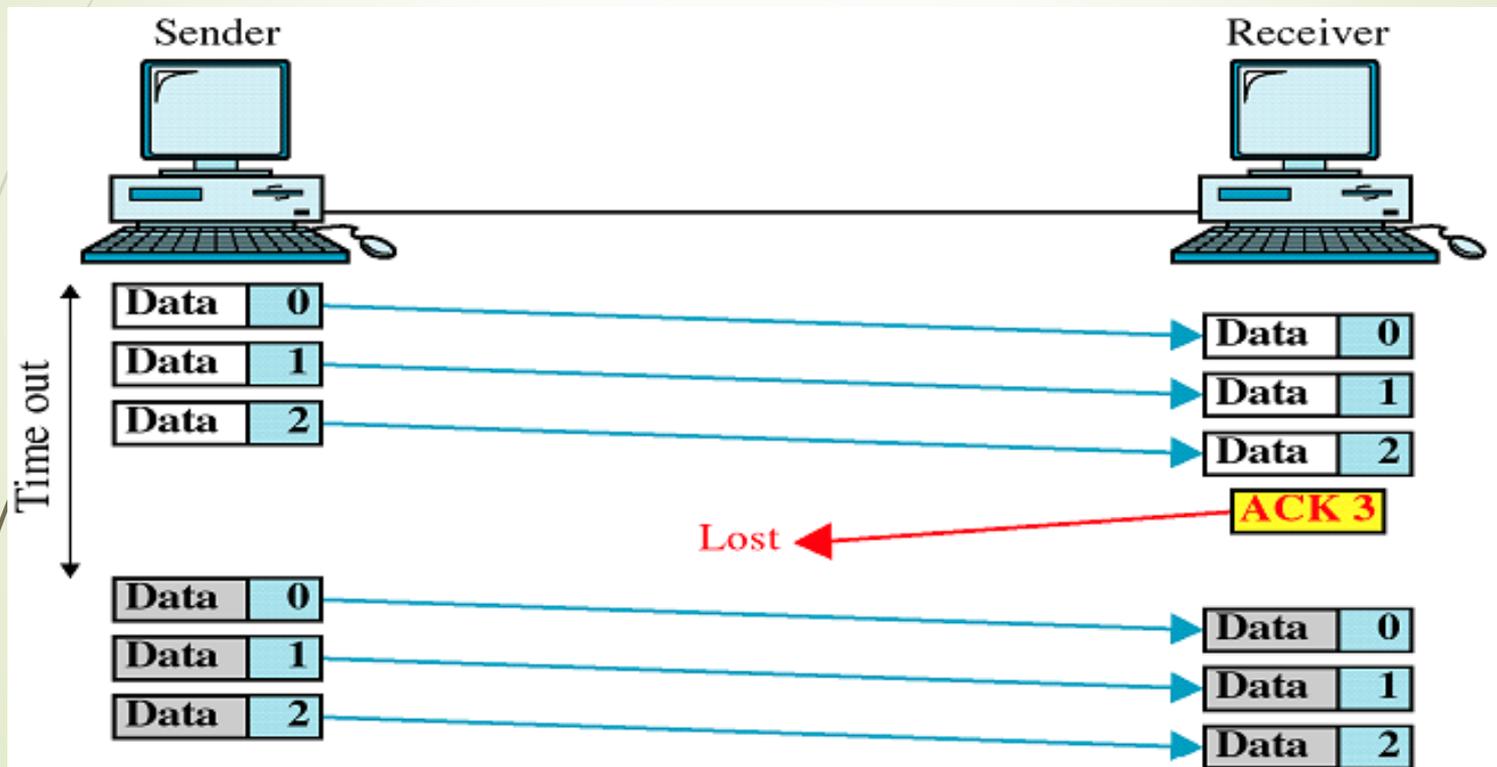


Go Back N - Lost Frame

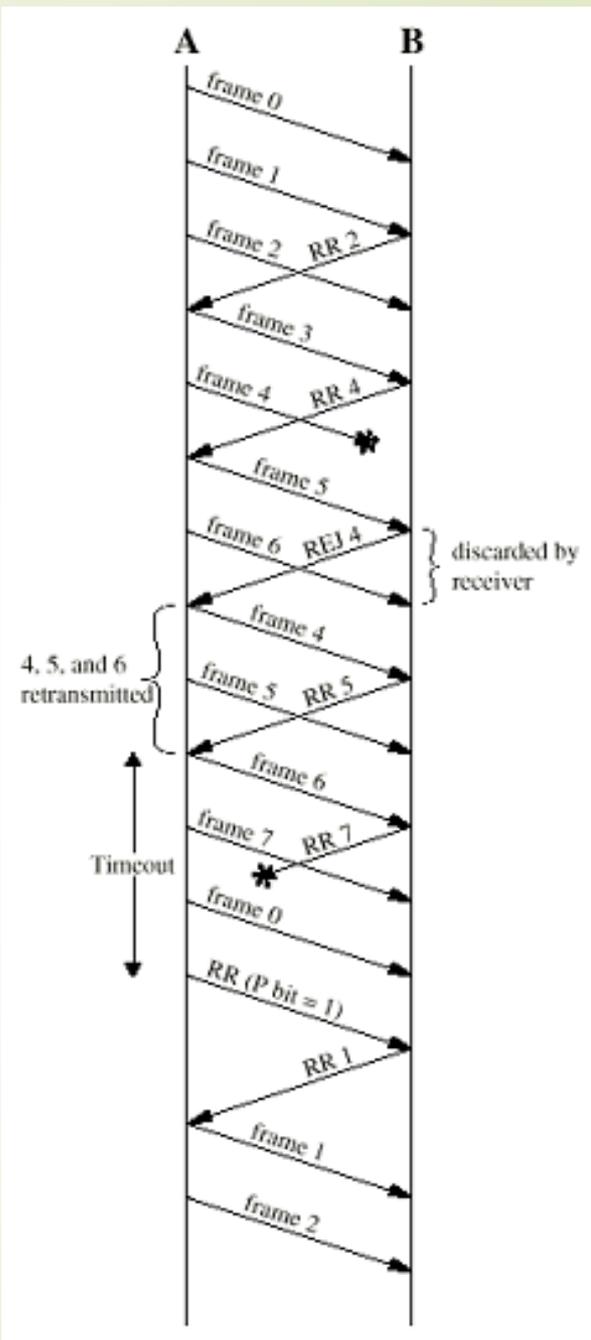


Go Back N

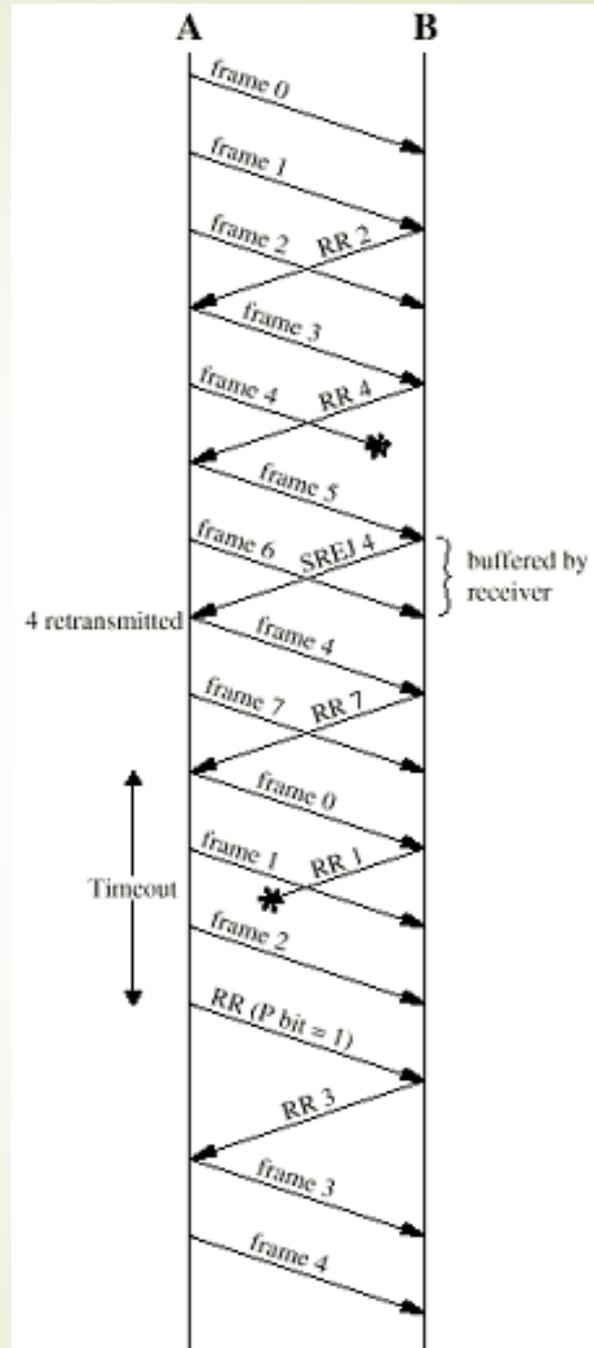
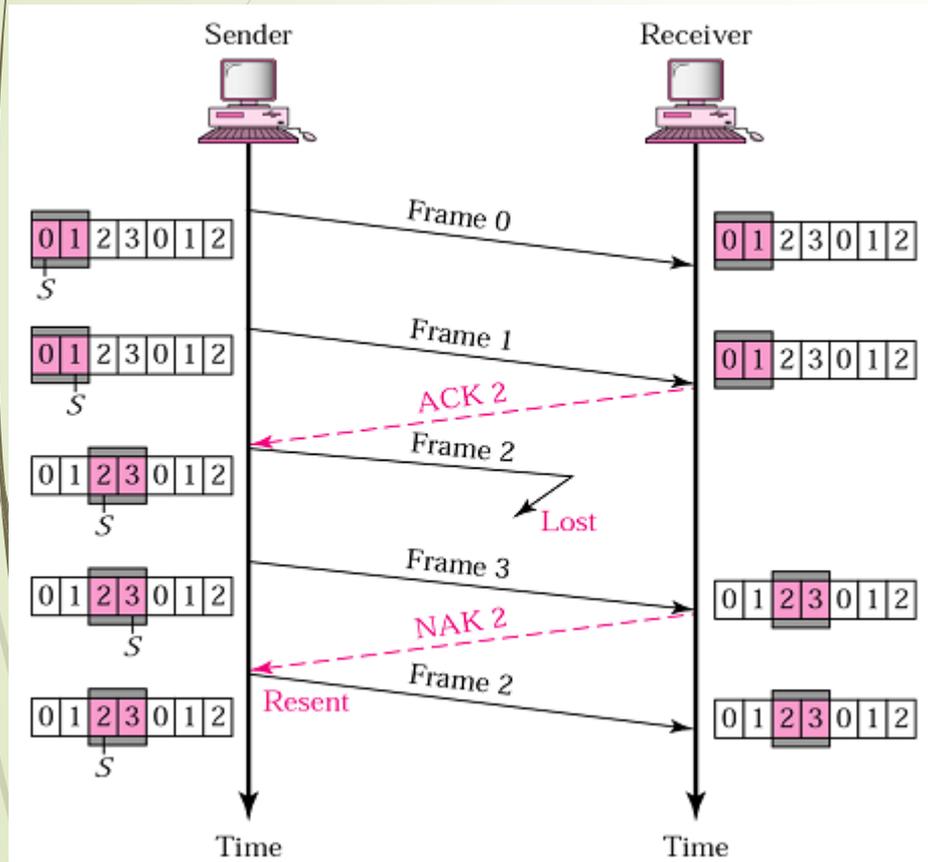
Damaged Acknowledgement



Go Back N Diagram



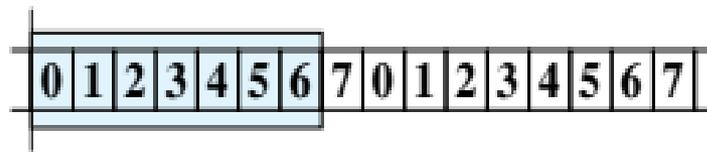
Selective Reject





Problems

- Suppose, for the **Sliding Window** based **flow control** protocol, frame numbers follow **K=2** bits model. Show the **protocol behavior steps** of the following scenarios, where the transmitter sends **10 frames** to the receiver. **a) a frame is lost** from transmitter to the receiver end, **b) an acknowledgement is lost** from receiver to the transmitter end.
- Use the above example to draw the steps for **Go Back N error control** protocol.
- Simulate **Selective Reject** protocol on the following data stream, where sender has the frames stored as follows.







Courtesy

- Professor Jiying Zhao, University of Ottawa
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