IIT KHARAGPUR

NPTEL ONLINE
CERTIFICATION COURSES

COMPUTER NETWORKS AND INTERNET PROTOCOLS

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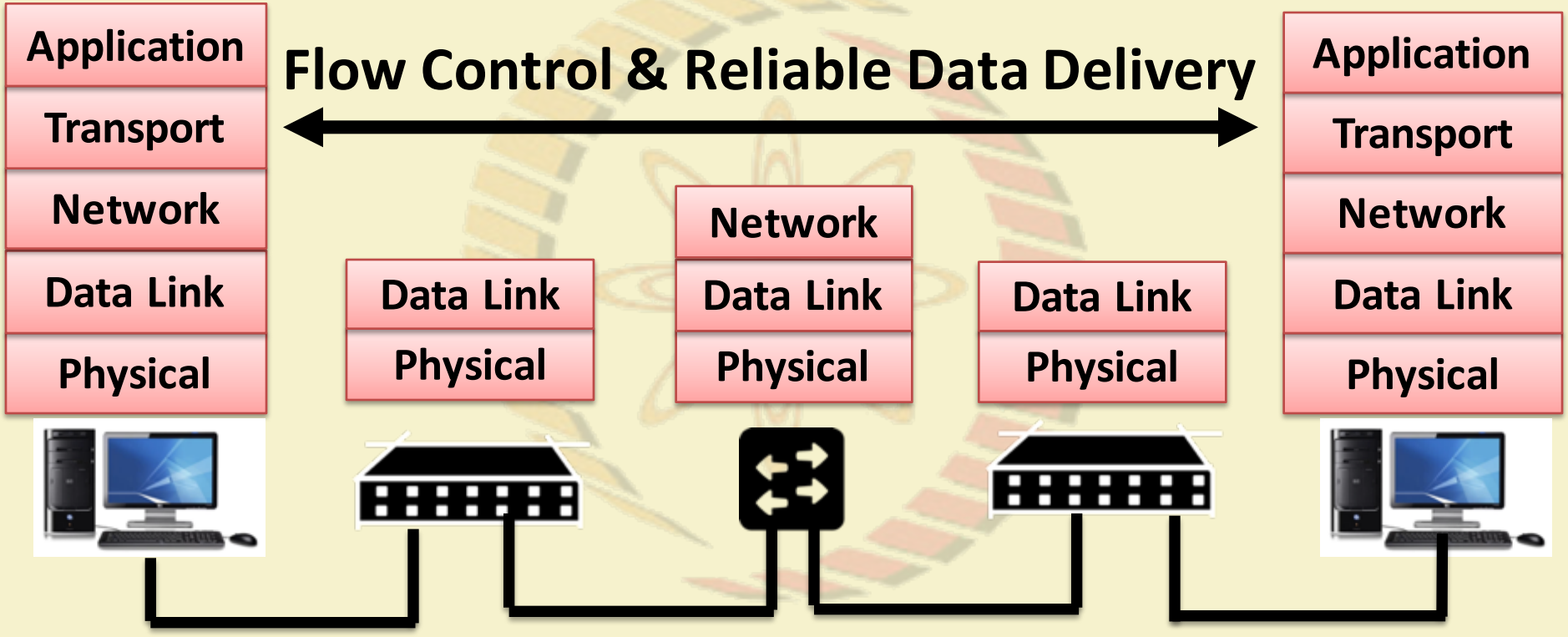
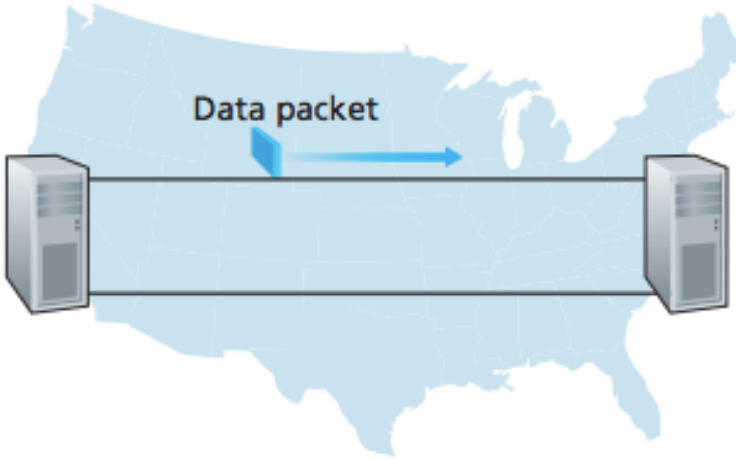
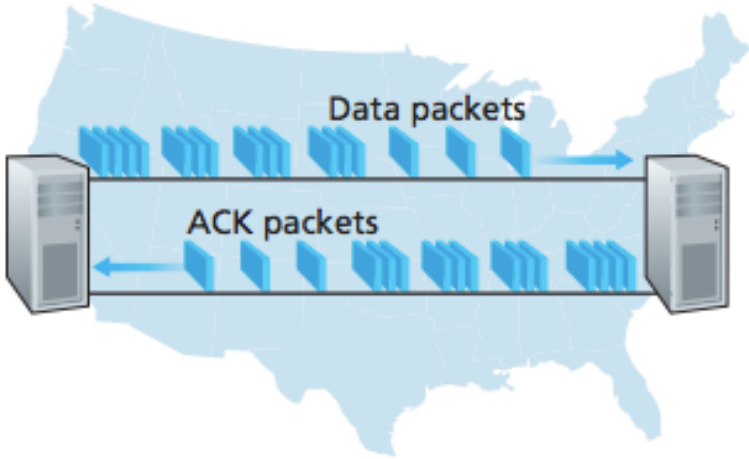
Transport Layer - V (Sliding Window Protocols)



Stop and Wait versus Sliding Window (Pipelined)



a. A stop-and-wait protocol in operation



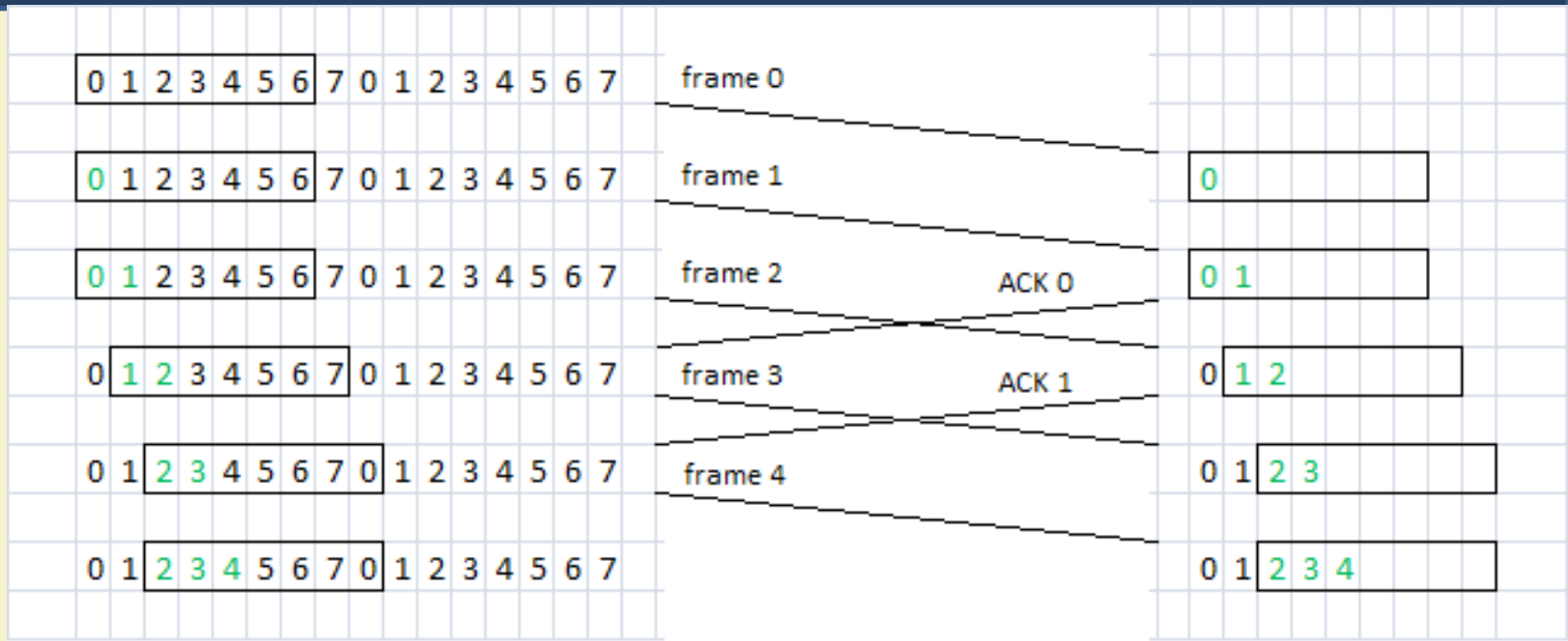
b. A pipelined protocol in operation

Source: Computer Networks, Kurose, Ross

Sliding Window Protocols

- Each outbound segment contains a sequence number – from 0 to some maximum (2^n-1 for a n bit sequence number)
- The sender maintains a set of sequence numbers corresponding to frames it is permitted to send (**sending window)**
- The receiver maintains a set of frames it is permitted to accept (**receiving window)**

Sliding Window Protocols – Sending Window and Receiving Window



Sliding window Protocol

Source:
http://ironbark.xtelco.com.au/subjects/DC/lectures/13/

Sliding Window for a 3 bit Sequence Number

Source: Computer Networks (5th Edition) by Tanenbaum, Wetherell

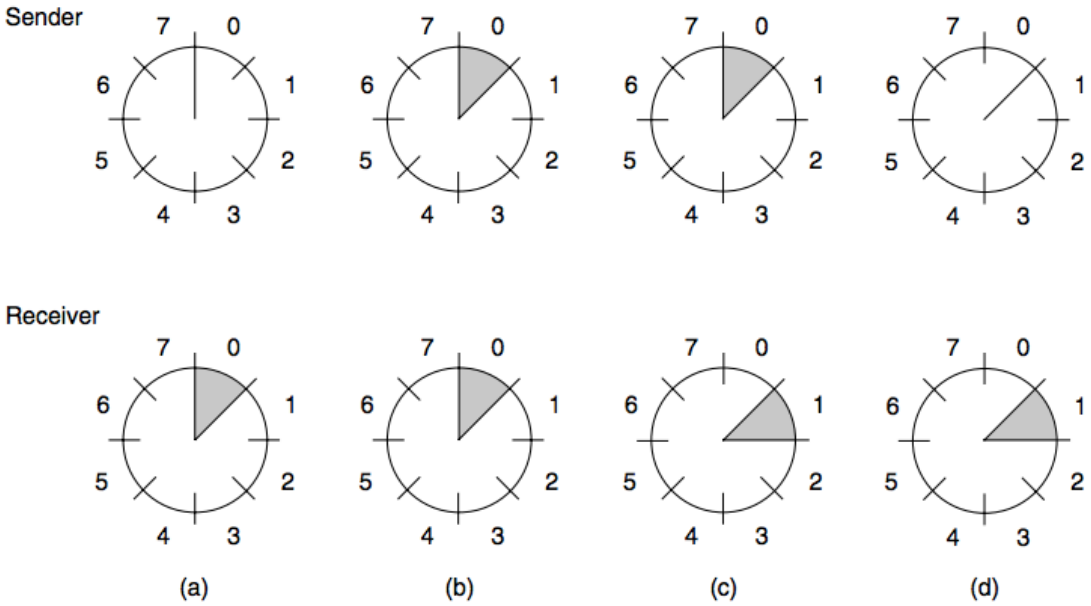
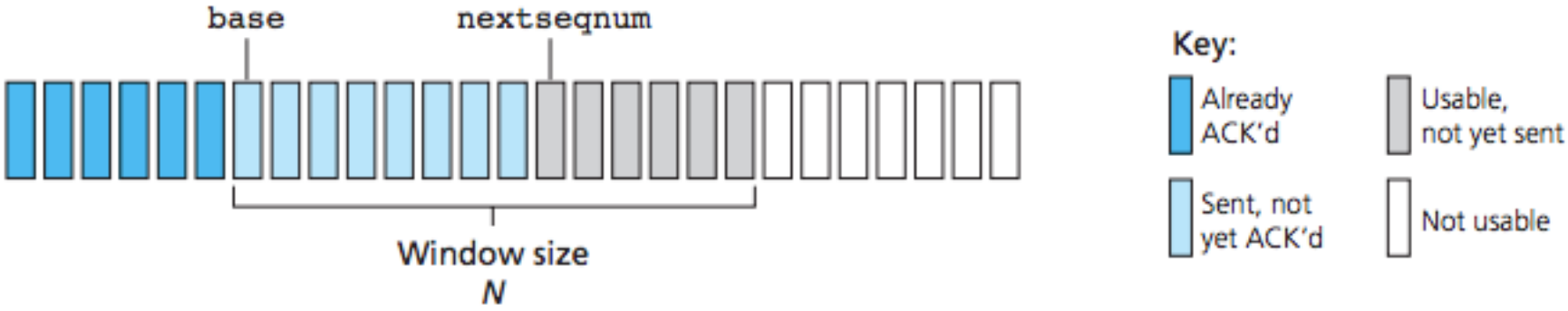


Figure 3-15. A sliding window of size 1, with a 3-bit sequence number. (a) Initially. (b) After the first frame has been sent. (c) After the first frame has been received. (d) After the first acknowledgement has been received.

Sliding Window Protocols in Noisy Channels

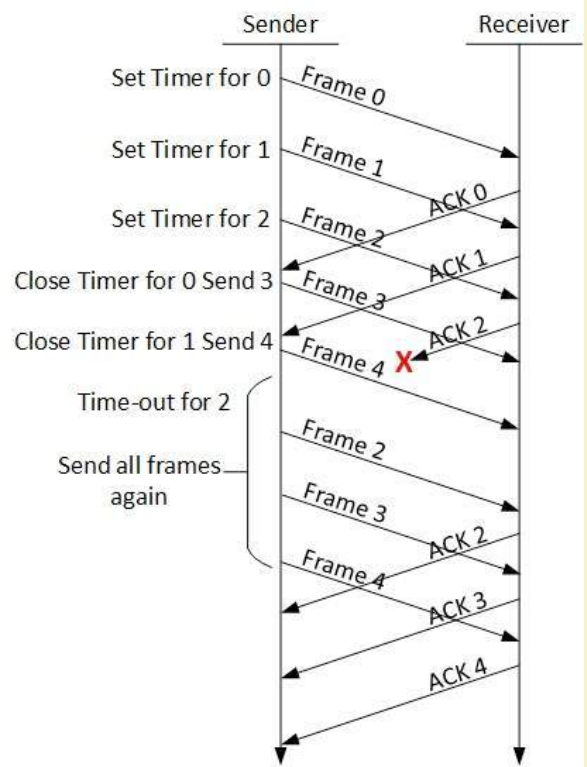
- **A timeout occurs if a segment (or the acknowledgment) gets lost**
- **How does the flow and error control protocol handle a timeout?**
- **Go Back N ARQ:** If segment N is lost, all the segments from segment 0 (start of the sliding window) to segment N are retransmitted
- **Selective Repeat (SR) ARQ:** Only the lost packets are selectively retransmitted
  - **Negative Acknowledgement (NAK) or Selective Acknowledgements (SACK):** Informs the sender about which packets need to be retransmitted (not received by the receiver)

Go Back N ARQ – Sender Window Control



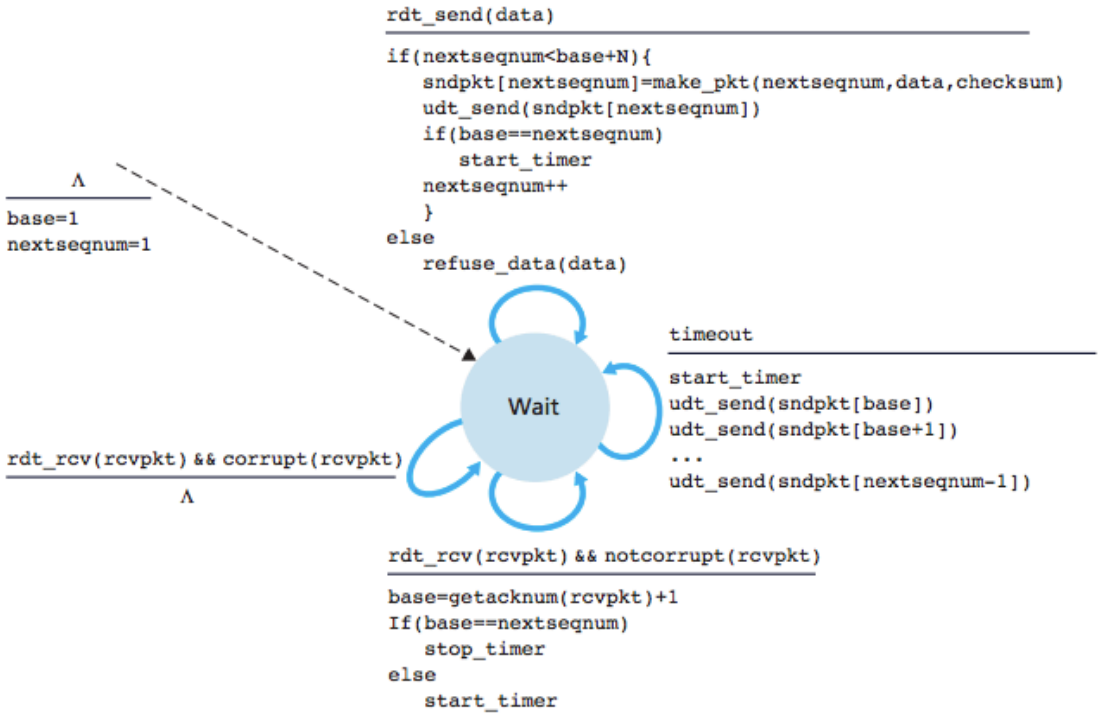
Source: Computer Networks, Kurose, Ross

Go Back N ARQ



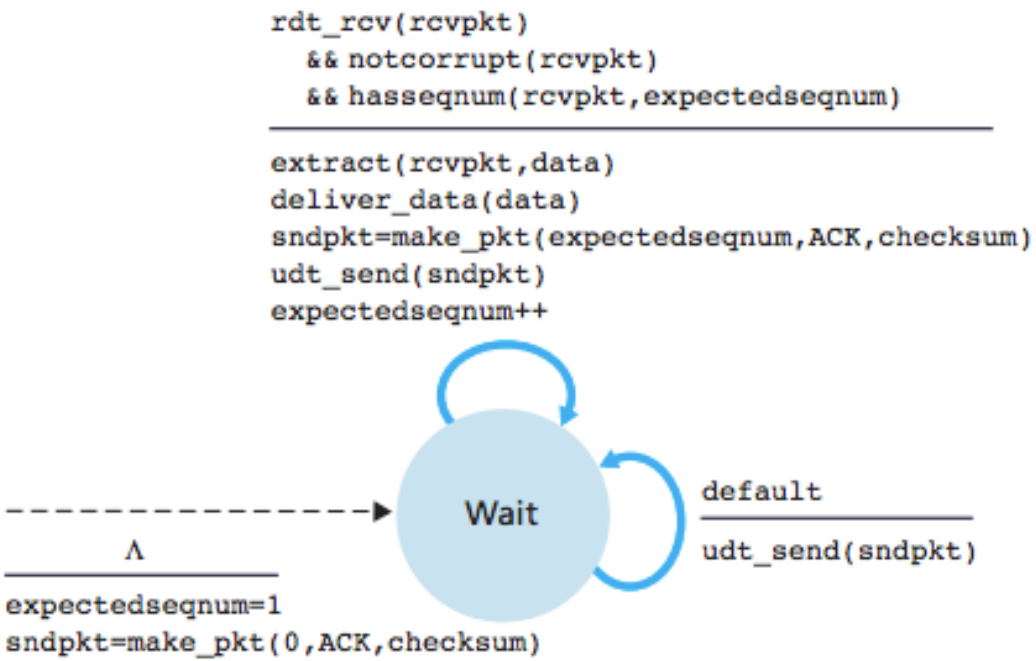
Source
https://www.tutorialspoint.com/data_communication_computer_network/data_link_control_and_protocols.htm

Go Back N ARQ – Sender



Source: Computer Networks, Kurose, Ross

Go Back N ARQ – Receiver

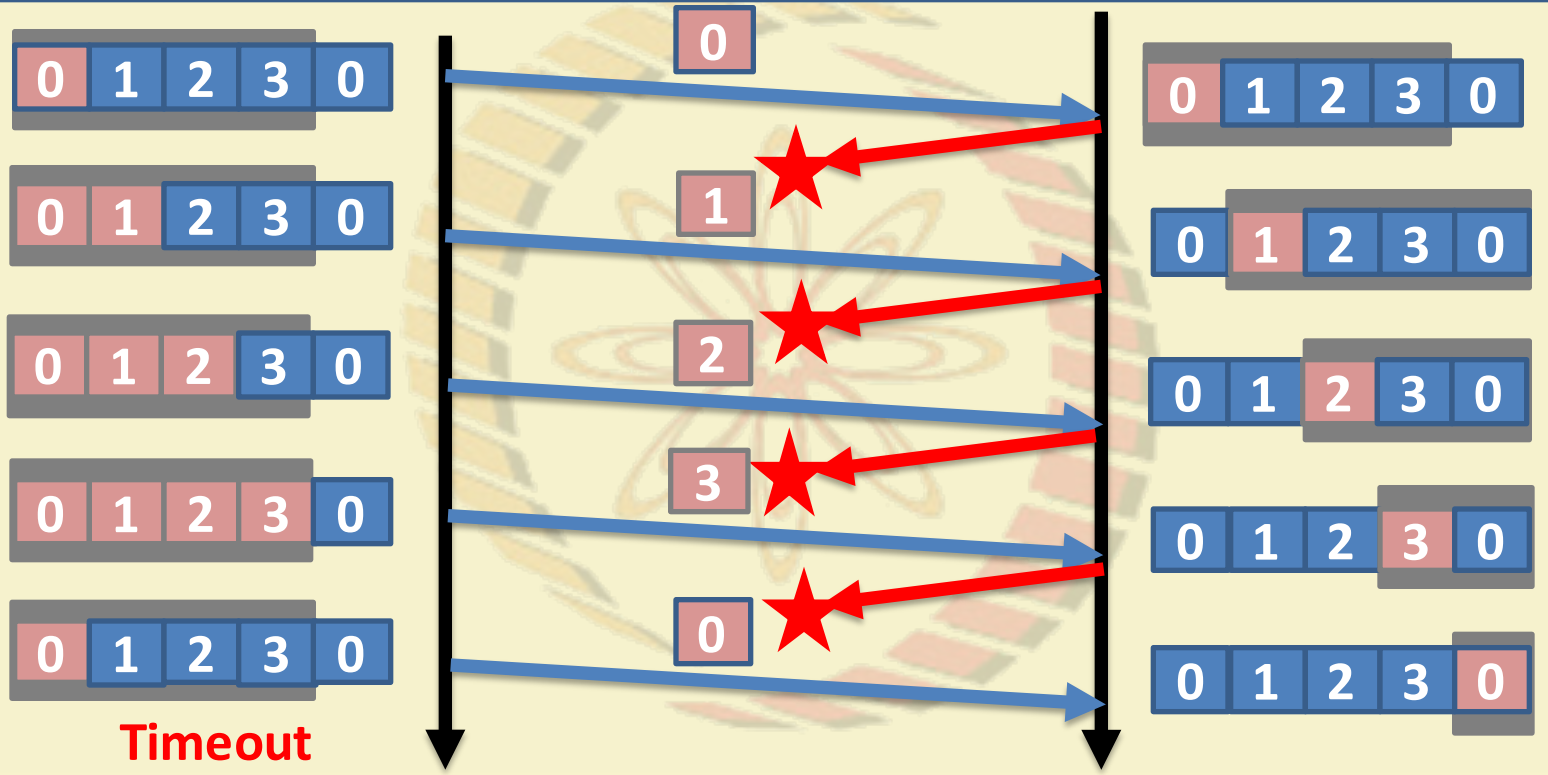


Source: Computer Networks, Kurose, Ross

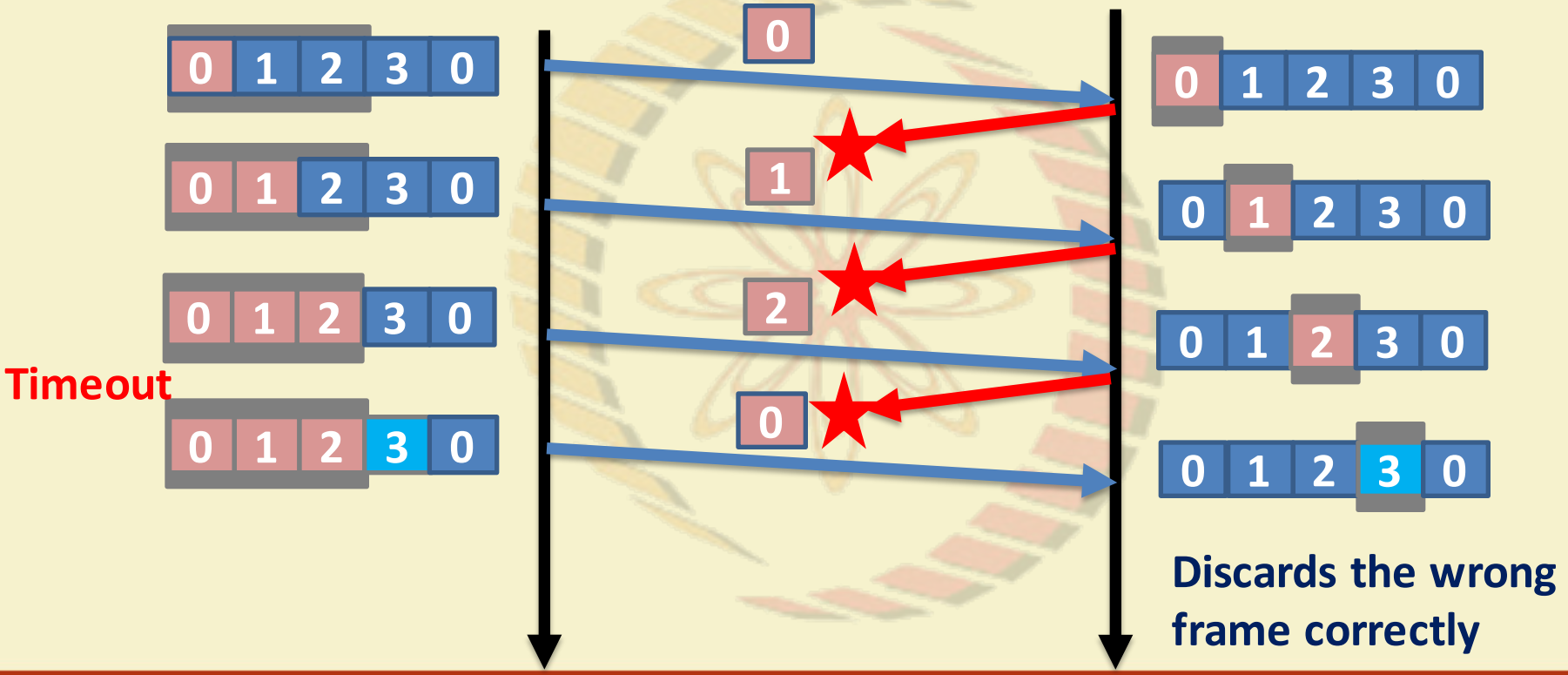
Go Back N ARQ – A Bound on Window Size

- **Outstanding Frames –** Frames that have been transmitted, but not yet acknowledged
- **Maximum Sequence Number (MAX_SEQ): MAX_SEQ+1** distinct sequence numbers are there
  - **0,1,…,MAX_SEQ**
- **Maximum Number of Outstanding Frames (=Window Size): MAX_SEQ**
- **Example:** Sequence Numbers (0,1,2,…,7) – 3 bit sequence numbers, number of outstanding frames = 7 **(Not 8)**

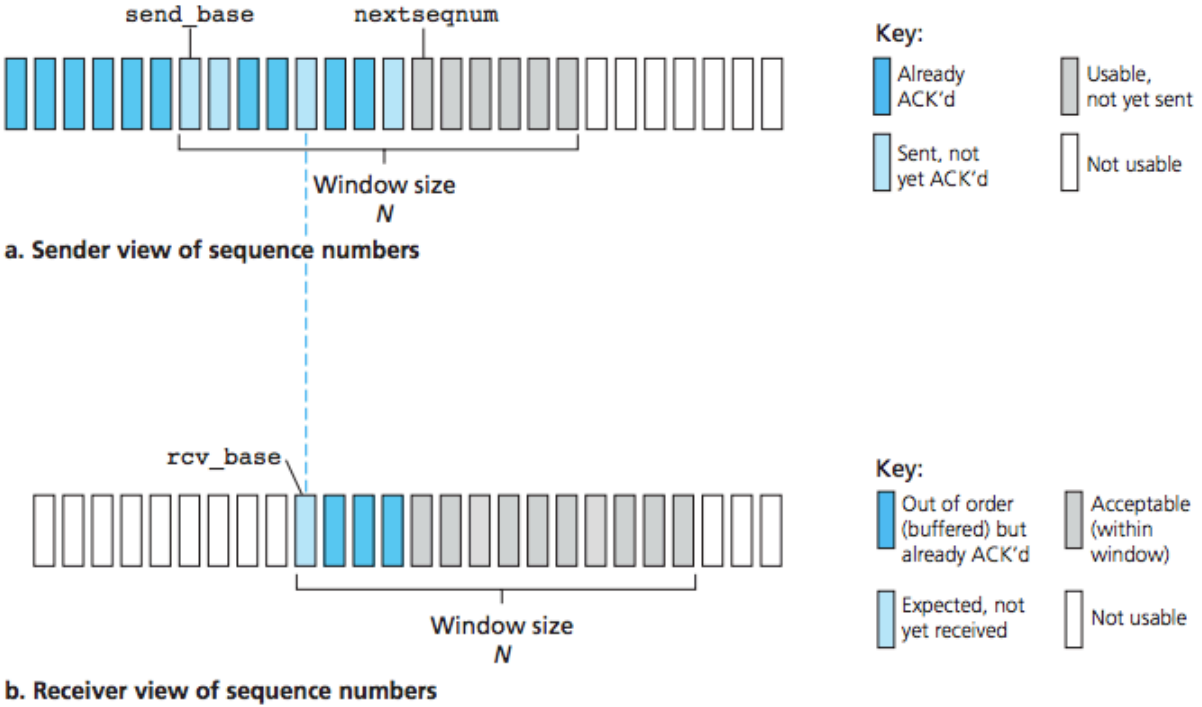
Go Back N ARQ (MAX_SEQ = 3, Window Size = 4)



Go Back N ARQ (MAX_SEQ = 3, Window Size = 3)

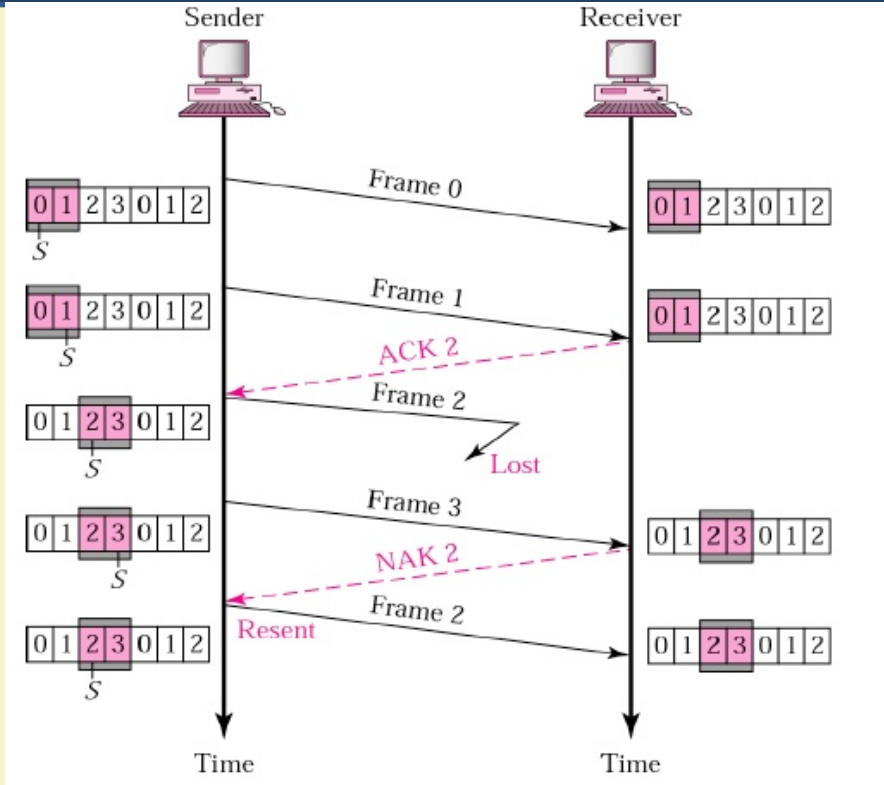


Selective Repeat (SR) – Window Control



Source: Computer Networks, Kurose, Ross

Selective Repeat ARQ



Source: Computer Networks, Tanenbaum

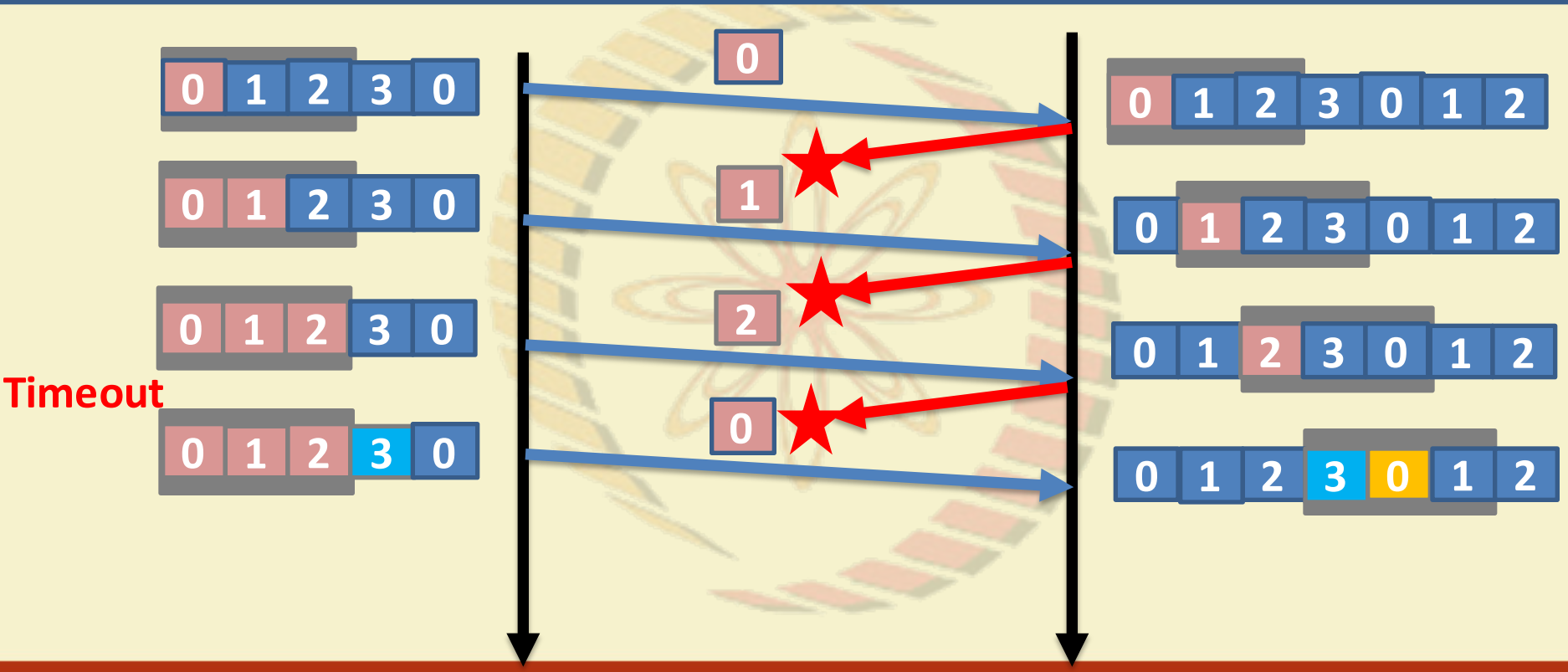
Selective Repeat – A Bound on Window Size

- **Maximum Sequence Number (MAX_SEQ): MAX_SEQ+1** distinct sequence numbers are there
  - **0,1,…,MAX_SEQ**

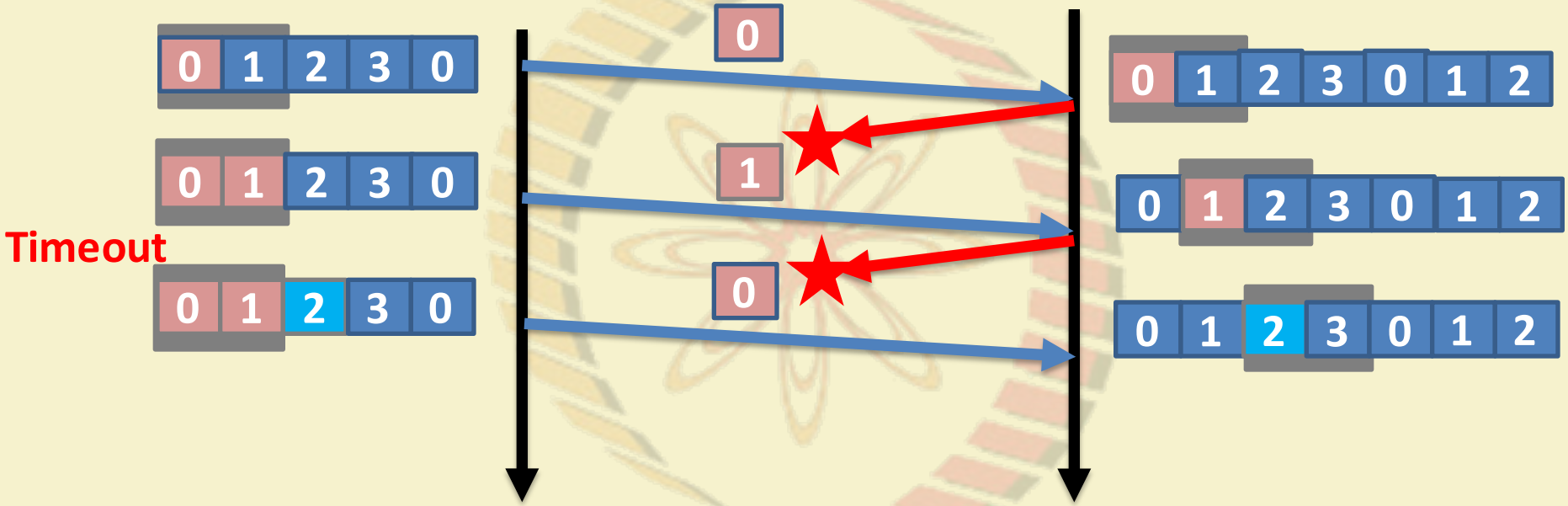
- **Maximum Number of Outstanding Frames (=Window Size): (MAX_SEQ+1)/2**

- **Example:** Sequence Numbers (0,1,2,…,7) – 3 bit sequence numbers, number of outstanding frames (window size) = 4

Selective Repeat (MAX_SEQ = 3, Window Size = 3)



Selective Repeat (MAX_SEQ = 3, Window Size = 3)



Discards the wrong frame correctly


thank you!