# IT301: Data Communication & Computer Network(DCCN)

Class: B. Tech (CS) Sec A
Semester : V
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Week 7

# Data Link Control Protocols

# Reliable Transmission

Reliable transmission of frames is important for effective data communication. It requires-

(i) Frame Synchronization- Recognizing beginning and end of each frames

(ii) Error control- Error detection and correction

If error can't be corrected, the frame is discarded and retransmitted by the sender

(i) Flow control- Regulating the flow of data between the sender and the receiver, to prevent receiver's buffer overflow

# Frame Transmission

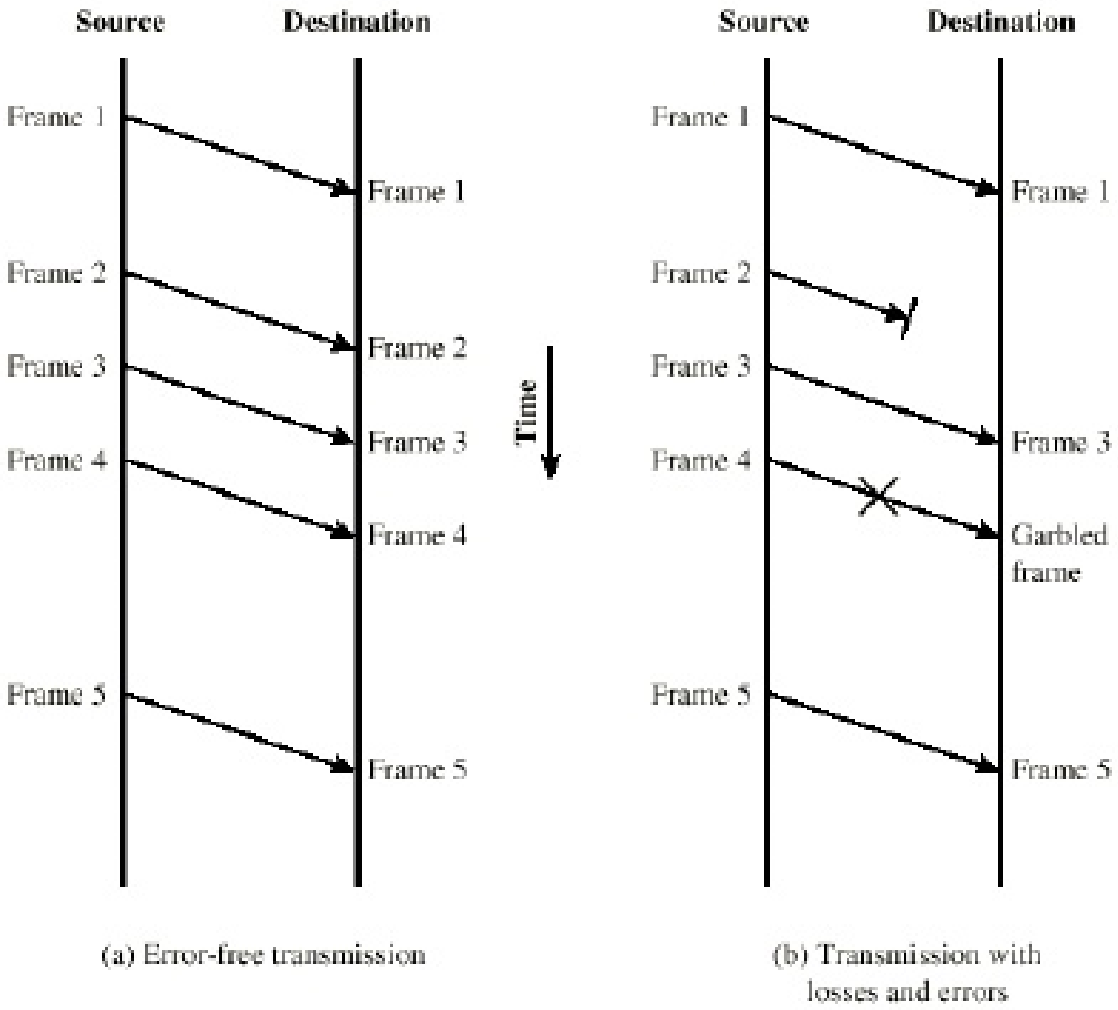
Data is transmitted as a sequence of frames

- Transmission Time

  Time taken by the sender to transmit all the bits of the frame to the medium

- Propagation Time
- Time it takes for a bit to travel from a source to a destination

# Frame Transmission



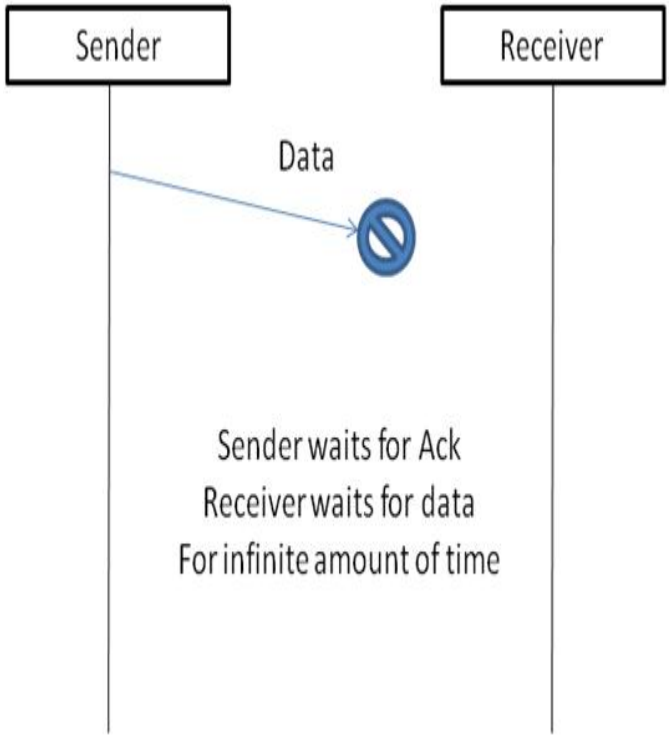

(a) Error-free transmission

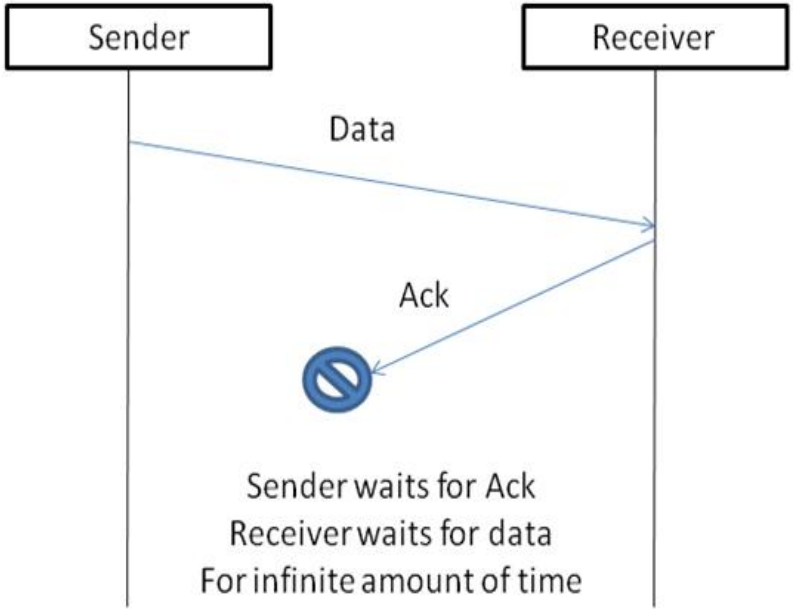
(b) Transmission with losses and errors

# Acknowledgements

- **Acknowledgement** (**ACK**) is a signal passed between communicating processes, computers, or devices to signify acknowledgement, or receipt of message, as part of a communications protocol.
- N**egative-acknowledgement** (**NAK** or **NACK**) signal is sent to reject a previously received message, or to indicate some kind of error.
- Acknowledgements and negative acknowledgements inform a sender of the receiver's state so that it can adjust its own state accordingly.

# Problems with ACKs



**Using both ACK and timer**

- Receiver sends ACK when it successfully receives a frame.
- After receiving ACK of a frame, the sender discards the frame from its buffer.
- Sender waits for ACK for a reasonable period of time after which it retransmits the frame.
- If the receiver get duplicate copies of a frame, it discards it.

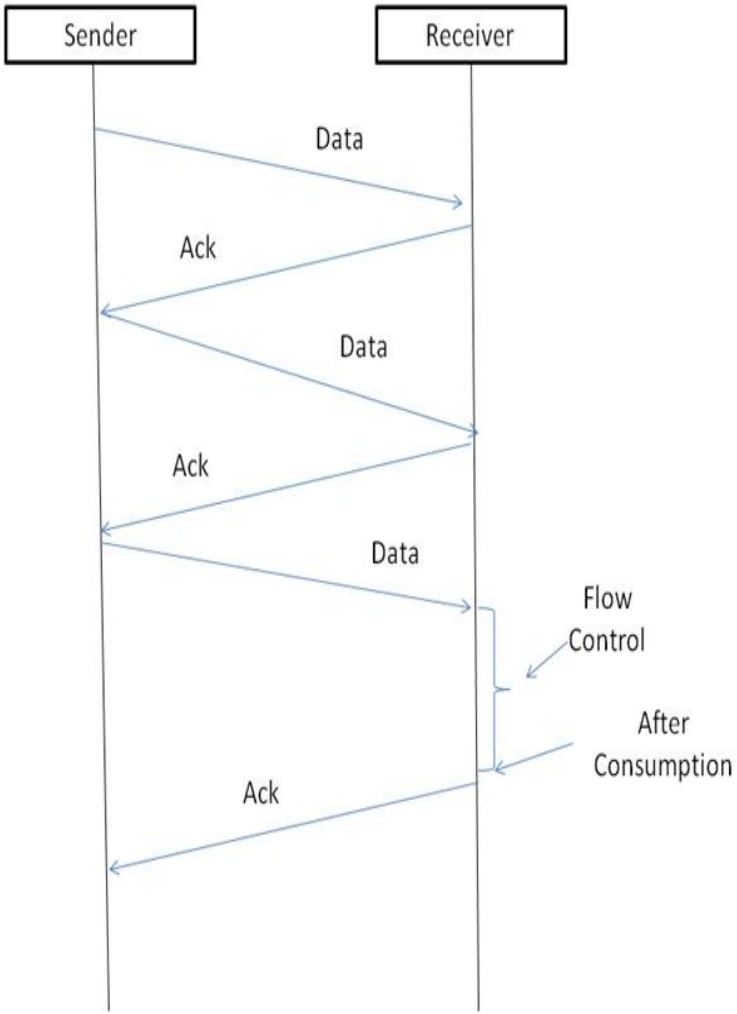
# Flow Control Mechanisms

**Stop and Wait-** only one frame is in transit at any time.

**Sliding Window Algorithm-** Sender sends some number of frames, and waits for ACKs. As it receives ACKs, sends more frames.

# Stop and Wait

- After receiving a frame, the receiver indicates its willingness to accept another frame by sending back an ACK frame acknowledging the frame just received.
- The sender must wait until it receives the ACK frame before sending the next data frame.



# Link Utilization

a = Propagation time / Transmission time

$$= \frac{d/V}{L/R}$$

d- link length

V- propagation velocity

L- frame length

R- data rate of the link

a=B/L, where B is bit length of the link (R.d/V)

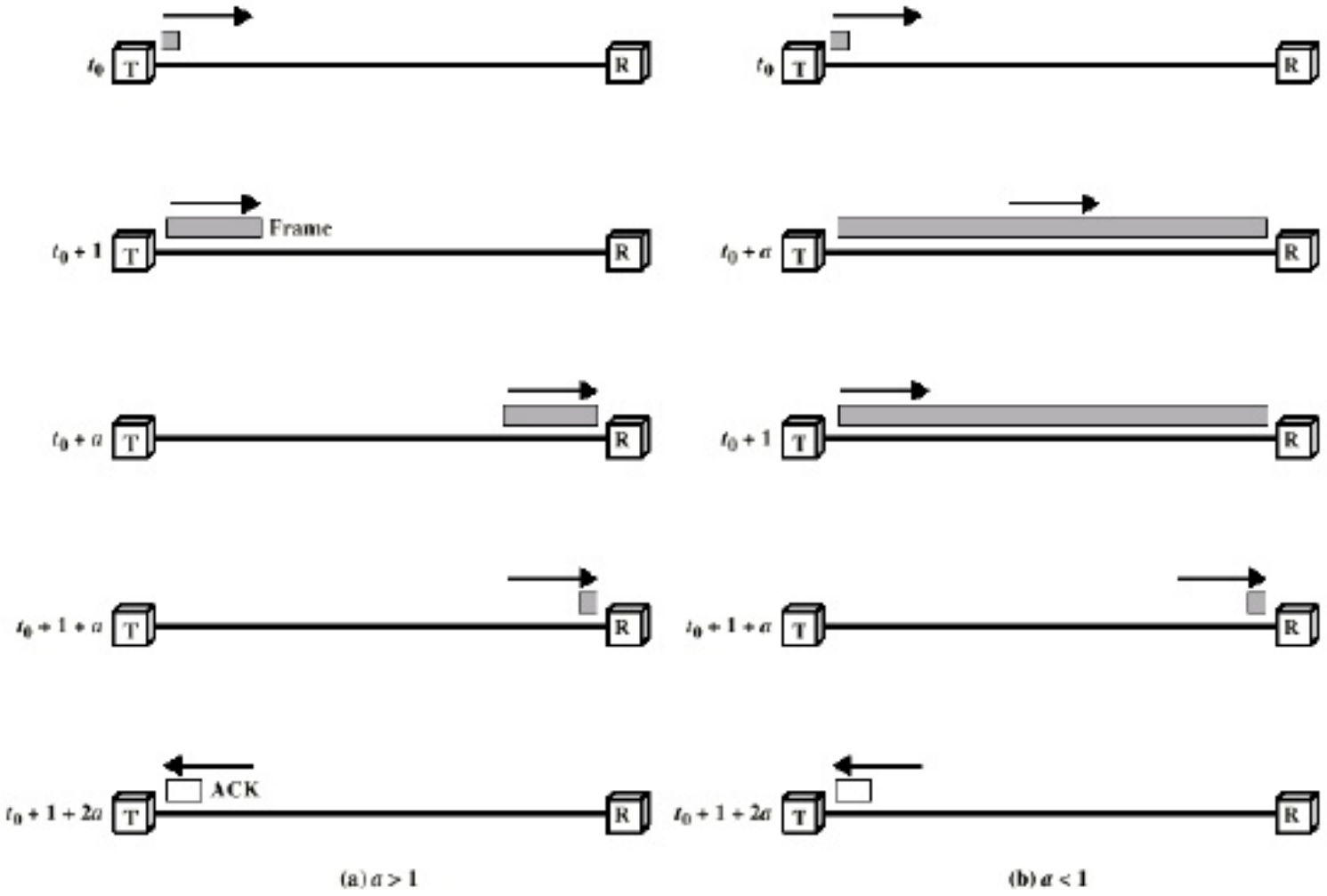
# Link Utilization

- $a < 1$ : Frame is sufficiently long such that the first bits of the frame arrive at the destination before the source has completed transmission of the frame.

- $a > 1$: Sender completes transmission of the entire frame before the leading bits of the frame arrive at the receiver.

- Link utilization $U = 1/(1+2a)$

# Link Utilization



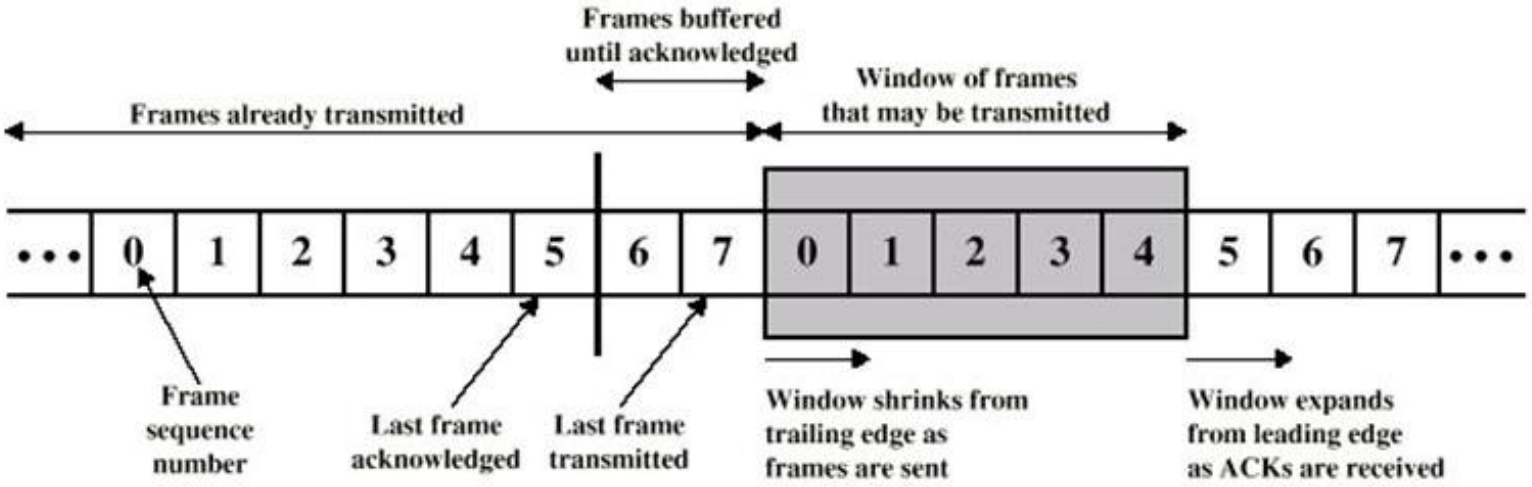
# Sliding Window

- To improve link utilization sender transmits multiple frames
- To keep track of the frames, sender station sends sequentially numbered frames.
- Sequence number is of limited size.
- Both sender and receiver use a window of fixed maximum size
- Sender window contains the sequence number of frames that sender is allowed to send at any time
- Receiver window is used by the receiver to keep the sequence number of frames that it can accept at any time
- Max. size of sender window should be less than or equal to the max. size of receiver window

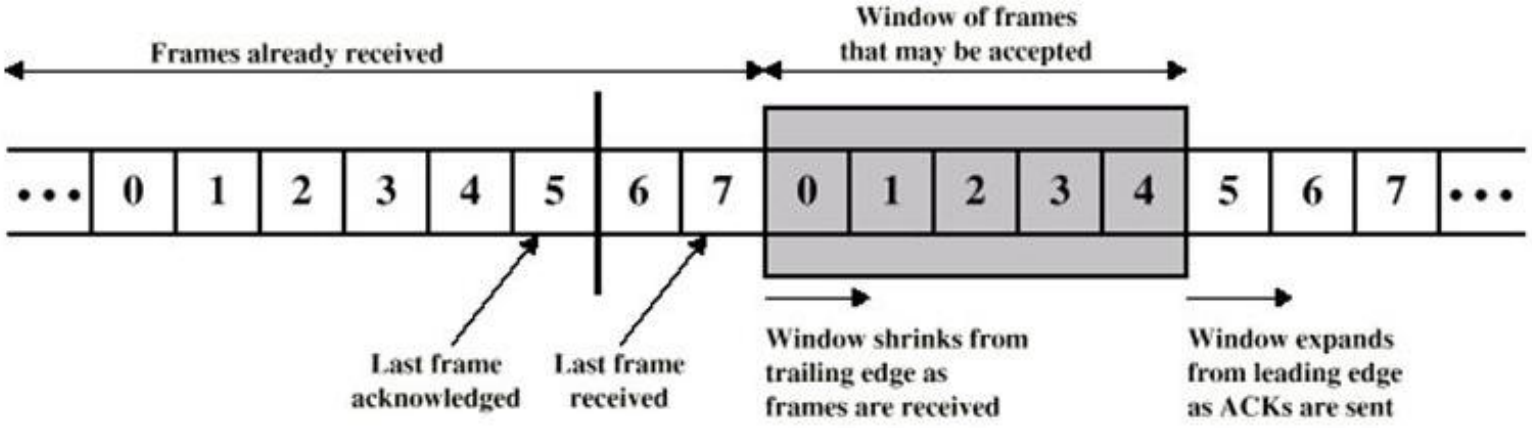
# Sliding Window

- Each side should have buffer with size greater than or equal to the maximum size of its window
- Among the frames arriving at receiver, some frames may have error and are discarded.
- Others are buffered until delivered to the higher layer.
- Frames are delivered in-order and their ACKs are sent to the sender.
- Receiver buffer out of order frames also, when the missing frames arrive, cumulative ACK is sent.

# Sliding Window

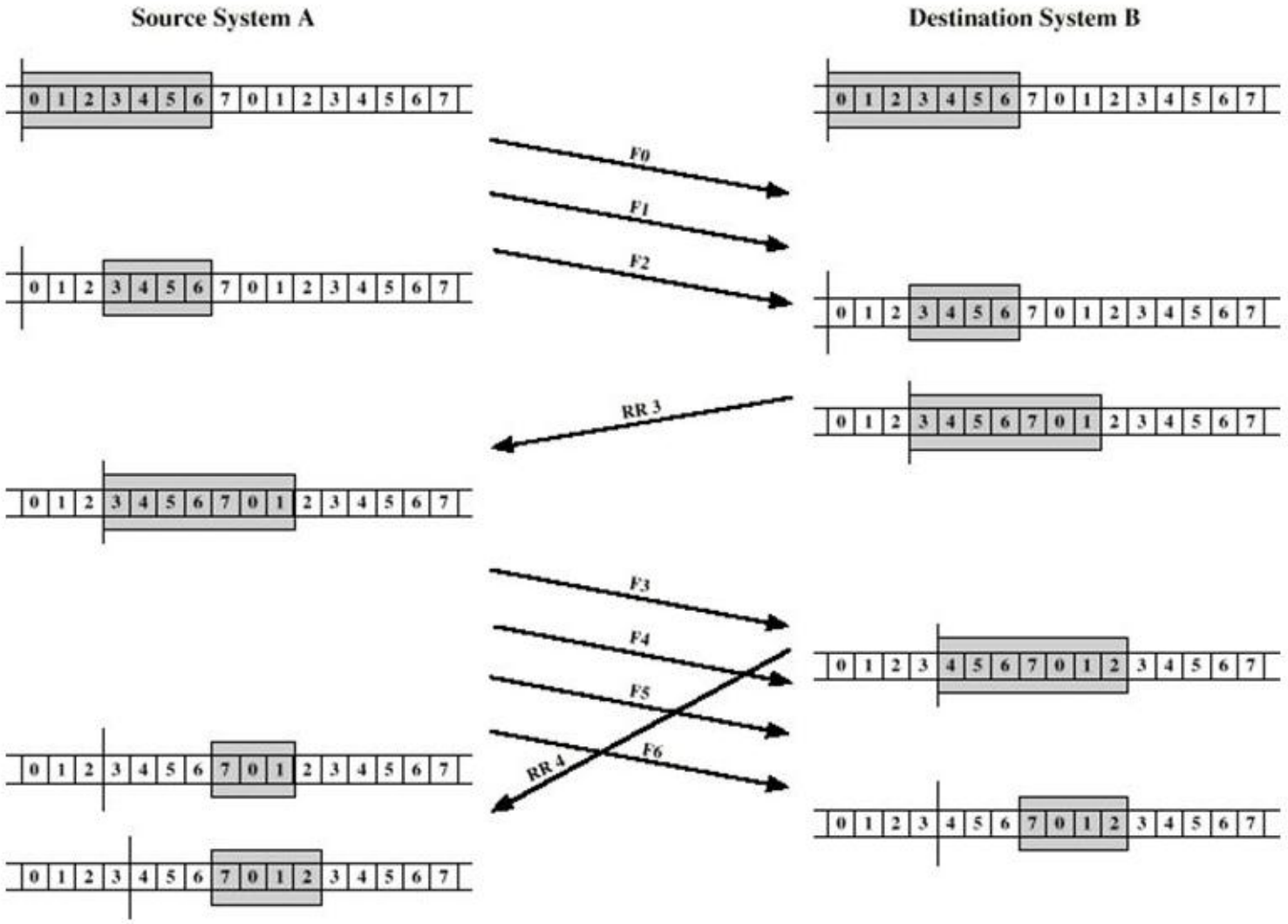



(a) Sender's perspective




(b) Receiver's perspective

# Example


Source System A
Destination System B
F0
F1
F2
RR 3
F3
F4
F5
F6
RR 4

# Sliding Window

Exclusive ACK frames

- RR- Receive Ready
- RNR- Receive Not Ready

Piggybacking

- Both acknowledgement and data can be combined into one frame

# Error Control

Detection and correction of errors

Two types of errors

- Lost Frames- fails to arrive
- Damaged Frame- arrives with error

Error control use

- Error detection
- Positive Acknowledgement
- Retransmission after timeout
- Negative Acknowledgement and Retransmission

# ARQ (Automatic Repeat Request)

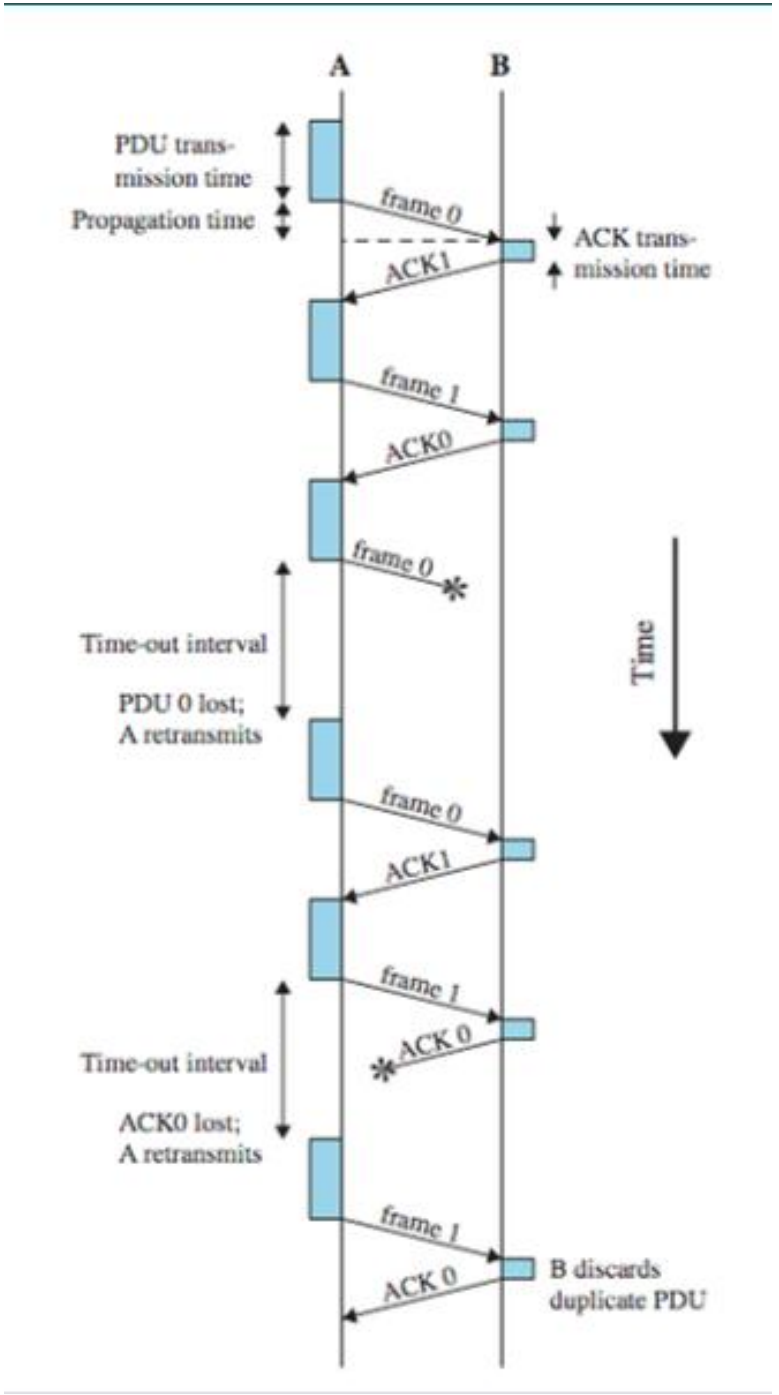
It is a mechanism for reliable data transmission that uses acknowledgements (or negative acknowledgements) and timeouts to transmit data over an unreliable communication link.

- Stop-and-wait ARQ
- Go-back-N ARQ
- Selective-reject ARQ

# Stop and wait ARQ

- Transmits a single frame and waits for ACK
- If no ACK is received by the time timer expires, frame is retransmitted
- If ACK is sent but got damaged in transit, frame gets retransmitted resulting in duplicate frames at receiver
- Frames are alternatively numbered 0 and 1, to identify duplicates frames

# Stop and wait ARQ



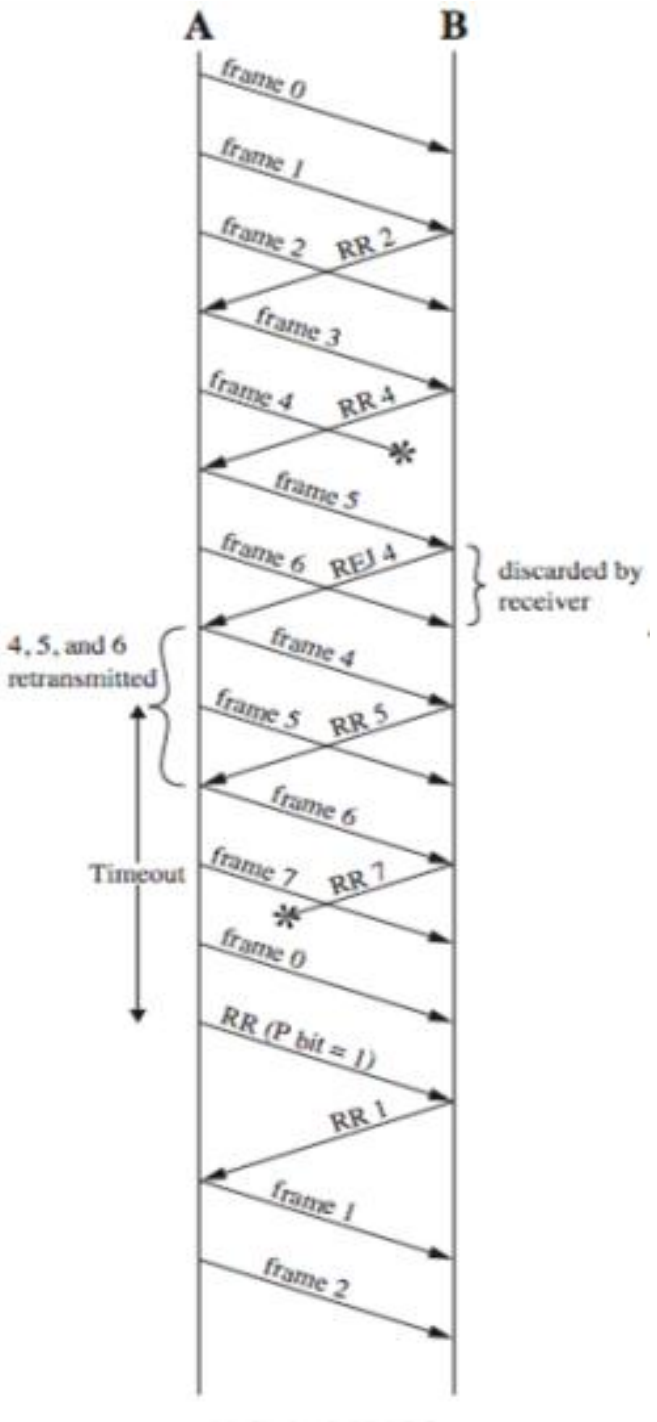
# Go-Back-N ARQ

- Based on sliding window flow control
- Frames are sequentially numbered modulo a max value
- If the destination detects frame error
  - send negative ACK (REJ- Reject) on receiving next frame
  - discards all future incoming frames until the frame in error is correctly received
- On receiving REJ frame, Source station retransmits frame in error as well as all succeeding frames
- If the timer expires, without any message from the receiver, then source can either retransmit the frame whose timer expired or it can send RR frame to the receiver to know the receiver status

# Source initiated RR

- RR frame is sent if the Source timer expires (in case of damaged frame or damaged RR)
- RR frame has a P-bit, which is set to 1 by the source
- On receiving RR frame, receiver replies with RR frame indicating the frame number it is expecting next
- Sender respond accordingly

# Go-Back-N ARQ


A
B
frame 0
frame 1
frame 2
RR 2
frame 3
frame 4
RR 4
frame 5
frame 6
REJ 4
discarded by receiver
4, 5, and 6 retransmitted
frame 4
frame 5
RR 5
frame 6
Timeout
frame 7
RR 7
frame 0
RR (P bit = 1)
RR 1
frame 1
frame 2

# Selective-Reject ARQ