

NOISY CHANNELS

Error Control

Stop-and-Wait ARQ

Sliding Window

Go-back-N

ARQ

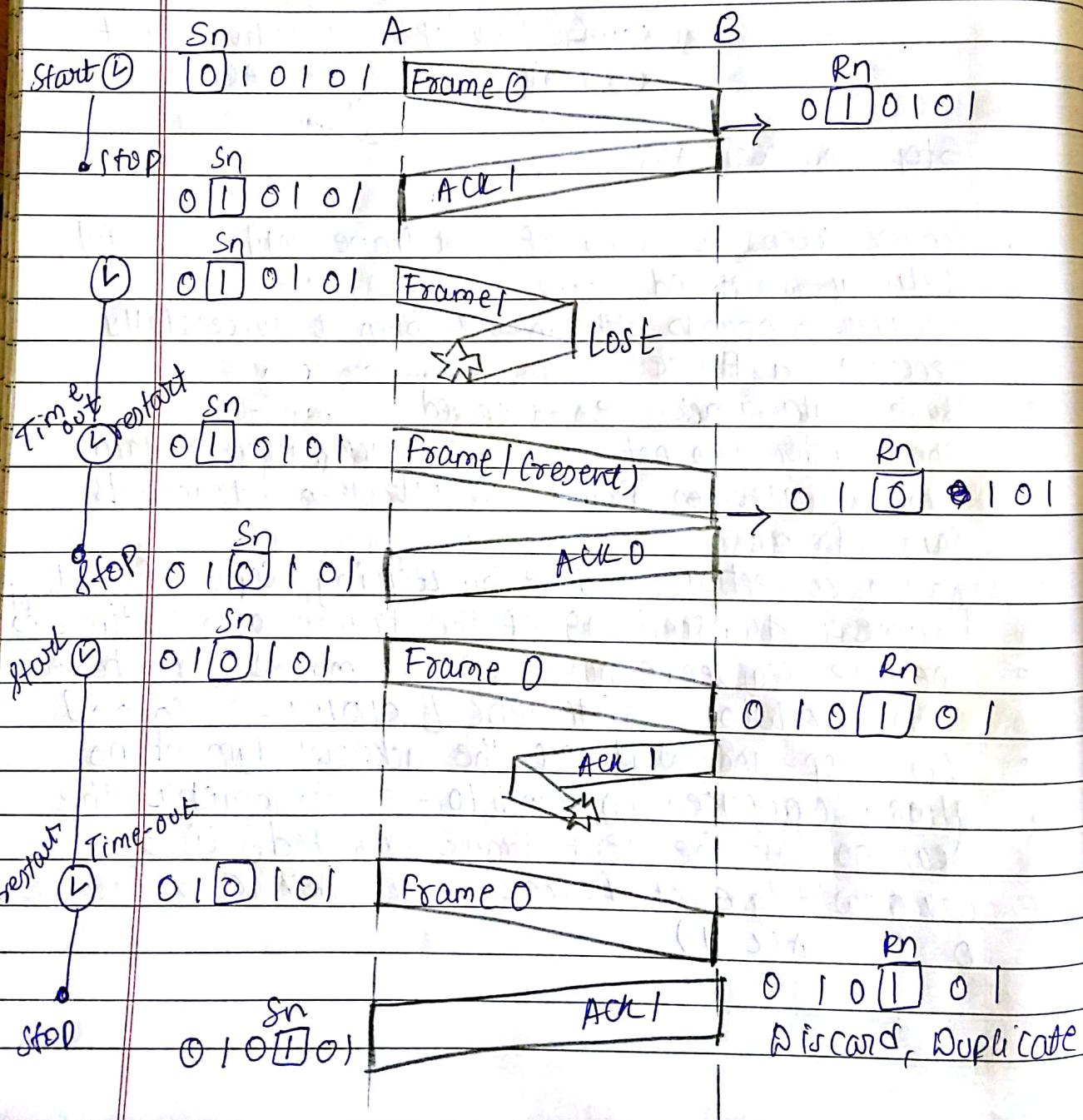
Selective Repeat

ARQ

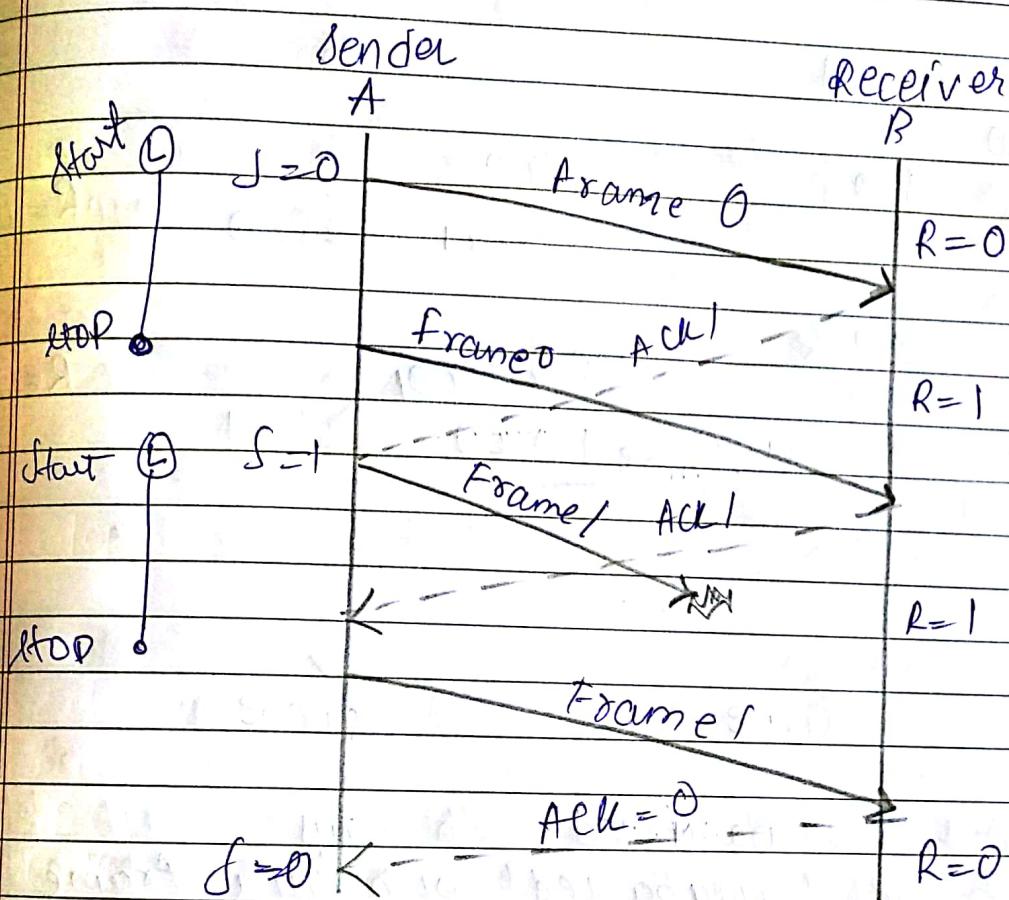
Stop-and-Wait ARQ

- Sender keeps a copy of sent frame until successful delivery is ensured
- Receiver responds with an ack when it successfully receives a frame.
- Both data & ack are numbered
- When sender does not receive an ack within certain time, it assumes frame is lost, then retransmits same frame.
- Error correction is done by keeping copy of sent frame & retransmitting of the frame when the timer expires.
- We use sequence nos to no frames. Seq no based on modulo-2 arithmetic [010101 ... so on]
- In Stop-and-Wait ARQ, the acknowledgement no always announces in modulo-2 arithmetic the seq no of the next frame expected (like acknowledgement of frame 1 is ACK 0 & frame 0 is ACK 1)

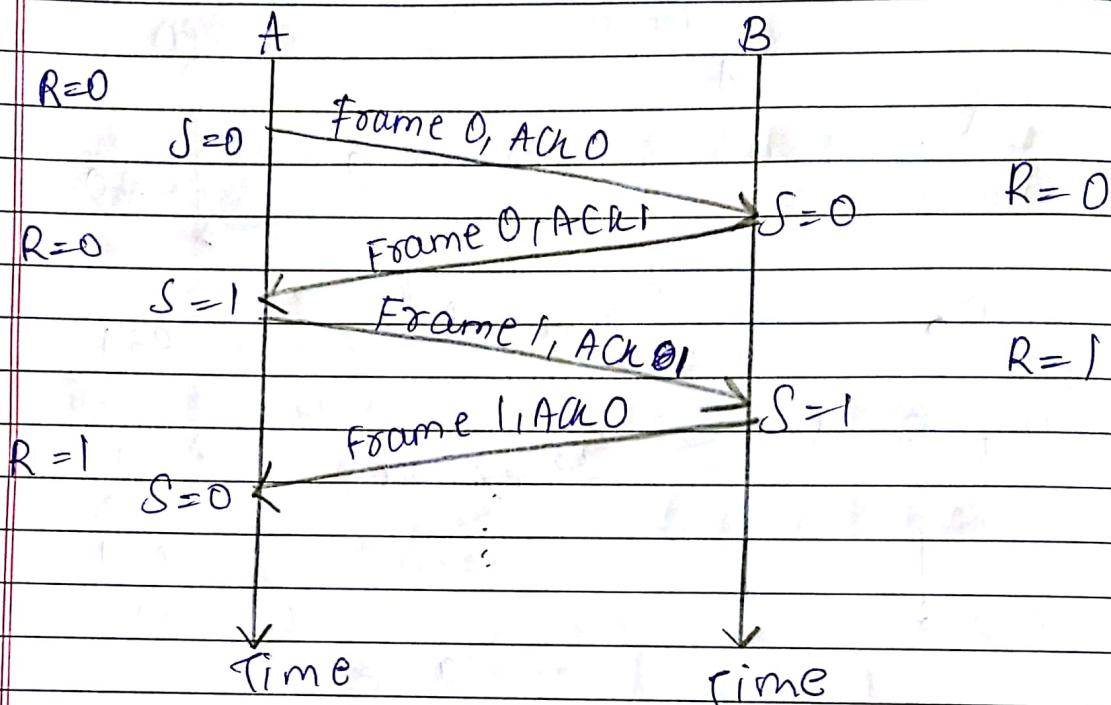
- In above fig frame 1 is lost & resent after timeout
resent frame 1 is acknowledged & timer stops
- Sender has no idea if the frame or acknowledgement is lost, so after the timeout, it resends frame 0, which is acknowledged



DELAYED ACK



BIDIRECTIONAL TRANSMISSION



- Data are transferred both ways
- ACK are "piggybacked" with data frame
- Piggy backing
 - In two-way commⁿ, whenever a data frame is received, the receiver waits and does not send the ack back to sender immediately
 - The receiver waits until its network layer passes in the next data packet.
 - The delayed acknowledgment is then attached to outgoing frame.
 - This technique of temporarily delaying the acknowledgment so that it can be hooked with next data frame is known as Piggy backing.

SLIDING WINDOW PROTOCOL's Go-Back-N ARQ

- Let say frame header contains m bits for seq number

In the Go-Back-N Protocol, the seq numbers are modulo 2^m , where m is the size of the seq no field in bits
 sending more than one frame at once requires sender to buffer multiple frames

- known as "sending window"
- Any of these frames in window can be lost.

window size = 7													
---	5	6	7	0	1	2	3	4	5	6	7	0	---

- Once the first frame in window is ACKed
 - ACKed frames are removed from the buffer
 - more frames are transmitted
 - The window slides to the right

Before Sliding

After Sliding two frames

window size = 7													
5	6	7	0	1	1	2	3	4	5	6	7	0	

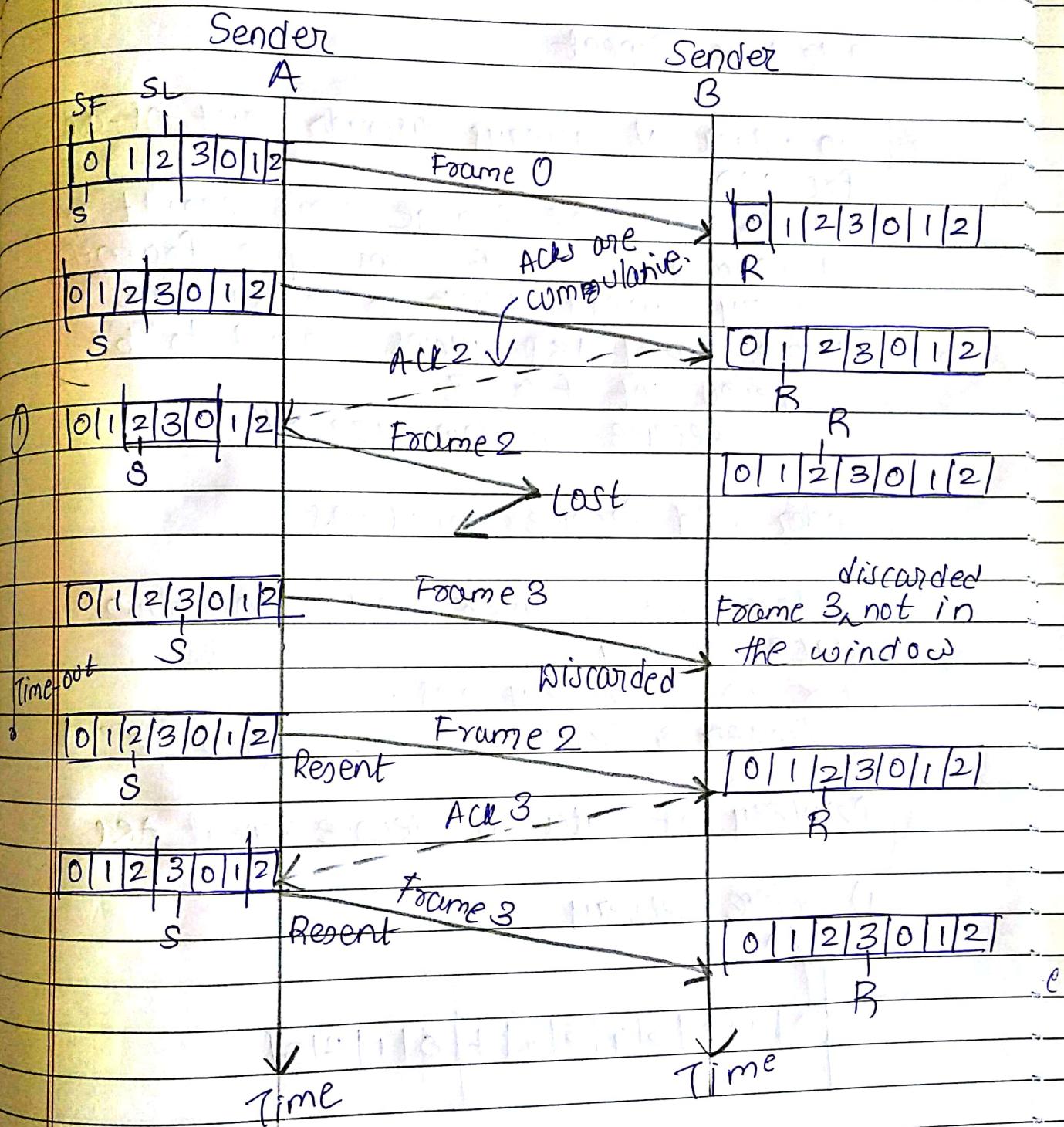
Receivers accept only frame at a time.

- If a frame is lost, the lost frame & all the following frames must be retransmitted.

Window Size

- m-bit sequence number
- window size: 2^{m-1}
 - Up to 2^{m-1} , can be sent without ACK frame
- receive window size: 1
 - frame are received in order.
- send window is an abstract concept defining an imaginary box of size 2^{m-1} with three variables SF, SN & Ssize
- send window can slide 1 more slot when a valid acknowledgment arrives
- receive window is an abstract concept defining an imaginary box of size 1 with one single variable RN

Diagrammatically:



Window size $\leq 2m$

Selective Repeat

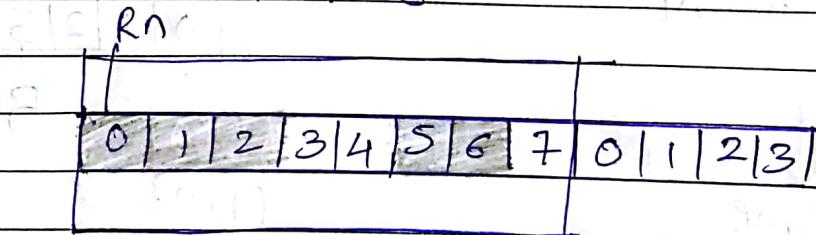
- o Go-Back-N always discards out-of-order frames
 - losing one frame may result in retransmission of multiple frames
 - very inefficient in noisy link
- o Selective Repeat ARQ allows frames to be received out of order
 - ∴ Receive window size > 1

Sender and Receiver windows

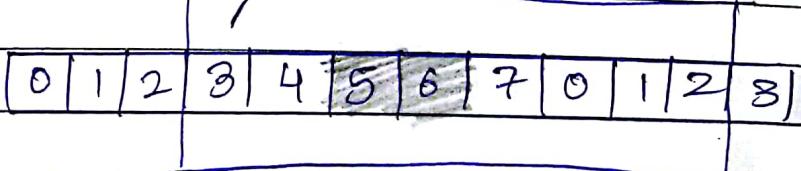
- Sender and Receiver share window space equally
for m bit seq nos:
Sender & Receive size upto 2^{m-1}

Delivery of data in Selective Repeat ARQ

a) Before Delivery



b) After delivery



Selective Repeat ARQ Use -ve ACK

- Used by receiver to indicate missing frame

Sender

Receiver

A

B

