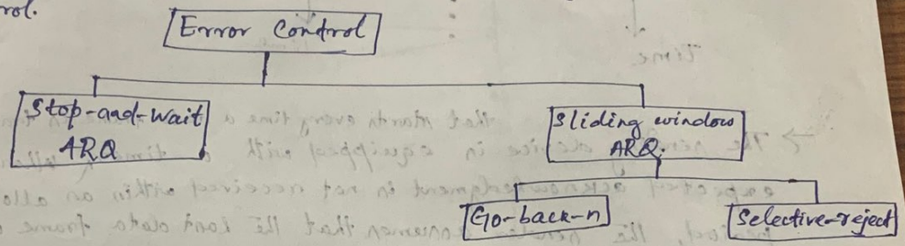
Error Control

In data link layer, the term error control refers primarily to methods of error detection and retransmission.

Whenever an error is detected by the receiver node, a negative acknowledgment (NAK) is returned and the specified frames are retransmitted. This process is called automatic repeat request (ARQ).

Error control in data link layer is based on automatic repeat request (ARQ), which means retransmission of data in three cases: damaged frame, lost frame and lost acknowledgment.

ARQ error control is implemented in the data link layer as an adjunct to flow control.



Stop-and-wait ARQ

It is a form of stop-and-wait flow control extended to include retransmission of data in case of lost or damaged frames.

For retransmission to work, four features are added to the basic flow control mechanism.

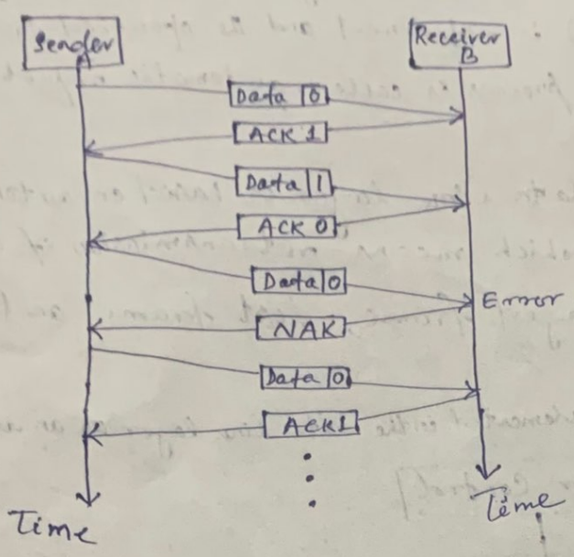
→ Both data frames and ACK frames are numbered alternately 0 and 1. A data 0 frame is acknowledged by an ACK 1 frame, indicating that the receiver has gotten data 0 and is now expecting data 1.

→ The sender keeps a copy of the last frame transmitted until it receives an acknowledgment for that frame.

→ If an error is discovered in a data frame, a NAK frame is returned (NAK are not numbered). When the sending device receives a NAK,

it resends the frame transmitted after the last acknowledgment, regardless of number.

⇒ Example: stop-and-wait ARQ, (damaged ~~or copied~~ corrupted frame)



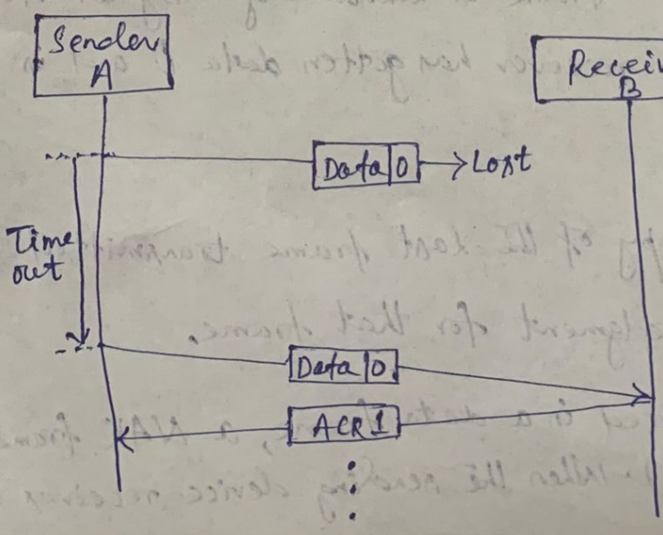
→ The sending device is equipped with a timer that starts every time a data frame is transmitted. ~~When~~ If an expected acknowledgment is not received within an allotted time period, the sender assumes that the last data frame was lost in transit and sends it again.

Lost frame

Any of the three (data, ACK, NAK) frames can be lost in transit.

Lost data frame

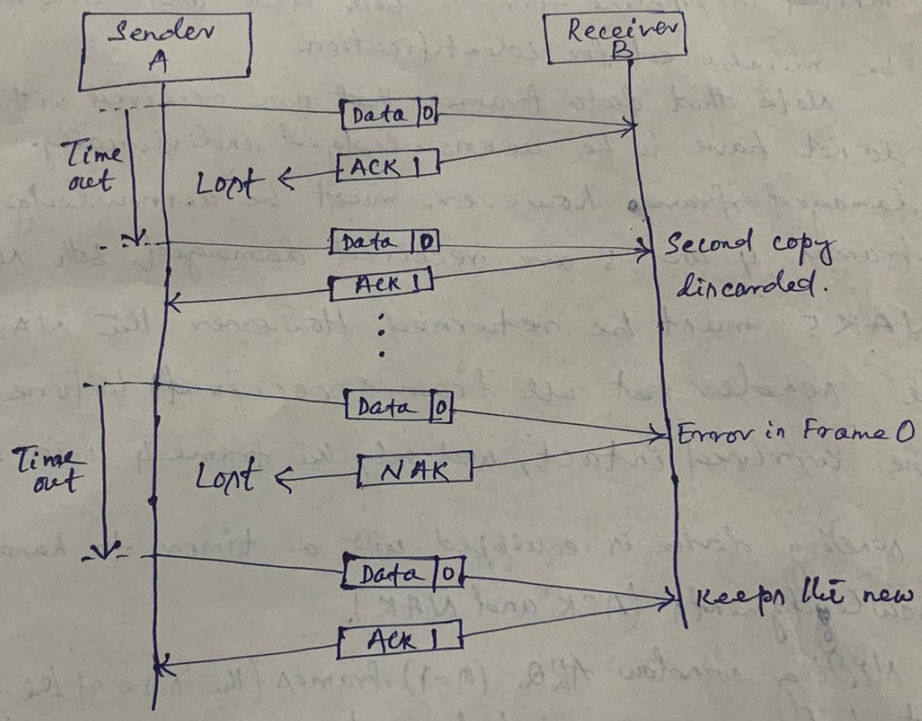
The sending device waits for an ACK or NAK frame until its timer goes off. After the expiry of the timer, it retransmits the last data frame, restarts the timer and waits for an acknowledgment.



Lost ACK and/or NAK

→ When the lost frame is NAK i.e in this case the data frame received by the receiver is found to be ~~corrupted~~ corrupted and transmits a NAK frame but it is not received by the sending device. So the sending device waits until its timer goes off, then retransmits the lost data frame. Now the receiver accepts the new copy and returns the appropriate ACK. (assuming the copy arrives undamaged).

→ If the lost frame was an ACK, the receiver recognizes the new copy as a duplicate, acknowledgement its receipt, then discards it and waits for the next frame.



frames, [illegible]
mechanism.

→ The sending device keeps copies of all transmitted frames until they have been acknowledged.

→ Since in sliding window technique the data frames are transmitted in pipeline form, so both ACK and NAK frames must be numbered for identification.

Note that data frames that are received without errors do not have to be acknowledged individually. Every damaged frame however, must be acknowledged. If data frames 4 and 5 are received damaged, both NAK 4 and NAK 5 must be returned. However the NAK 4 tells the sender that all frames received before frame 4 have arrived intact, and only the frame 4 is in error.

→ The sending device is equipped with a timer to handle lost acknowledgments (ACK and NAK).

In sliding window ARQ (n-1) frames (the size of the window) may be sent before an acknowledgment must be received. If n-1 frames are awaiting acknowledgment, the sender starts a timer and waits before sending any more. If the allotted time has run out with no acknowledgment, the sender assumes that the frames were not received and retransmits one or all of them depending upon the protocol.

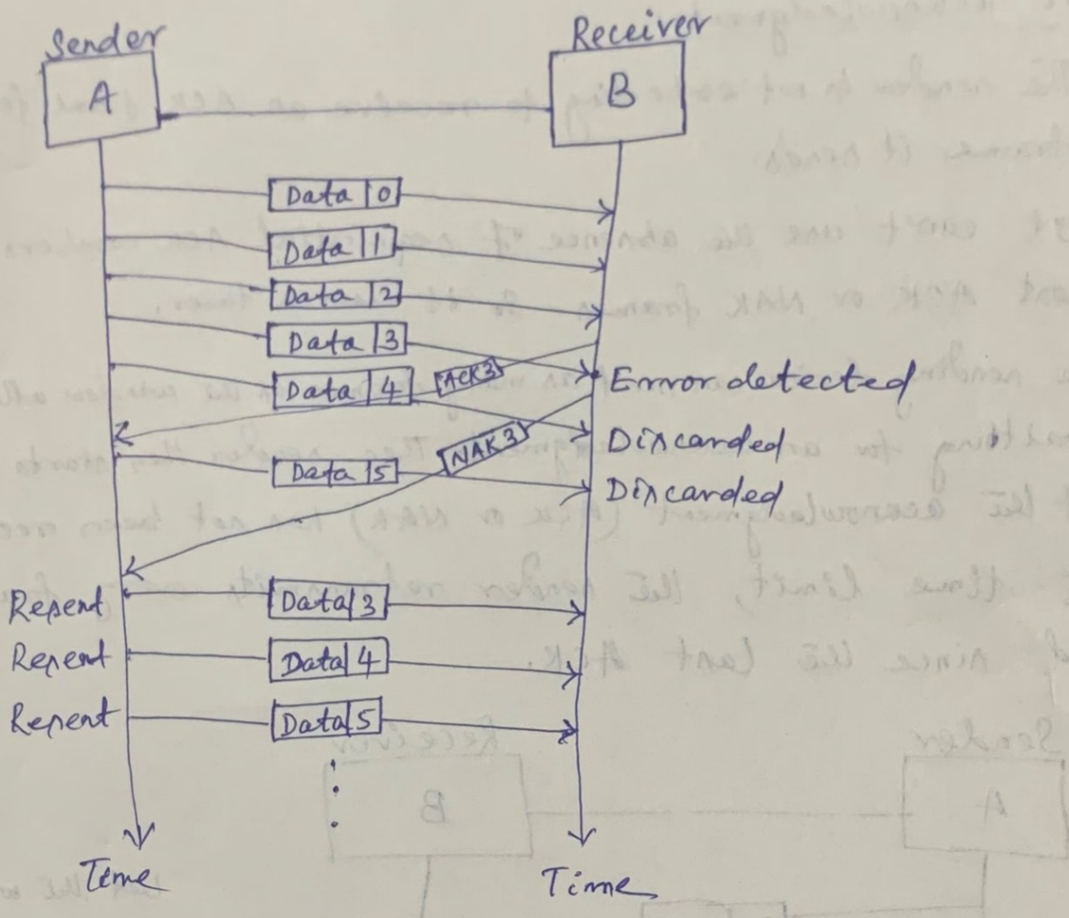
Go-Back-n ARQ

In this method, if one frame is lost or damaged, all frames sent since the last frame acknowledged are retransmitted.

Damaged frame

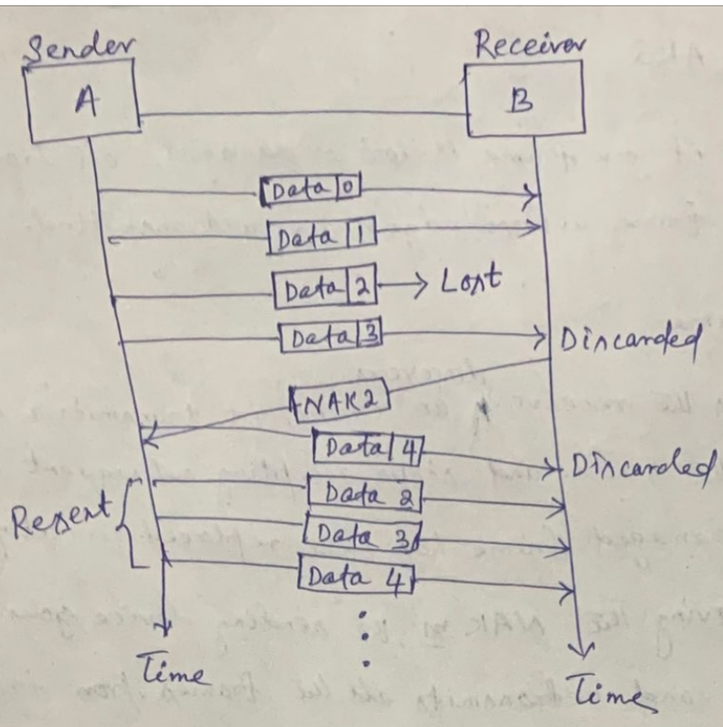
→ As soon as the receiver discovers an error, it transmits a NAK m frame to the sender and stops accepting subsequent frames until the damaged frame has been replaced correctly.

→ After receiving the NAK m, the sending device goes back to frame no. m and retransmits all the frames from frame m.



Lost Data Frame

→ The data frames are transmitted sequentially. If one or more frames are ~~corrupted~~ lost in transit, the receiver checks the

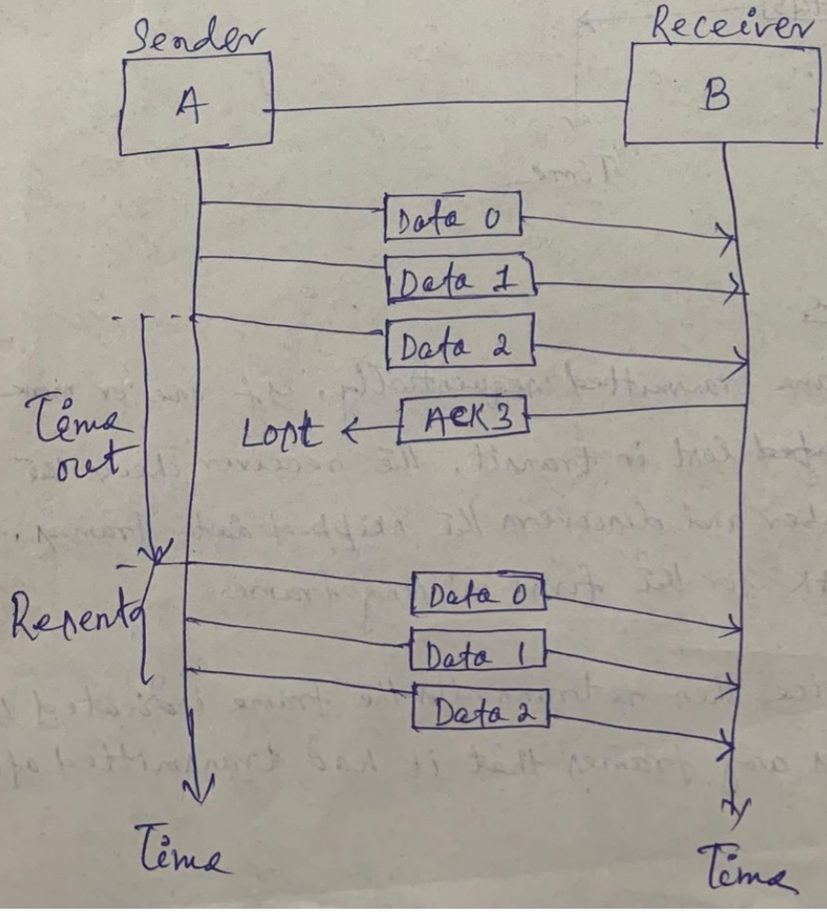


Lost acknowledgment

→ The sender is not expecting to receive an ACK frame for every data frame it sends.

→ It can't use the absence of sequential ACK numbers to identify lost ACK or NAK frames. So it uses a timer.

→ The sending device can send as many frames as the window allows before waiting for an acknowledgments. Then sender then starts a timer. If the acknowledgment (ACK or NAK) has not been received within the time limit, the sender retransmits every frame transmitted since the last ACK.



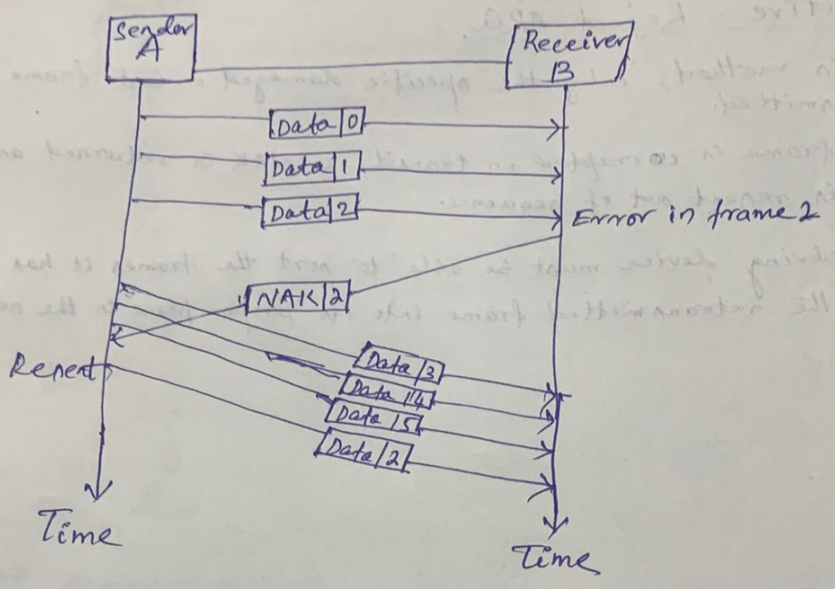
Let the window length is 3
i.e modulo - 4.

Selective - Reject ARQ

→ In this method, only the specific damaged or lost frame is retransmitted.

→ If a frame is corrupted in transit, a NAK is returned and the frame is resent out of sequence.

→ The receiving device must be able to sort the frames it has and insert the retransmitted frame into its proper place in the sequence.


Sender A
Receiver B
Data 0
Data 1
Data 2
Error in frame 2
NAK 2
Reset
Data 3
Data 4
Data 5
Data 2
Time
Time