

DATA COMMUNICATION CONCEPTS

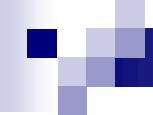
CHAPTER 6

DATA LINK CONTROL

6.0 OBJECTIVES

At the end of this chapter, you should be able to:

1. Analyze and apply the concept of Data Link Control



DATA LINK CONTROL



Data Link Layer

- Data Link Layer function:

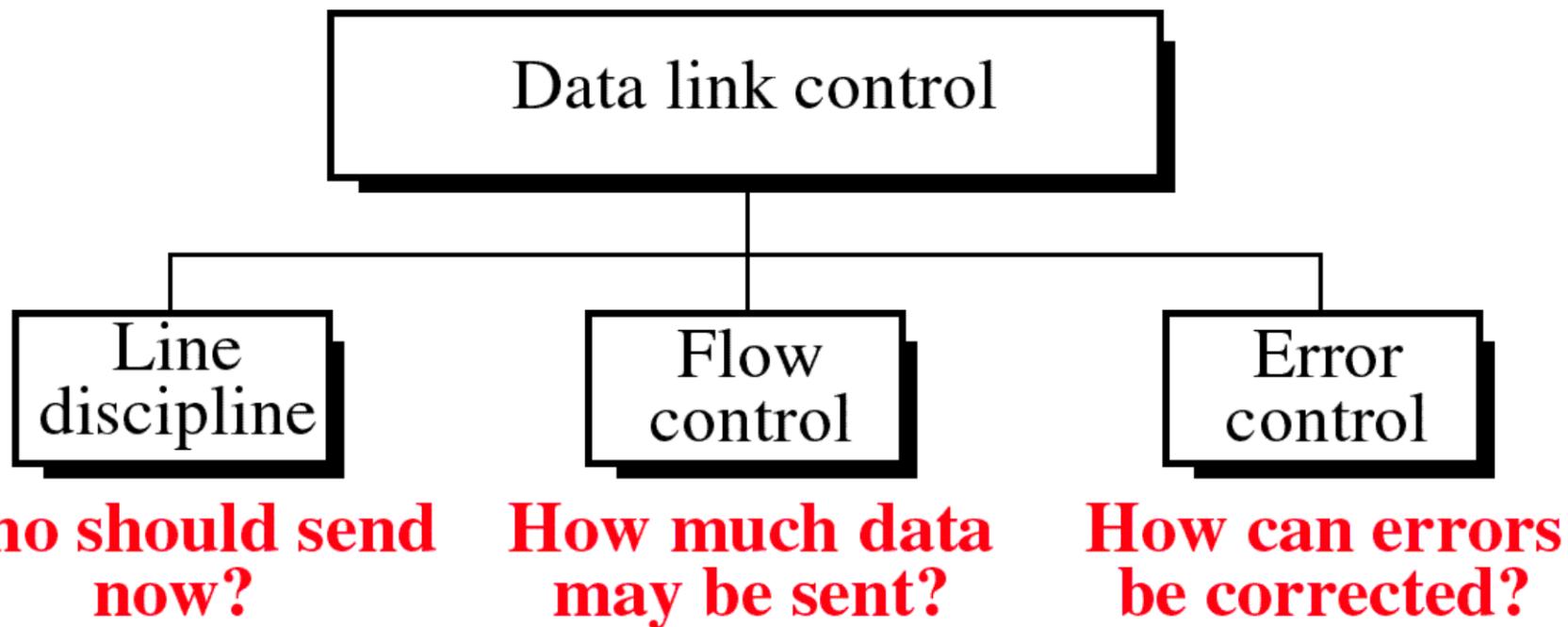


Figure 4.14 : Data Transmission

LINE DISCIPLINE

- Coordinates the link system. It determines which device can send and when it can send.
- 2 categories: ENQ/ACK and POLL/SELECT

FLOW CONTROL

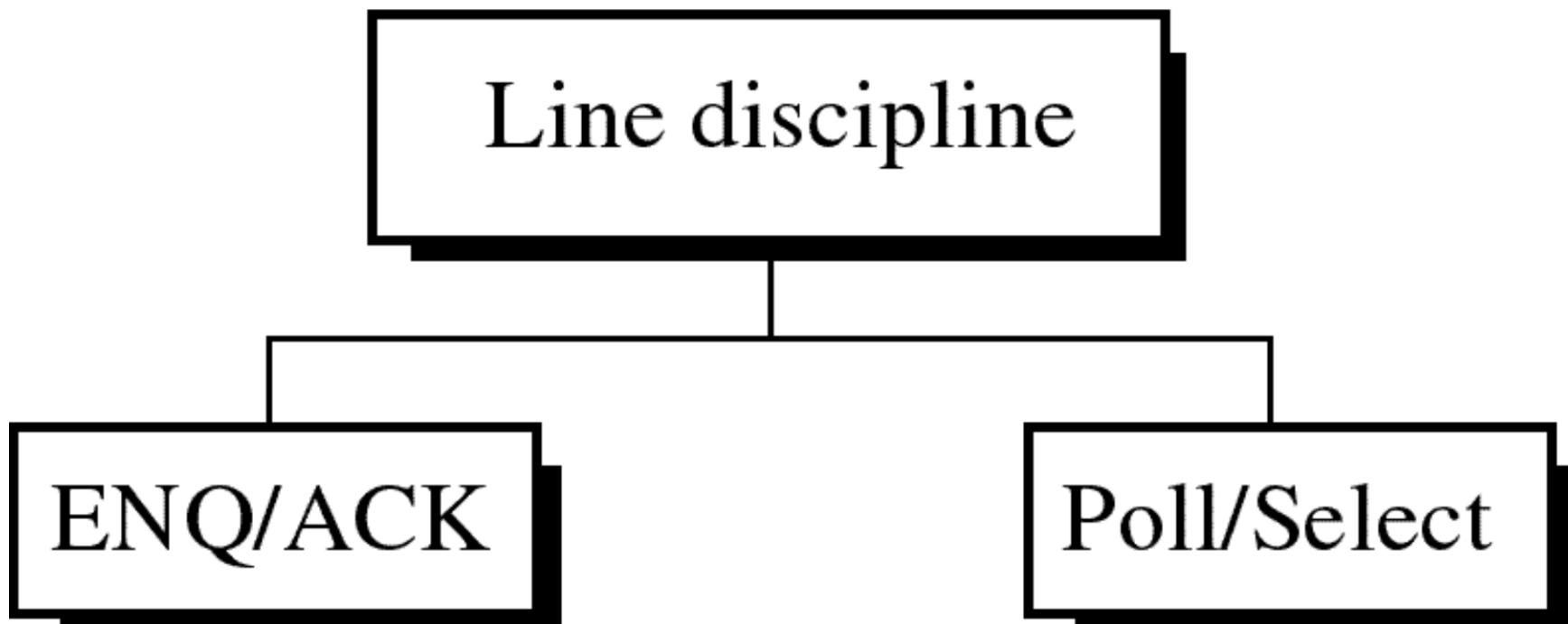
- Coordinates the amount of data that can be sent before receiving acknowledgement.
- Also provides the receiver's acknowledgement of frame receive intact and so is linked to error control.
- 2 ways: STOP-n-WAIT and SLIDING WINDOW

ERROR CONTROL

- Allows the receiver to inform the sender of any frames lost or damaged in transmission and coordinates the retransmission of those frames by the sender.
- 2 categories of error control:
 - i) STOP-n-WAIT ARQ
 - ii) SLIDING WINDOW ARQ:
 - a. Go-Back-n
 - b. Selective-Reject

6.1 DATA LINK CONTROL – LINE DISCIPLINE

- Established the status of a device (sender or receiver) on a link.



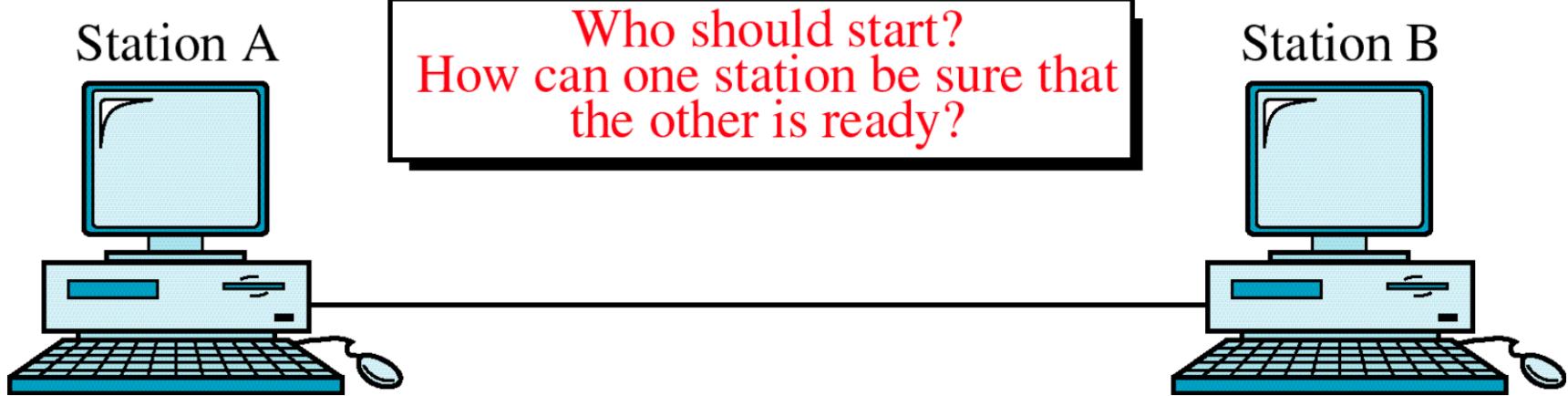
6.1.1 ENQ/ACK

- Is a line discipline method used in **point-to-point connections**.
- Responds with an **acknowledge (ACK)** if it is ready to receive data or a **negative acknowledgement (NAK)** if it is not ready.

SENDER	RECEIVER
■ ENQ frame	■ ACK frame – ready
■ DATA frame	■ NAK frame – not ready

- 2 terms for ACK:
 - i) Ready to receive data frame
 - ii) Expect to get next data frame

ENQ/ACK



ENQ/ACK

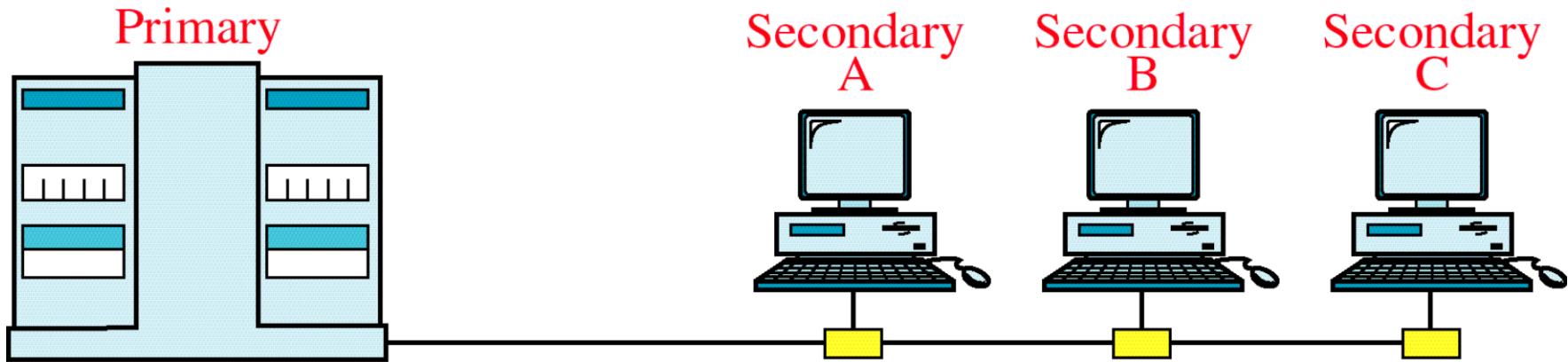
6.1.2 POLL/SELECT

- Is a line discipline method used in **multipoint connections**.
- The **primary** device always initiates communication with either a **POLL** or **SELECT** frame.
- A **POLL** frame is sent to the secondary device by the primary to determine if the secondary has data to send. The secondary respond by sending a **NAK (no data to send)** or a data frame.
- A **SEL** frame is sent from the primary device to the secondary device to tell the secondary to prepare to receive data. The secondary responds with an **ACK** or a **NAK**.

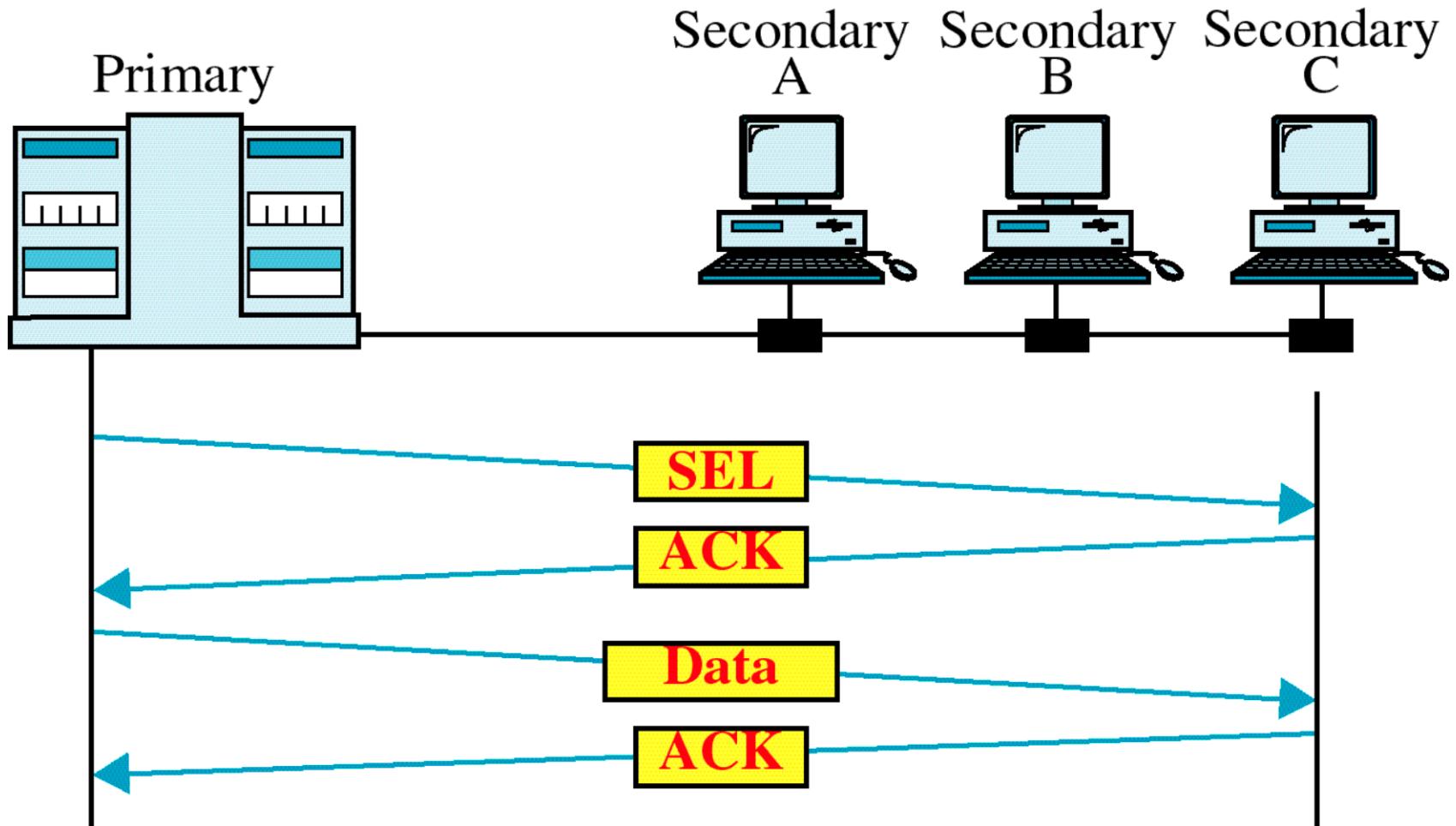
POLL (Primary)	SELECT (Primary)
■ Secondary (send data)	■ Secondary (receive data)
■ NAK frame (no data)	■ ACK frame (ready to receive)
■ DATA frame (has data)	■ NAK frame (not ready to receive)

Multipoint Discipline

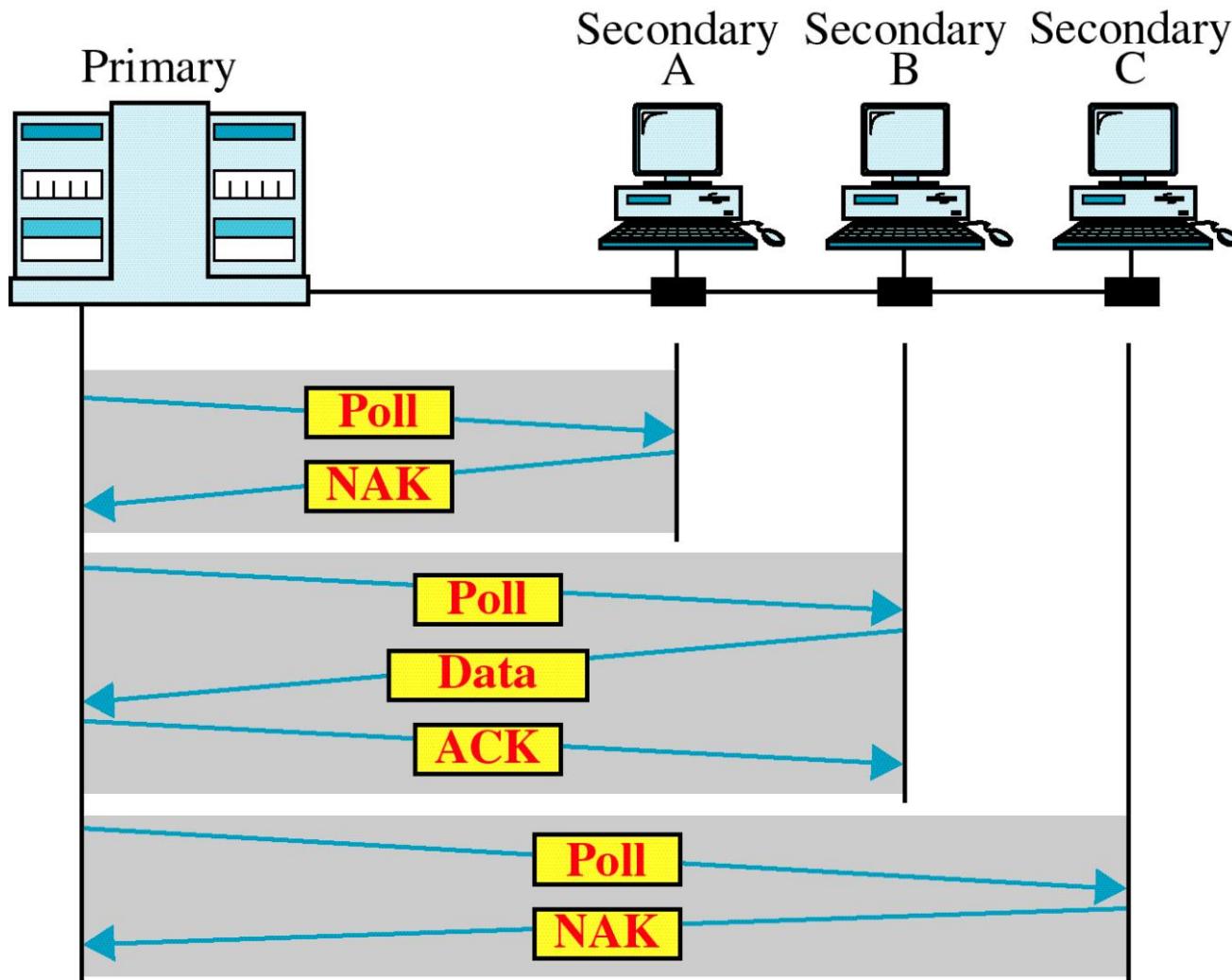
Who has the right to the channel?



SELECT

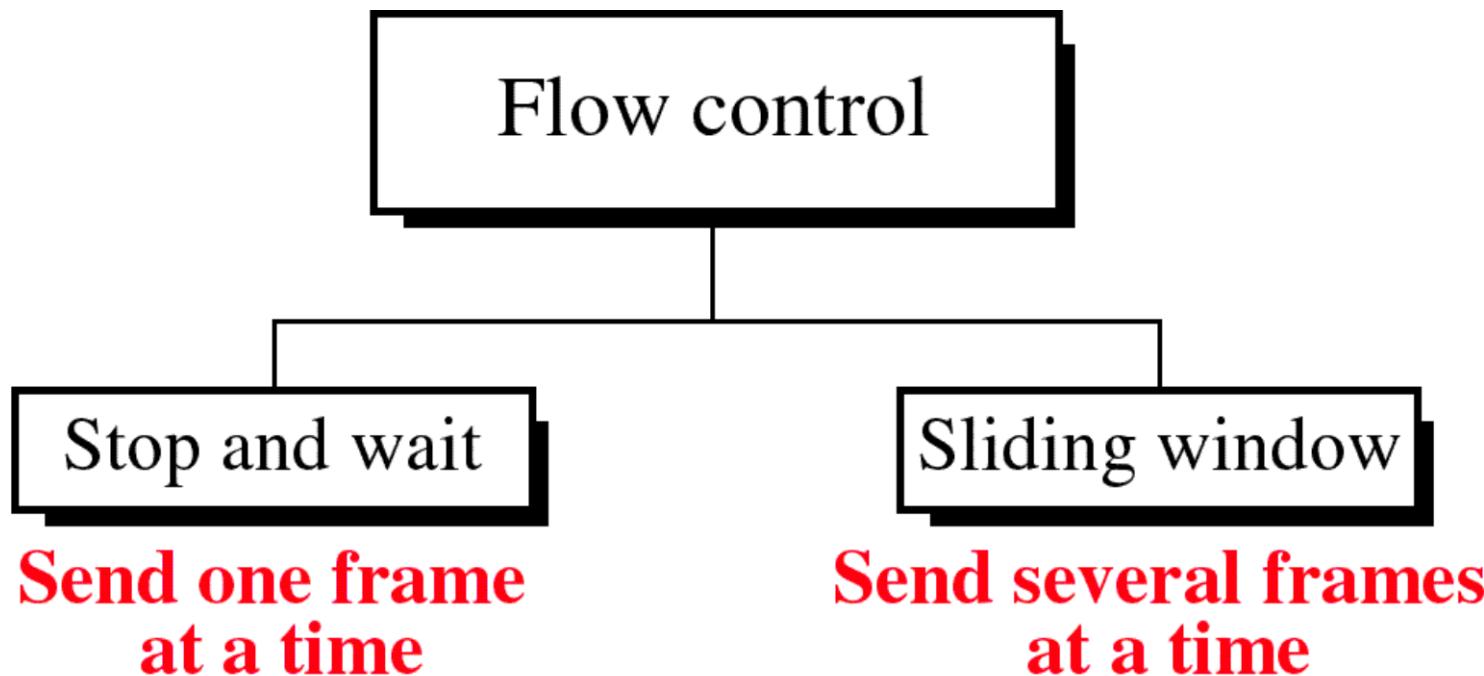


POLL



6.2 DATA LINK CONTROL – FLOW CONTROL

- Set of procedures used to restrict the amount of data the sender can send before waiting for ACK.



6.2.1 STOP-n-WAIT

- The sender sends one frame and waits for an acknowledgement before sending the next frame.

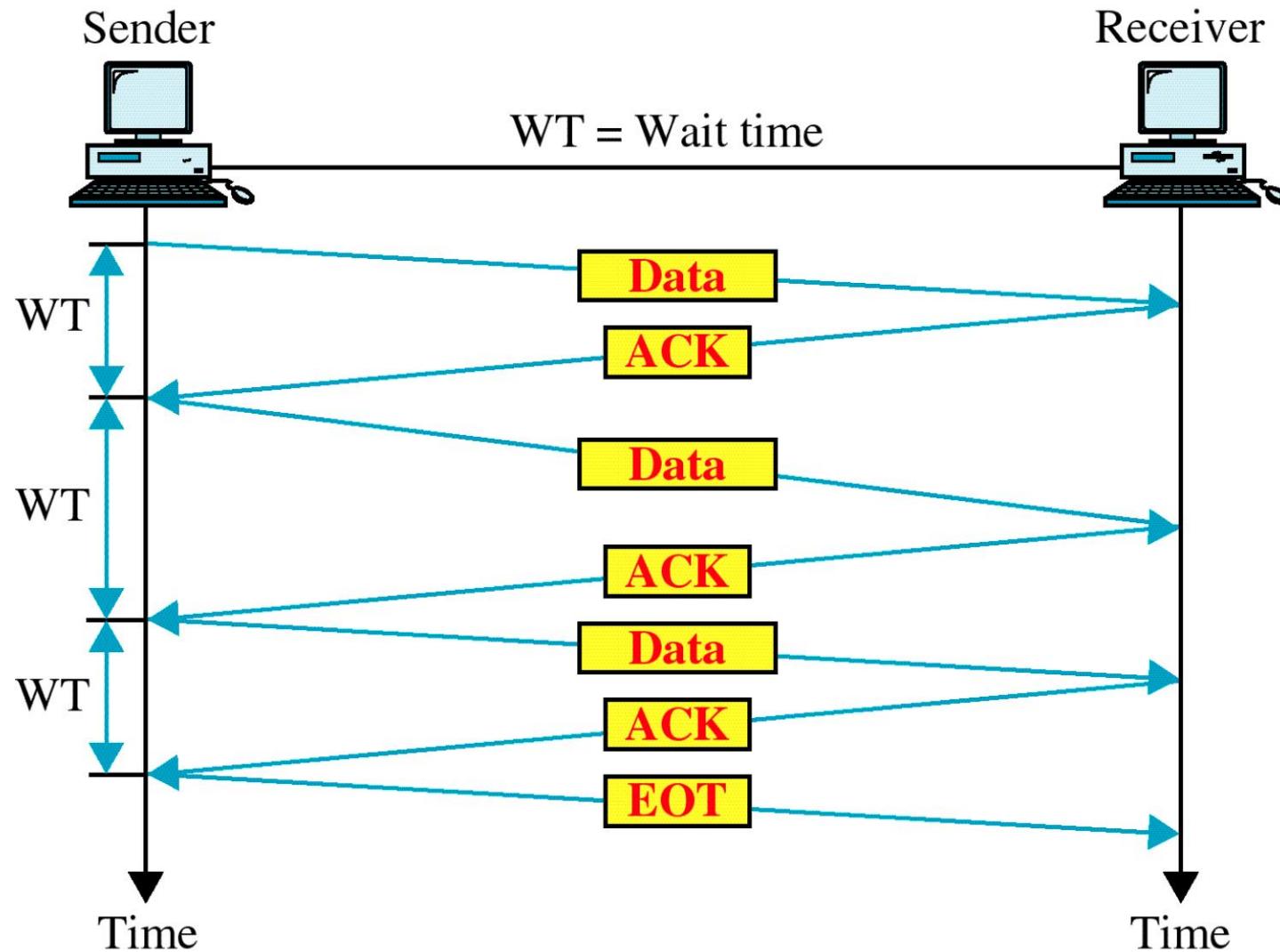
Advantage:

1. Simplicity – each frame is checked and acknowledged before the next frame is sent.

Disadvantage:

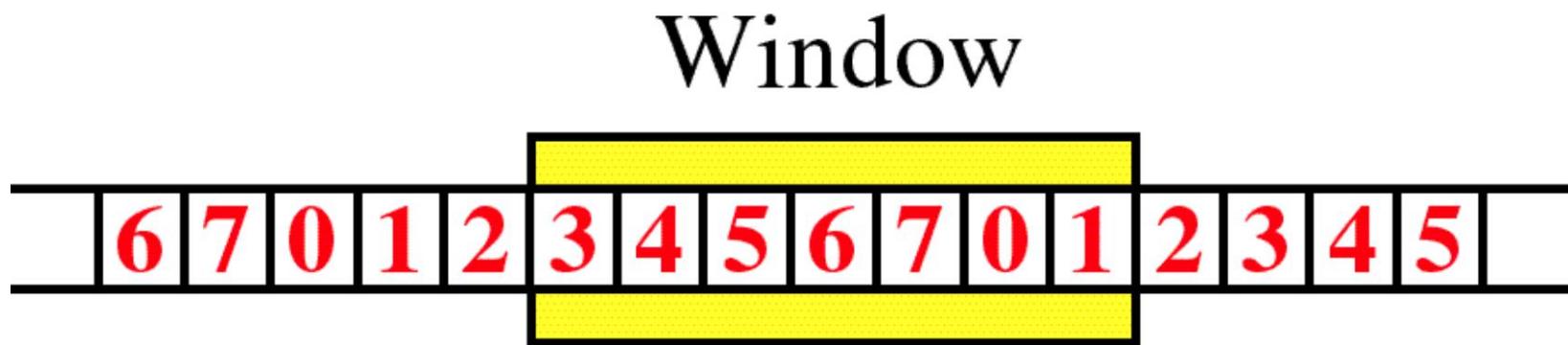
1. Inefficiency – stop and wait is slow. Each frame must travel all the way to the receiver and an ACK must travel all the way back before the next frame can be sent.

STOP and WAIT

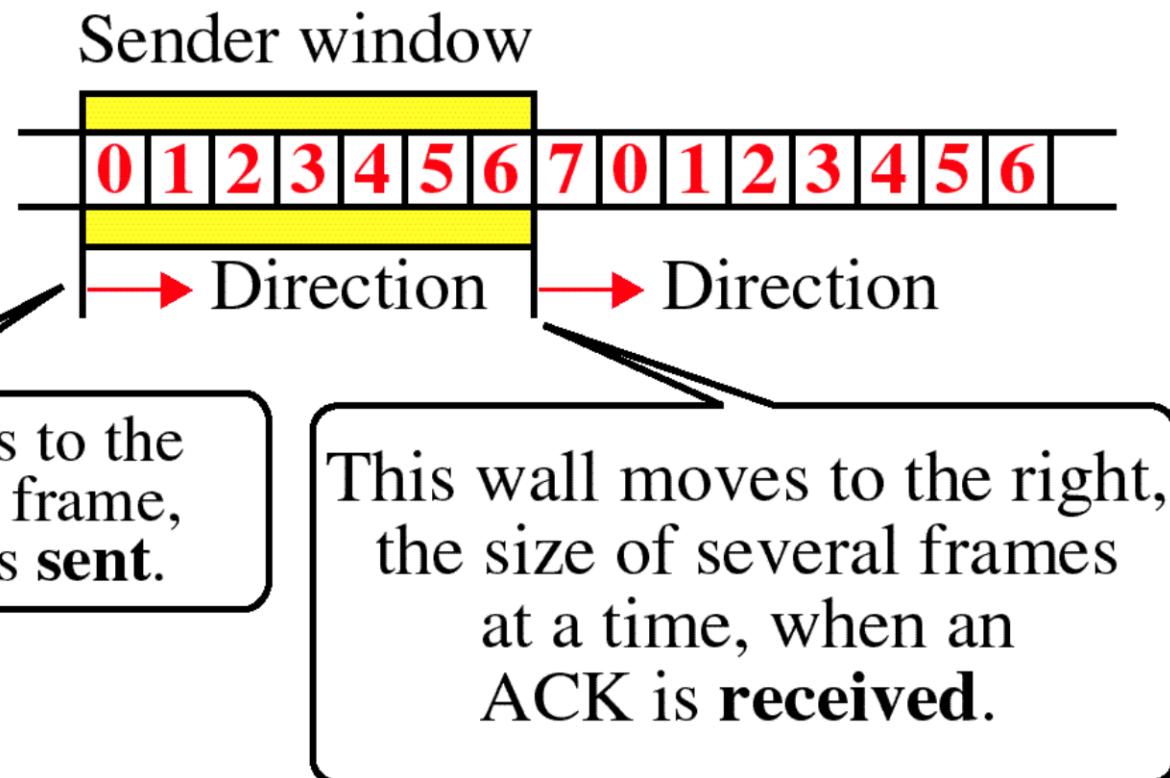


6.2.2 SLIDING WINDOW

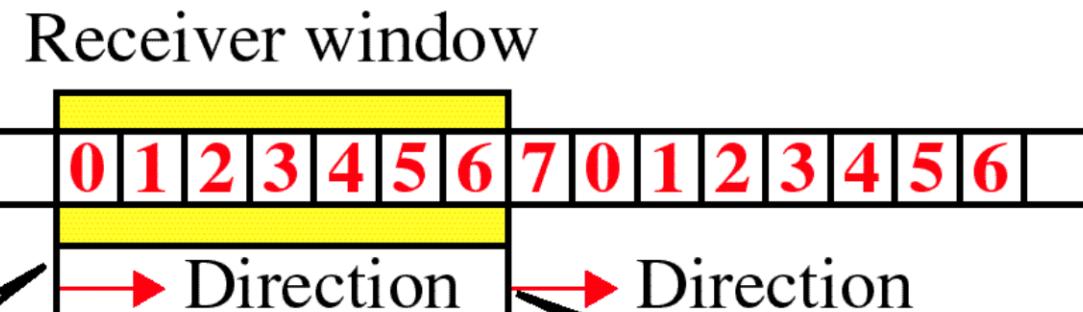
- Several frames can be in transit at a time.



Sender Sliding Window



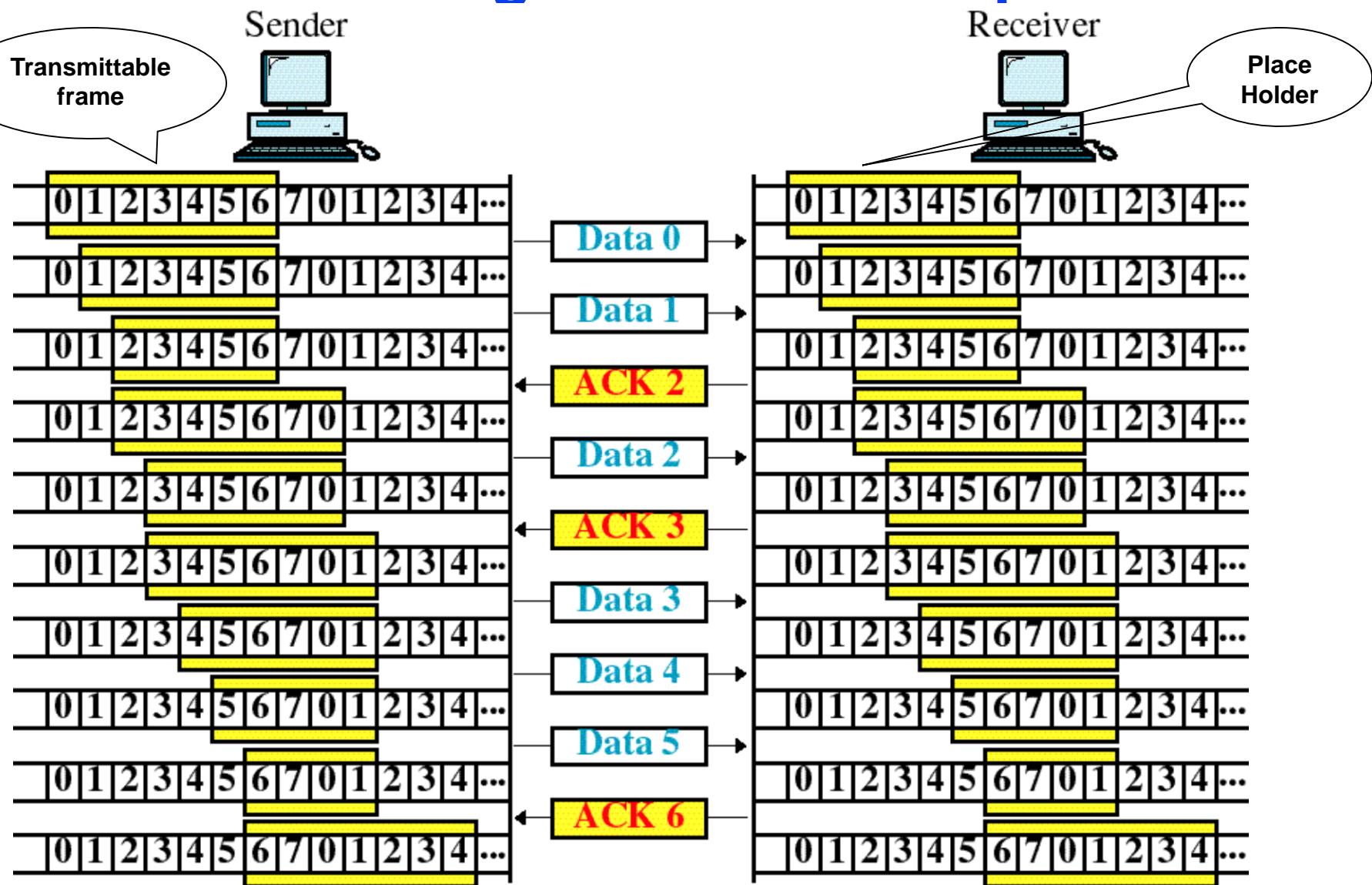
Receiver Sliding Window



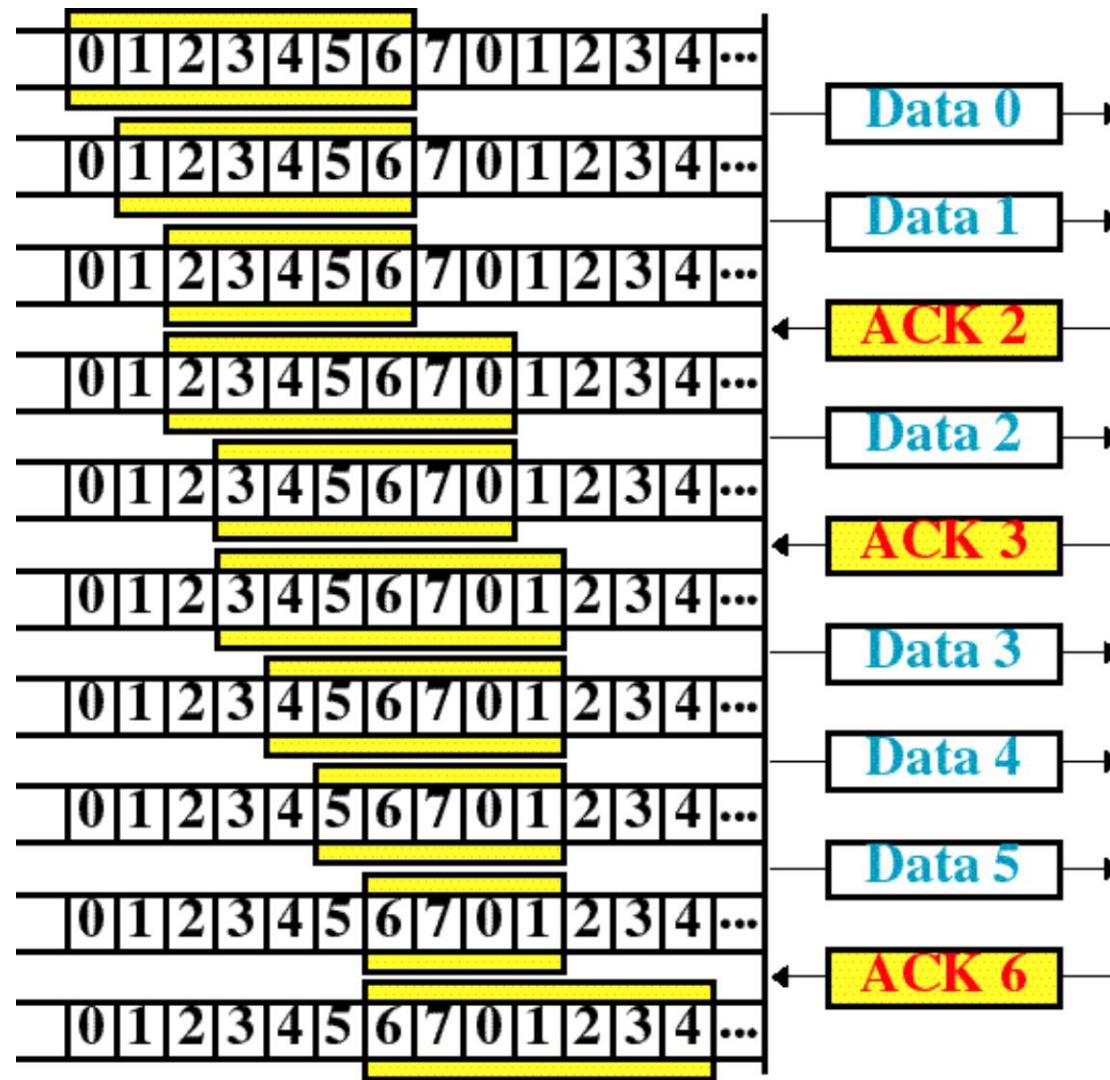
This wall moves to the right, frame by frame, when a frame is **received**.

This wall moves to the right, the size of several frames at a time, when an ACK is **sent**.

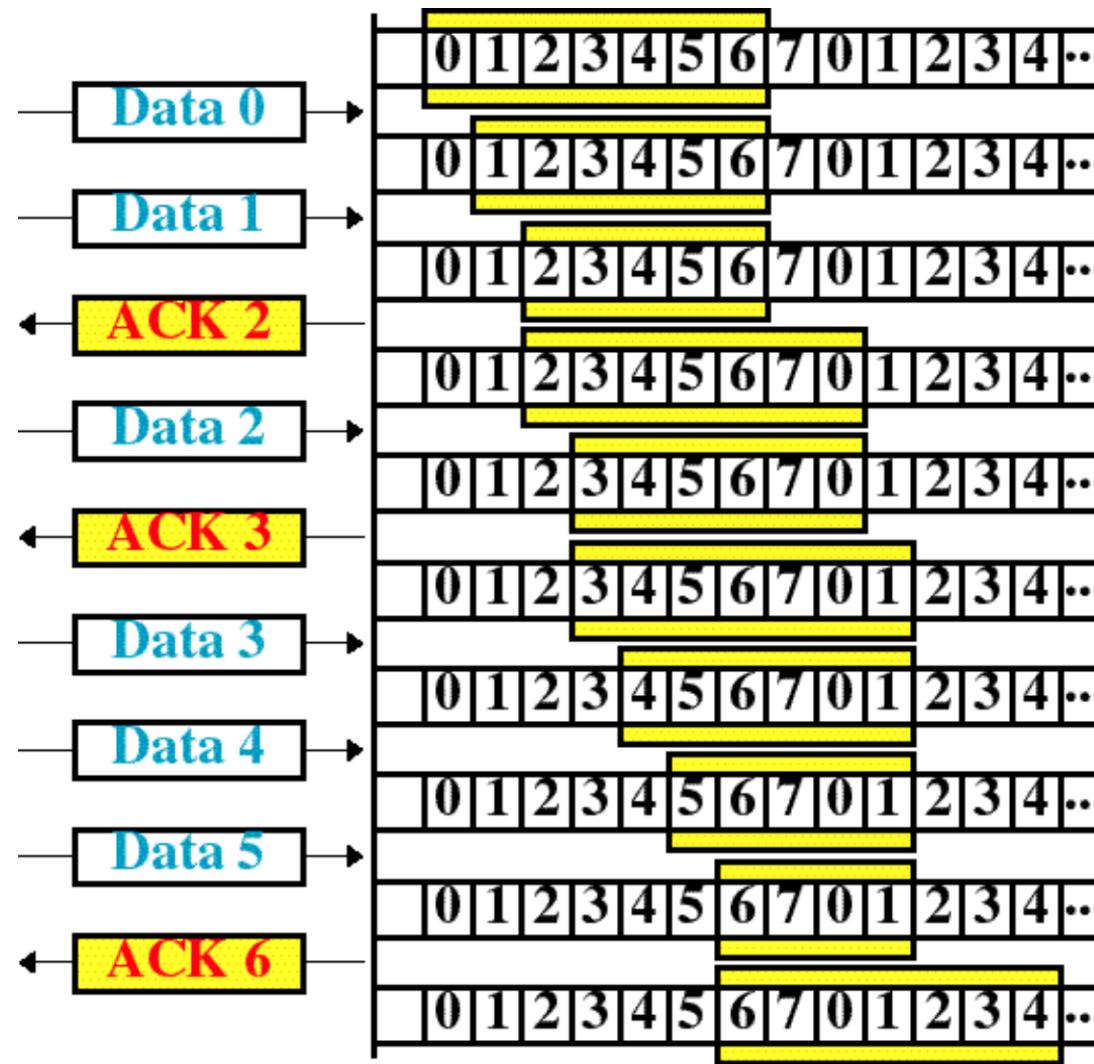
Sliding Window Example



Sender

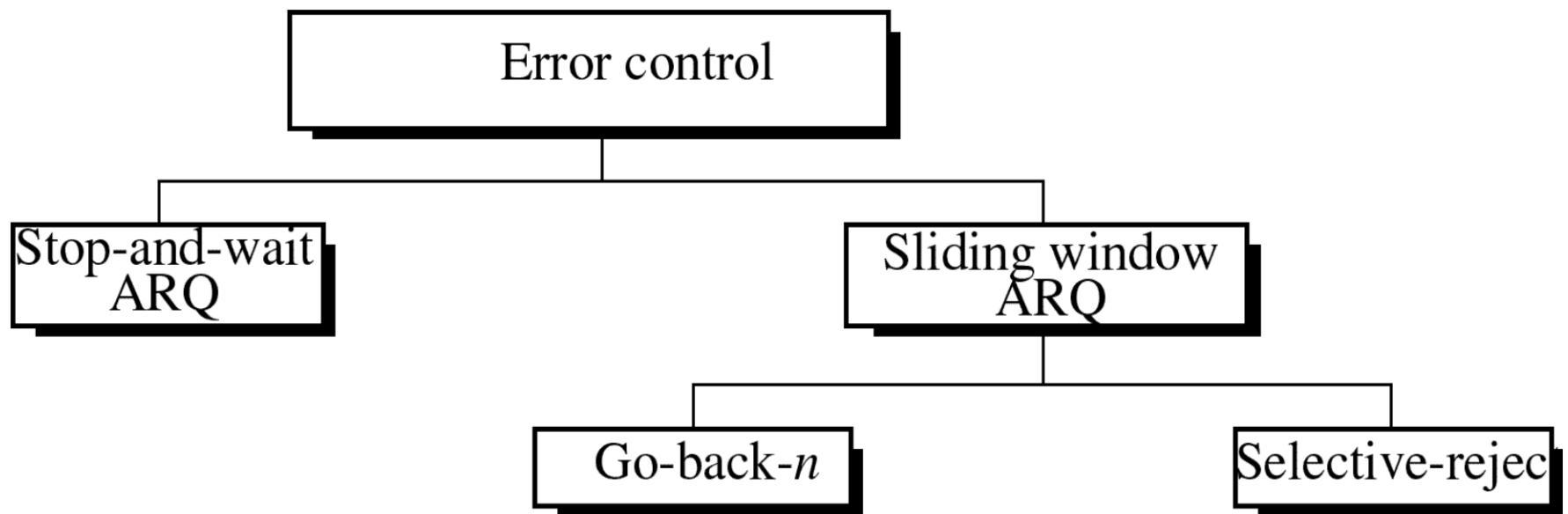


Receiver



6.3 DATA LINK CONTROL – ERROR CONTROL

- Refers primarily to methods of **error detection** and **retransmission**.
- Based on **ARQ (Automatic Repeat Request)** which means retransmission of data in THREE cases:
 1. Damage frame
 2. Lost frame
 3. Lost acknowledgement
- **ARQ:** means if any error detected, a NAK is returned and the frames are retransmitted.



6.3.1 STOP-n-WAIT ARQ

- Is a form of stop and wait flow control extended to include retransmission of data in case of lost or damaged frames.
- Must follow the basic flow control mechanism:
 1. The sending device keeps a copy of the last frame transmitted until it receives an ACK for that frame.
 2. For **identification** purposes, both data frames and ACK frames are numbered **alternately 0 and 1**.
 3. If an **error** is discovered in a data frame, a **NAK** frame is returned.
 4. The **sending device** is equipped with a **timer**.

DAMAGED FRAME

- When a frame is discovered by the receiver to contain an error, it returns a NAK frame and the sender retransmits the last frame.

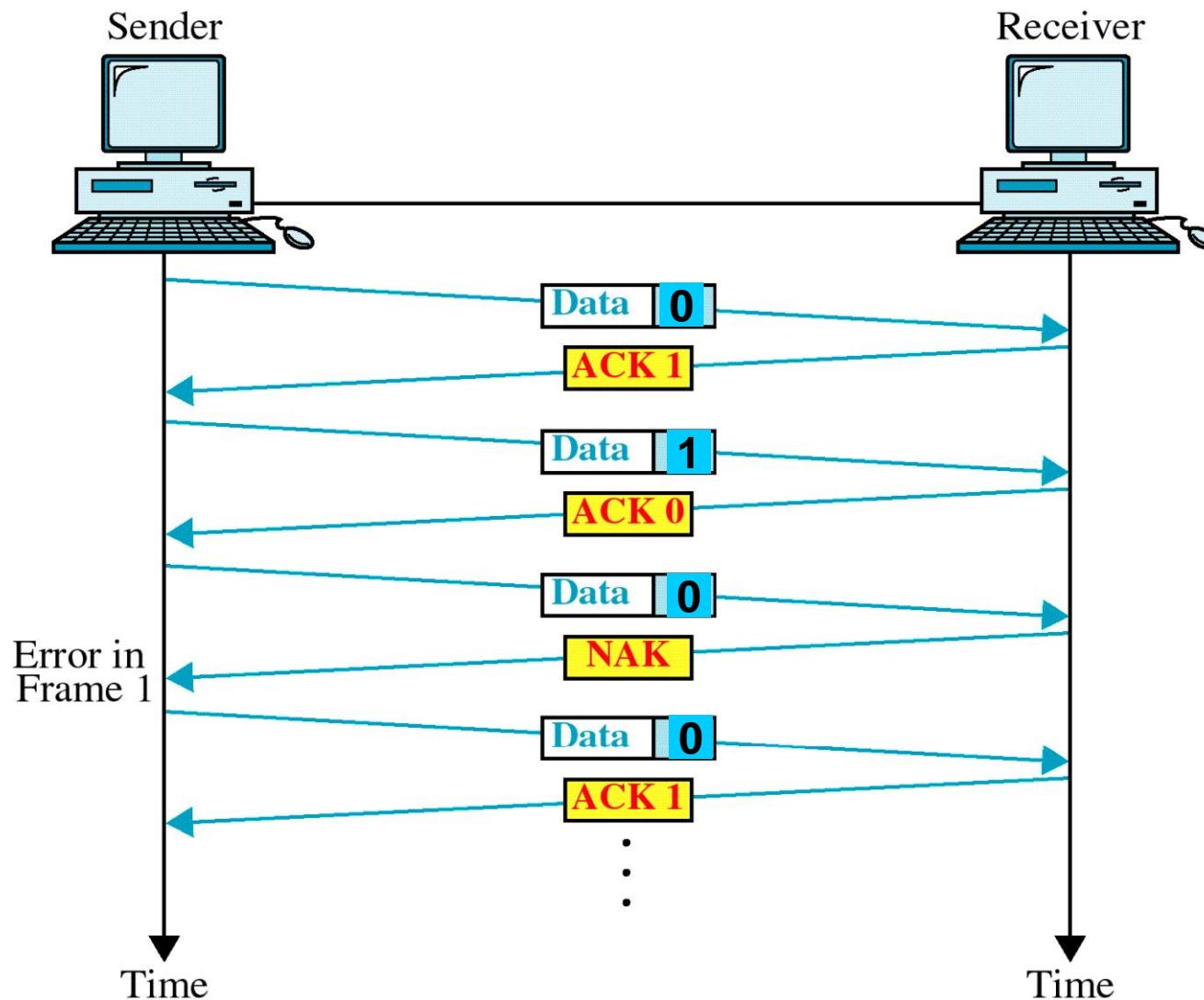
LOST DATA FRAME

- The sender is equipped with a timer that starts every time a data frame is transmitted.
- The sending device waits for an ACK or NAK frame until its timer goes off.

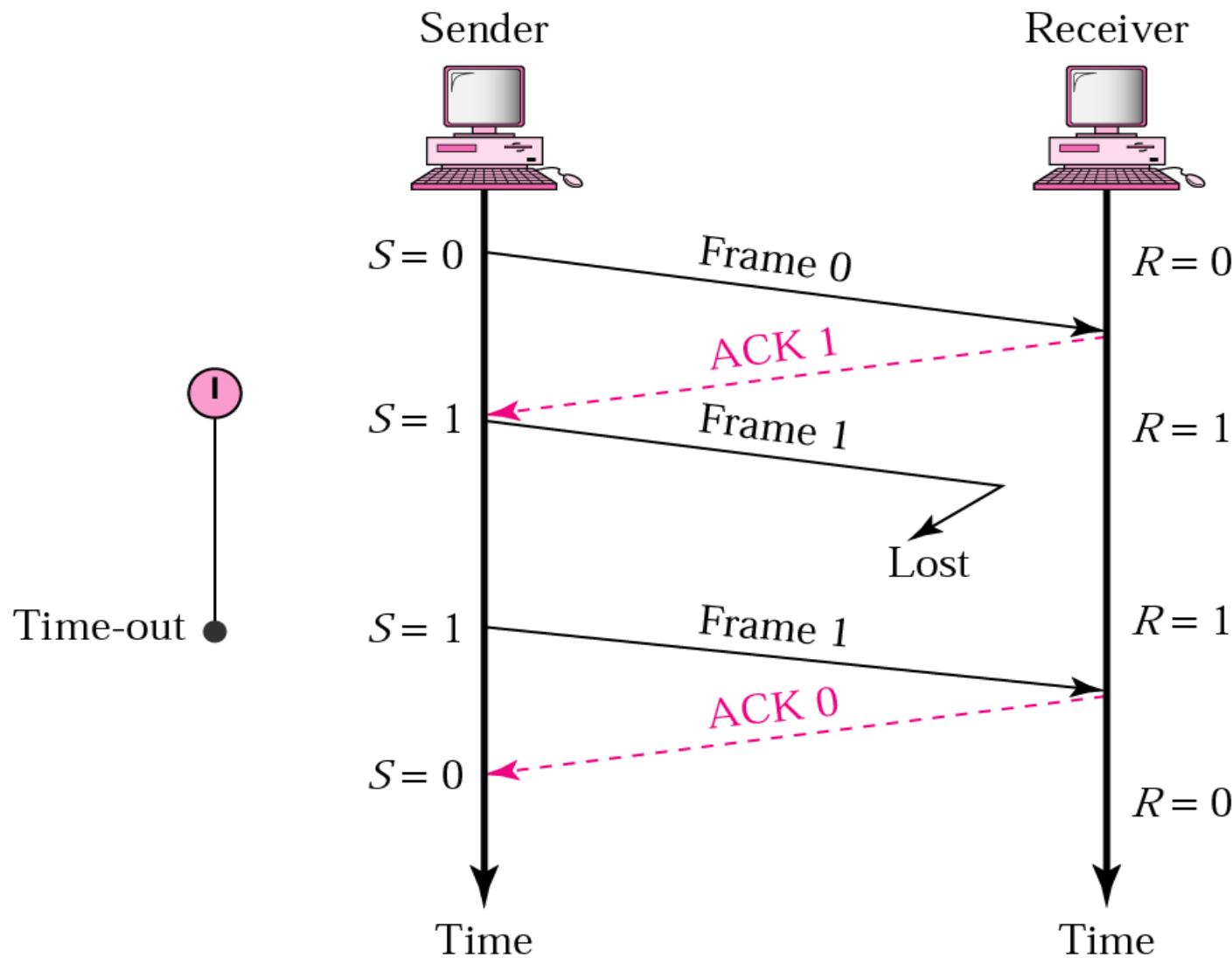
LOST ACK

- The ACK or NAK frame from receiver is lost in transit.

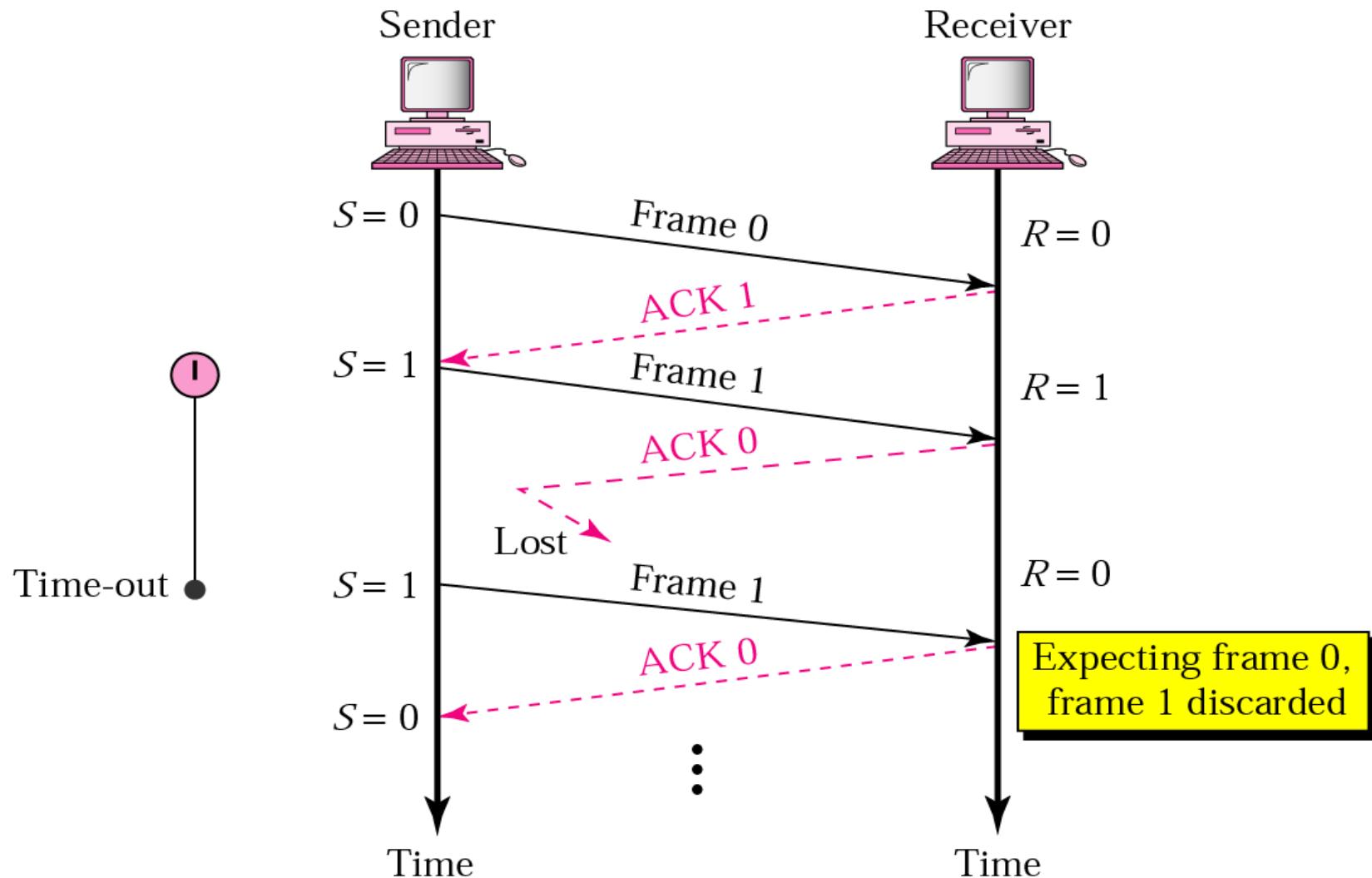
Stop-n-Wait ARQ: Damaged Frame



Stop-n-Wait ARQ: Lost Frame



Stop-n-Wait ARQ: Lost ACK Frame



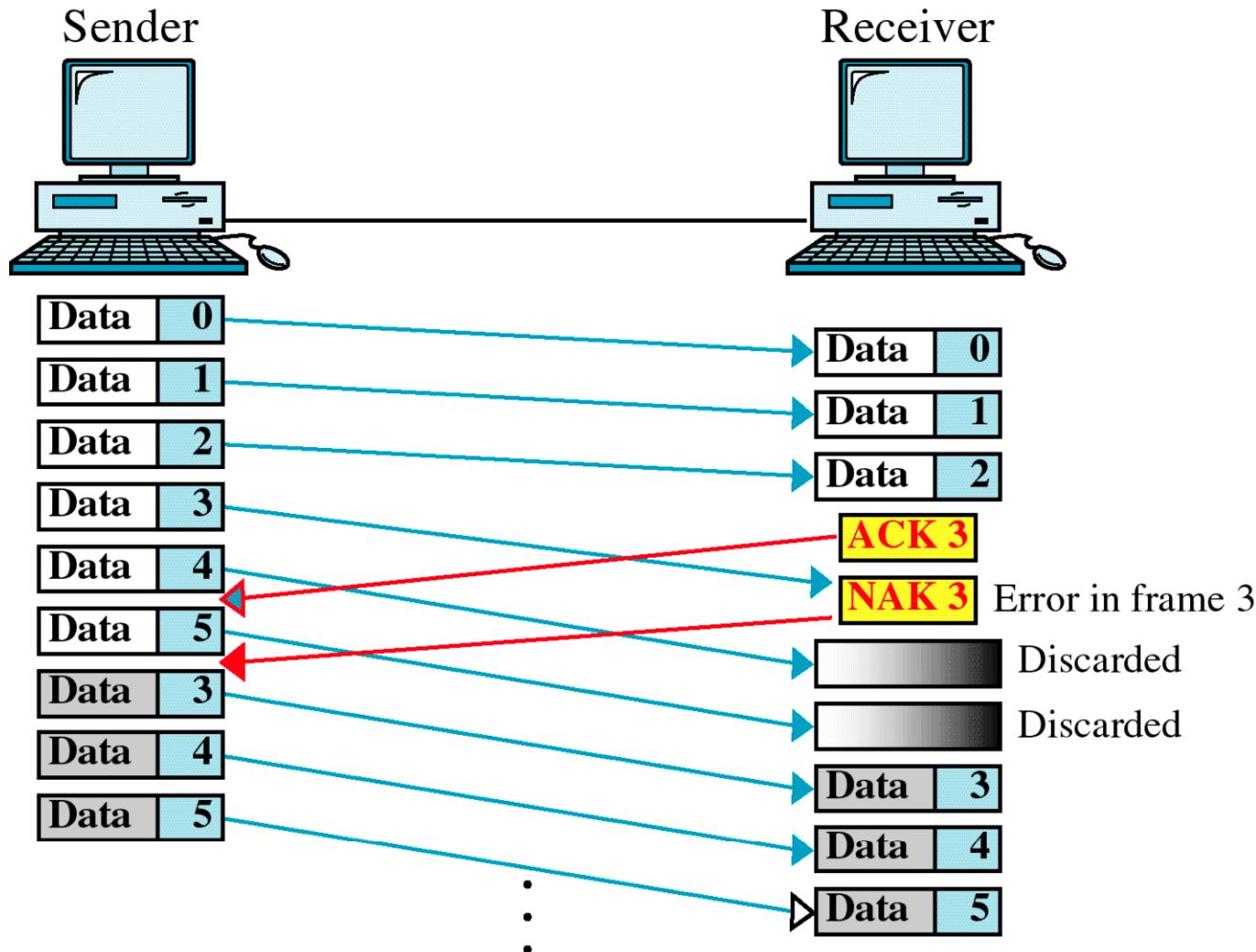
6.3.2 SLIDING WINDOW ARQ

- Must follow the basic flow control mechanism:
 1. The sending device keeps a copy of the last frame.
 2. If an error is discovered in a data frame, a NAK frame is returned.
 3. The sending device is equipped with a timer.
- 2 types:
 1. Go-Back-n ARQ
 2. Selective-Reject ARQ

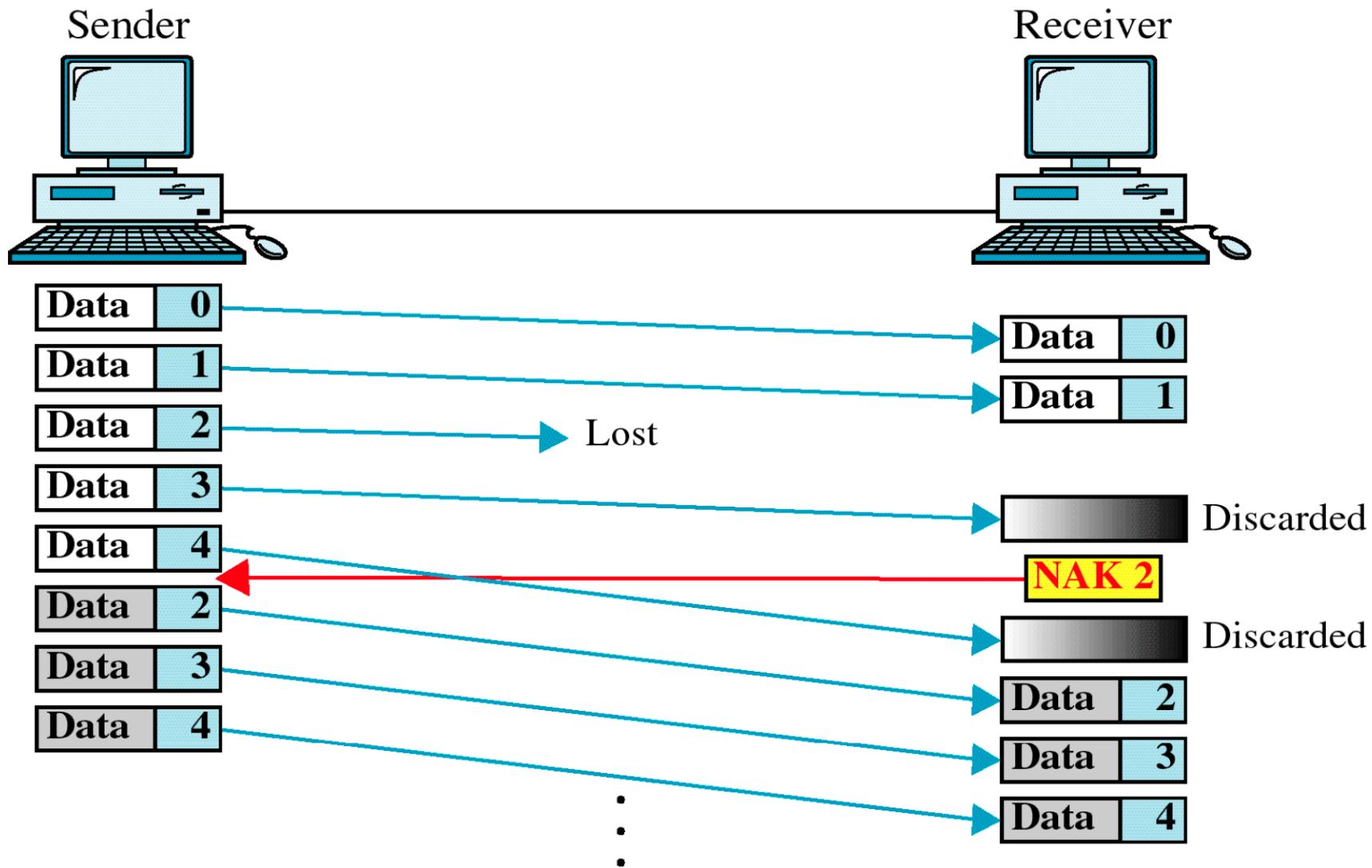
GO-BACK-n ARQ

- If one frame is lost or damaged, all frames sent since the last frame acknowledged are retransmitted.
- Error:
 1. Damage frame
 2. Lost data frame
 3. Lost ACK

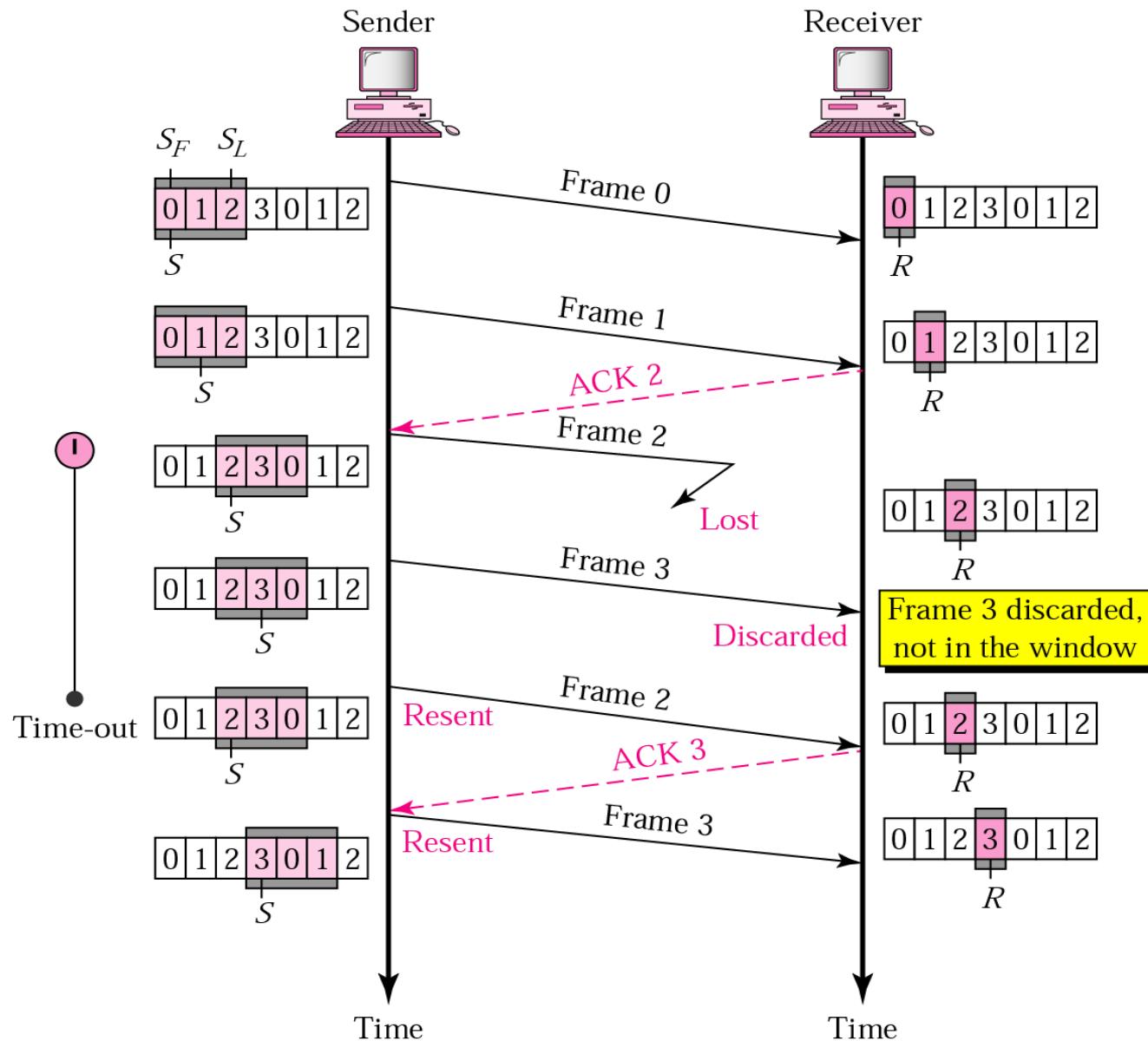
Go-Back-n ARQ: Damaged Frame



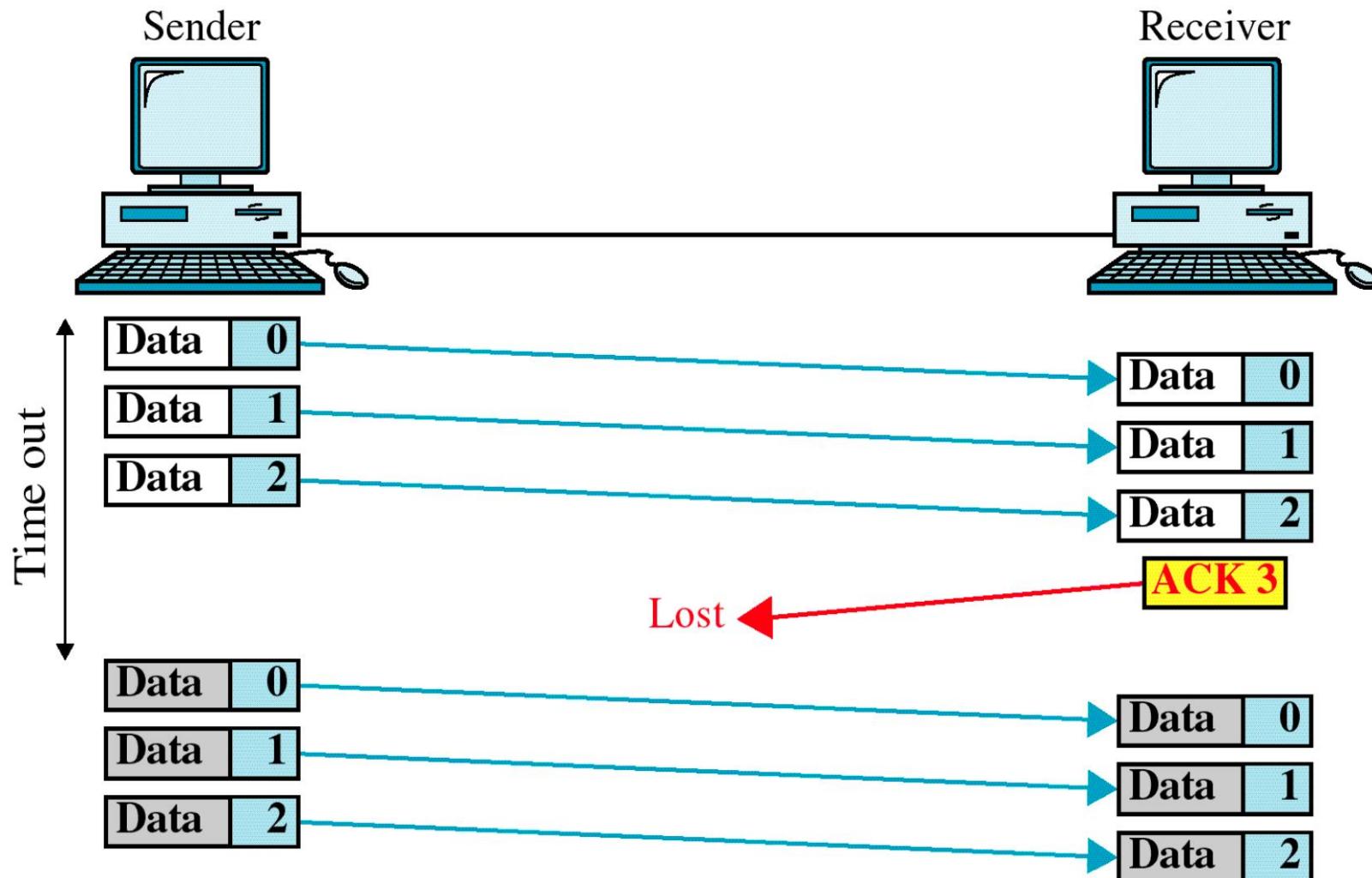
Go-Back-n ARQ: Lost Frame (1)



Go-Back-n ARQ: Lost Frame (2)



Go-Back-n ARQ: Lost ACK Frame

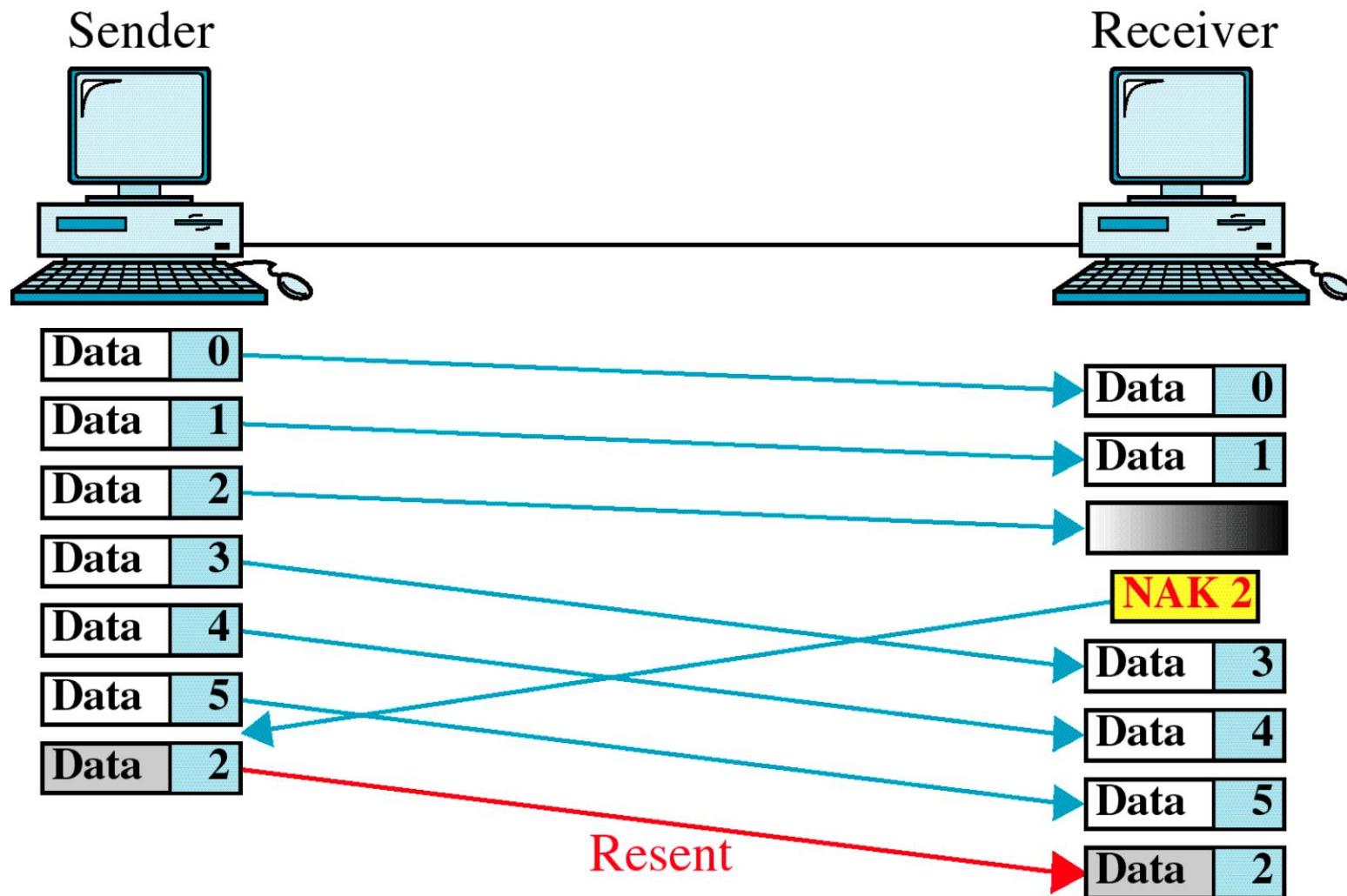


SELECTIVE-REJECT ARQ

- 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.
- Different from Go-Back-n ARQ in the following ways:
 1. The receiving device must contain **sorting logic** to enable it to reorder frames received out of sequence.
 2. The sending device must contain a **searching mechanism** that allows it to find and select only the requested frame to retransmit.

3. A buffer in the receiver must keep all previously received frame on hold until all retransmission have been sorted and any duplicate frames have been identified and discard.
4. To aid selectivity, ACK numbers like NAK numbers must refer to the frame received/lost instead of the next frame expected.

Selective-Reject: Damaged Frame



Selective-Reject: Lost Frame

