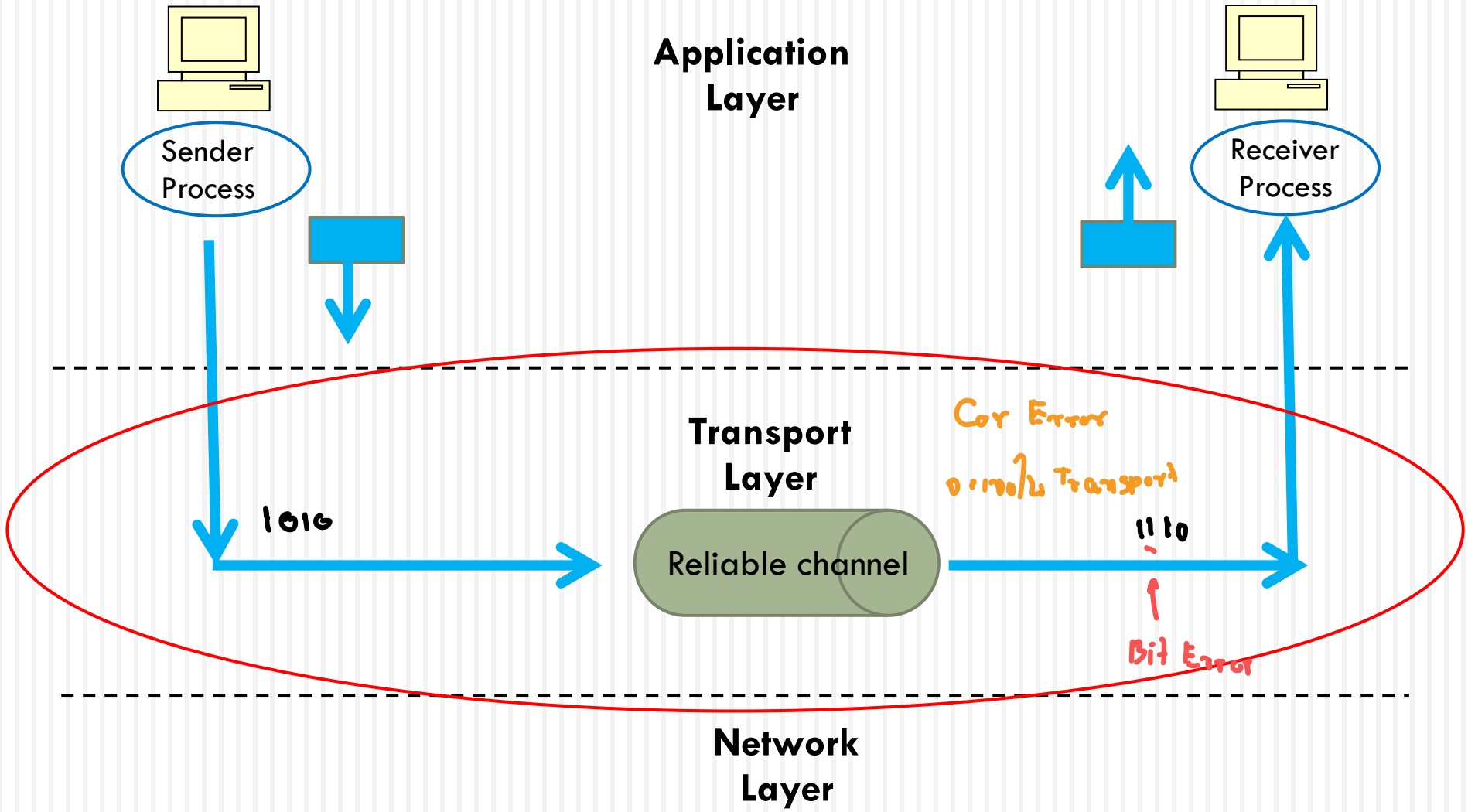
PRINCIPLE OF RELIABLE DATA TRANSFER

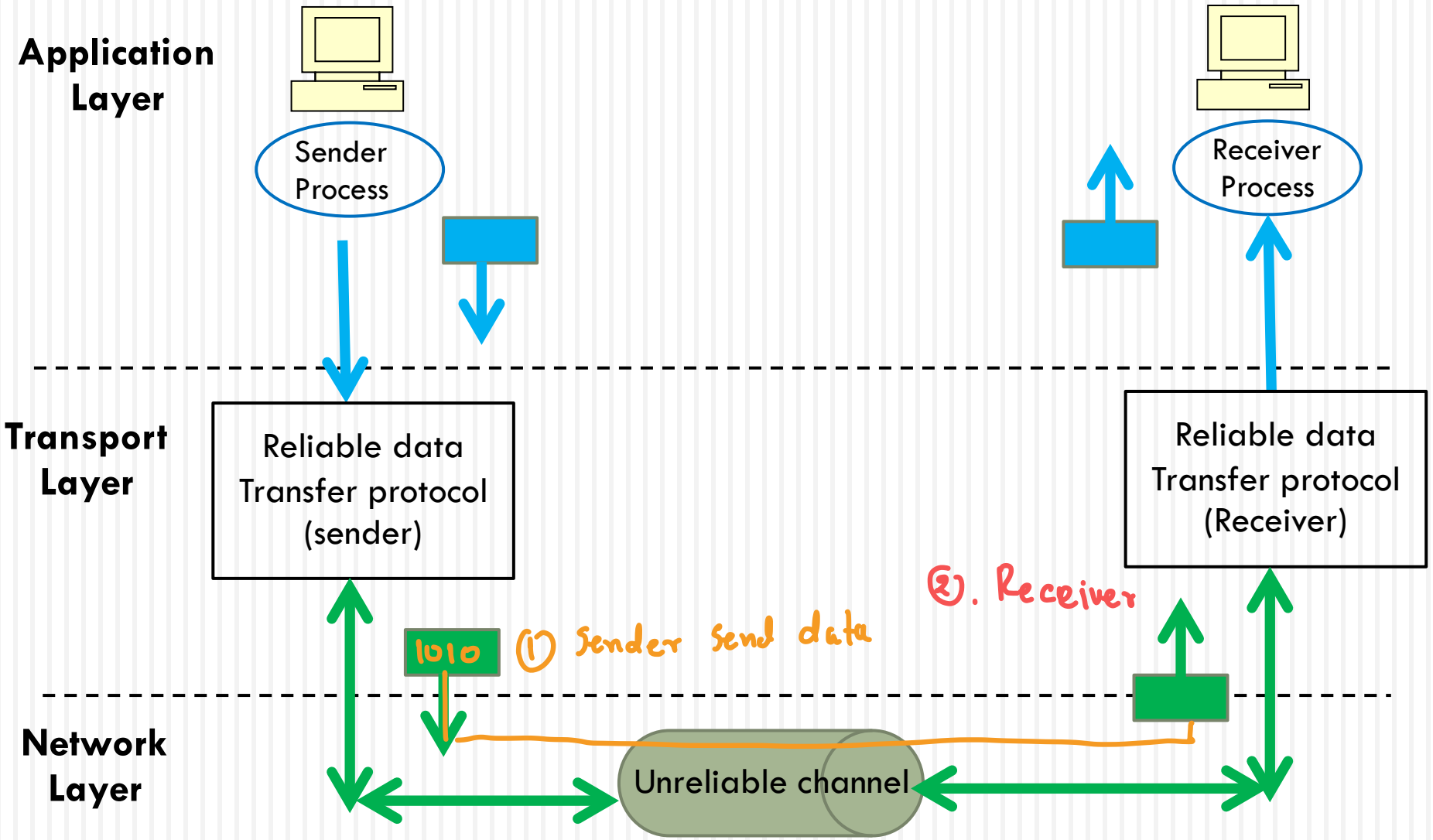
Introduction to Computer Networks (ICN)

Faculty of IT, KMITL 2019

Principle of Reliable Data Transfer



Principle of Reliable Data Transfer



Reliable Transfer is “Sender know that the transmission is error”

- How Sender can know about Error in the data transmission process
- What types of error that can occur

Stop-and-Wait ARQ

flow control ไม่ให้ Receiver รับข้อมูลมากเกินไป

- The ***simplest*** flow and error control mechanism

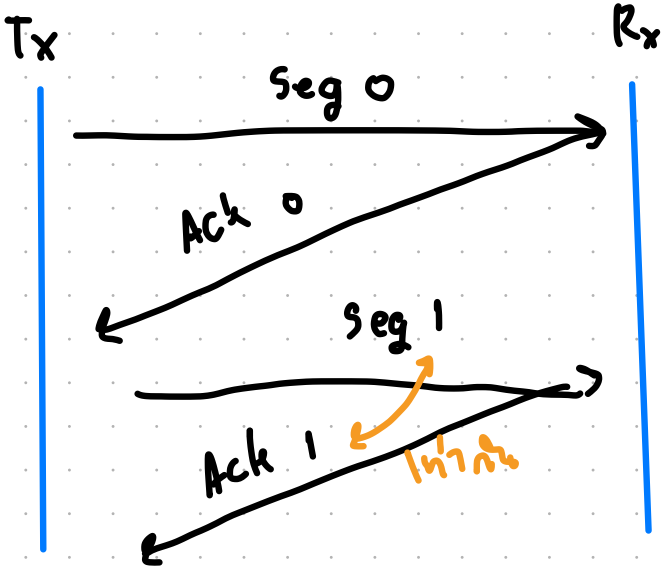
Automatic Repeat Request

The key concept are

Transmitter ผู้ส่ง

- Tx will send next segment only when it receives the ACK of previous segment from Rx and keep copy of transmitted segment until get ACK back
- Rx must send ACK back to Tx after receiving a segment from Tx

Receiver ผู้รับ

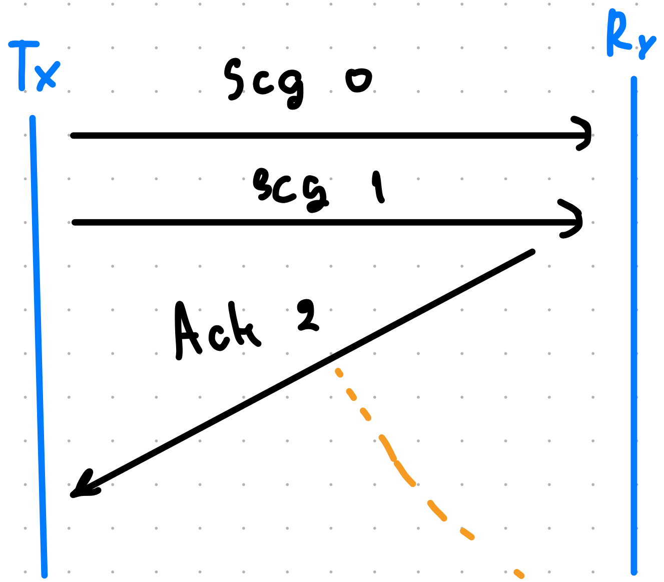


แบบที่ 1

Ack Number = Seq ของ Segment ของที่ได้รับ

เปลือง overhead และทำให้เปลือง overhead ด้วย

Cumulative Ack



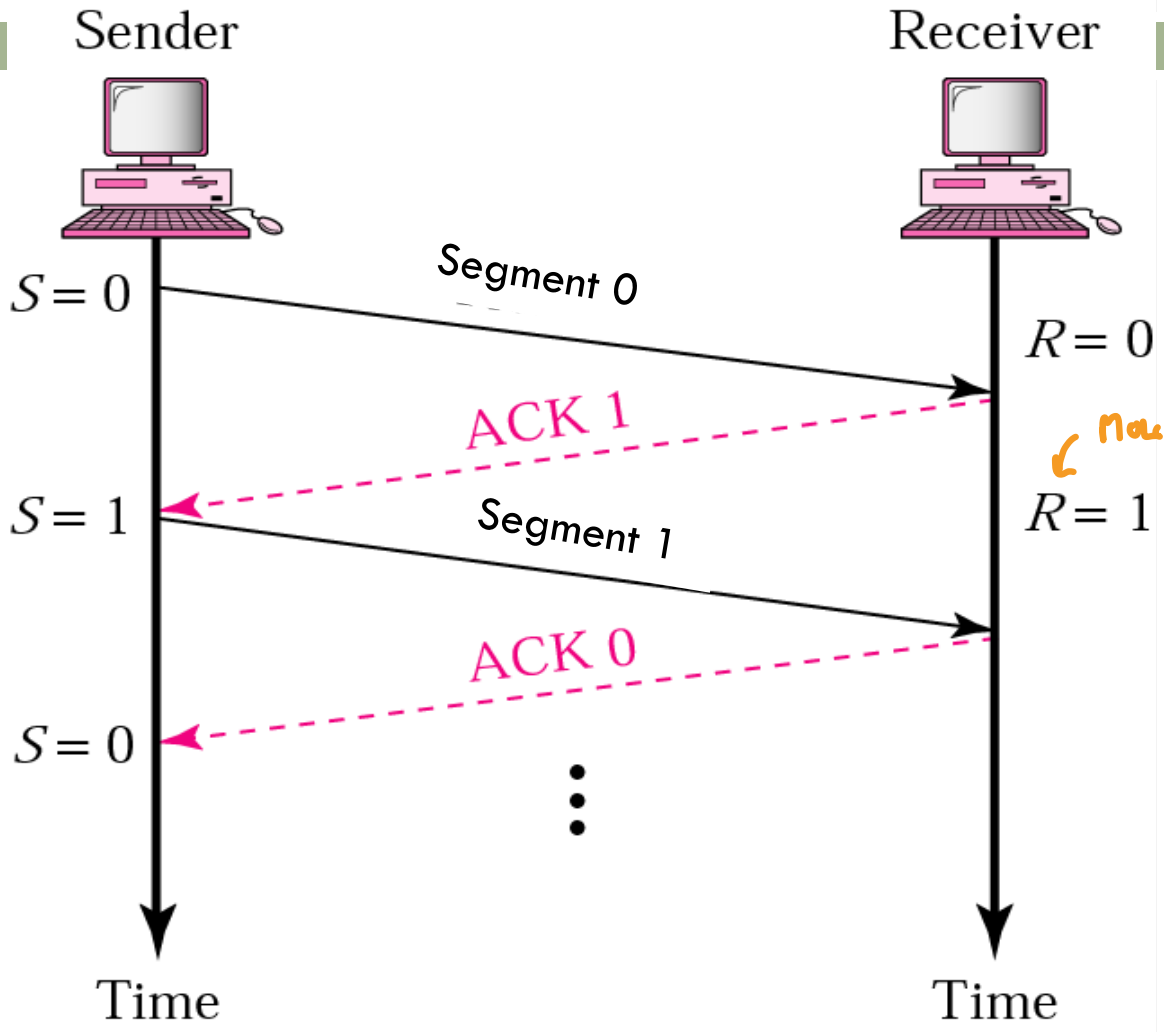
แบบที่ 2

บอกว่าข้อมูลชุดต่อไปที่ต้องการ คือ ชุดที่ 2

และ ข้อมูลชุดก่อนหน้าได้รับแล้ว

หมายถึง ข้อมูลชุดต่อไป

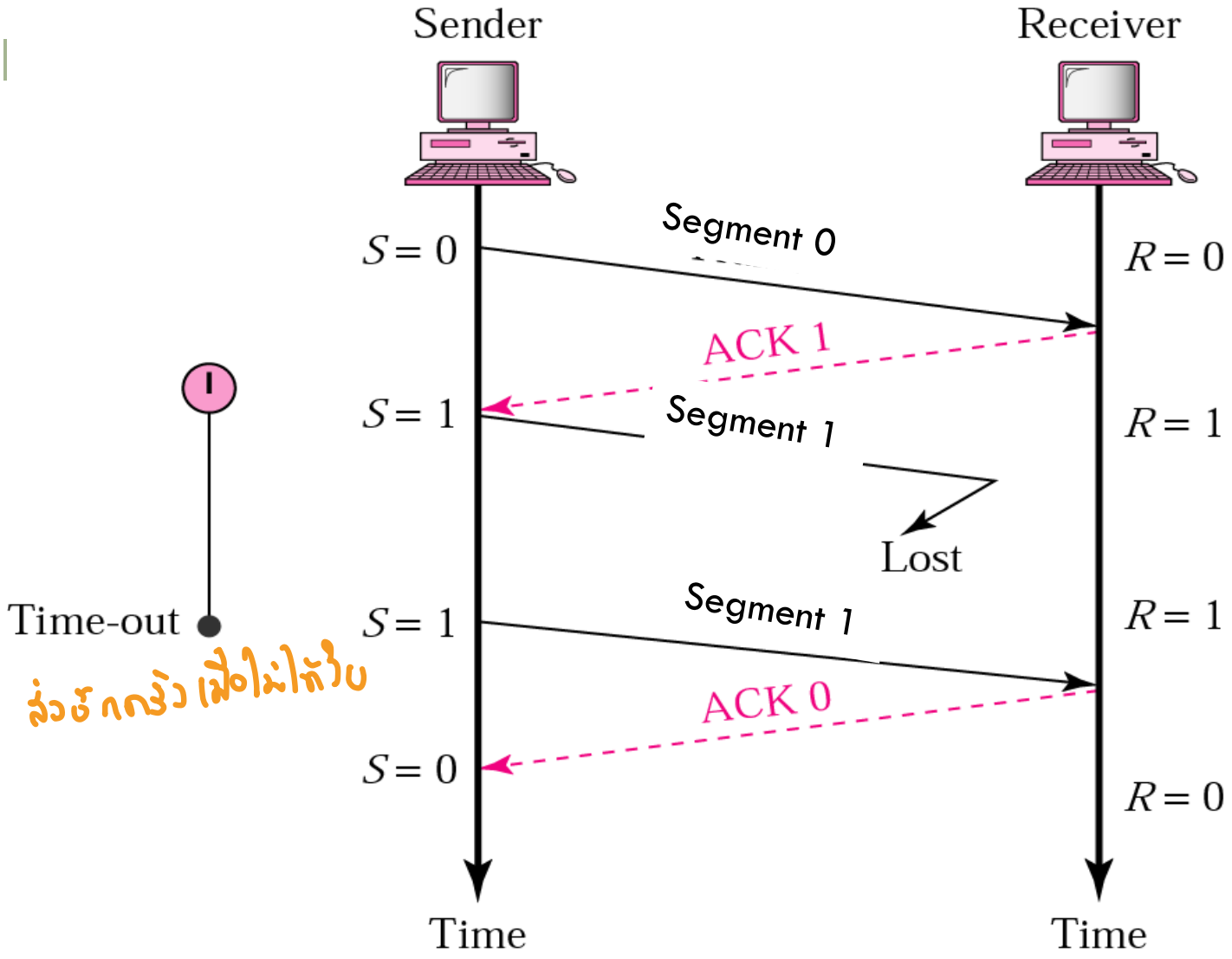
Normal Operation



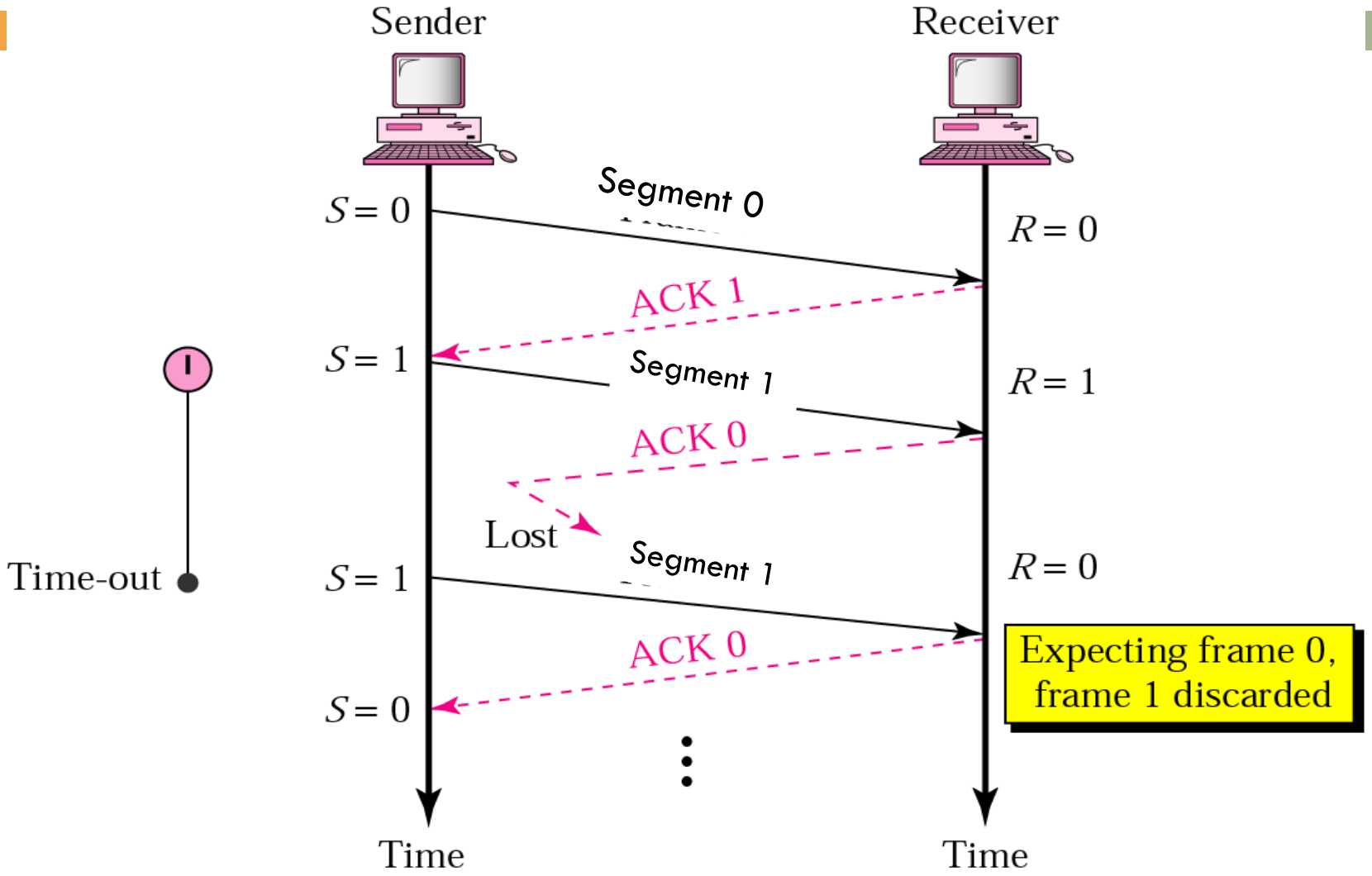
Type of Error

- Damage or Lost ACK
- Damage or Lost segment
  - Receiver discard damage segment and do nothing
  - After time-out at Transmitter become expired, Tx will retransmit its last transmitted segment
- Delay of ACK

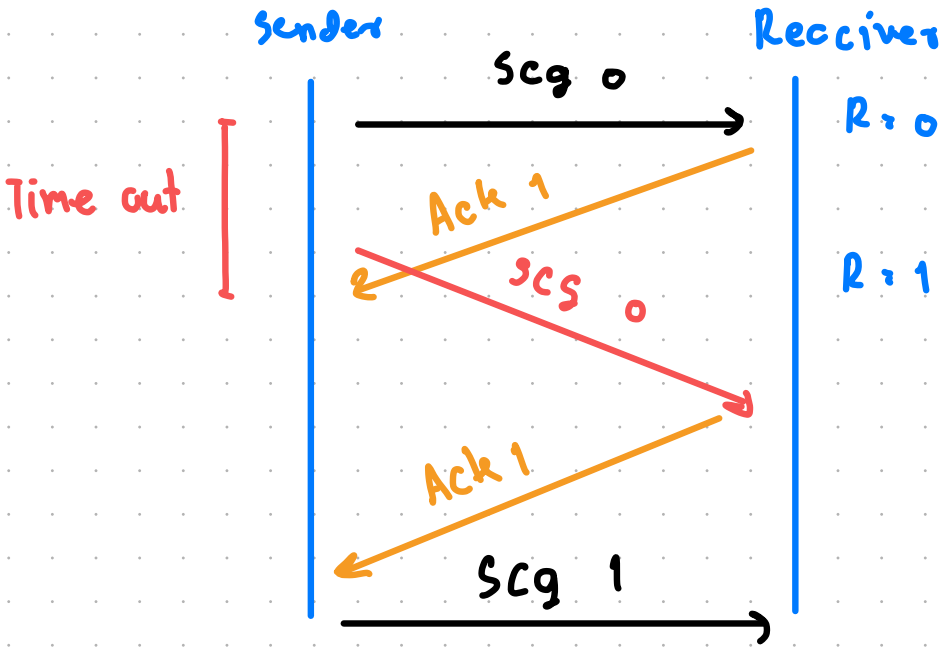
Stop-and-Wait ARQ: Lost Segment



Stop-and-Wait ARQ: ACK Lost

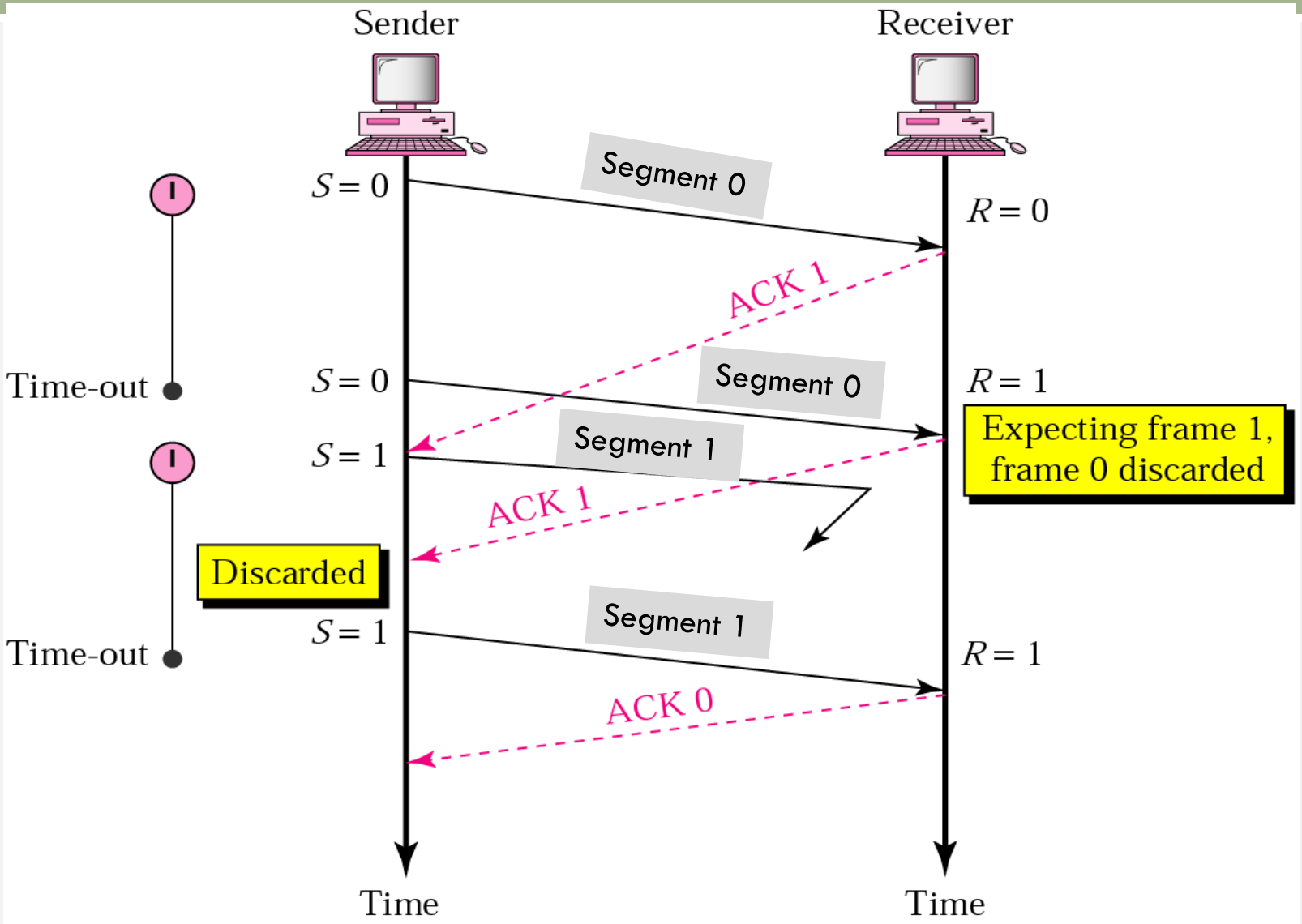


In Stop-and-Wait ARQ, numbering frames prevents the retaining of duplicate frames.



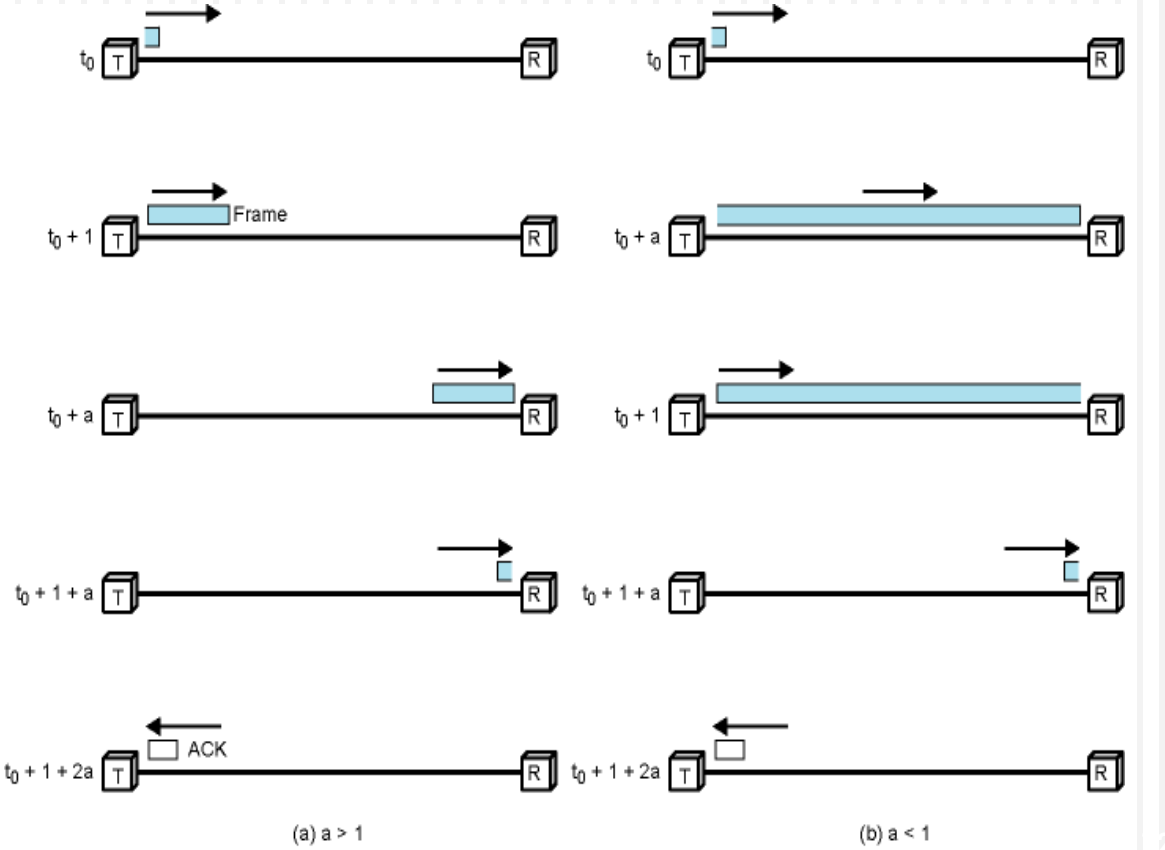
อย่างน้อยต้องมี 2 เบอร์
เพื่อไม่ให้สับสน

Stop-and-Wait: delayed ACK



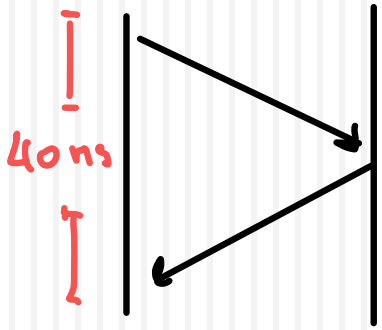
Drawback of Stop-and-wait

- Works well for large segments **BUT** Inefficient for smaller segments



Stop-and-Wait is very inefficient

- Suppose segments being transferred are 1000 bits long over a channel of speed 1.5 Mbps
- Suppose from beginning of transmission to receipt of ACK , time elapses 40 ms.
- $40 \times 10^{-3} \times 1.5 \times 10^{6} = 60{,}000$ bits can be transferred within 40ms, however only 1000 bits of data can be sent!!



Solving Efficiency problem

- By allow Transmitter to send an amount of data without waiting for ACK
- Better used of Medium

There are 2 Protocols that using this concept

- Go-Back-N ARQ
- Selective Repeat ARQ

Go-Back-N ARQ

- Sequence Number
- Sliding Window Algorithm
- Resending segments

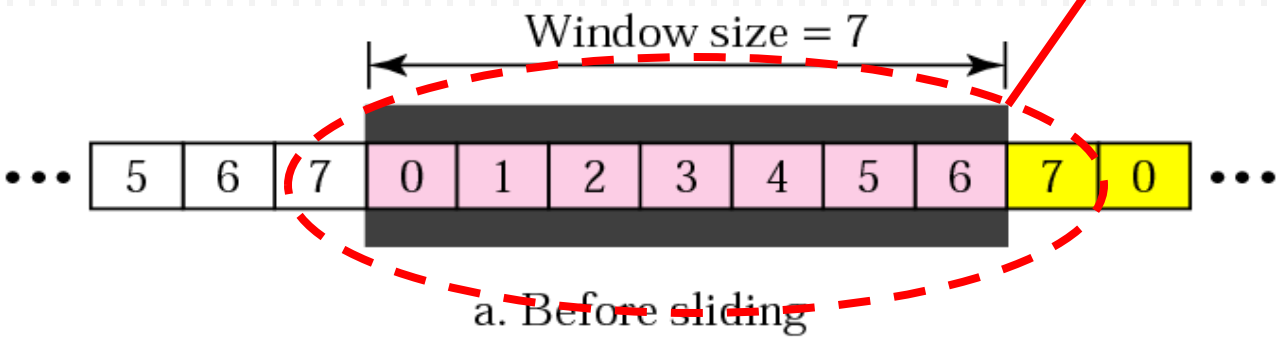
Sequence Number

- For Tx and Rx to keep on track with each other
  - How Tx know which segment is successfully received at Rx
  - How Rx request for retransmitting the expected segment
- One of factors to set no. of segments that can be sent without receiving ACK

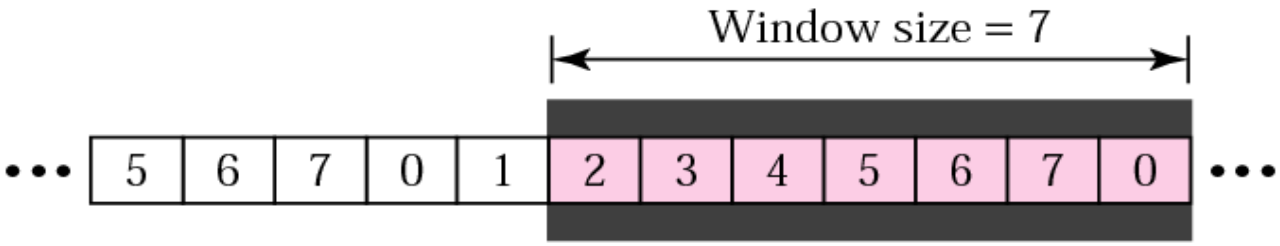
  - Receiver window
  - Limitation of ARQ

Sending Sliding Window

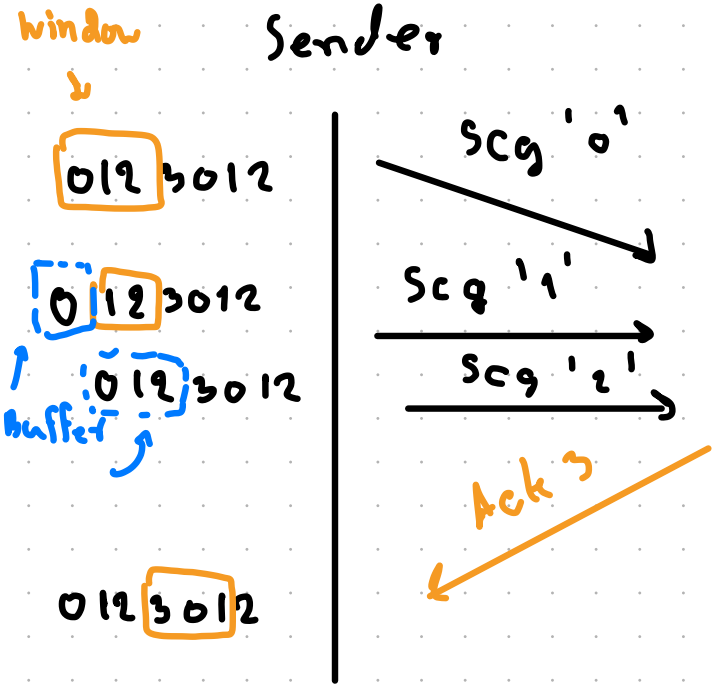
Up to amount of buffer too



a. Before sliding



b. After sliding two **segment**



Sliding window

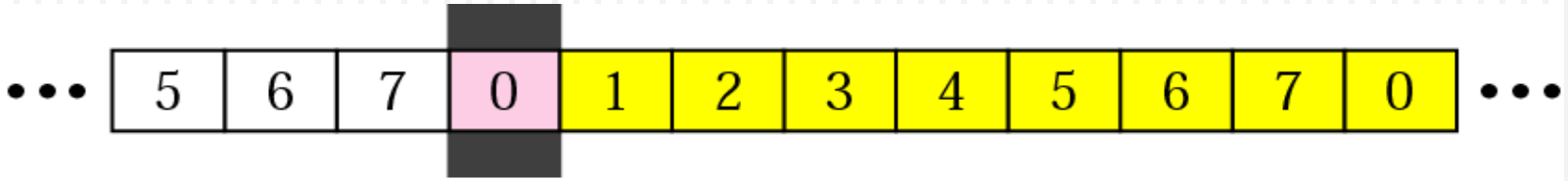
ผู้ส่งสามารถส่งได้เรื่อยๆ ใน window

โดยจะ buffer ตามที่รับ Ack

How Sending Window move

- Shrink one after sending 1 segment
- Expand to the right when receiving ACK
- Keep the copy of unacknowledged segments

Receiver Sliding Window



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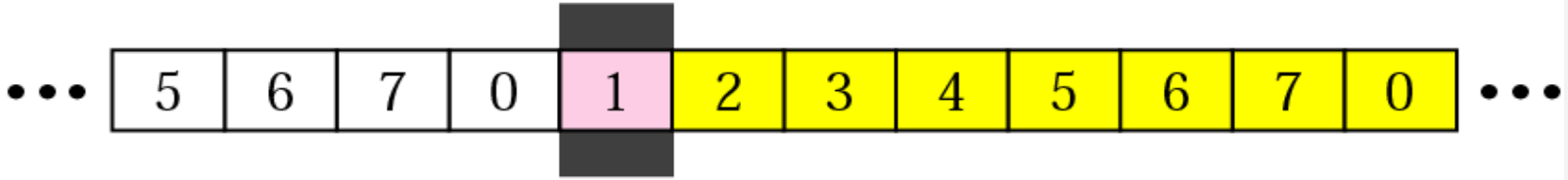
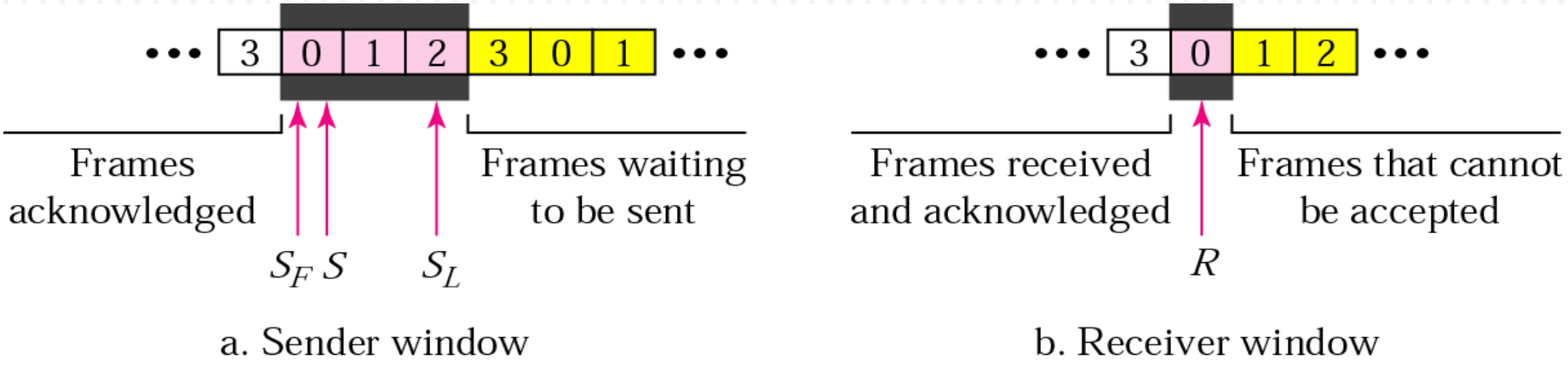


b. After sliding

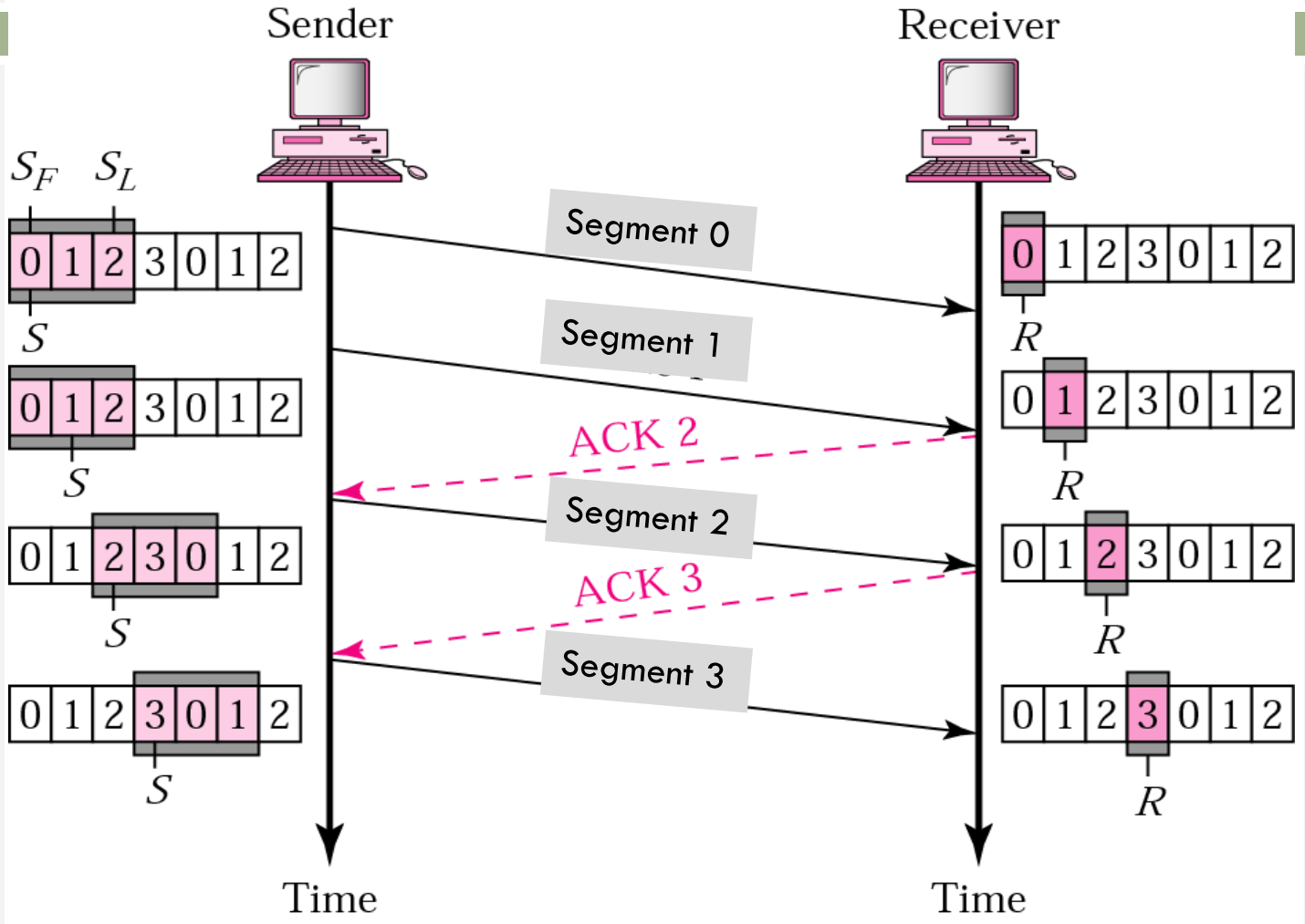
Control Variables



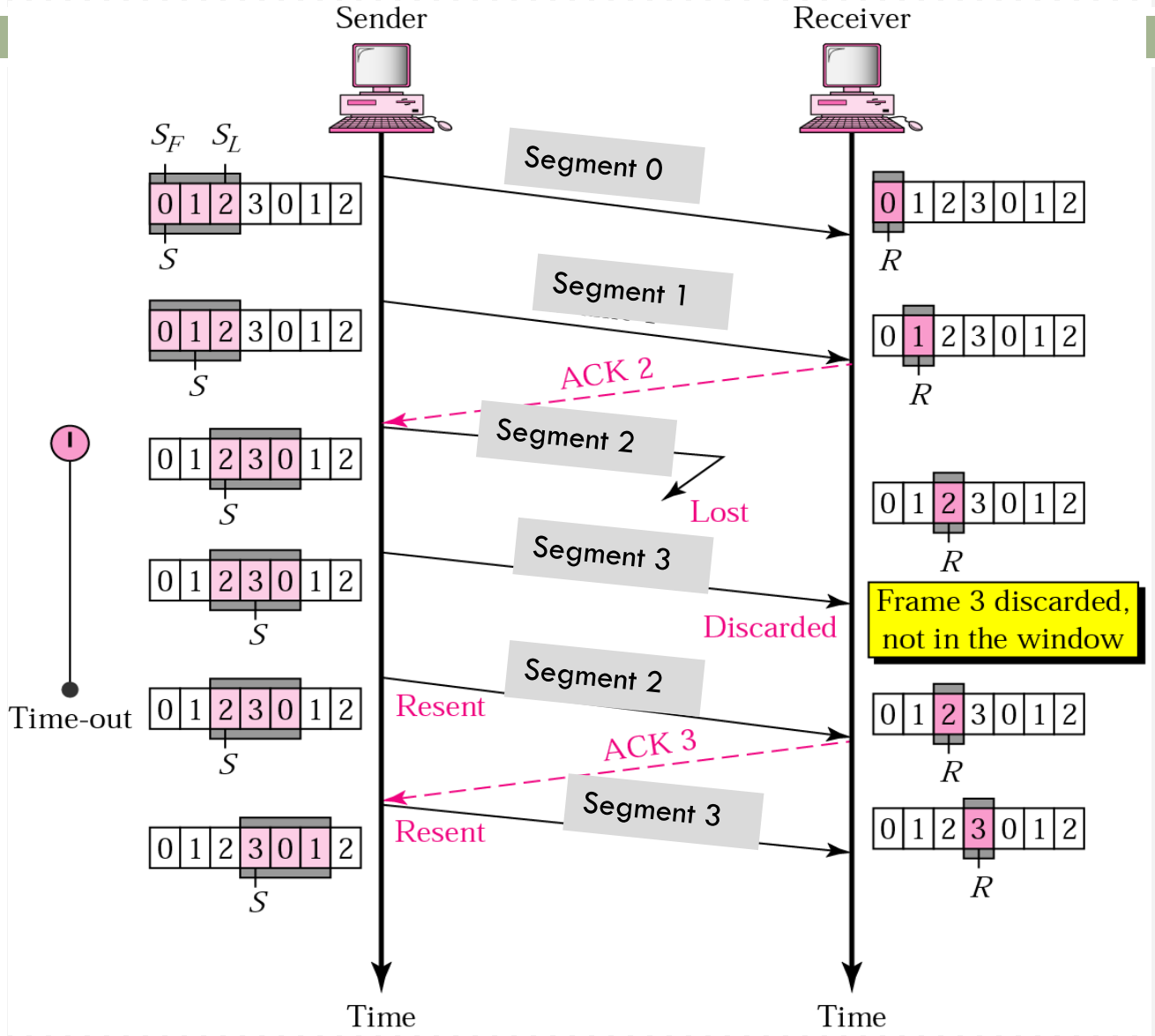
Type of Error

- Damage or Lost ACK
- Damage or Lost segment
- Delay of ACK

Go-Back-N: Normal Operation



Go-Back-N: Lost Segment



Pros & Cons of Go-Back-N

Pros:

- Simplifies Process at Receiver site
- No need to buffer out-of-order segment (just discarded)

Cons:

- Inefficient in Noisy Environment (retransmission is likely to occurs)
- Every "out-of-order" but "error-free" segment will be deleted

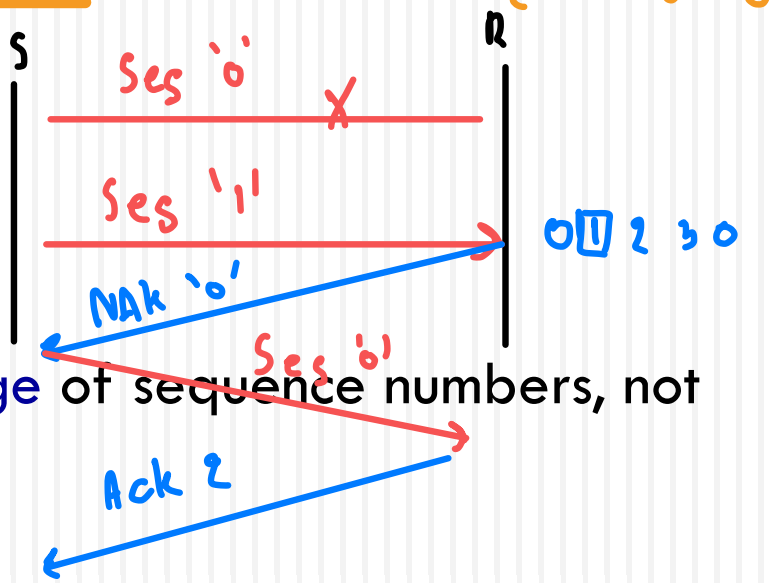
Selective-Repeat ARQ

- Sender and Receiver Windows
- Operation
- Bidirectional Transmission
- Pipelining

Concept of Selective Repeat

- **"Not resending multiple segments when only 1 segment is damaged, only the damaged is resent"**

- **Mostly** similar with Go-Back-N

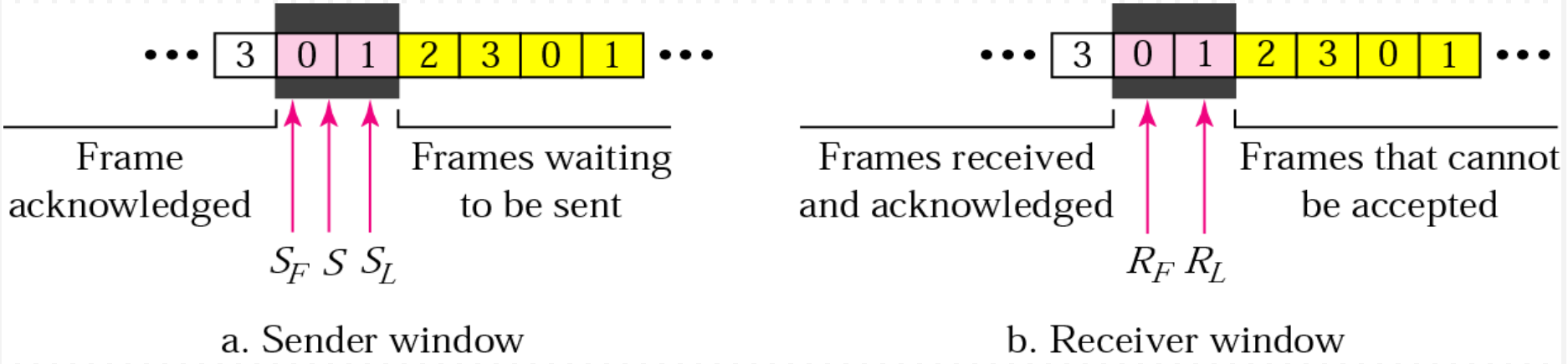


The main differences are

- The receiver will looking for a range of sequence numbers, not only one specific number.

- Introducing new type of ACK, **Negative Acknowledgment (NAK)** for report sequence number of damaged segment

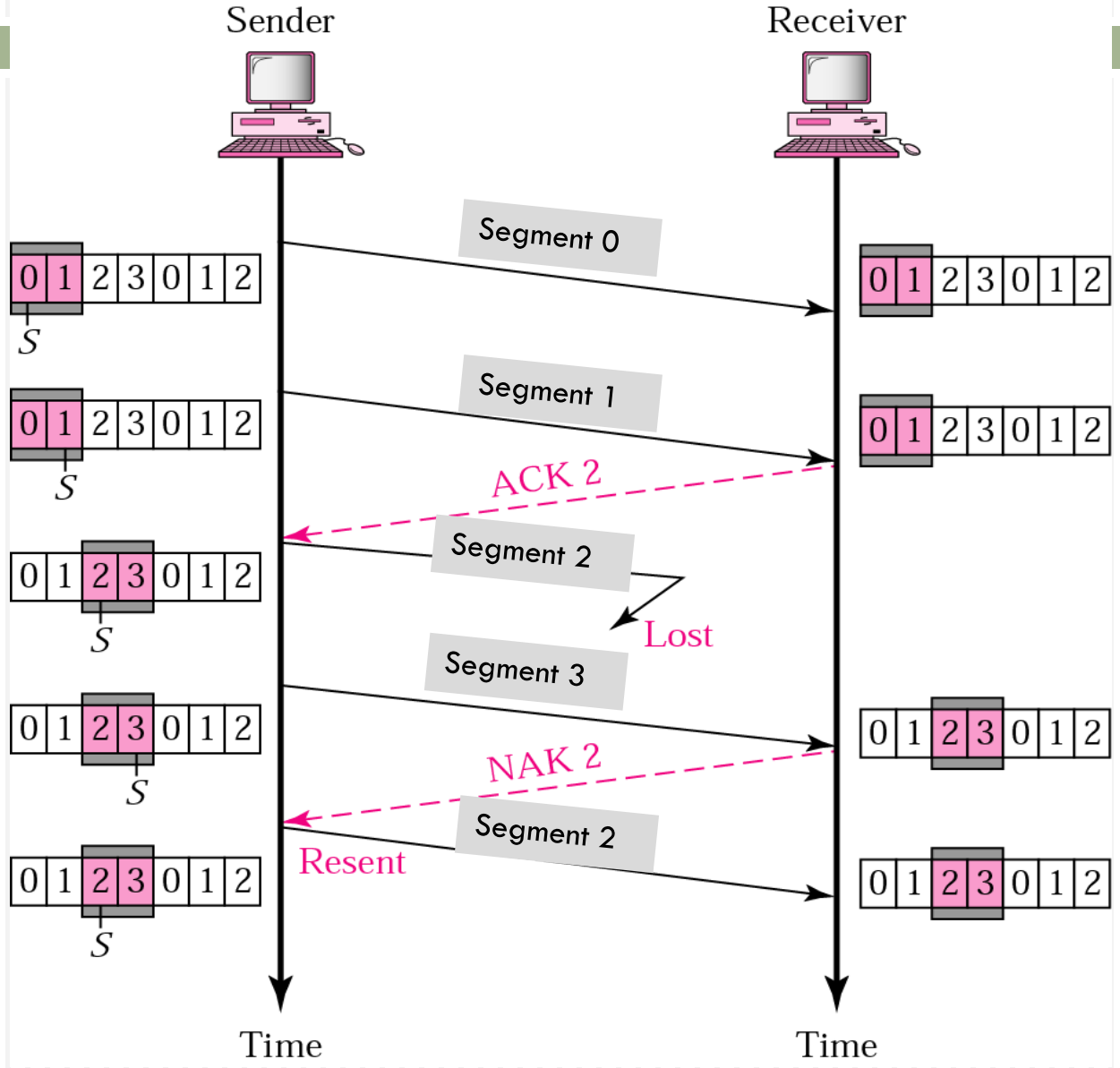
Sender and Receiver Window



a. Sender window

b. Receiver window

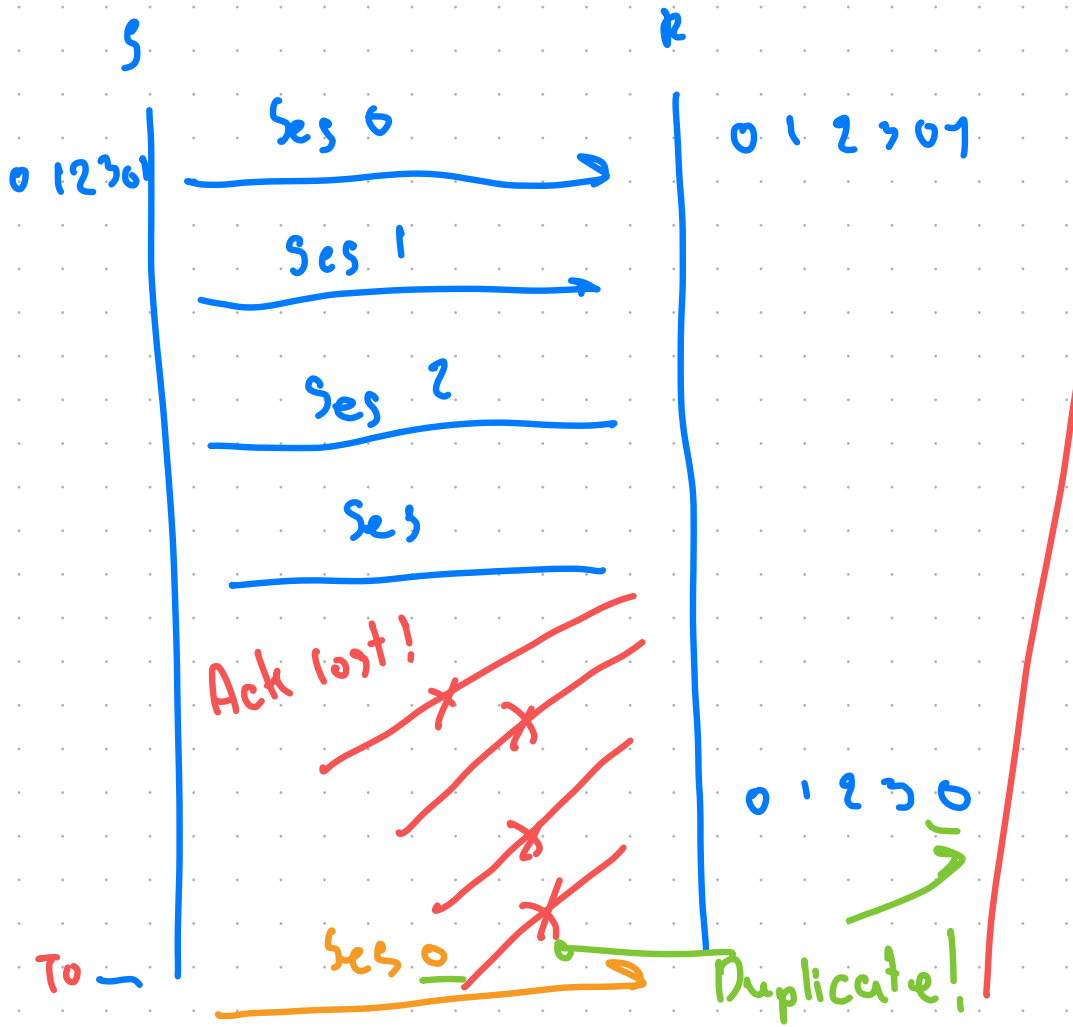
Selective-Repeat : Lost Segment



Max window ของ Go back - N

$2^n - 1$ โดย n คือจำนวน bit ของ segue number

0 1 2 3 0 1 2 3 => 00, 01, 10, 11 → $2^2 - 1 = 3$



Max window ของ selective repeat

$= 2^{(n-1)}$

$= 2^n \times 2^{-1}$

$= \frac{2^n}{2}$