Error Control

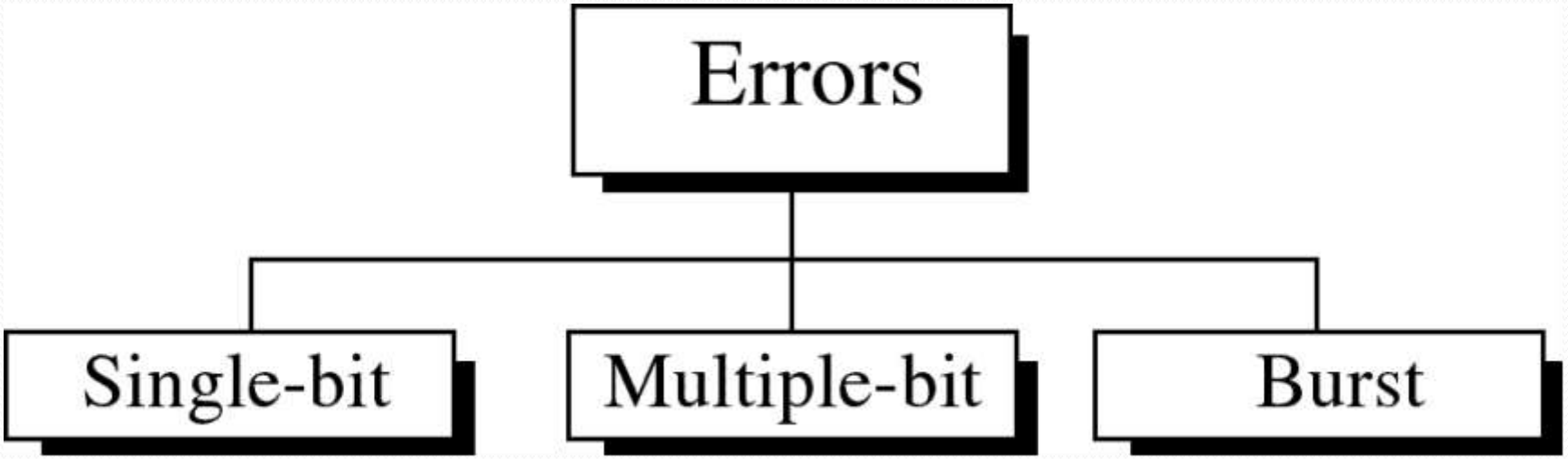
Error Control

- Error control includes both error detection and error correction.
- It allows the receiver to inform the sender if a frame is lost or damaged during transmission and coordinates the retransmission of those frames by the sender.
- Error control in the data link layer is based on automatic repeat request (ARQ). Whenever an error is detected, specified frames are retransmitted.

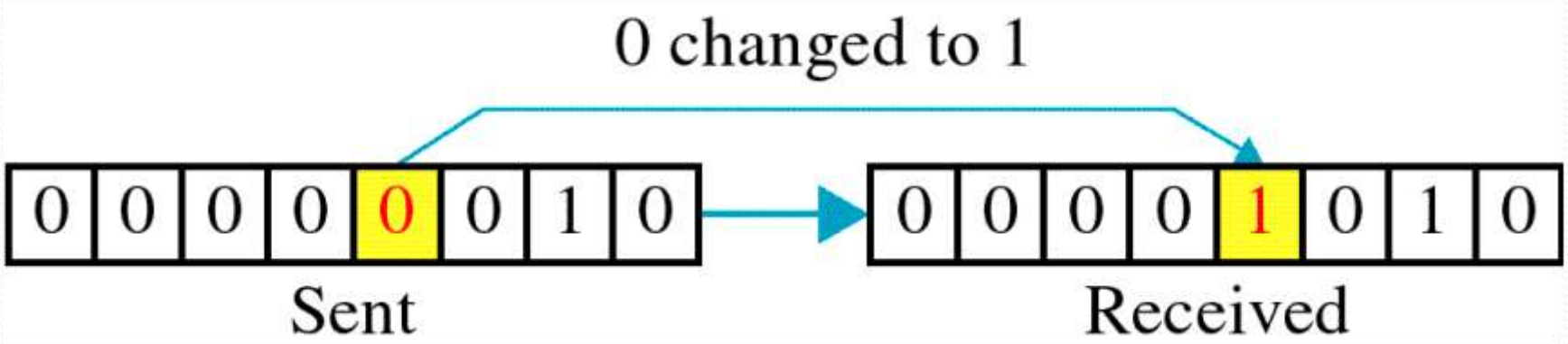
According to Behrouz A.Forouzan

- At the sending node, a frame in a data-link layer need to be changed to bits, transformed to be electromagnetic signals, and transmitted through the transmission media.
- At the receiving node, electromagnetic signals are received, transformed to bits and put together to create a frame.
- Since electromagnetic signals are susceptible to error, and a frame is susceptible to error.
- The error need first to be detected . After detection, it need to be either corrected at the receiver node or discarded and retransmitted by sending node.

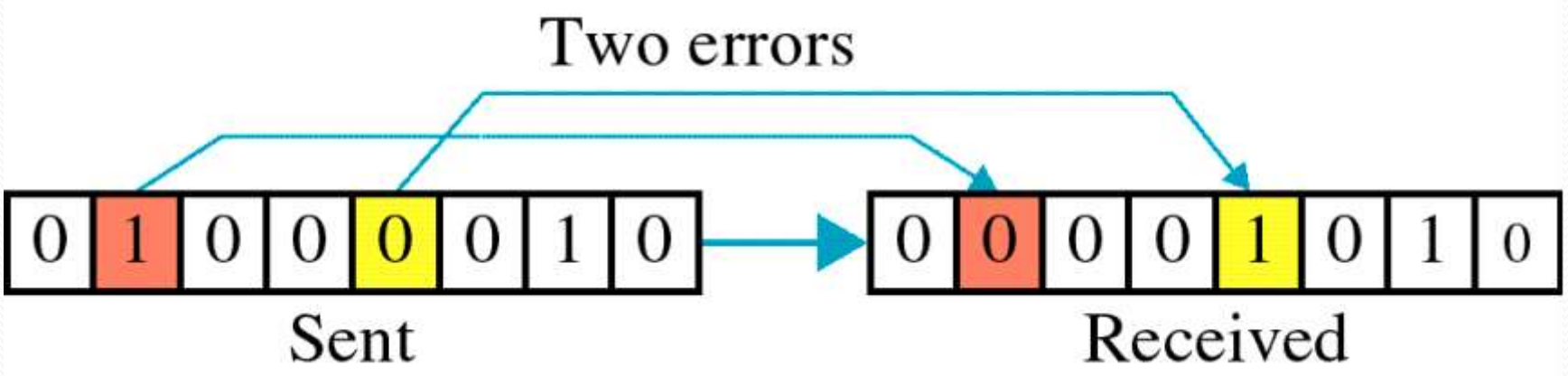
Error Types



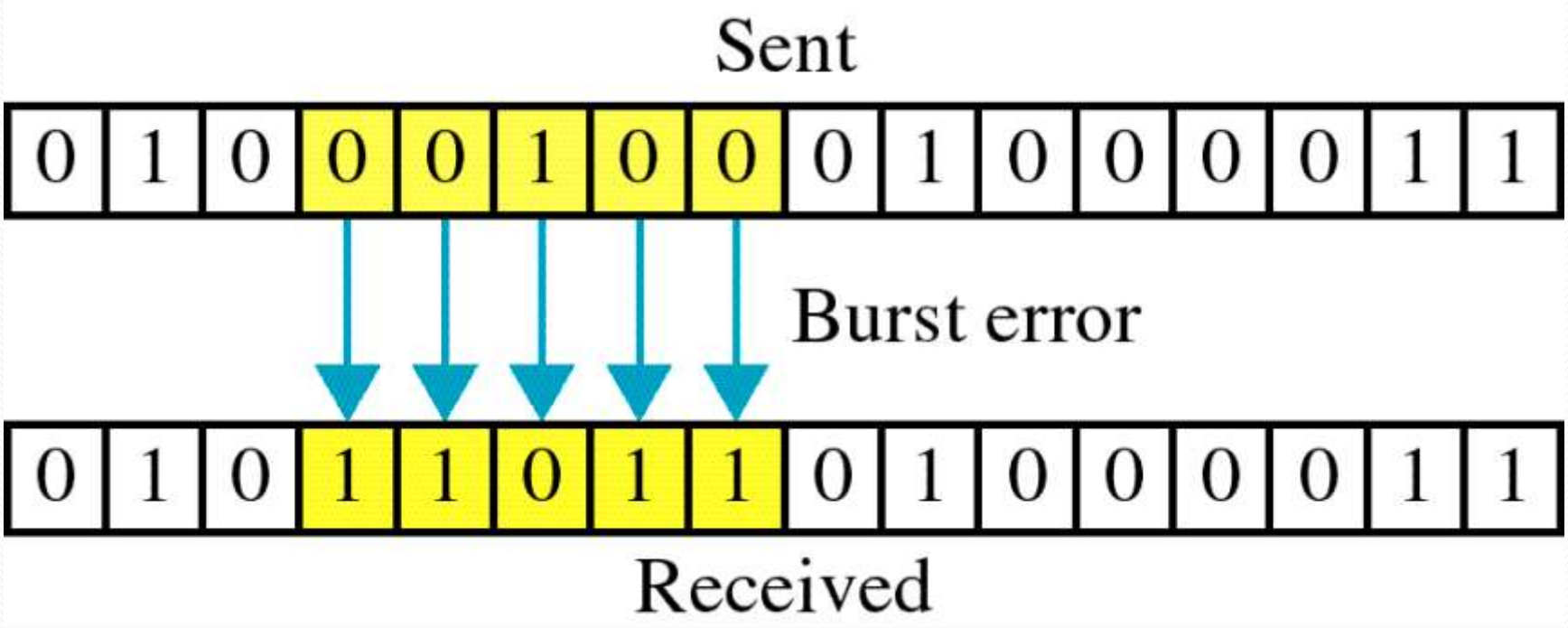
Single-bit error



Multiple-bit error



Burst error


Sent
0 1 0 0 0 1 0 0 0 1 0 0 0 0 1 1
Burst error
0 1 0 1 1 0 1 1 0 1 0 0 0 0 1 1
Received

How error occurs

- A burst error is more likely to occur than a single bit error because the duration of the noise signal is normally longer than the duration of 1 bit,which means that when noise affect data, it affects a set of bits.
- The number of bits affected depends on the data rates and the duration of noise.
- Ex-if we sending data at 1 kbps, a noise of 1/100 second can affect 10 bits, if we sending data at 1 mbps the same noise can affect 10,000 bits.

Two Basic forms of Error control:-

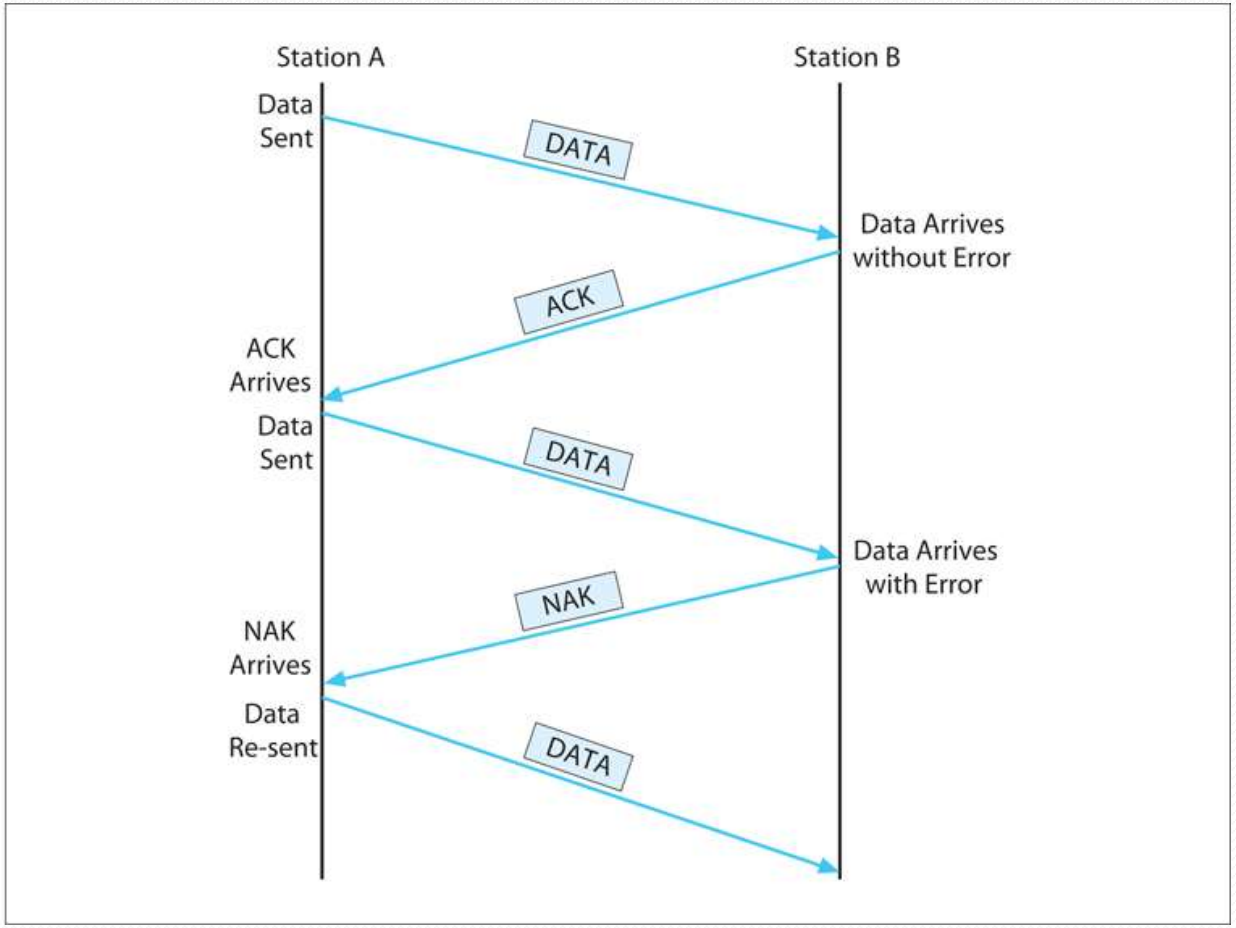
- Stop-and-wait error control
- Sliding window error control

Stop-and-Wait Error Control

- Stop-and-wait is the simplest of the error control protocols
- A transmitter sends a frame then stops and waits for an acknowledgment
  - If a positive acknowledgment (ACK) is received, the next frame is sent
  - If a negative acknowledgment (NAK) is received, the same frame is transmitted again

Stop-and-Wait Error Control (continued)

Figure 6-8
Sample dialog using Stop-and-wait error control

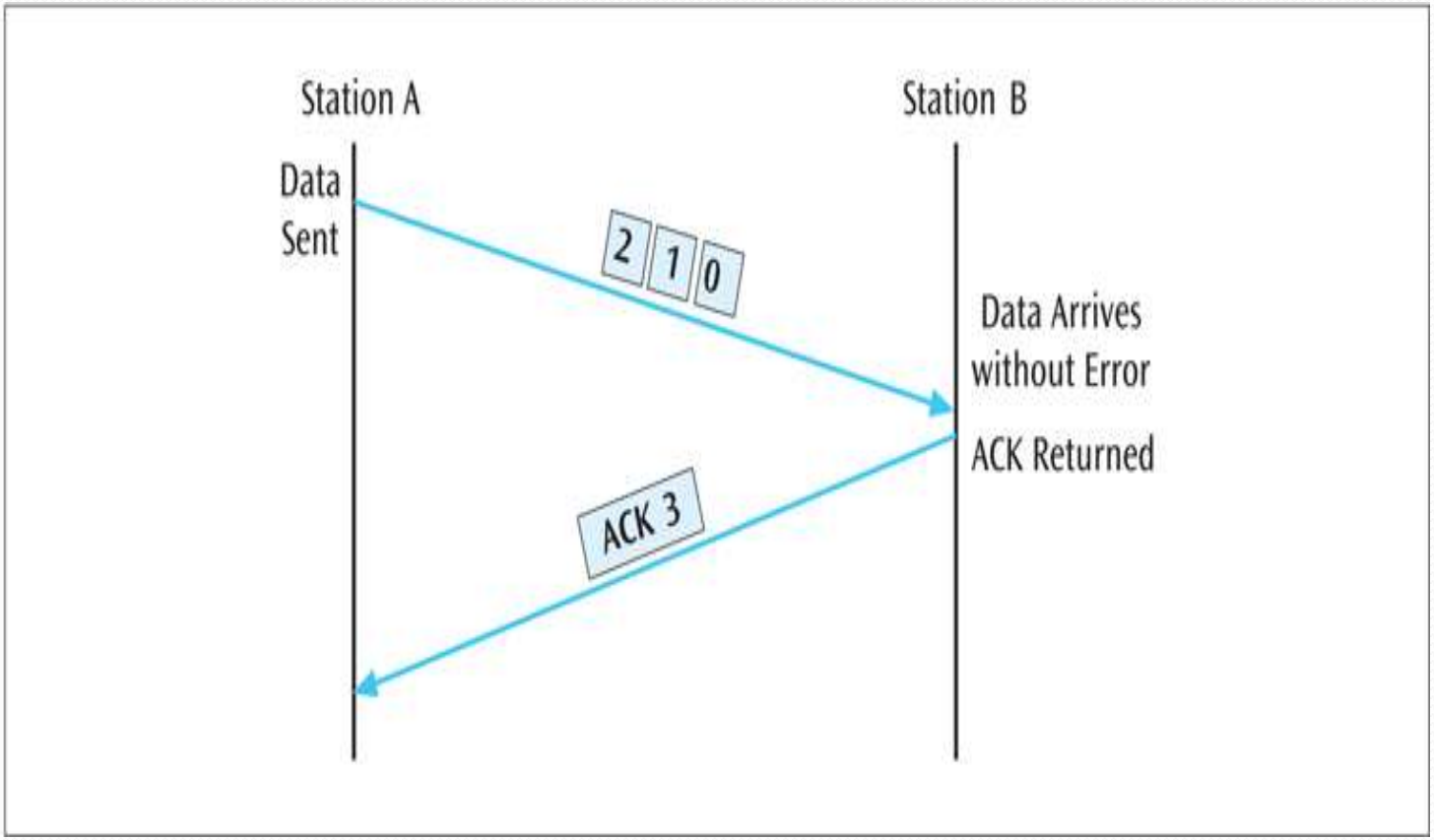


Sliding Window Error Control

- These techniques assume that multiple frames are in transmission at one time
- A sliding window protocol allows the transmitter to send a number of data packets at one time before receiving any acknowledgments
  - Depends on window size
- When a receiver does acknowledge receipt, the returned ACK contains the number of the frame expected next

Sliding Window Error Control (continued)

Figure 6-9
Example of sliding window

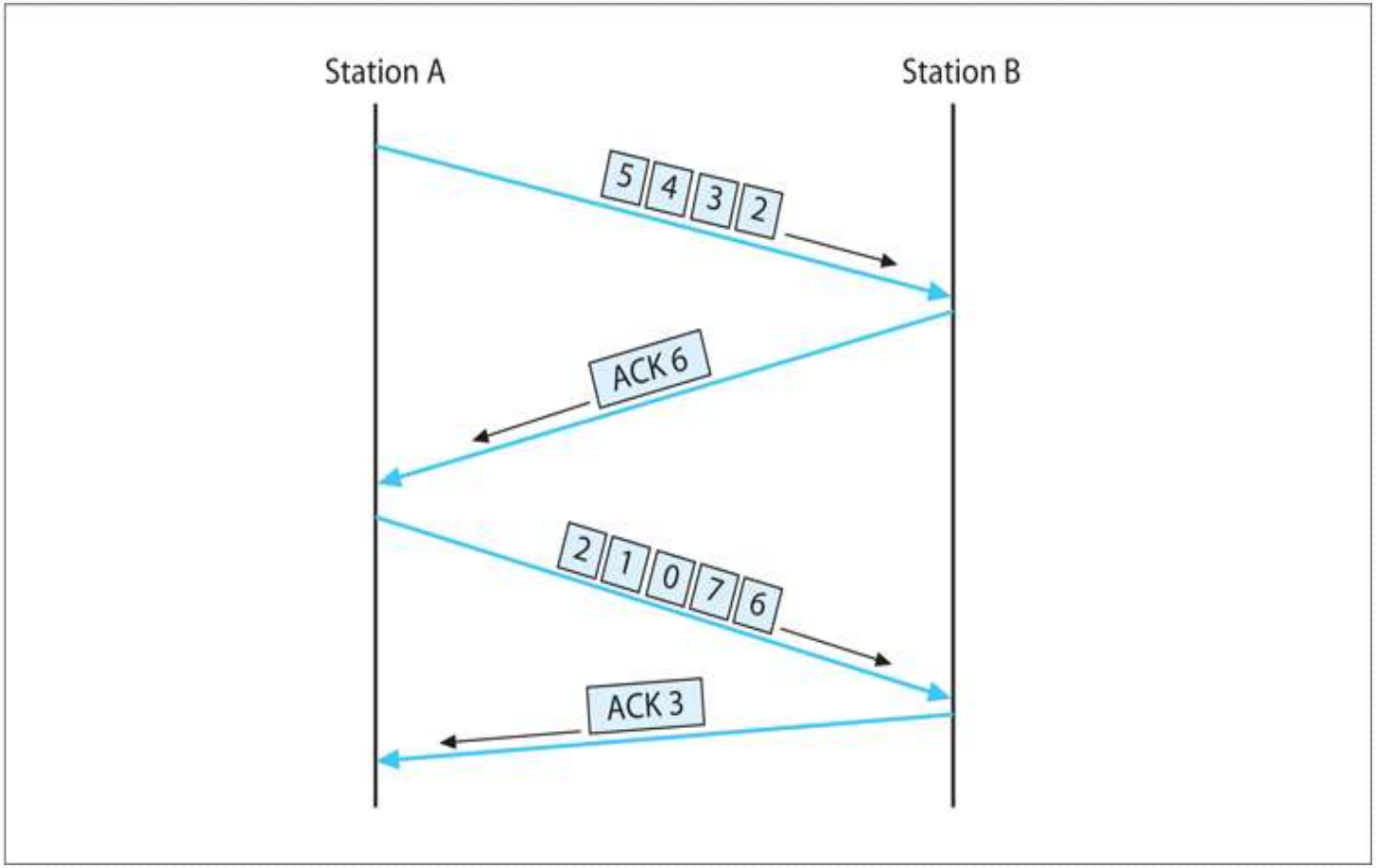


Sliding Window Error Control (continued)

- Older sliding window protocols numbered each frame or packet that was transmitted
- More modern sliding window protocols number each byte within a frame
- An example in which the packets are numbered, followed by an example in which the bytes are numbered:

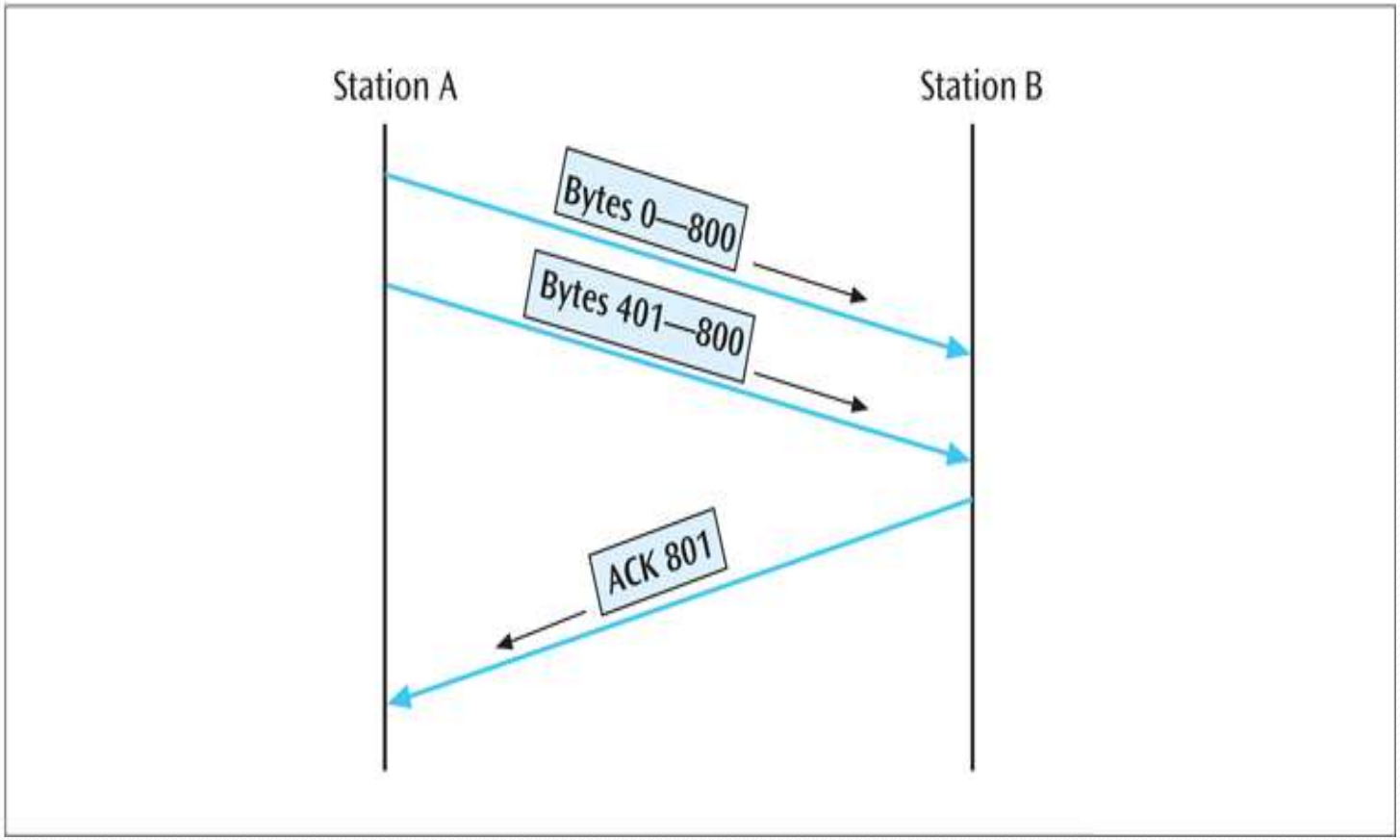
Sliding Window Error Control (continued)

Figure 6-10
Normal transfer of data between two stations with numbering of the packets



Sliding Window Error Control (continued)

Figure 6-11
Normal transfer of data between two stations with numbering of the bytes



Sliding Window Error Control (continued)

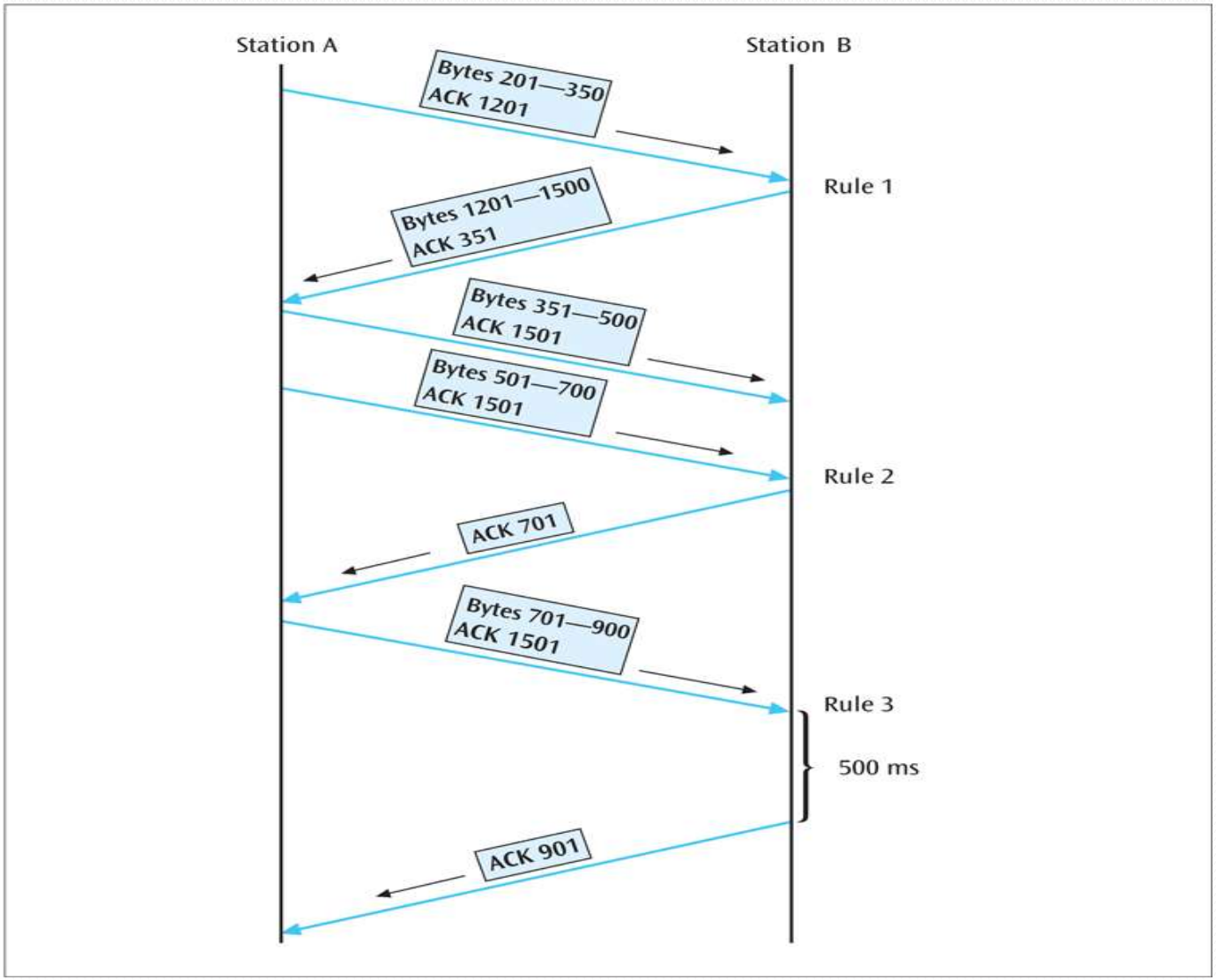
- Notice that an ACK is not always sent after each frame is received
  - It is more efficient to wait for a few received frames before returning an ACK
- How long should you wait until you return an ACK?

Sliding Window Error Control (continued)

- Using TCP/IP, there are some basic rules concerning ACKs:
  - Rule 1: If a receiver just received data and wants to send its own data, piggyback an ACK along with that data
  - Rule 2: If a receiver has no data to return and has just ACKed the last packet, receiver waits 500 ms for another packet
    - If while waiting, another packet arrives, send the ACK immediately
  - Rule 3: If a receiver has no data to return and has just ACKed the last packet, receiver waits 500 ms
    - No packet, send ACK

Sliding Window Error Control (continued)

Figure 6-12
Three examples of returning an acknowledgment (ACK)

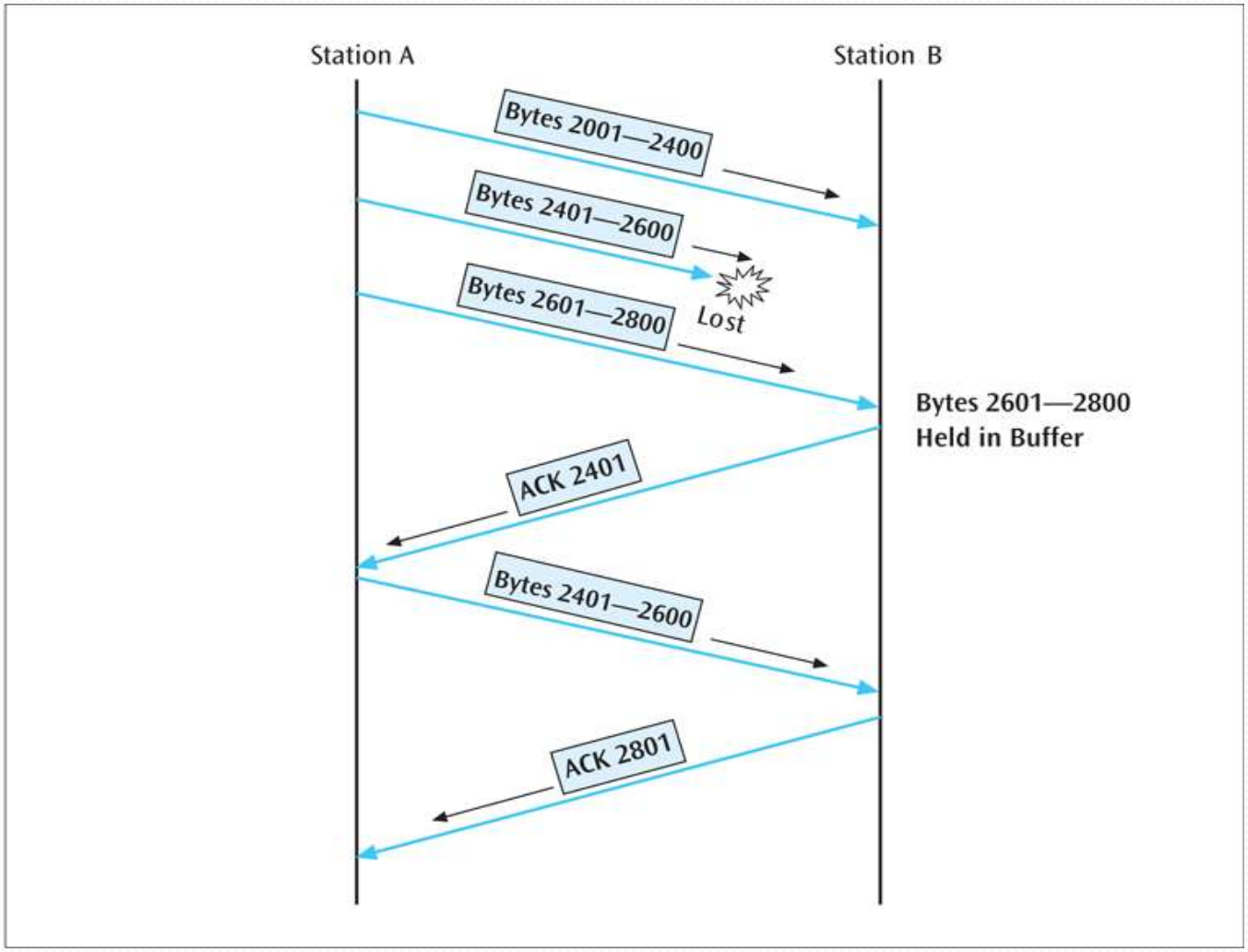


Sliding Window Error Control (continued)

- What happens when a packet is lost?
  - As shown in the next slide, if a frame is lost, the following frame will be “out of sequence”
    - The receiver will hold the out of sequence bytes in a buffer and request the sender to retransmit the missing frame

Sliding Window Error Control (continued)

Figure 6-13
A lost packet and Station B's response



Sliding Window Error Control (continued)

- What happens when an ACK is lost?
  - As shown in the next slide, if an ACK is lost, the sender will wait for the ACK to arrive and eventually time out
    - When the time-out occurs, the sender will resend the last frame

Sliding Window Error Control (continued)

Figure 6-14
A lost acknowledgment and the retransmission of a packet