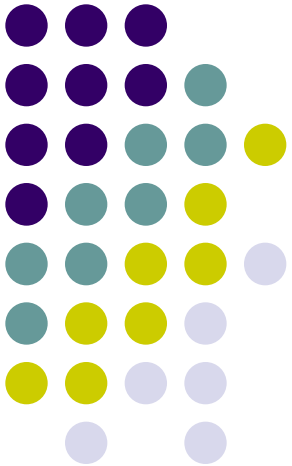
ELEN 4017

Network Fundamentals

Lecture 17

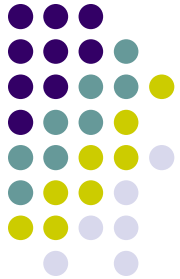


Purpose of lecture

Chapter 3: Transport Layer

- Selective Repeat

Selective Repeat



- Avoids **unnecessary retransmissions** by having the sender **only retransmit only those packets** that are suspected to be received with errors.
- Limited to a window size N.
- Unlike GBN, sender will have already received ACKs for some packets.
- **Out of order packets received will be buffered**.
- **All packets received correctly** will be **ACK'ed**.

Selective Repeat

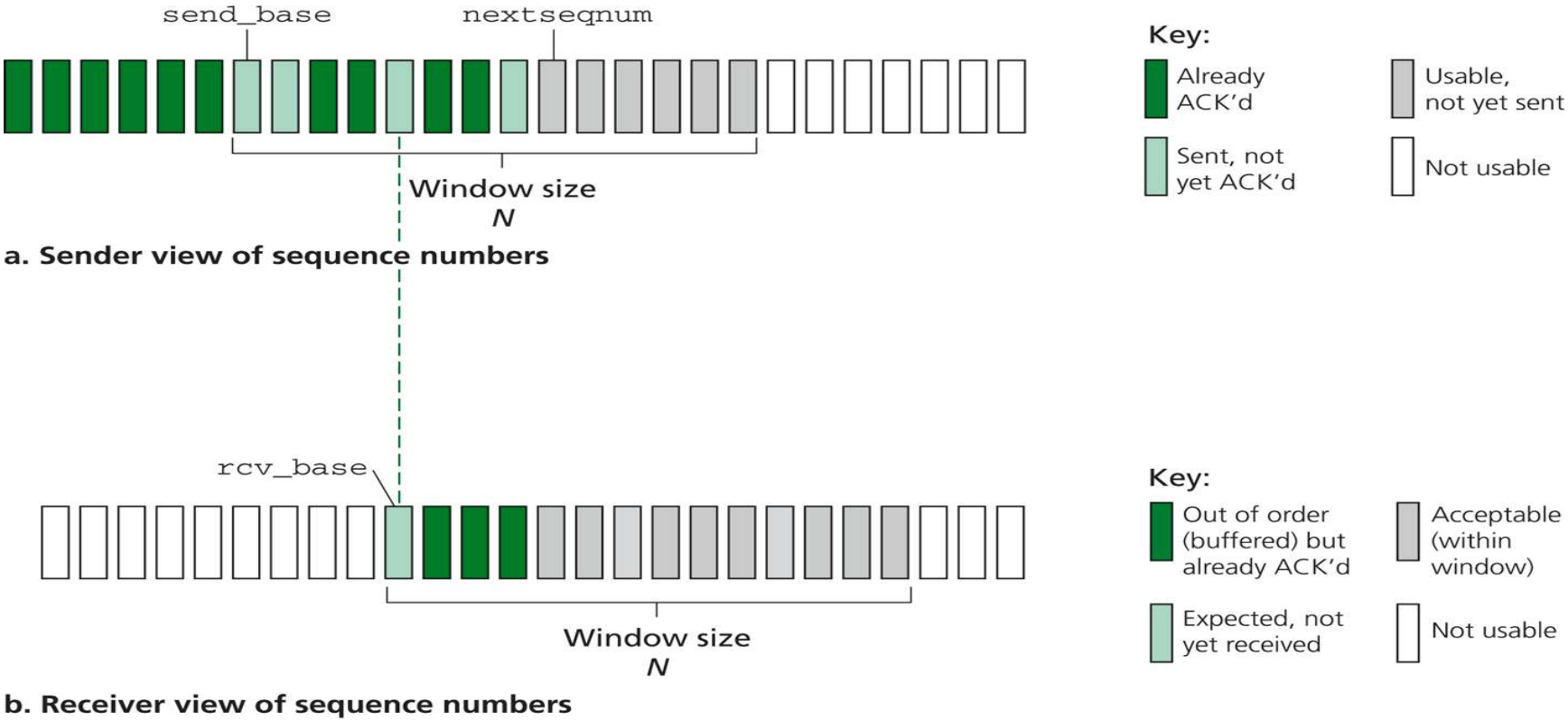


Figure 3.23 ♦ Selective-repeat (SR) sender and receiver views of sequence-number space

Selective repeat

sender

data from above :

- if next available seq # in window, send pkt

timeout(n):

- resend pkt n, restart timer

ACK(n) in [sendbase,sendbase+N]:

- mark pkt n as received
- if n smallest unACKed pkt, advance window base to next unACKed seq #

receiver

pkt n in [rcvbase, rcvbase+N-1]

- send ACK(n)
- out-of-order: buffer
- in-order: deliver (also deliver buffered, in-order pkts), advance window to next not-yet-received pkt

pkt n in [rcvbase-N,rcvbase-1]

- ACK(n)

otherwise:

- ignore

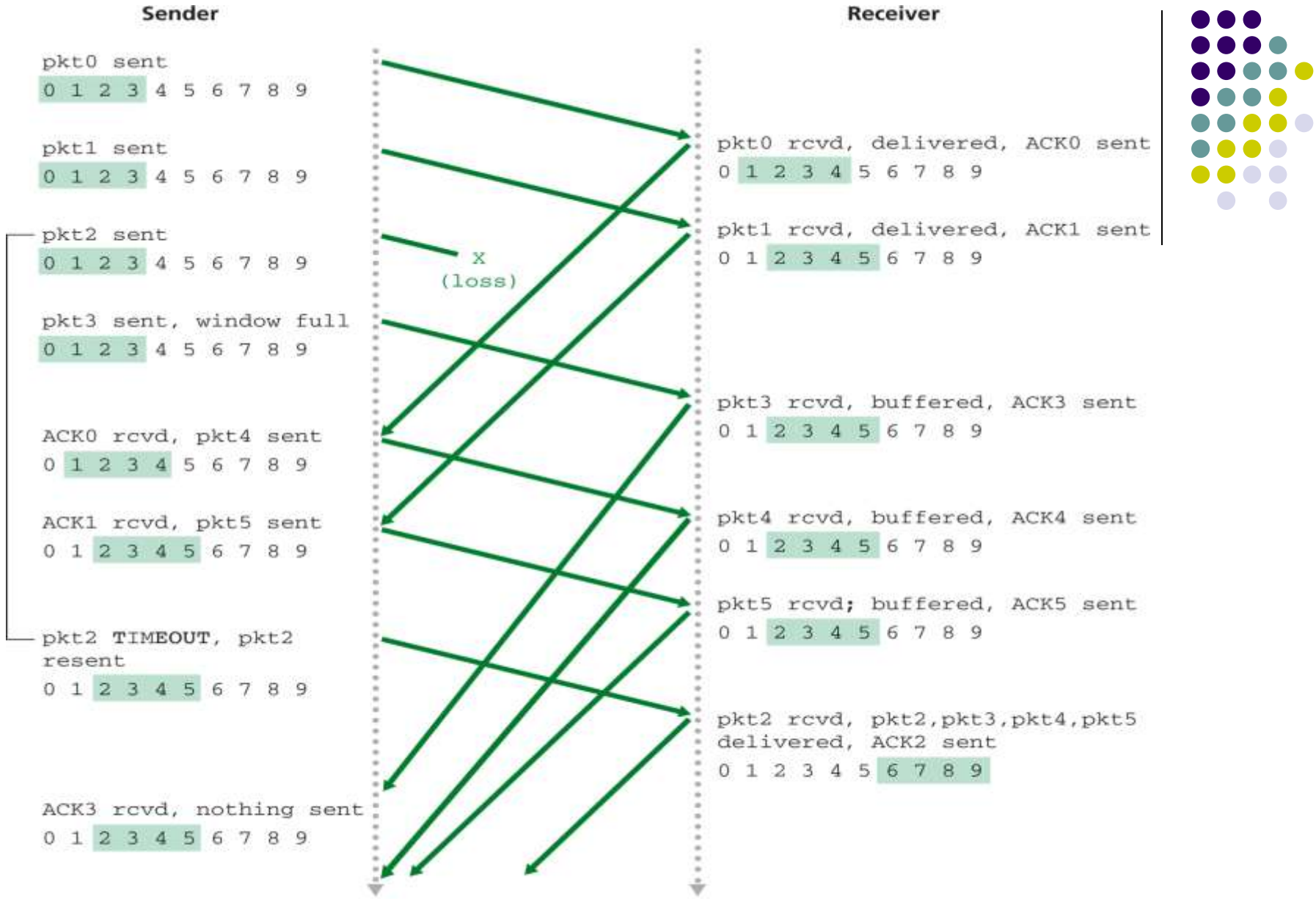
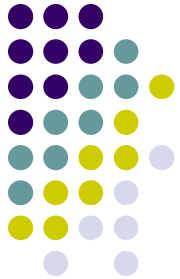


Figure 3.26 ♦ SR operation

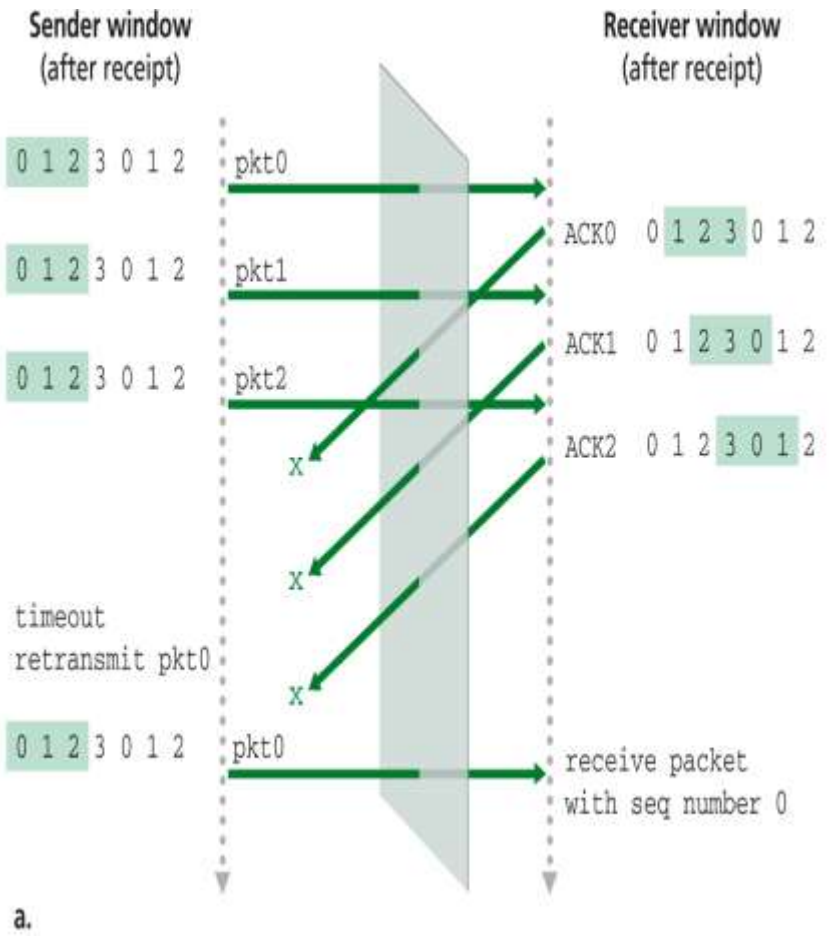
Relationship between window size and sequence number range



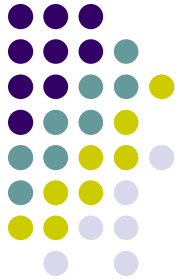
- The dimensioning of the window size and sequence number range can have consequences on whether inconsistencies can occur.
- Consider sequence number range = [0,1,2,3]
- Window size = 3.
- Packets 0 -2 are transmitted and correctly received and acknowledged by the receiver.
- Receivers window is over 4,5,6 packets which will have sequence numbers 3,0,1

Scenario 1: Acks for first 3 packets are lost

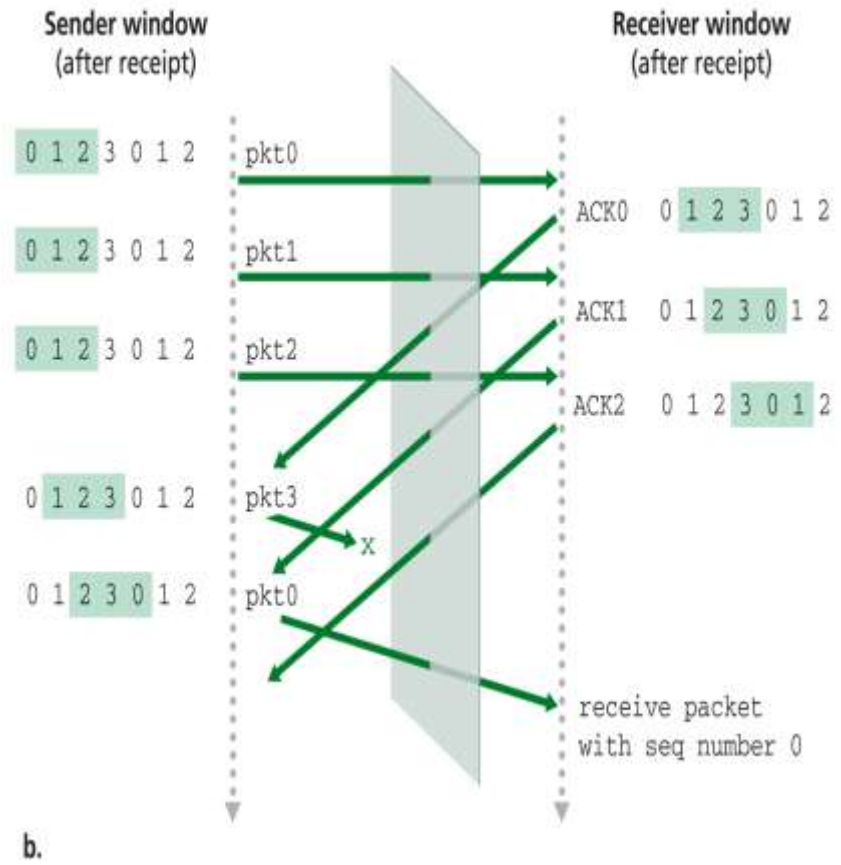
- Since ACKs are lost, sender will retransmit first 3 packets.
- Thus receiver next receives a packet with sequence number = 0.
- This is a **retransmitted** packet.



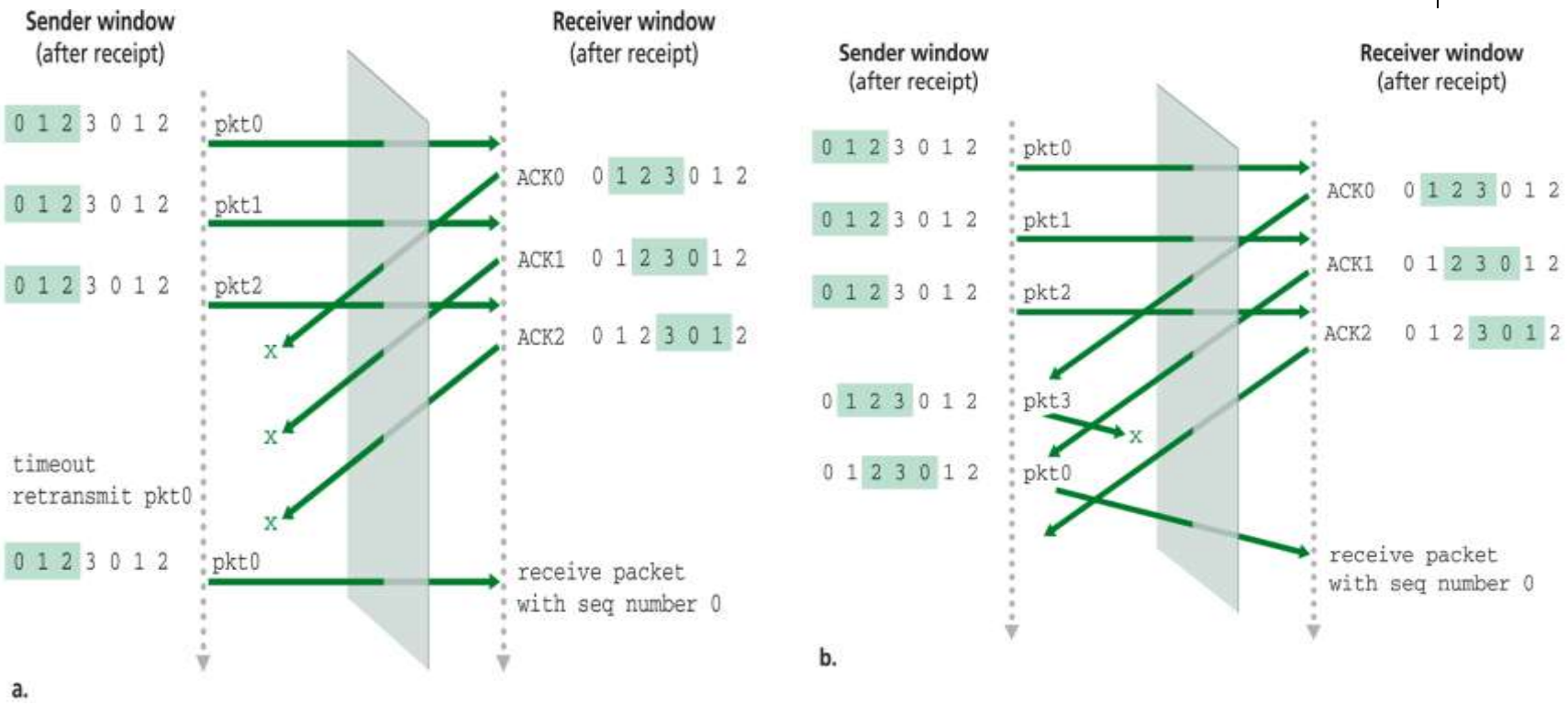
Scenario 2 – ACKs for first 3 packets delivered successfully



- Since all 3 ACKs received, the sender moves the window forward.
- Packet with sequence no 3 is lost.
- Packet with sequence no 0 arrives.
- This is a **new** packet.



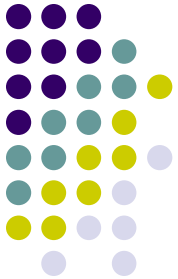
Scenarios cannot be distinguished at the receiver



- The receiver cannot distinguish between the two scenarios. Thus we need to choose the window size and sequence number to prevent this.
- For SR protocols:

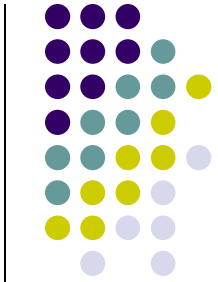
$$\text{windowsize} \leq 0.5 \text{ seq\_no\_space}$$

Applet demo of SR



- Applet demo
- Do a google search for ‘Selective Repeat’ to find applets on the Internet.
- Experiment by deleting packets, deleting ACKs, etc. to verify the behaviour of SR.

Summary of reliable data transfer mechanisms



Mechanism	Use, Comments
Checksum	Used to detect bit errors in a transmitted packet.
Timer	Used to timeout/retransmit a packet, possibly because the packet (or its ACK) was lost within the channel. Because timeouts can occur when a packet is delayed but not lost (premature timeout), or when a packet has been received by the receiver but the receiver-to-sender ACK has been lost, duplicate copies of a packet may received by a receiver.
Sequence number	Used for sequential numbering of packets of data flowing from sender to receiver. Gaps in the sequence numbers of received packets allow the receiver to detect a lost packet. Packets with duplicate sequence numbers allow the receiver to detect duplicate copies of a packet.
Acknowledgment	Used by the receiver to tell the sender that a packet or set of packets has been received correctly. Acknowledgments will typically carry the sequence number of the packet or packets being acknowledged. Acknowledgments may be individual or cumulative, depending on the protocol.
Negative acknowledgment	Used by the receiver to tell the sender that a packet has not been received correctly. Negative acknowledgments will typically carry the sequence number of the packet that was not received correctly.
Window, pipelining	The sender may be restricted to sending only packets with sequence numbers that fall within a given range. By allowing multiple packets to be transmitted but not yet acknowledged, sender utilization can be increased over a stop-and-wait mode of operation. We'll see shortly that the window size may be set on the basis of the receiver's ability to receive and buffer messages, or the level of congestion in the network, or both.