

PART XII

**RELIABLE STREAM TRANSPORT SERVICE
(TCP)**

Transmission Control Protocol (TCP)

- Major transport service in the TCP/IP suite
- Used for most Internet applications (esp. World Wide Web)

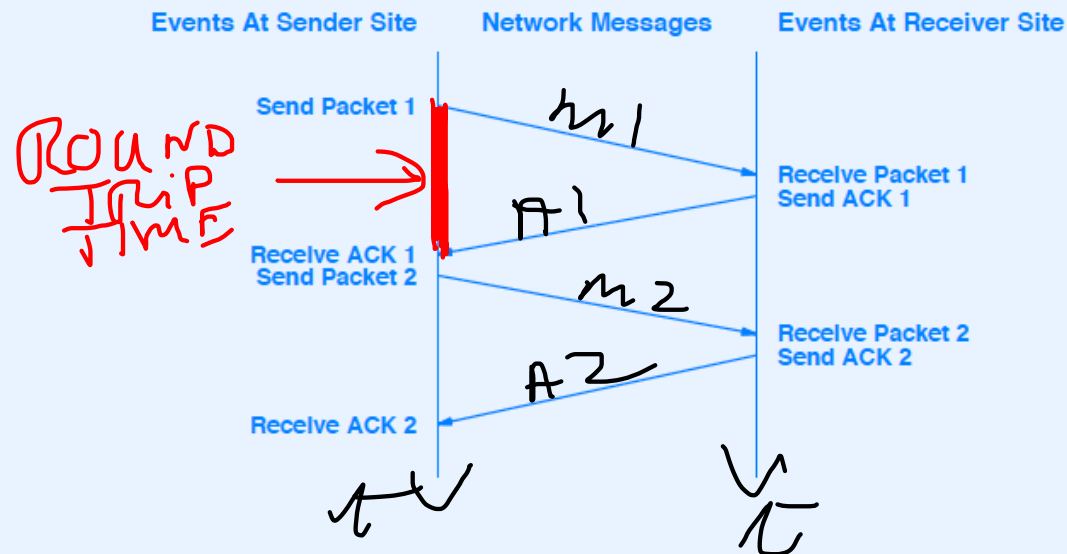
TCP Characteristics

- Stream orientation
- Virtual circuit connection
- Buffered transfer
- Unstructured stream
- Full duplex connection
- Reliability

Providing Reliability

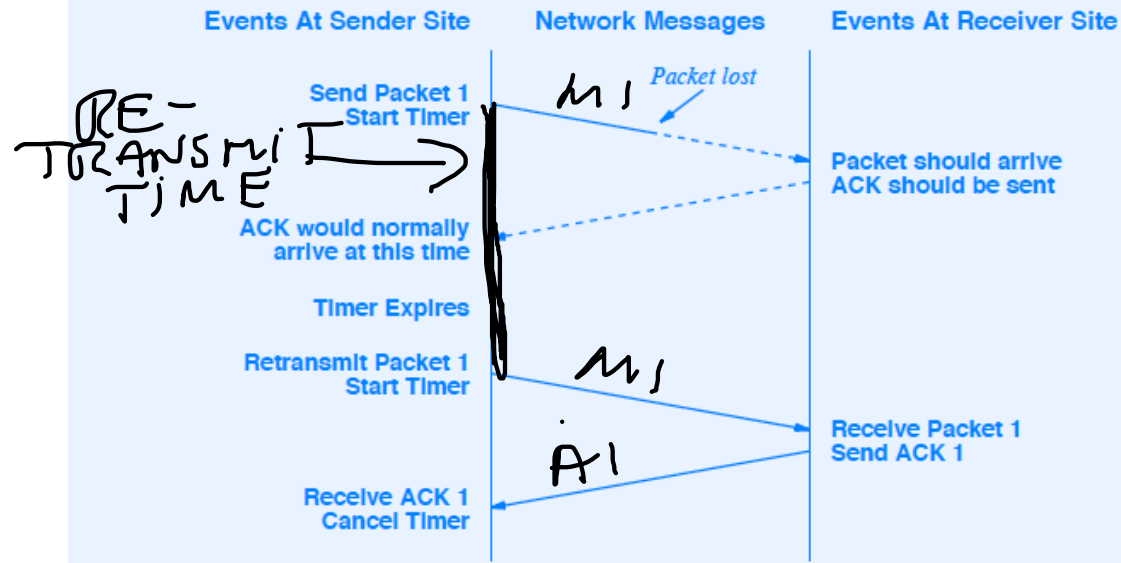
- Traditional technique: Positive Acknowledgement with Retransmission (PAR)
 - Receiver sends *acknowledgement* when data arrives
 - Sender starts timer whenever transmitting
 - Sender retransmits if timer expires before acknowledgement arrives

Illustration Of Acknowledgements



- Time moves from top to bottom in the diagram

Illustration Of Recovery After Packet Loss



RE-TRANSMIT TIME

RETRANSMIT TIME

>

ROUND TRIP TIME

The Problem With Simplistic PAR

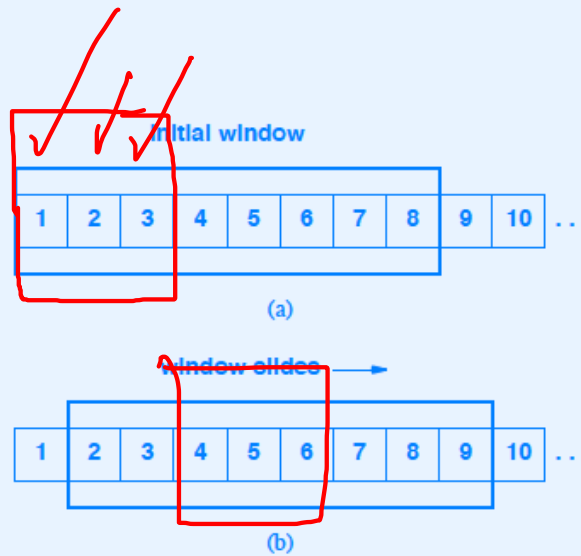
A simple positive acknowledgement protocol wastes a substantial amount of network bandwidth because it must delay sending a new packet until it receives an acknowledgement for the previous packet.

- Problem is especially severe if network has long latency

Solving The Problem

- Allow multiple packets to be outstanding at any time
- Still require acknowledgements and retransmission
- Known as *sliding window*

Illustration Of Sliding Window

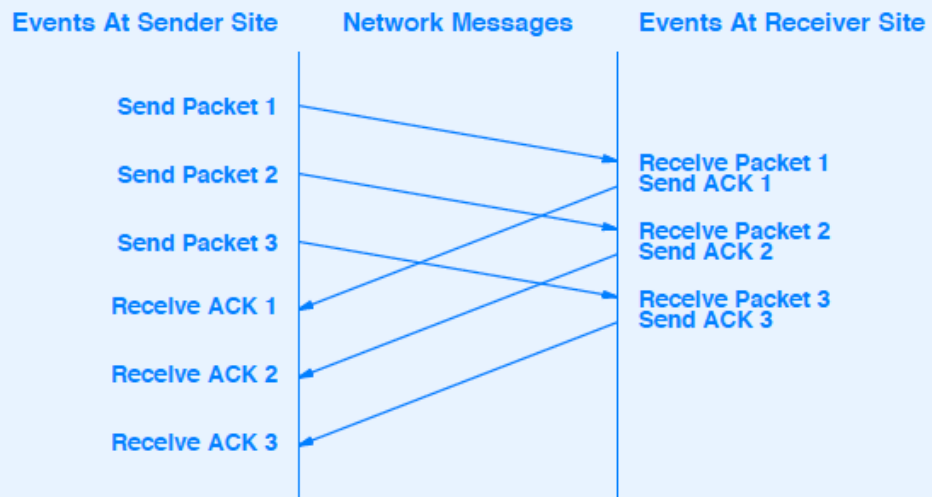


- Window size is fixed
- As acknowledgement arrives, window moves forward

Why Sliding Window Works

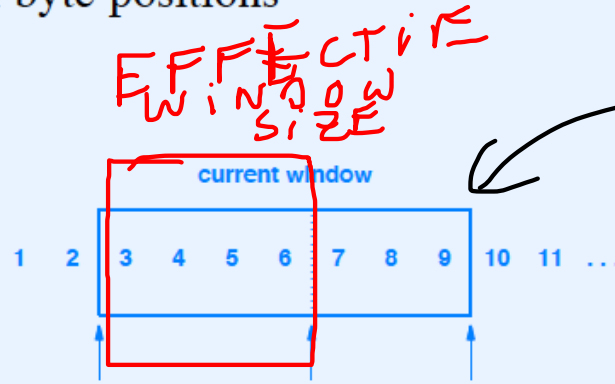
Because a well-tuned sliding window protocol keeps the network completely saturated with packets, it obtains substantially higher throughput than a simple positive acknowledgement protocol.

Illustration Of Sliding Window



Sliding Window Used By TCP

- Measured in byte positions
- Illustration



- Bytes through 2 are acknowledged
- Bytes 3 through 6 not yet acknowledged
- Bytes 7 though 9 waiting to be sent
- Bytes above 9 lie outside the window and cannot be sent

determined
by
Receiver
EVERY
ACK
IS ACCOMPANIED
BY
WINDOW
ADVERTISING
SETS WINDOW
FOR
SENDER

