



# Computer Transport Layer

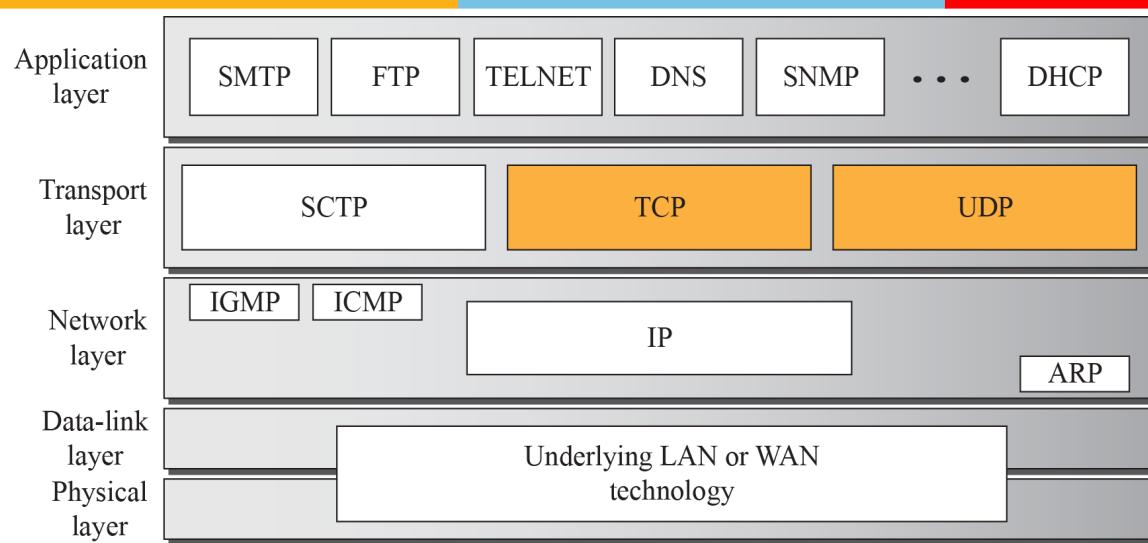
## Networks:

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Acknowledgement: Slides and Images adapted from Kurose, and Forouzan (TMH)

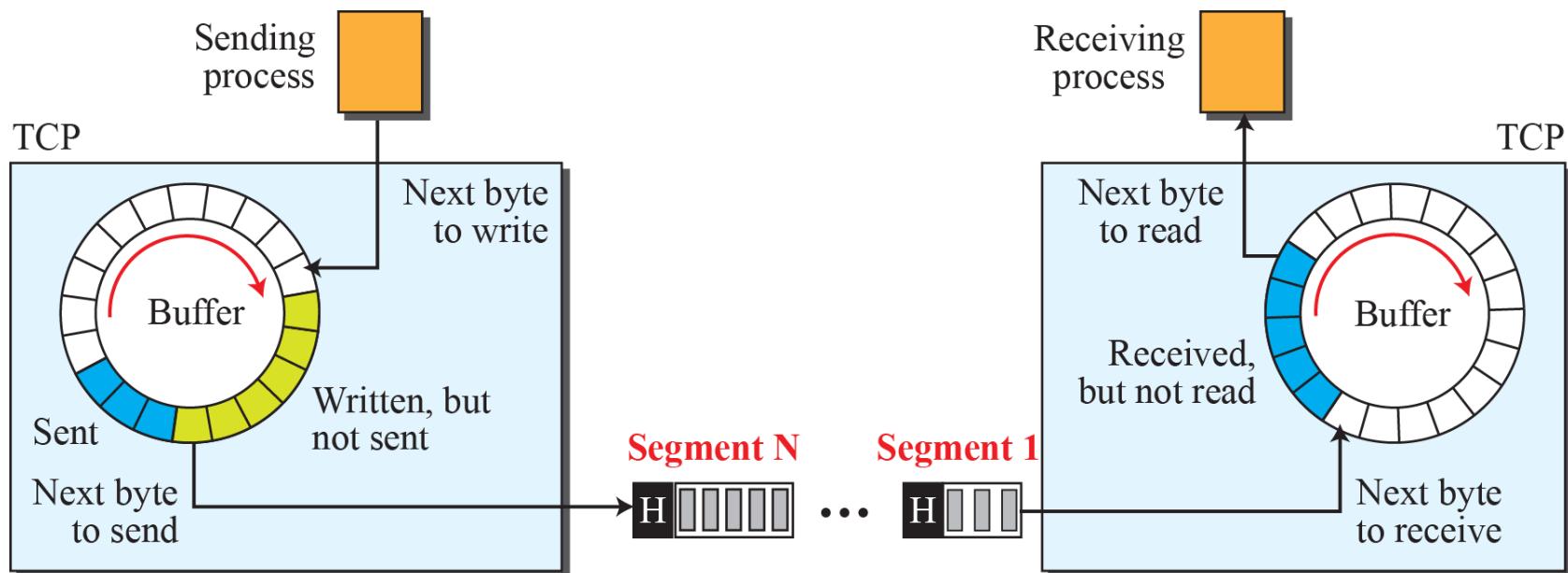
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# Internet Transport Layer



Port	Protocol	UDP	TCP	Description
7	Echo	√		Echoes back a received datagram
9	Discard	√		Discards any datagram that is received
11	Users	√	√	Active users
13	Daytime	√	√	Returns the date and the time
17	Quote	√	√	Returns a quote of the day
19	Chargen	√	√	Returns a string of characters
20, 21	FTP		√	File Transfer Protocol
23	TELNET		√	Terminal Network
25	SMTP		√	Simple Mail Transfer Protocol
53	DNS	√	√	Domain Name Service
67	DHCP	√	√	Dynamic Host Configuration Protocol
69	TFTP	√		Trivial File Transfer Protocol
80	HTTP		√	Hypertext Transfer Protocol
111	RPC	√	√	Remote Procedure Call
123	NTP	√	√	Network Time Protocol
161, 162	SNMP		√	Simple Network Management Protocol

# TCP Segments



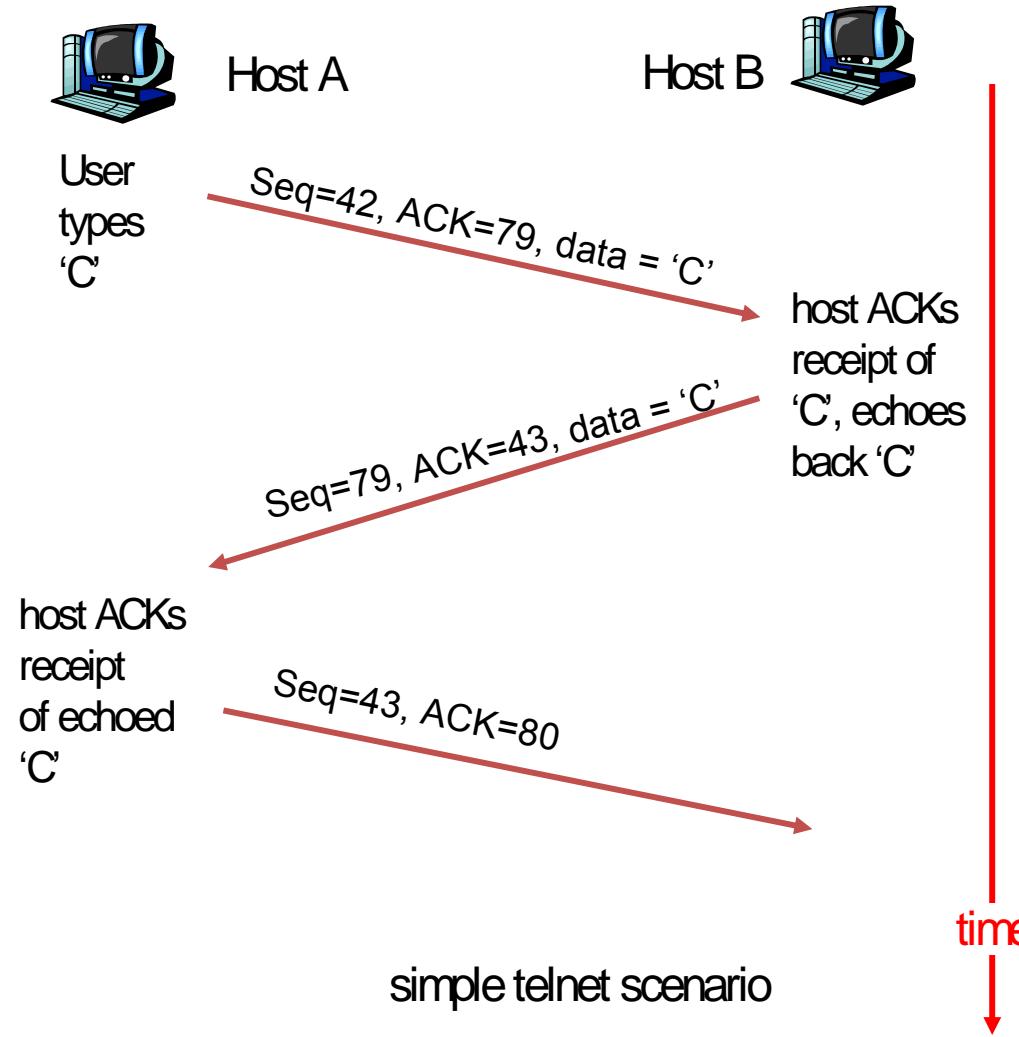
# Sequence Numbers

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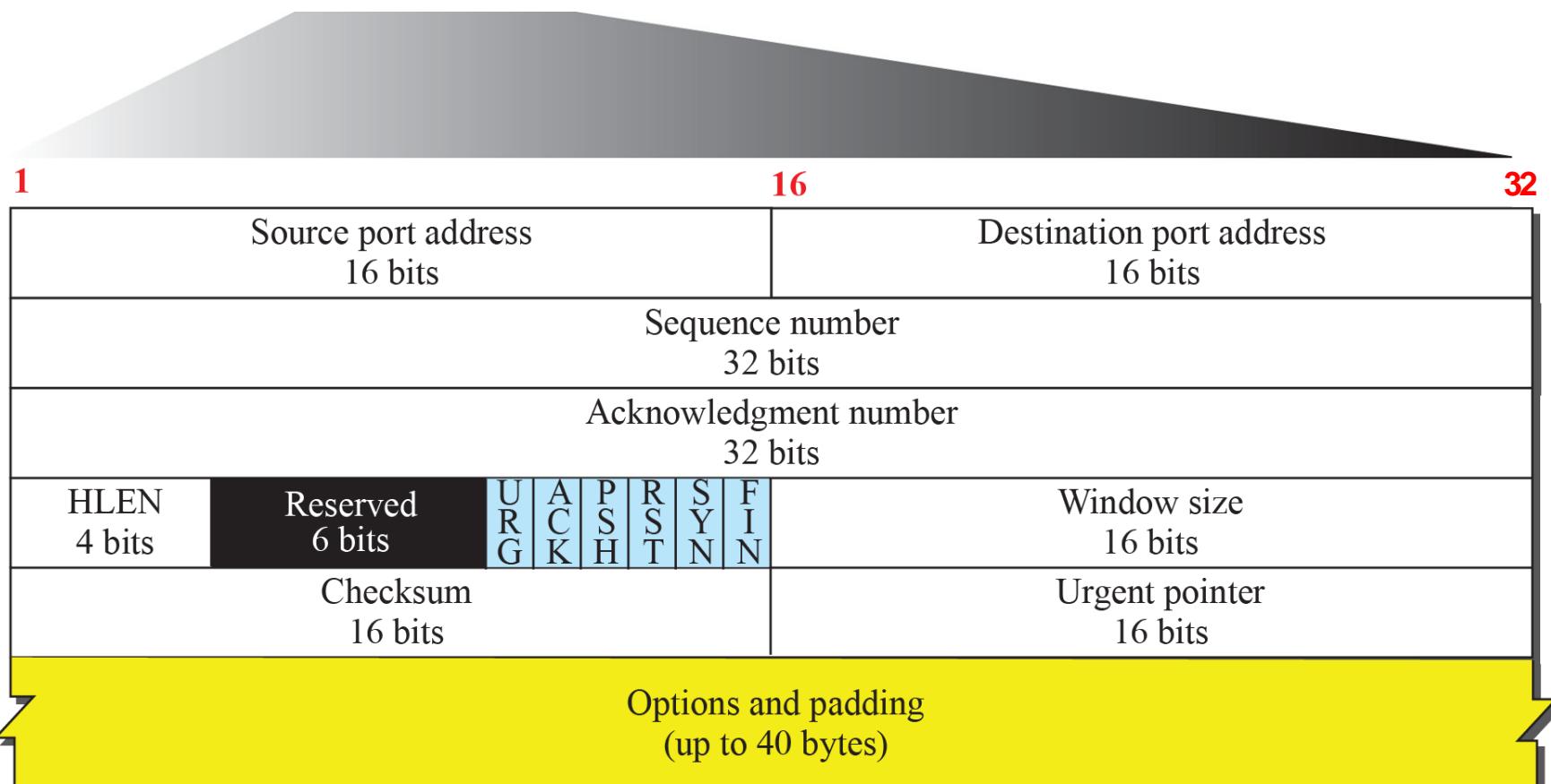
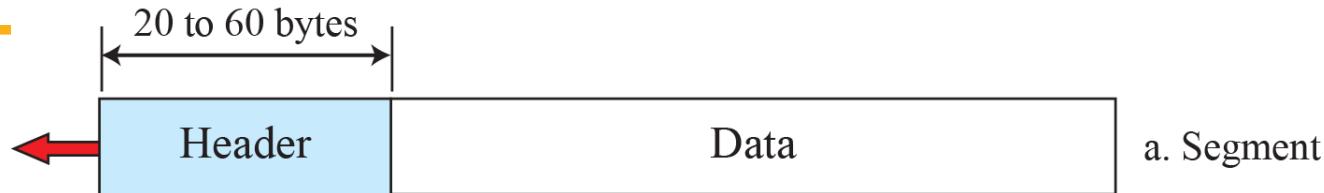
Suppose a TCP connection is transferring a file of 4,000 bytes. The first byte is numbered 10,001.

What are the sequence numbers for each segment if data are sent in **four** segments, each segment has a carrying capacity of 1,000 bytes?

# TCP Sequence Number & ACK Numbers

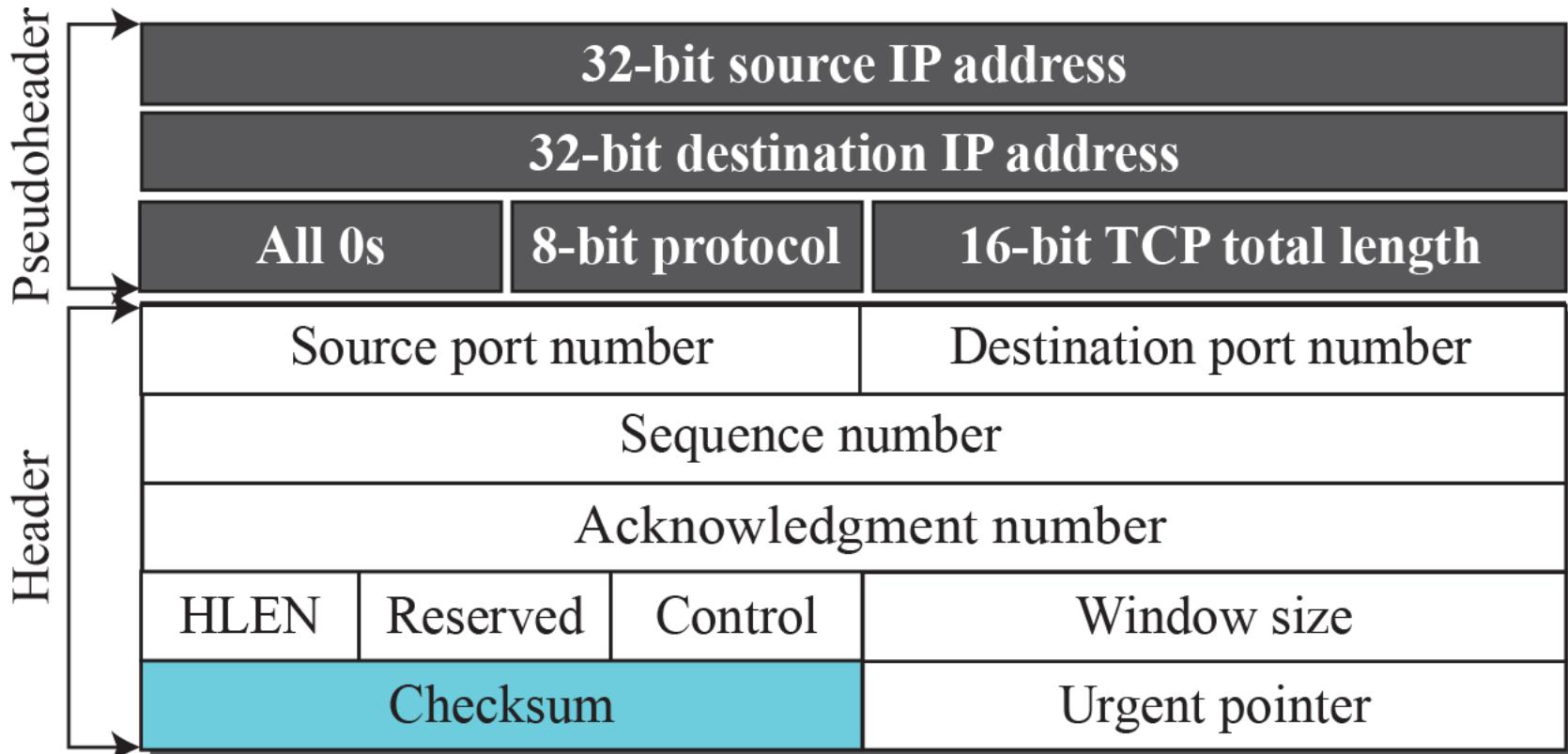


# TCP Segment Format



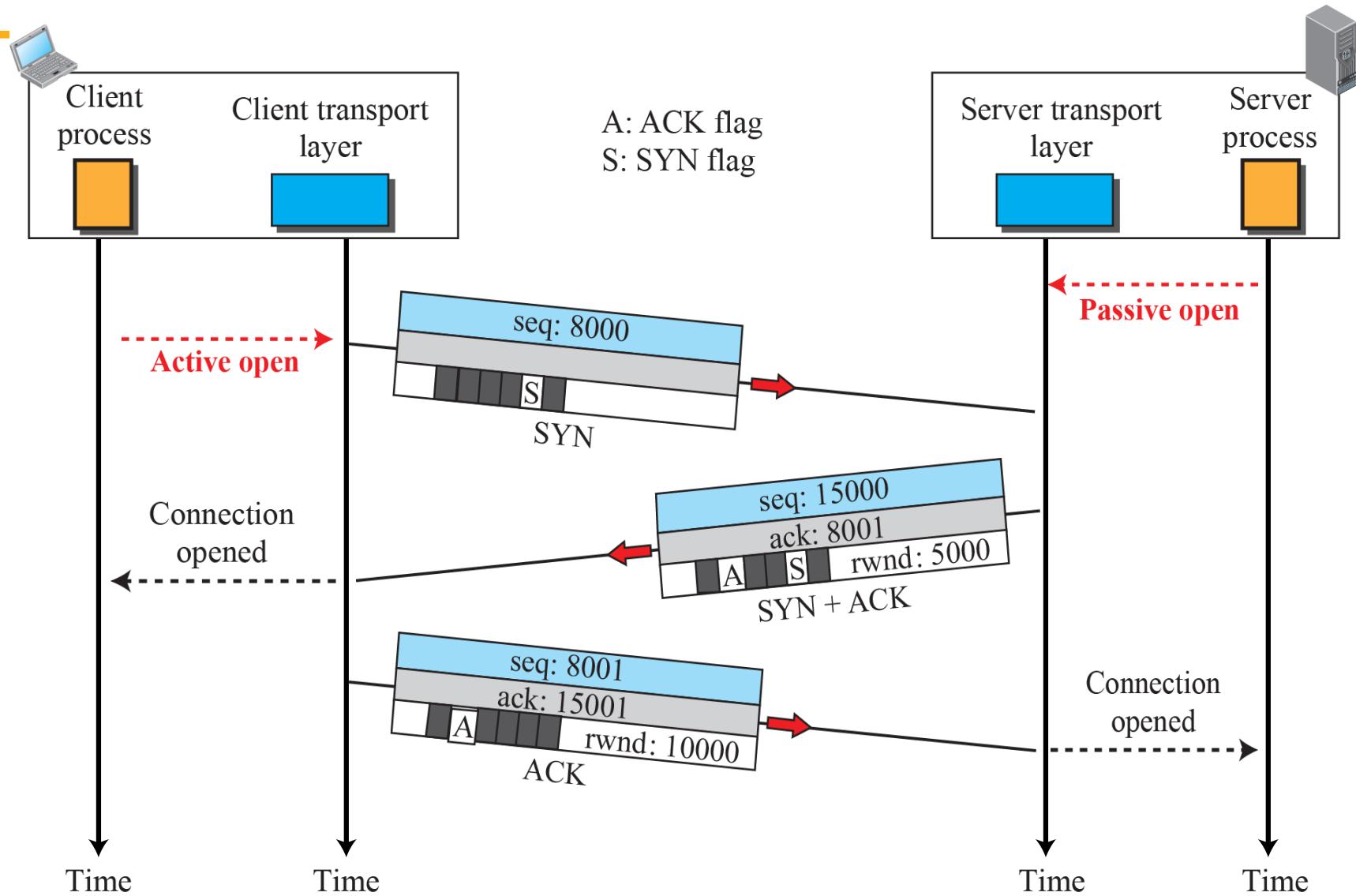
b. Header

# Pseudo header for Checksum

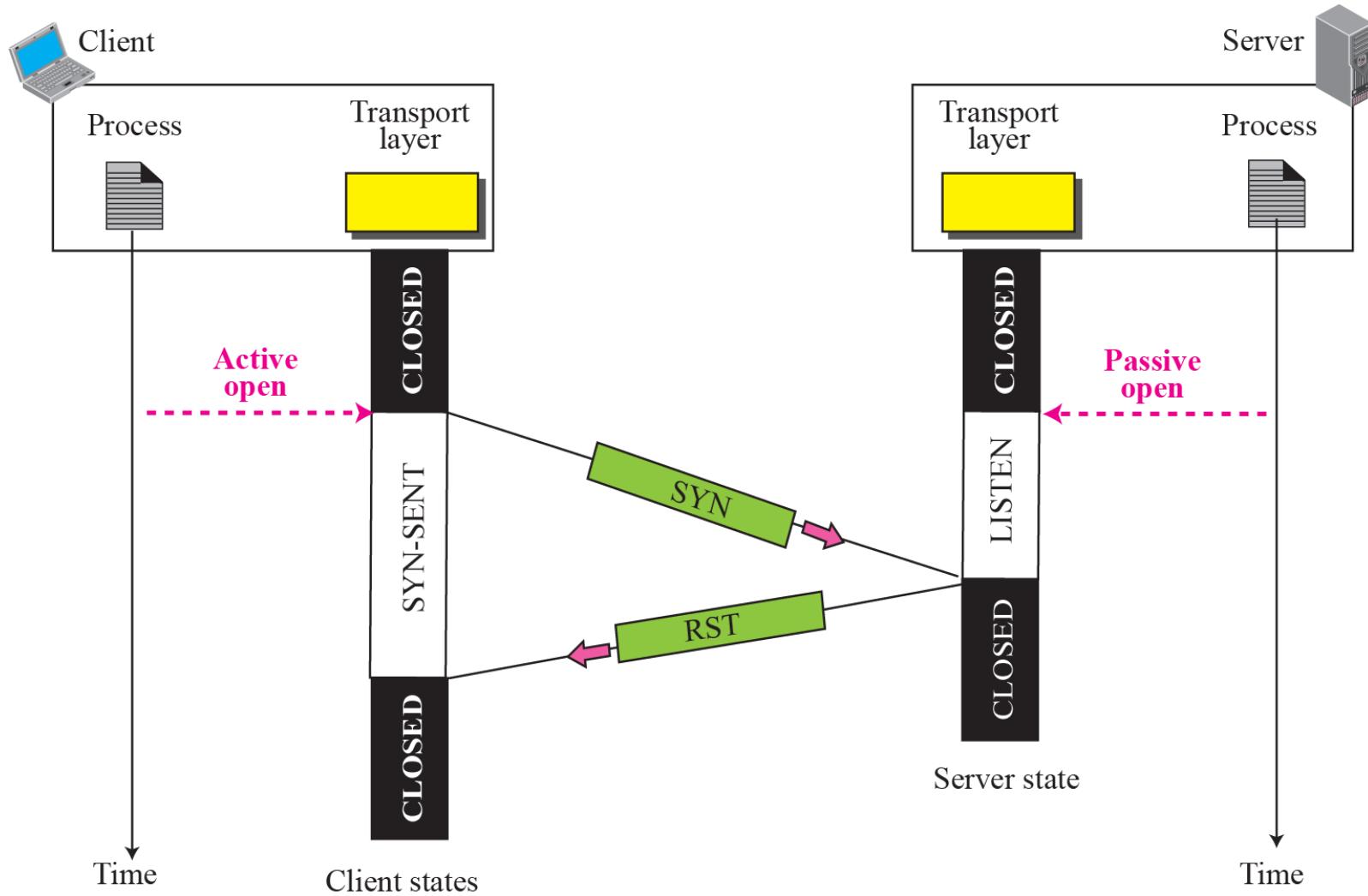


Data and option  
 (Padding must be added to make  
 the data a multiple of 16 bits)

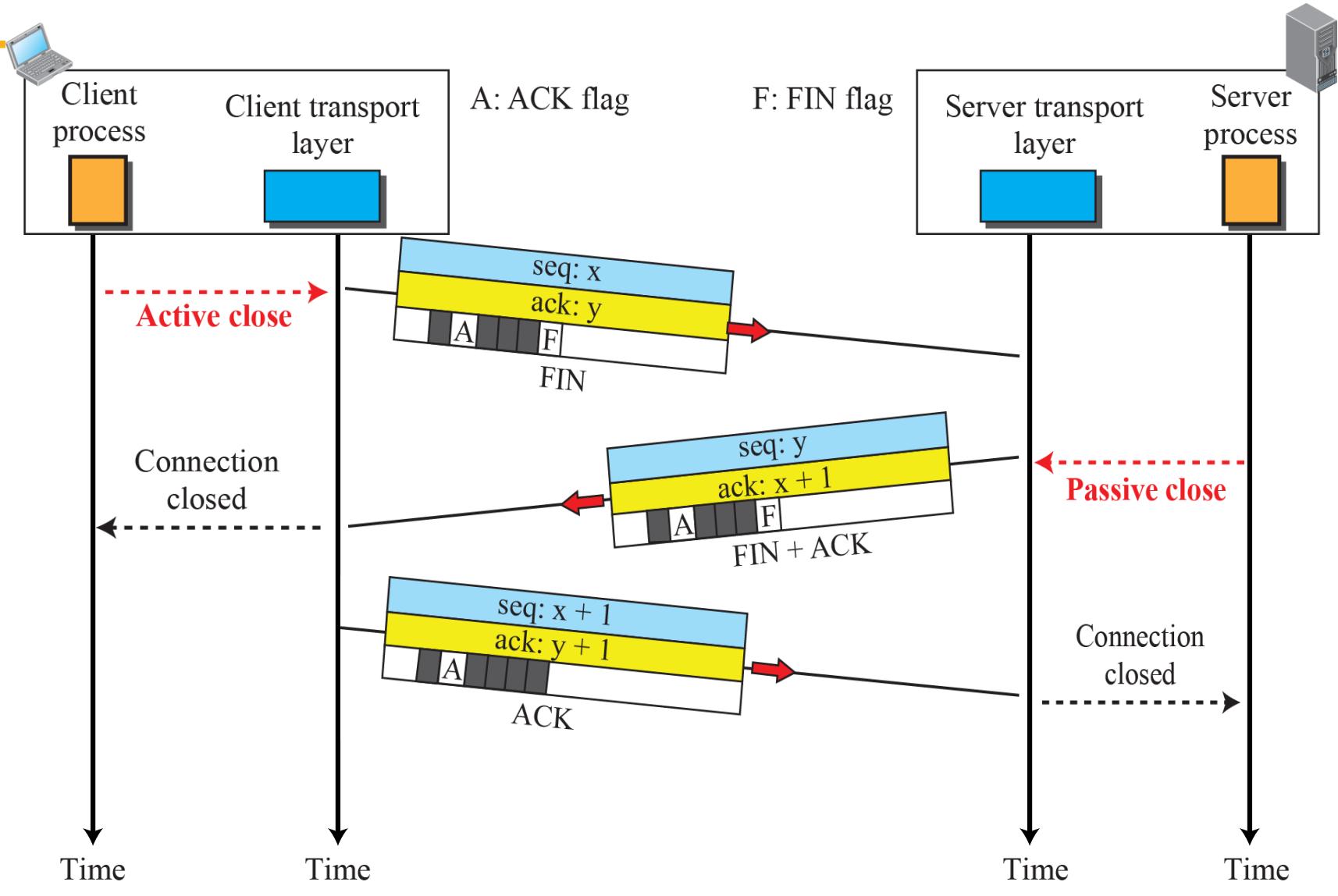
# Connection establishment



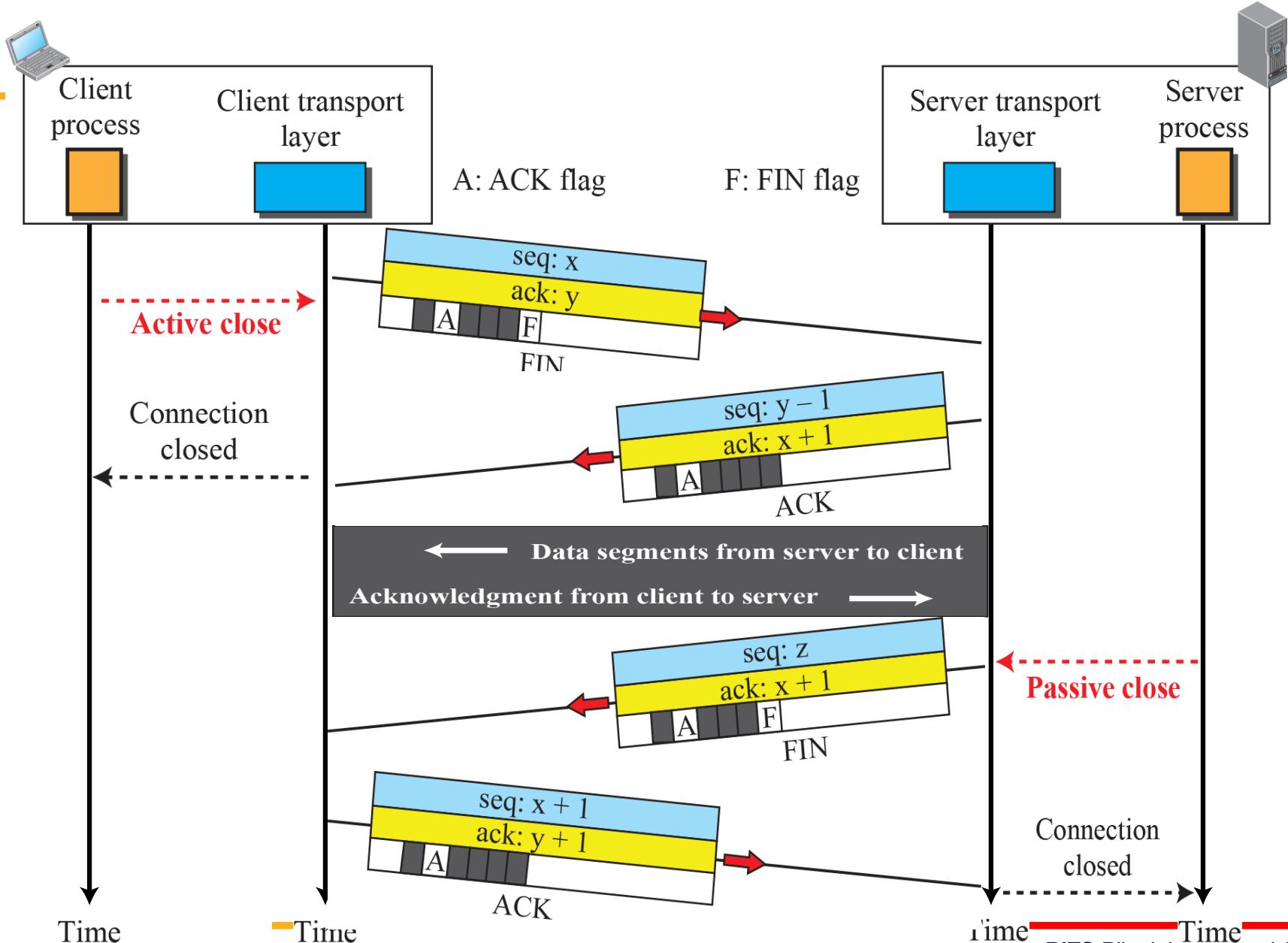
# Denying a connection



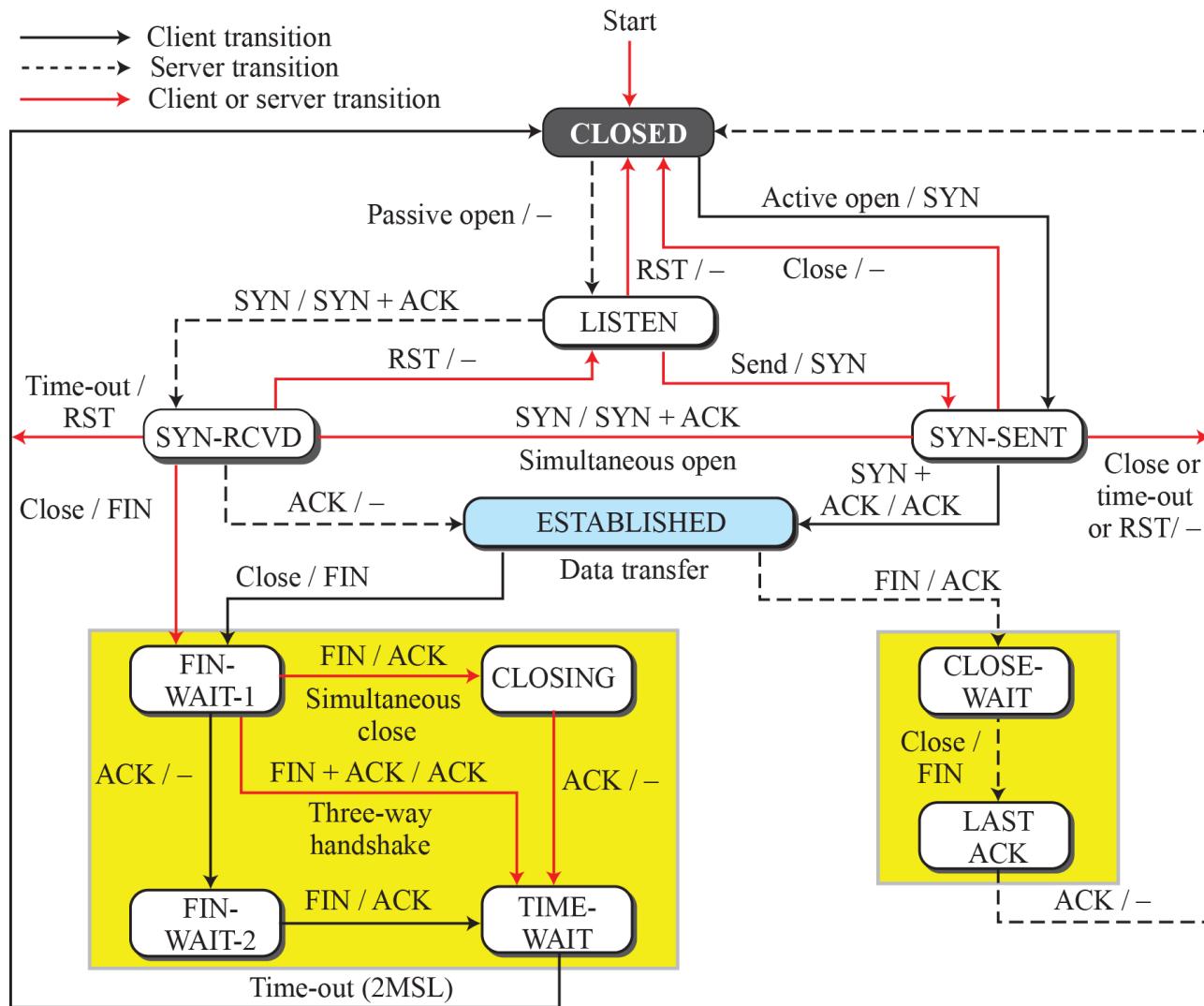
# Connection termination



# Half Close



# TCP State Transitions



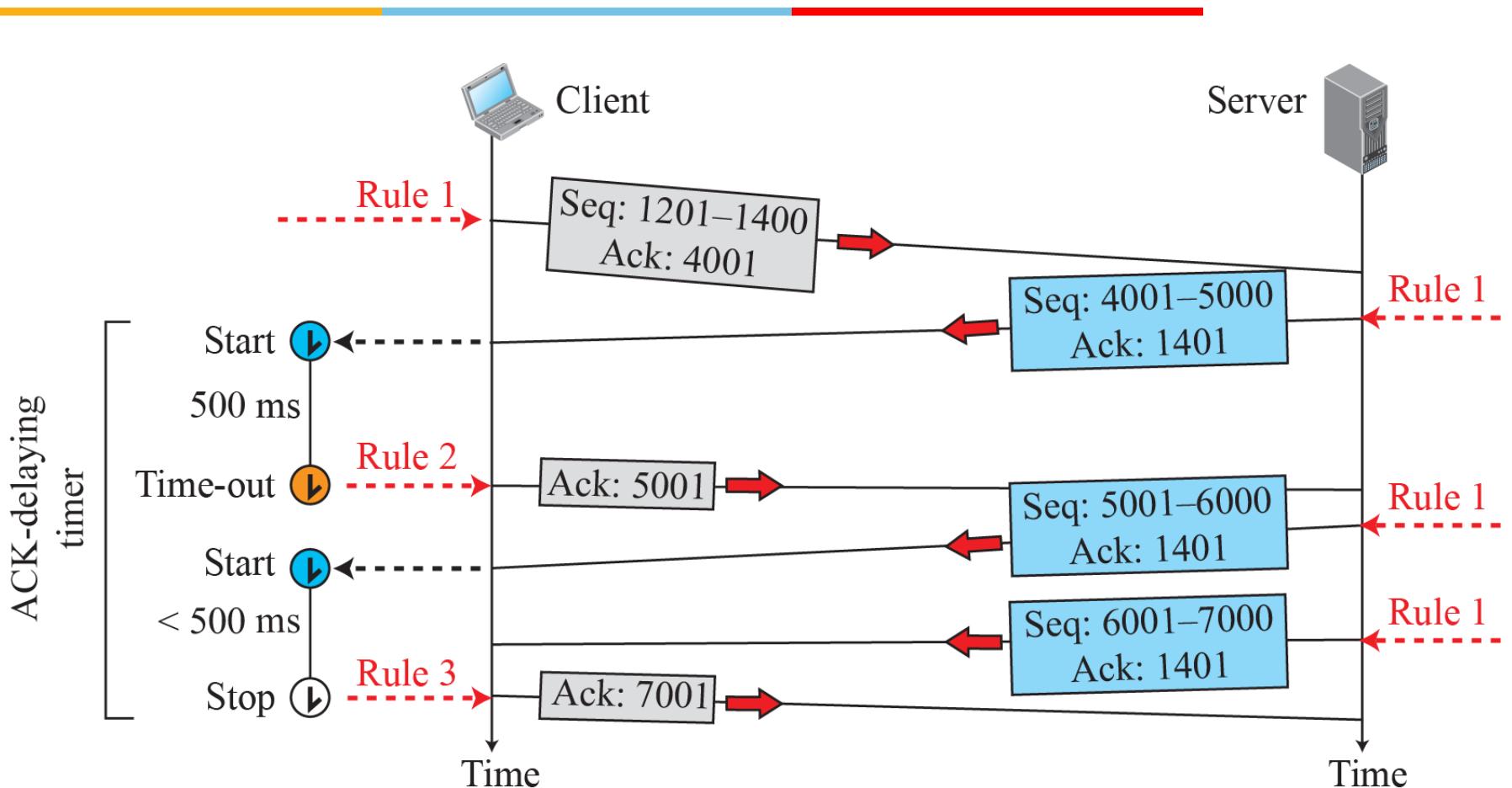
# Triggering Transmissions

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TCP has three mechanism to trigger the transmission of a segment

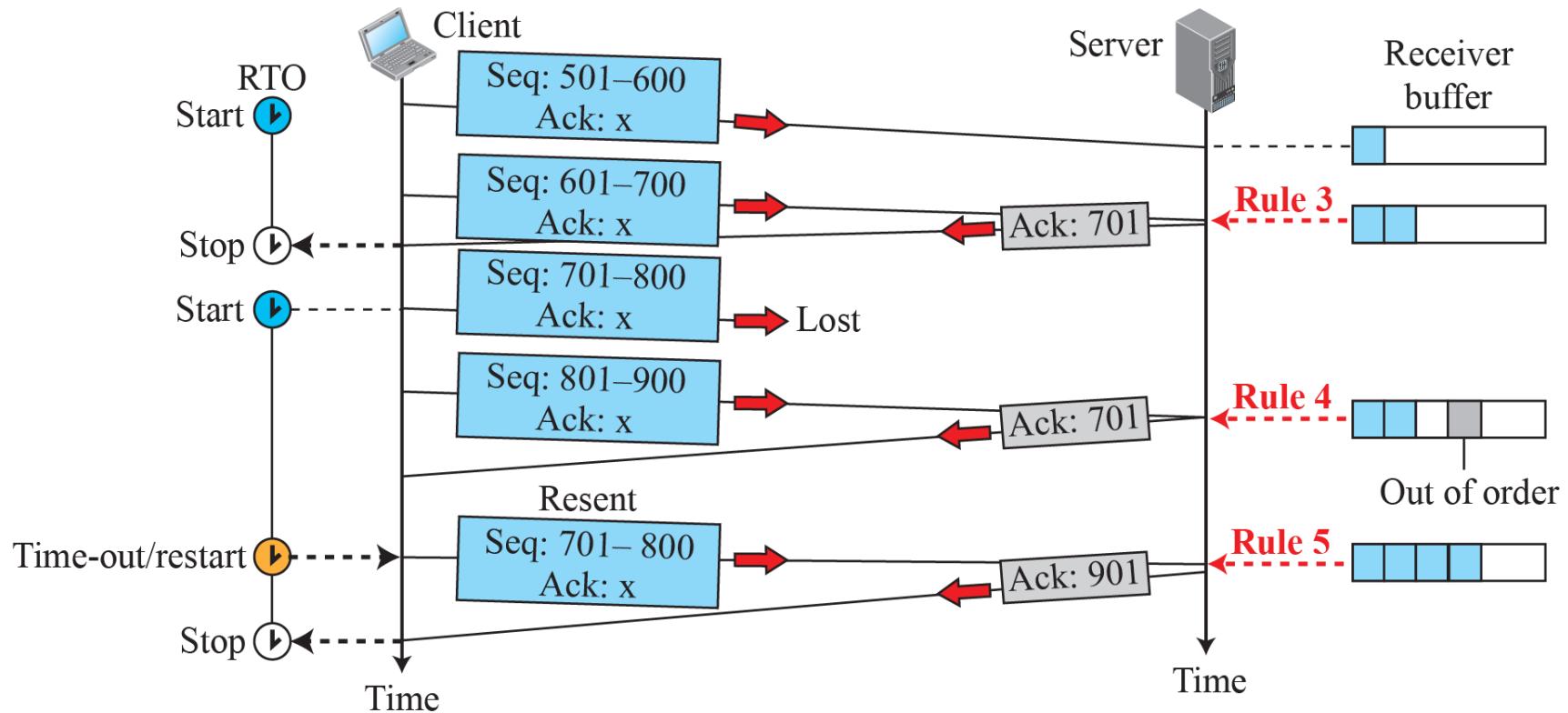
- 1) TCP maintains a variable MSS and sends a segment as soon as it has **collected MSS** bytes from the sending process
  - MSS is usually set to the size of the largest segment TCP can send without causing local IP to fragment.
  - MSS: MTU of directly connected network – (TCP header + IP header)
- 2) Sending process has explicitly asked TCP to send it
  - TCP supports **push** operation
- 3) When a **timer fires**
  - Resulting segment contains as many bytes as are currently buffered for transmission

# TCP: Go-Back-N or Selective Repeat? Recap



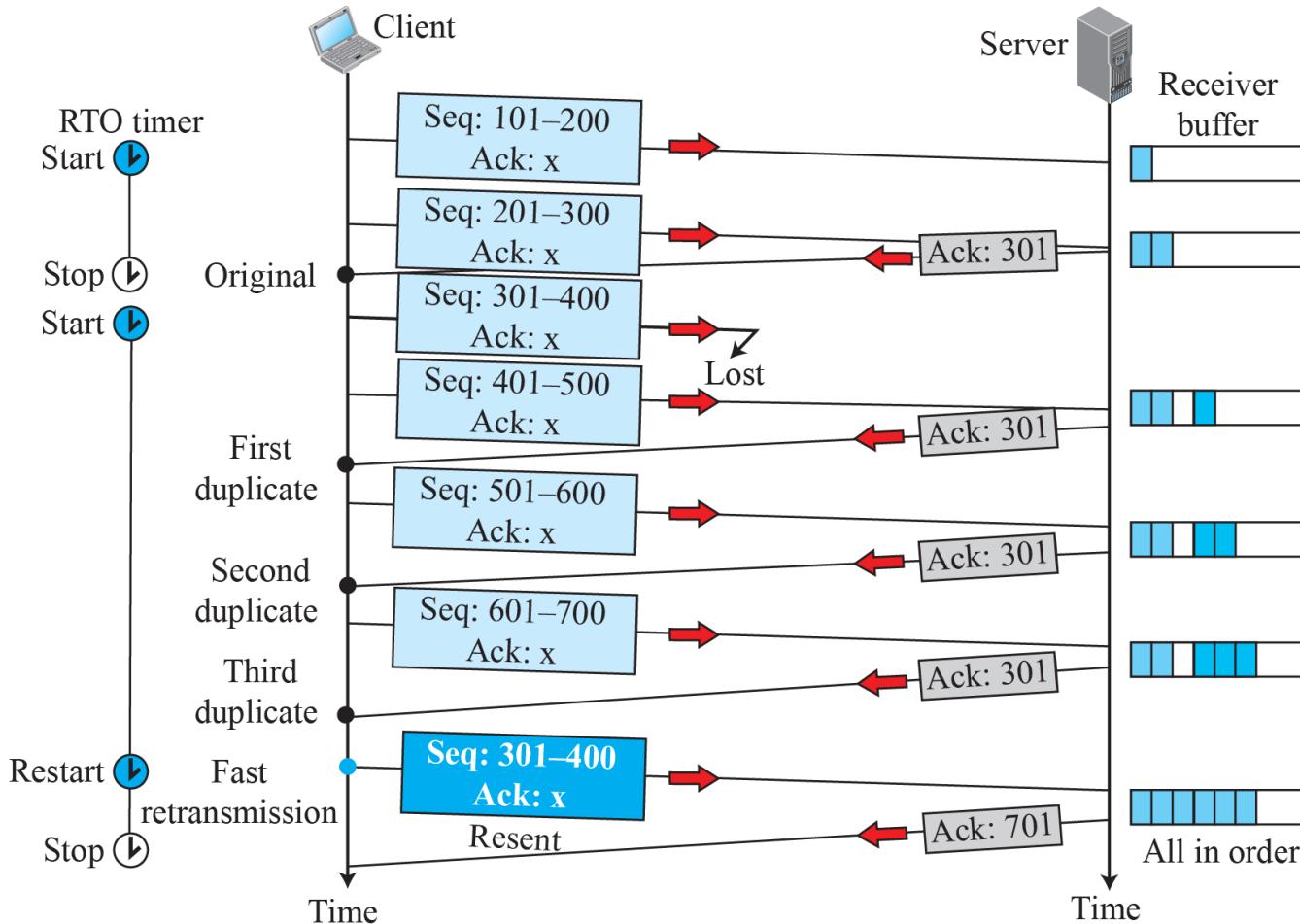
Normal Operation

# Continued...



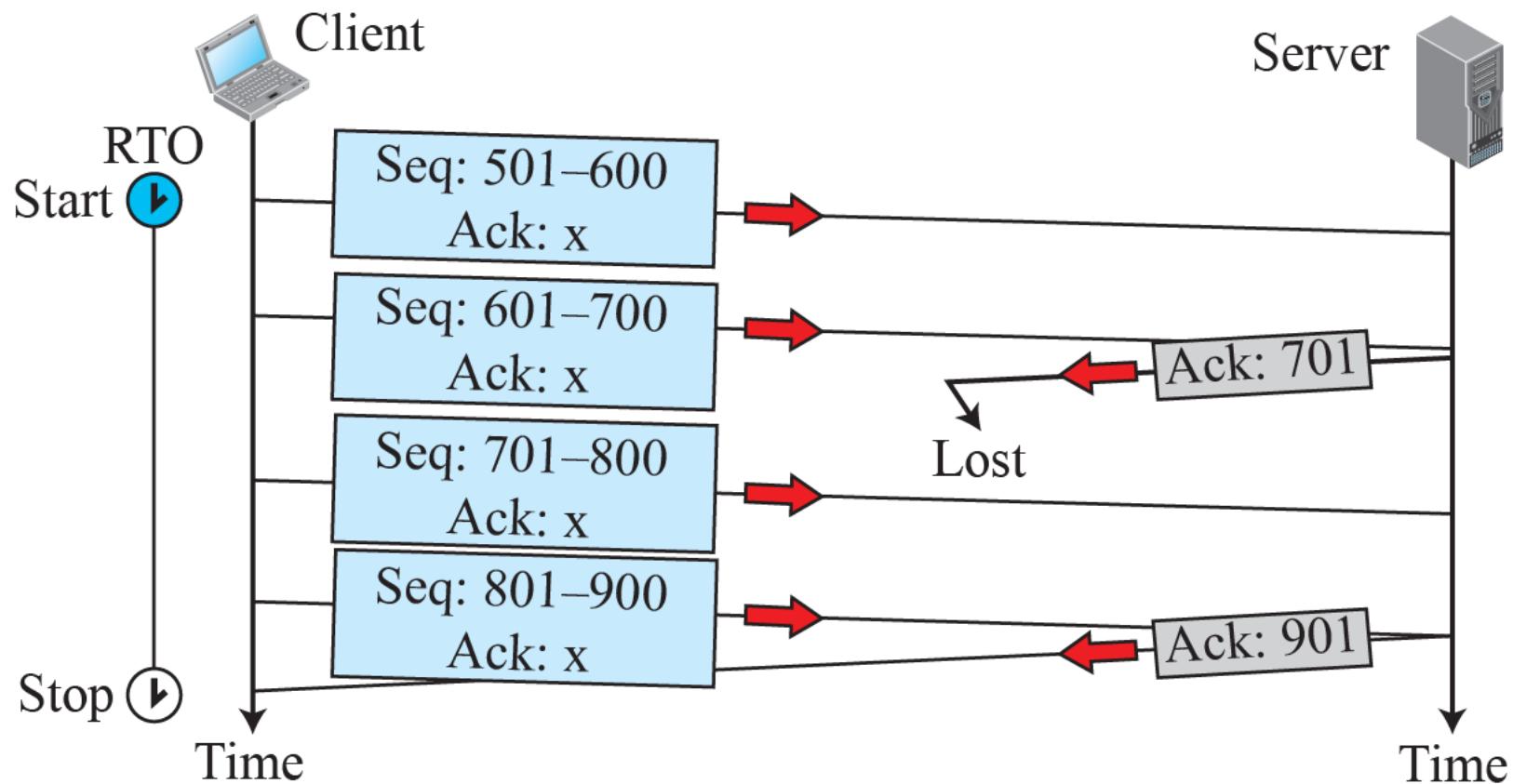
Lost Segment

# Continued...



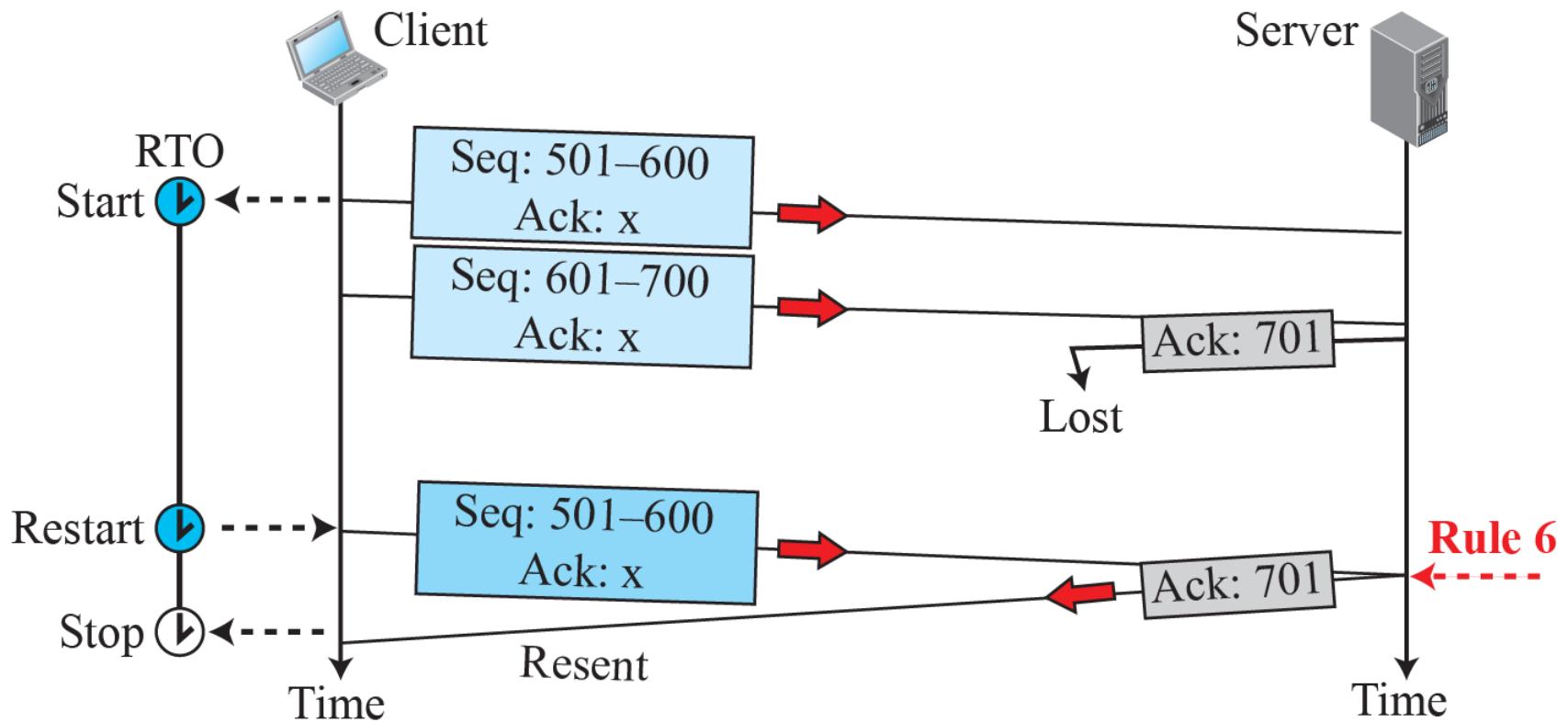
## Fast Retransmit

# Continued...



**Lost Acknowledgement**

# Continued...



Lost Acknowledgement corrected by resending a segment