Computer Networks

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TRANSMISSION CONTROL PROTOCOL OVERVIEW

- Provides a connection-oriented reliable packet delivery by
  - Sending acks
  - Maintaining a retransmission timer
  - Checksum on header and data
  - Segment and resequence data
  - Checks for and discards duplicates
  - Provides flow control

TCP Connections

- Not end-to-end TDM or FDM circuit
- Not a virtual circuit
- Provides for full-duplex data transfer
- Point-to-Point

TCP Connections

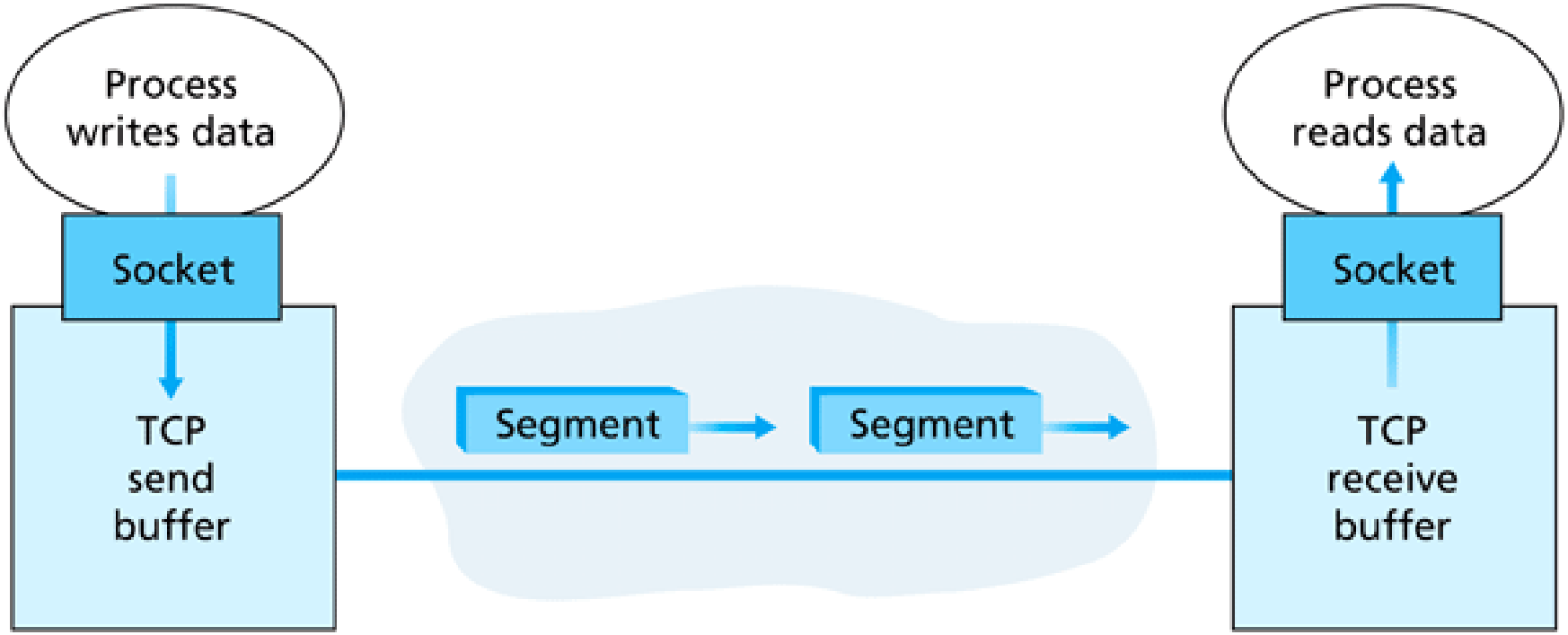

Figure 3.28 ♦ TCP send and receive buffers

TCP Applications

- TCP used by services such as:
  - TELNET
  - FTP
  - SMTP
  - WWW

TCP Segment Structure

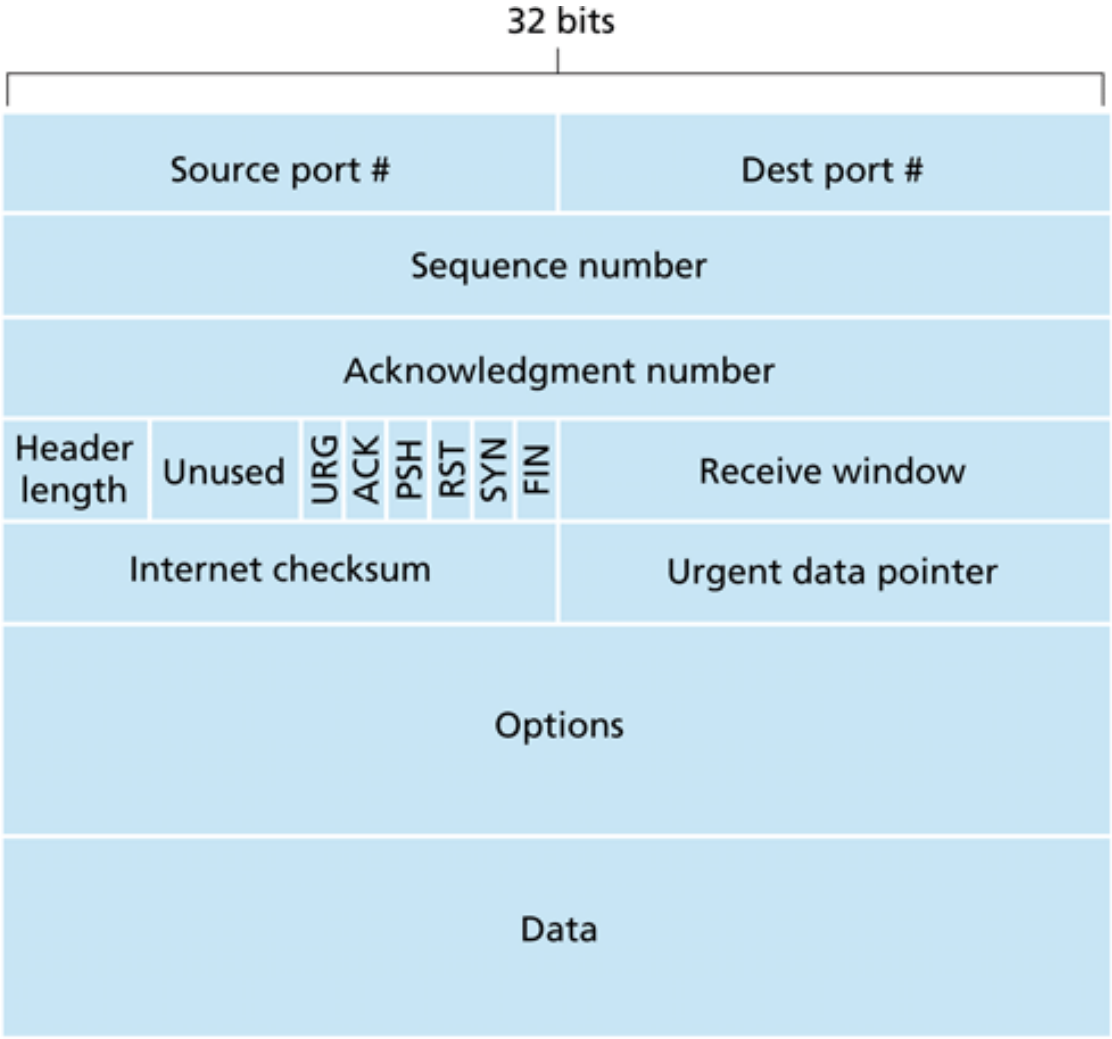

Figure 3.29 ♦ TCP segment structure

(TCP) Segment Structure

TCP FIELD	DESCRIPTION
Source Port Number	Identifies the sending application
Destination Port Number	Identifies the receiving application
Sequence Number	Identifies the byte in the stream of data
Acknowledgement Number	Identifies the next sequence number that the sender expects the to receive.
Length	4-bit Header Length
URG	Urgent Pointer
ACK	Acknowledgment Number is valid
PSH	Receiver should pass this data to the application as soon as possible
RST	Reset the connection
SYN	Synchronize sequence numbers to initiate a connection
FIN	The sender is finished sending data
Window Size	The number of outstanding segments allowed at any one time without being acknowledged
Checksum	Covers the header and data
Urgent Pointer	Positive offset that must be added to the sequence number to yield the number of the last byte of data
Options	usually Maximum Segment Size (MSS)

TCP Port Numbers

Decimal	Keyword	UNIX Keyword	Description
9	DISCARD	discard	Discard all incoming data port
19	CHARGEN	chargen	Character Generator
20	FTP-Data	ftp-data	File transfer data port
21	FTP-CMD	ftp	File transfer command port
23	TELNET	telnet	Telnet remote login port
25	SMTP	smtp	Simple Mail Transport Protocol
79	FINGER	finger	Finger
80	HTTP	http	Hypertext Transport Protocol
88	Kerberos	kerberos	Authentication Protocol
110	POP3	pop3	pc mail retrieval service port
118	NNTP	nntp	network news access port
179	BGP	bgp	border gateway protocol
513	Rlogin	rlogin	Remote login
514	Rexec	Recexec	Remote execute

Sequence Numbers

- Sequence Numbers
  - First byte numbered 0
  - File size 500,000 bytes
  - MSS 1,000 (500 segments)
  - Sequence #1=0, Sequence #2=1000, Sequence #3=2000, etc.
- Maximum Segment Size (MSS)
- Maximum Transfer Unit (MTU)

Acknowledgement Numbers

- Sequence number of next segment expected
  - Received bytes 0 through 535
  - Waiting for byte 536
  - Puts 536 in acknowledgement number field of segment
- Buffer out-of-order segments

- Host A is sending Host B a large file over a TCP connection. Assume Host B has no data to send Host A. Host B will not send acknowledgements to Host A because Host B cannot piggyback the acknowledgements on data.

TCP CONNECTION ESTABLISHMENT

- Requesting end sends a SYN segment
  - port number of server
  - initial sequence number
- Server responds with its own SYN
  - contains server's ISN
  - Acks the client's SYN by ACK the client's ISN + 1
- The client must acknowledge this SYN
  - ACKs the server's ISN + 1

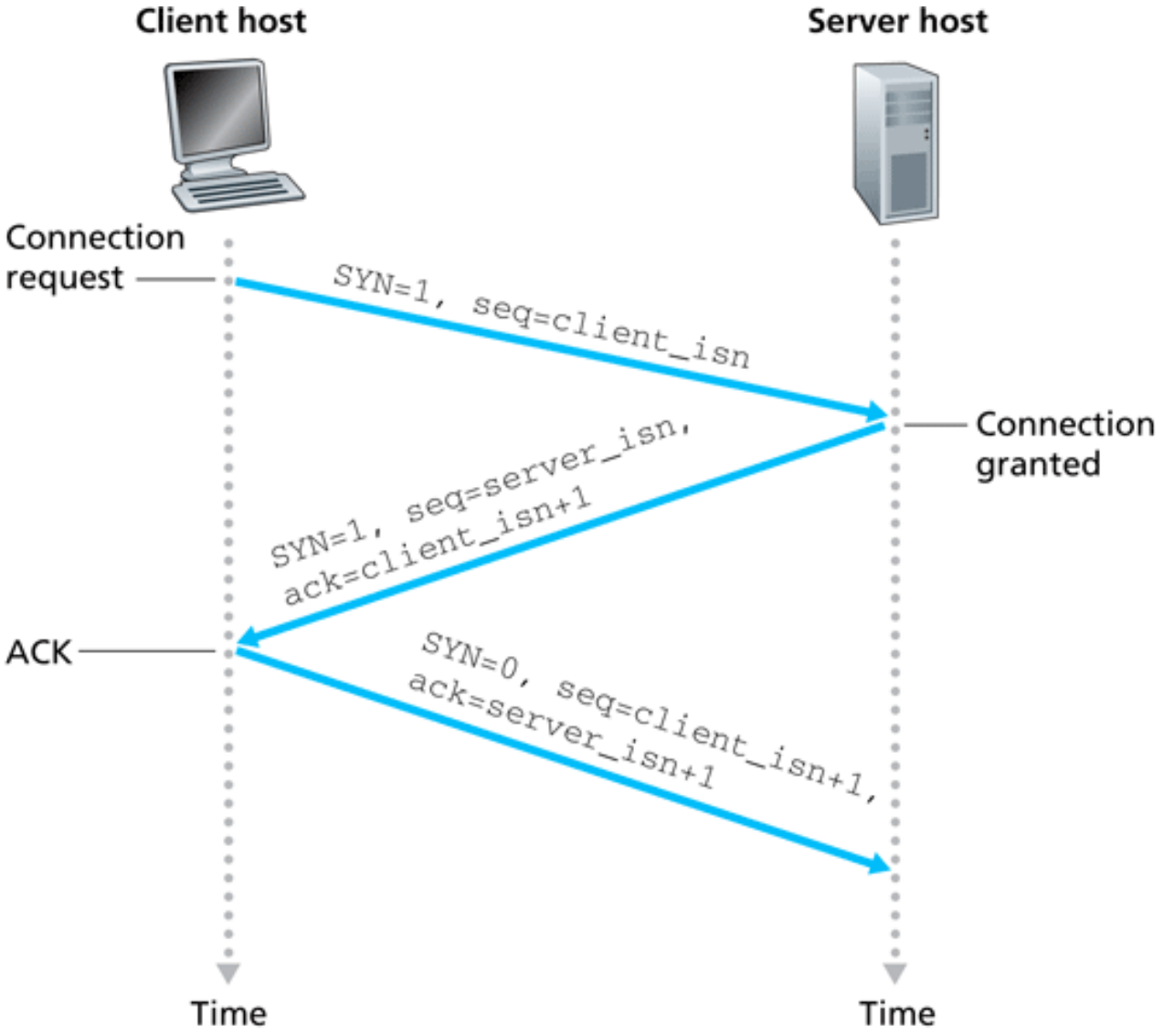

Figure 3.39 ♦ TCP three-way handshake: segment exchange

TCP Connection

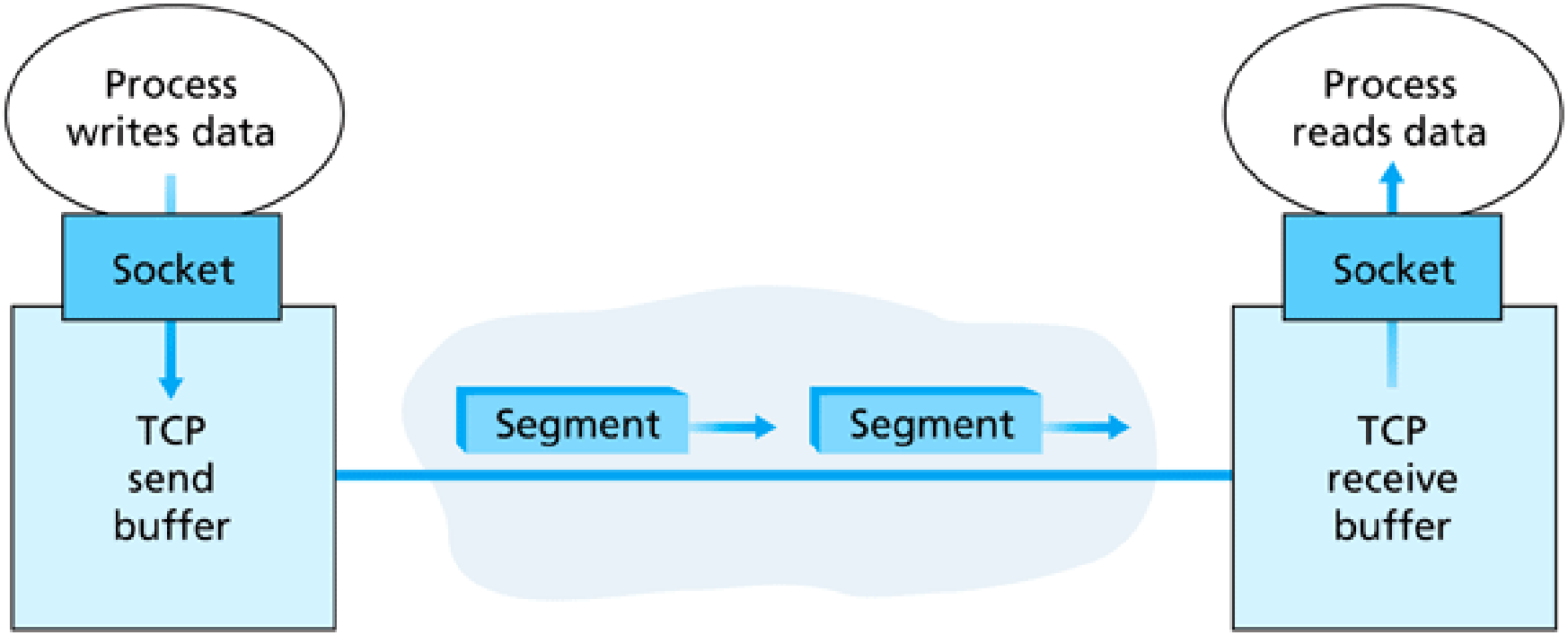

Figure 3.28 ♦ TCP send and receive buffers

Reliable-Data Transfer Service

- Sender is passed data from application-layer. Converts frames into segments. Passes segments to the Network-layer.
- When segment is sent to Network layer, a timer starts for that segment. If timer expires, timeout event occurs.
- Arrival of an acknowledgment segment from the receiver.

- Suppose Host A sends two TCP segments back to back to Host B over a TCP connection. The first segment has sequence number 90; the second has sequence number 110. How much data is in the first segment?
  1. 10 bytes
  2. 16 bytes
  3. 20 bytes
  4. 30 bytes

- Suppose Host A sends two TCP segments back to back to Host B over a TCP connection. The first segment has sequence number 90; the second has sequence number 110. Suppose that the first segment is lost but the second segment arrives at B. In the ACK sent from B to A, what will be the acknowledgement number?
  1. 90
  2. 110
  3. 130

TCP Flow Control

- Receive Buffers
- Buffer Overflow
- Receive Window

TCP Congestion Control

- End-end congestion control
- Controls the amount of traffic on the network