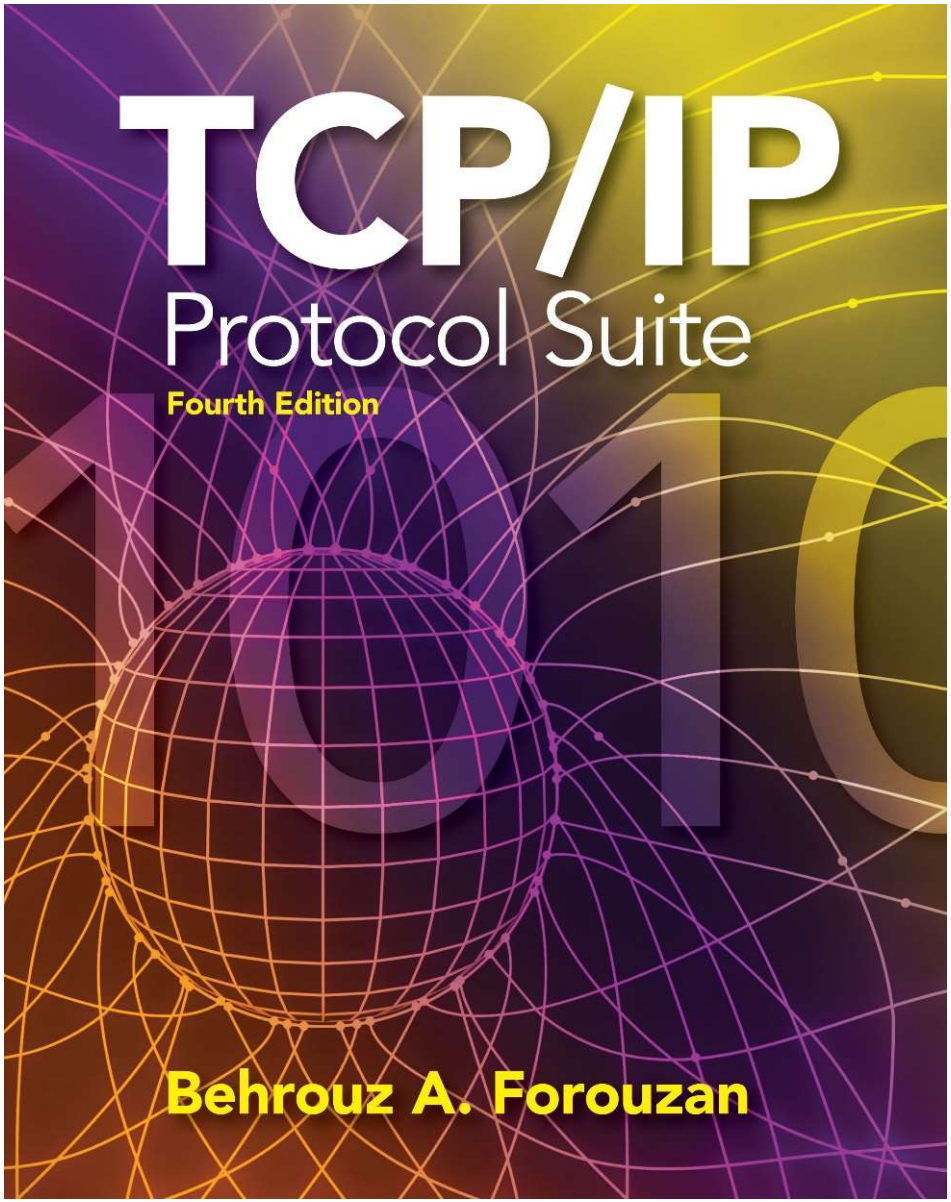
Chapter 15

Transmission Control Protocol (TCP)



Chapter Outline

Figure 15.1 *TCP/IP protocol suite*

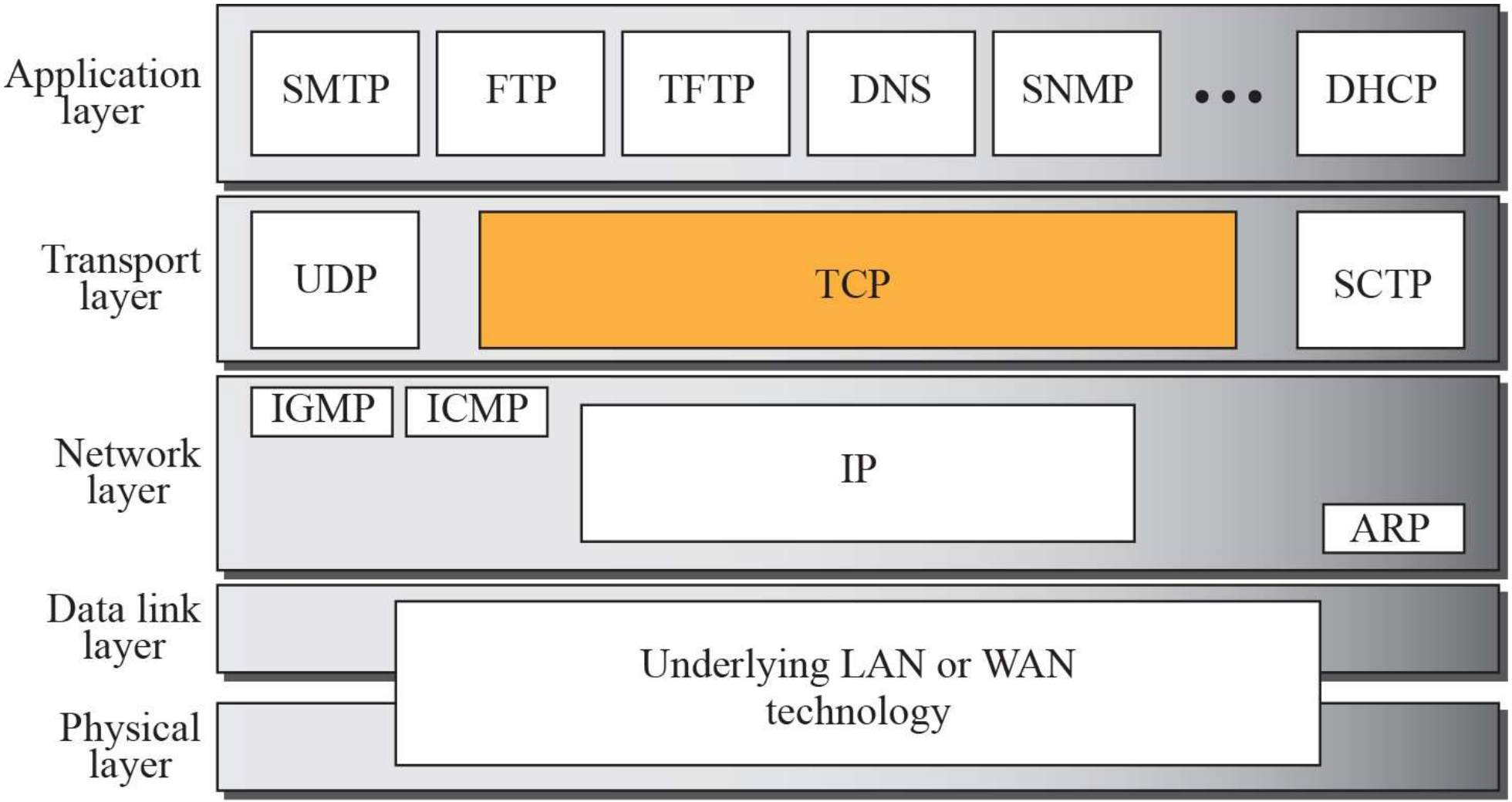


Table 15.1 *Well-known Ports used by TCP*

Port	*Protocol*	*Description*
7	Echo	Echoes a received datagram back to the sender
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 and 21	FTP	File Transfer Protocol (Data and Control)
23	TELNET	Terminal Network
25	SMTP	Simple Mail Transfer Protocol
53	DNS	Domain Name Server
67	BOOTP	Bootstrap Protocol
79	Finger	Finger
80	HTTP	Hypertext Transfer Protocol

Figure 15.2 *Stream delivery*

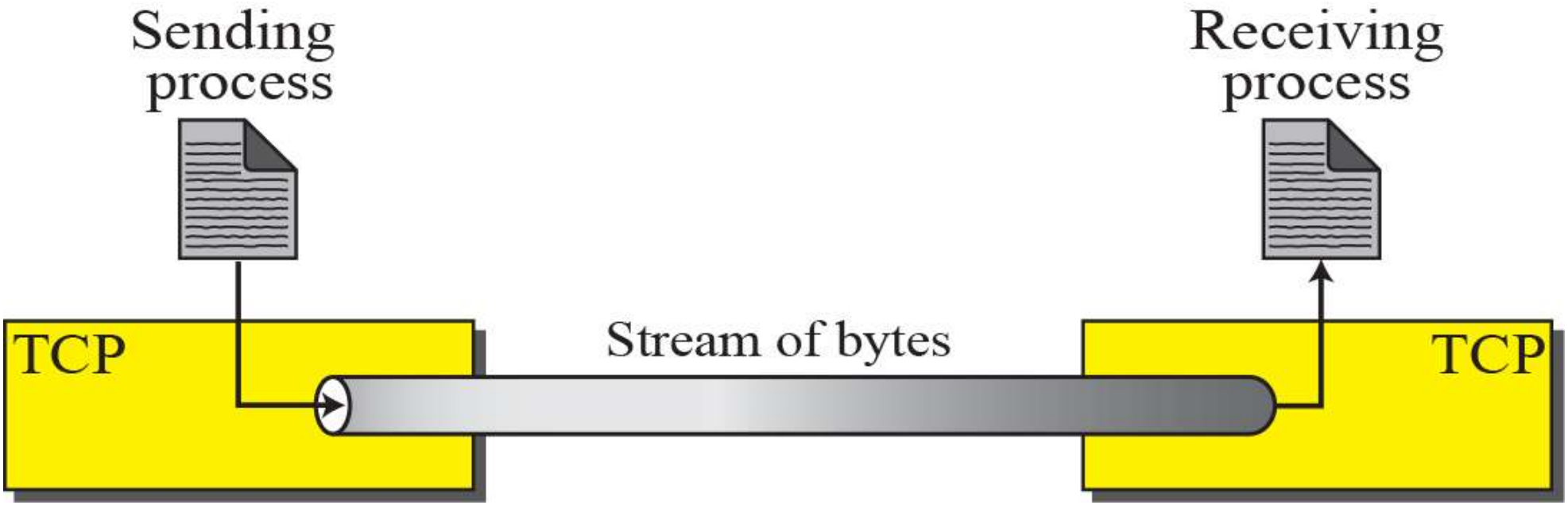


Figure 15.3 *Sending and receiving buffers*

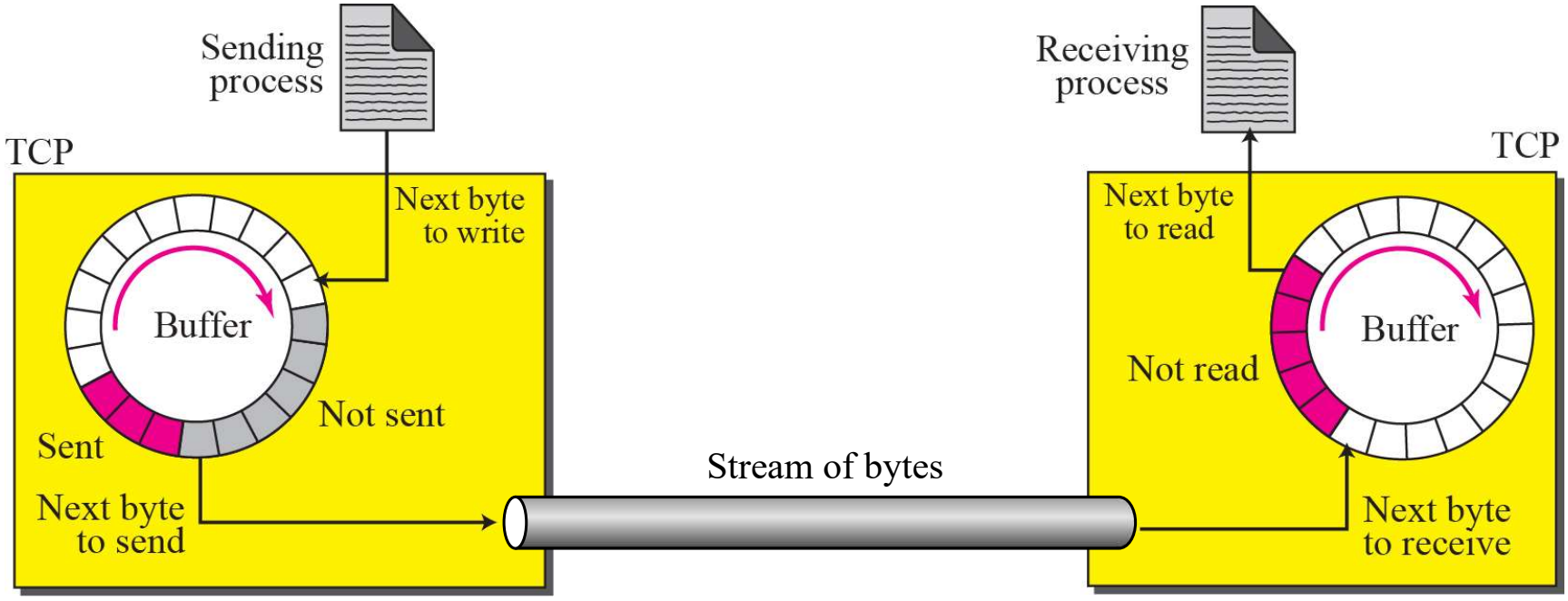
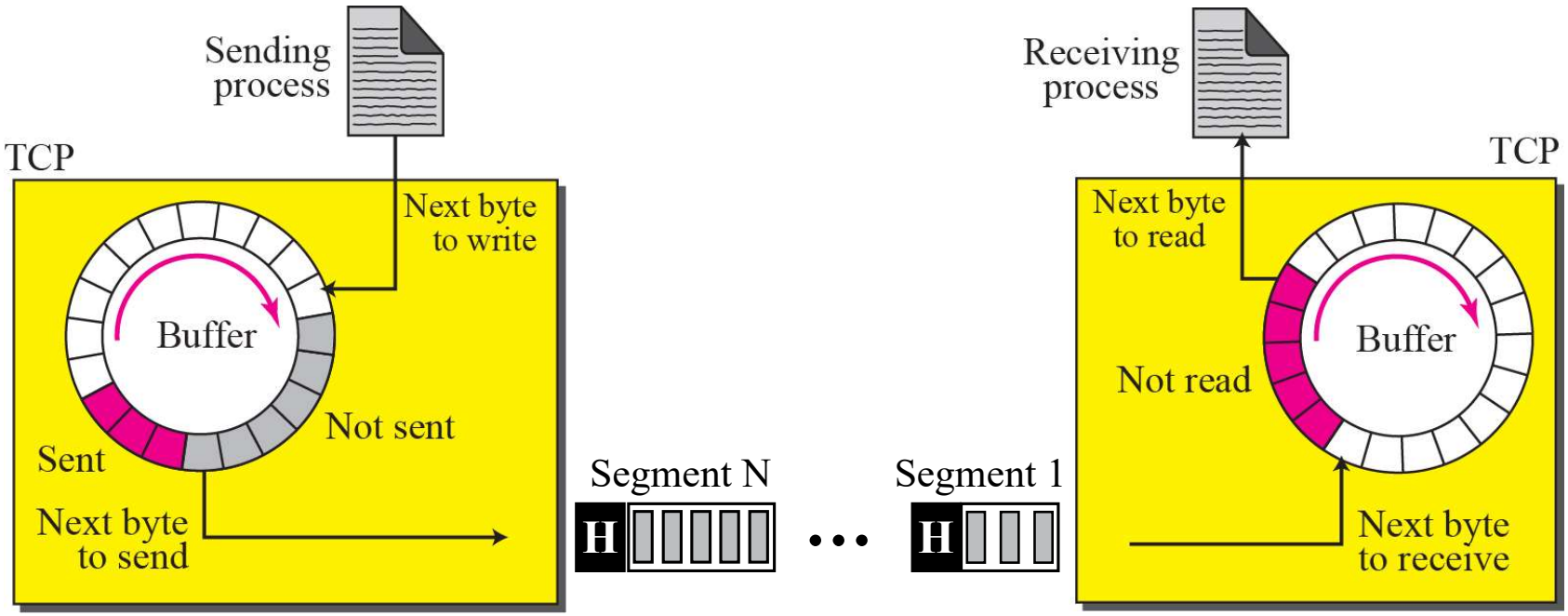


Figure 15.4 *TCP segments*



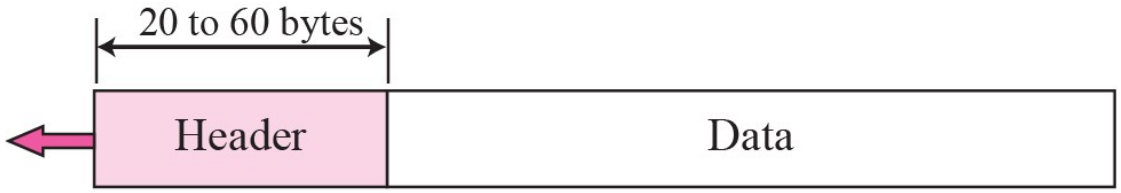
15-3 SEGMENT

Before discussing TCP in more detail, let us discuss the TCP packets themselves. A packet in TCP is called a segment.

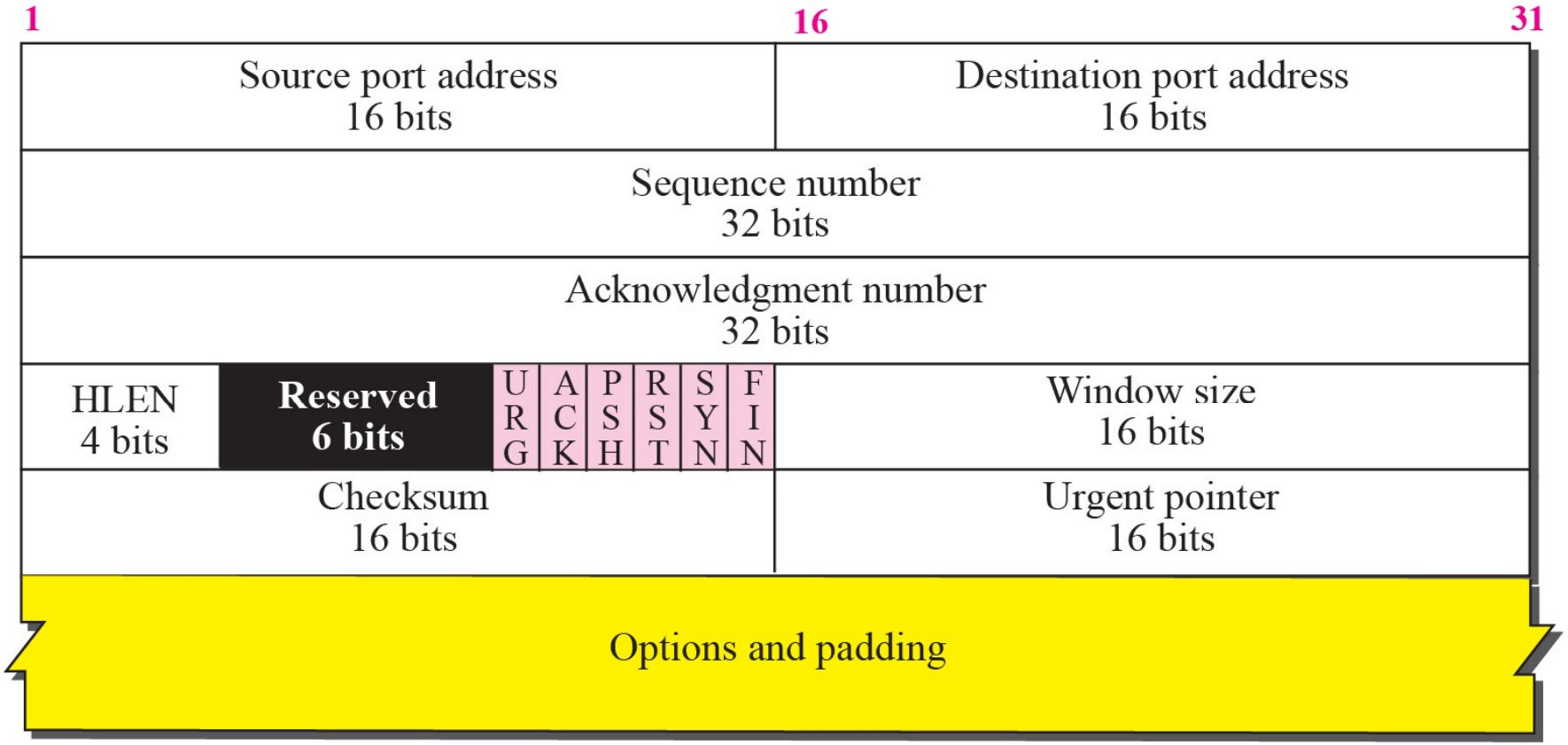
Topics Discussed in the Section

- ✓ **Format**
- ✓ **Encapsulation**

Figure 15.5 *TCP segment format*



a. Segment



b. Header

Figure 15.6 *Control field*

URG: Urgent pointer is valid
ACK: Acknowledgment is valid
PSH: Request for push
RST: Reset the connection
SYN: Synchronize sequence numbers
FIN: Terminate the connection

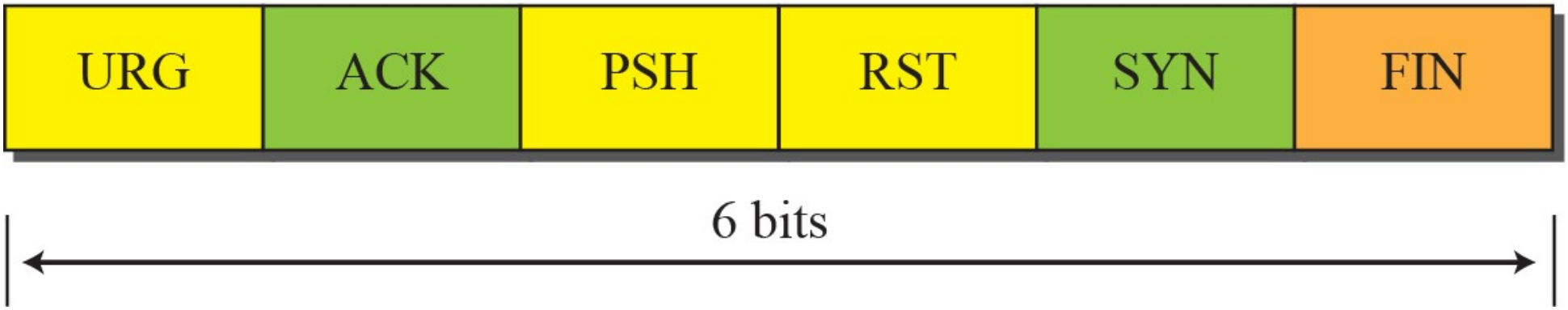
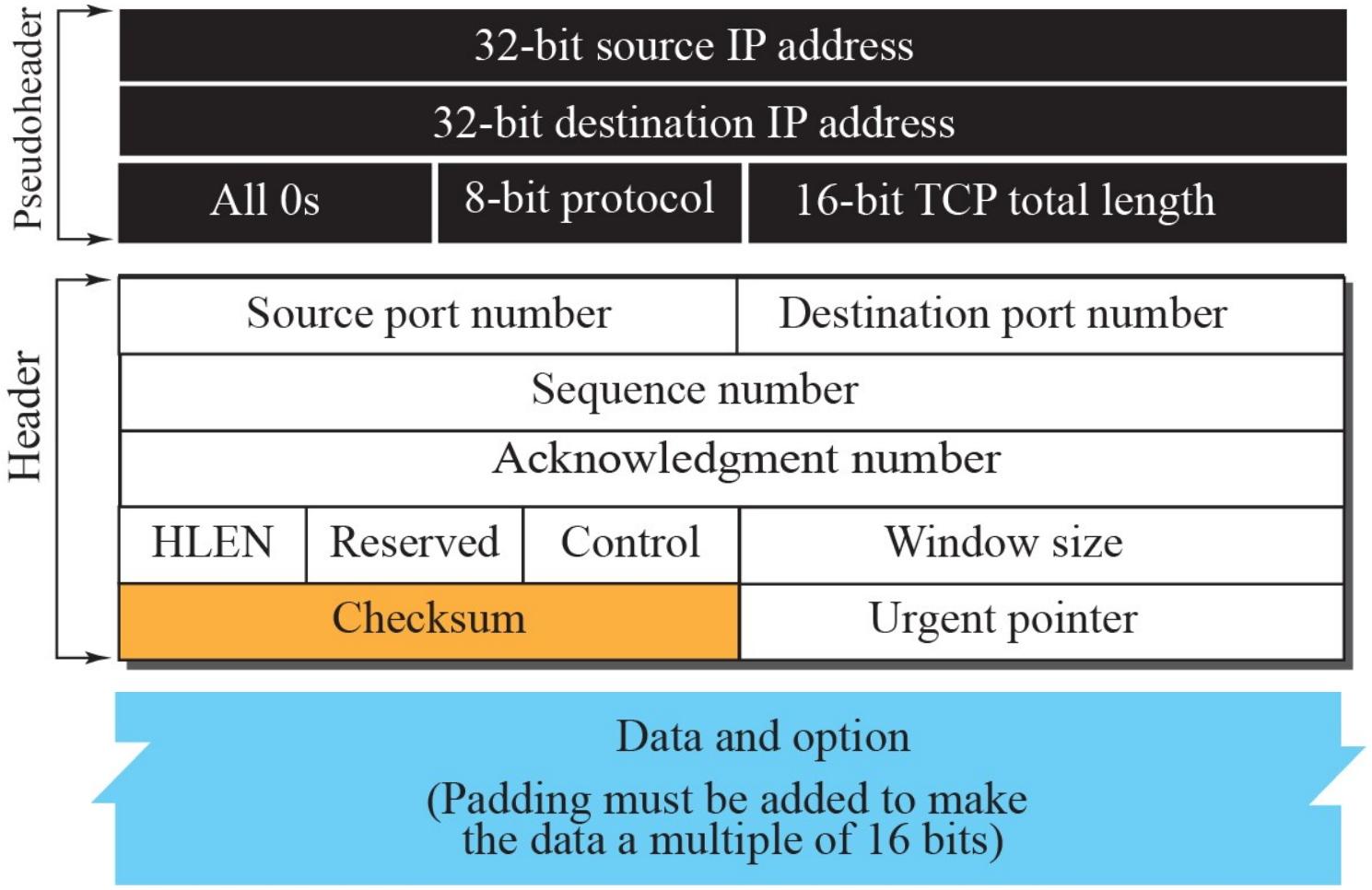
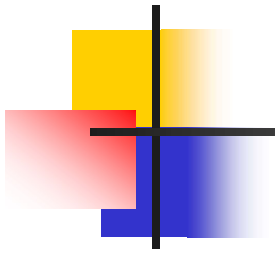


Figure 15.7 *Pseudoheader added to the TCP segment*





Note

The use of the checksum in TCP is mandatory.

Note

The bytes of data being transferred in each connection are numbered by TCP.

The numbering starts with an arbitrarily generated number.

Example 15.1

Suppose a TCP connection is transferring a file of 5,000 bytes. The first byte is numbered 10,001. What are the sequence numbers for each segment if data are sent in five segments, each carrying 1,000 bytes?

Solution

The following shows the sequence number for each segment:

Segment 1	→	Sequence Number:	10,001	Range:	10,001	to	11,000
Segment 2	→	Sequence Number:	11,001	Range:	11,001	to	12,000
Segment 3	→	Sequence Number:	12,001	Range:	12,001	to	13,000
Segment 4	→	Sequence Number:	13,001	Range:	13,001	to	14,000
Segment 5	→	Sequence Number:	14,001	Range:	14,001	to	15,000

Note

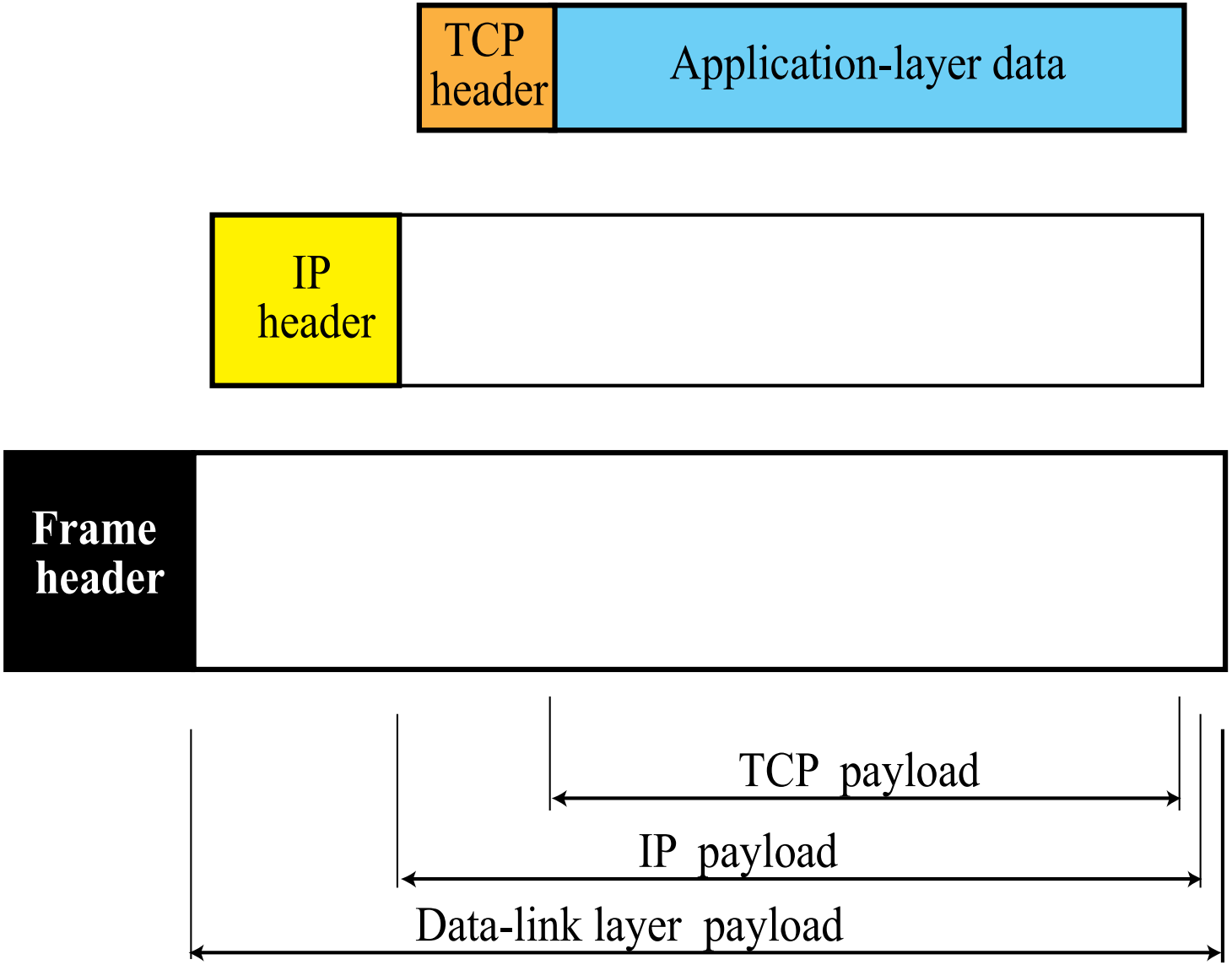
The value in the sequence number field of a segment defines the number assigned to the first data byte contained in that segment.

Note

The value of the acknowledgment field in a segment defines the number of the next byte a party expects to receive.

The acknowledgment number is cumulative.

Figure 15.8 *Encapsulation*



15-4 A TCP CONNECTION

TCP is connection-oriented. It establishes a virtual path between the source and destination.

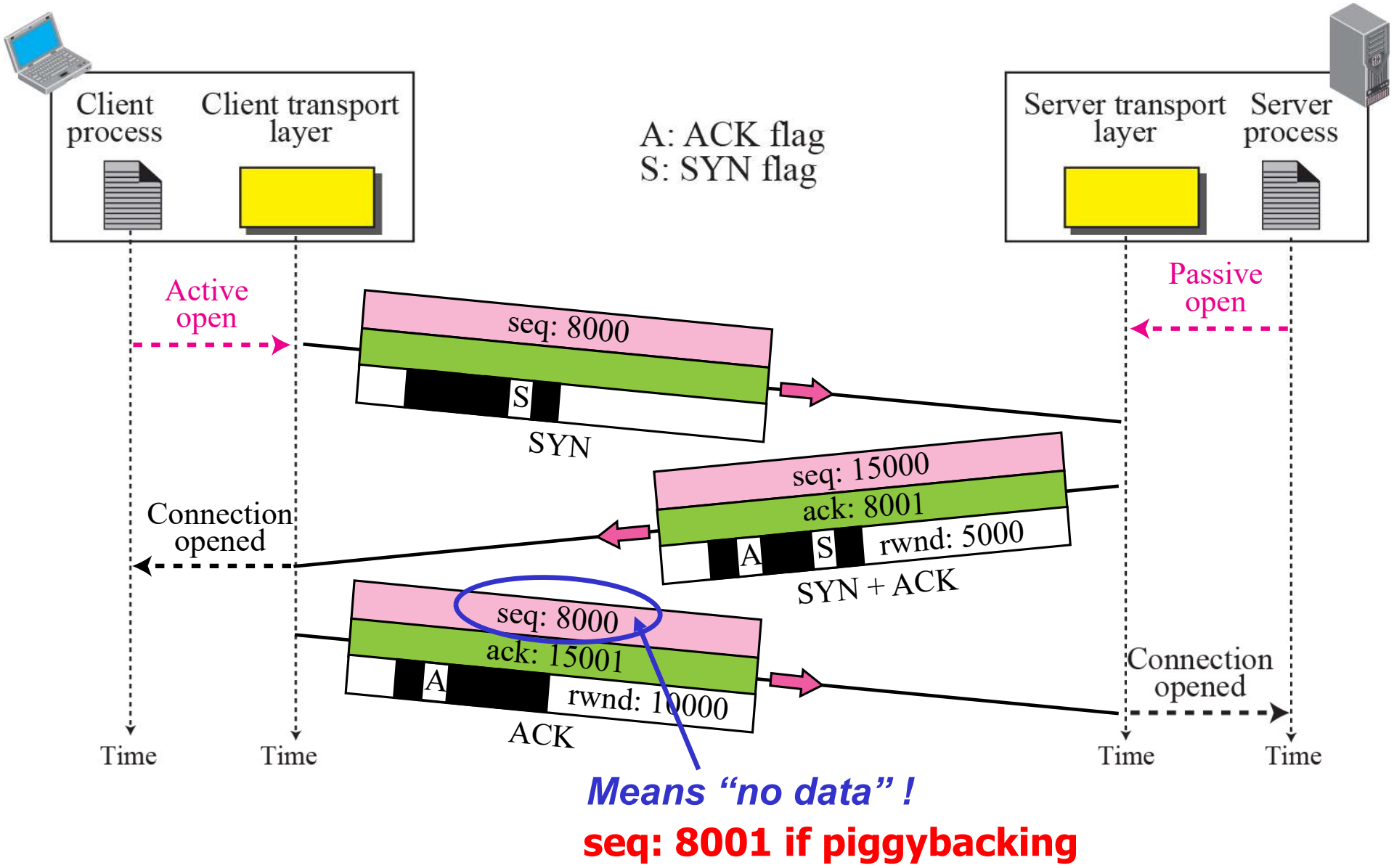
All of the segments belonging to a message are then sent over this virtual path. You may wonder how TCP, which uses the services of IP, a connectionless protocol, can be connection-oriented. The point is that a TCP connection is virtual, not physical.

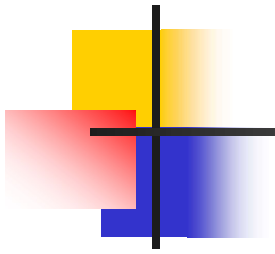
TCP operates at a higher level. TCP uses the services of IP to deliver individual segments to the receiver, but it controls the connection itself. If a segment is lost or corrupted, it is retransmitted.

Topics Discussed in the Section

- ✓ **Connection Establishment**
- ✓ **Data Transfer**
- ✓ **Connection Termination**
- ✓ **Connection Reset**

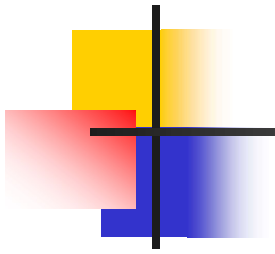
Figure 15.9 *Connection establishment using three-way handshake*





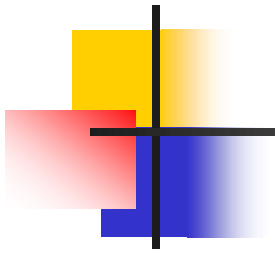
Note

A SYN segment cannot carry data, but it consumes one sequence number.



Note

A SYN + ACK segment cannot carry data, but does consume one sequence number.



Note

An ACK segment, if carrying no data, consumes no sequence number.

Figure 15.10 *Data Transfer*

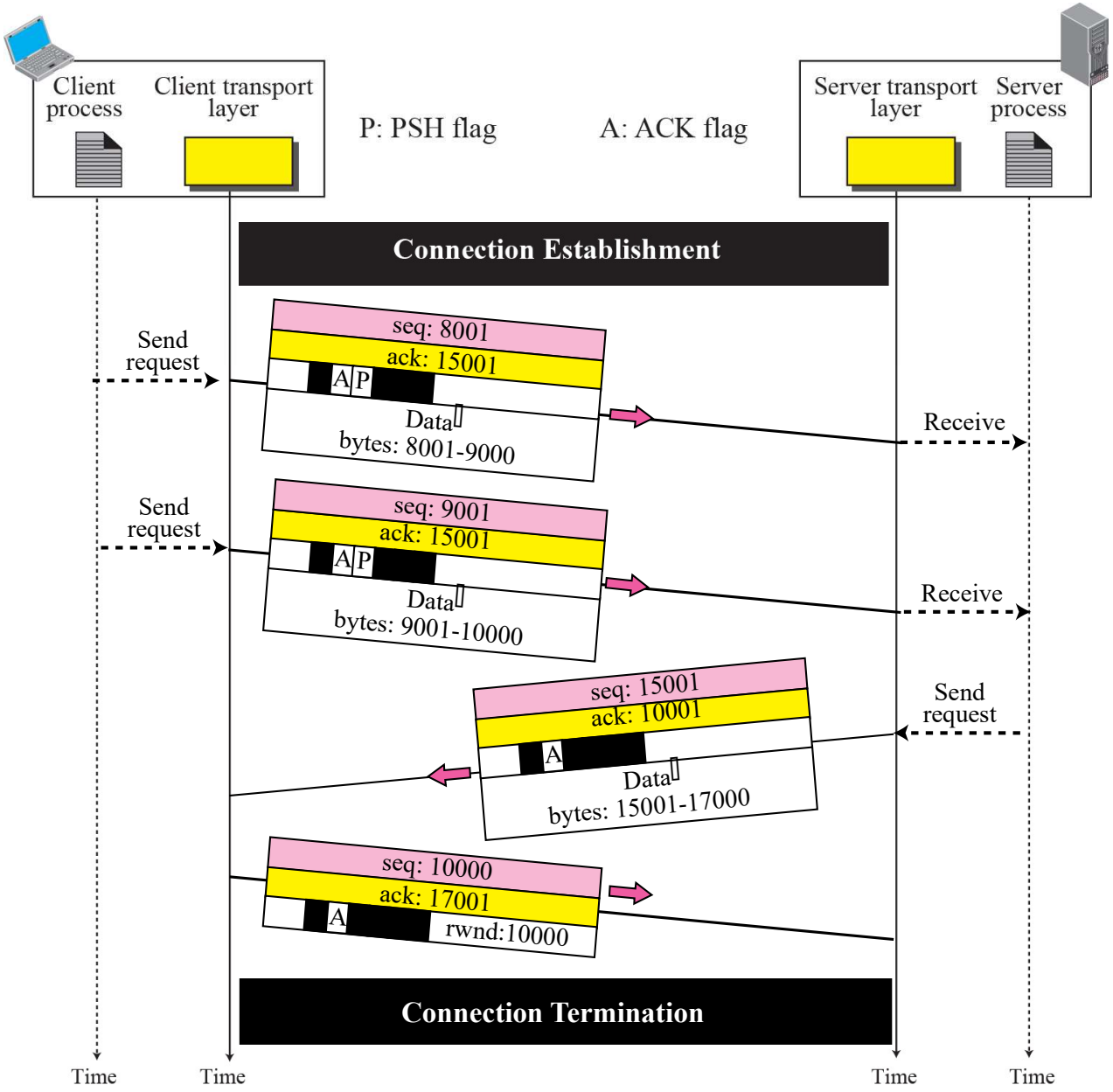
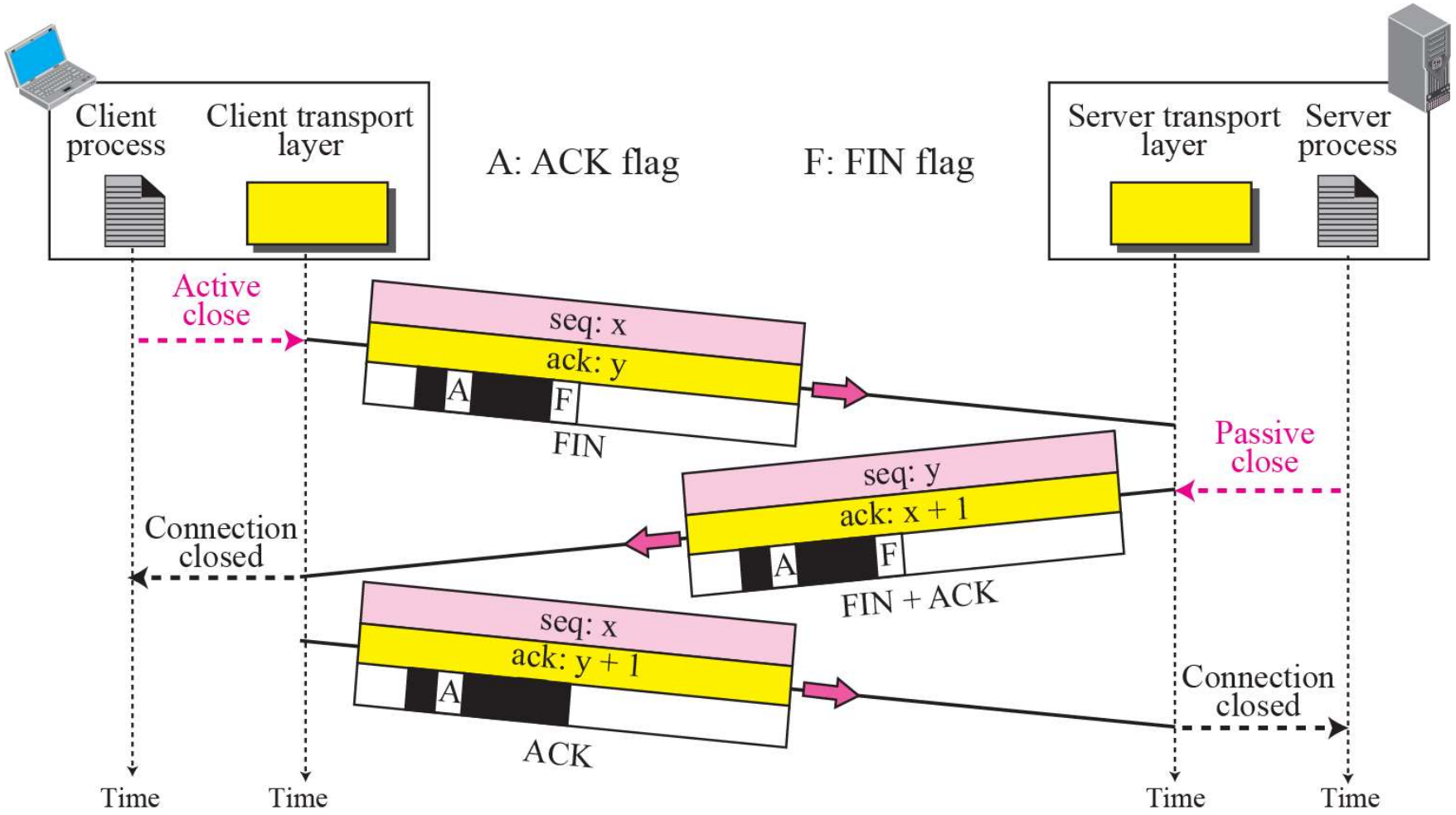
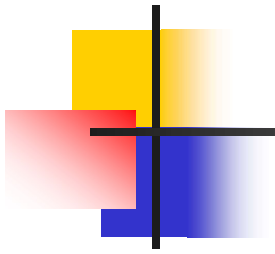


Figure 15.11 *Connection termination using three-way handshake*





Note

The FIN segment consumes one sequence number if it does not carry data.

Note

The FIN + ACK segment consumes one sequence number if it does not carry data.

Figure 15.12 *Half-Close*