TRANSMISSION CONTROL PROTOCOL TCP)

The second transport layer protocol is called Transmission Control Protocol (TCP). TCP is a connection oriented protocol, it creates a virtual connection between two TCPs to send data.

In addition, TCP uses flow and error control mechanisms at the transport level. TCP is called a *connection-oriented, reliable* transport protocol.

TCP Services:

Process-to-Process Communication:

- ✓ TCP provides process-to-process communication using port numbers.

Table: 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	Quoto	Returns a quote of the day
19	Chargen	Returns a string of characters
20	FTP, Data	File Transfer Protocol (data connection)
21	FTp, Control	File Transfer Protocol (control connection)
23	TELNET	Tenninal Network
25	SMTP	Simple Mail Transfer Protocol
53	DNS	Domain Name Server
67	BOOTP	Bootstrap Protocol
79	Finger	Finger
80	HTTP	Hypertext Transfer Protocol
111	RPC	Remote Procedure Call

Stream Delivery Service:

- TCP, is a stream-oriented protocol. It allows the sending process to deliver data as a stream ofbytes and allows the receiving process to obtain data as a stream of bytes. The sending

process produces (writes to) the stream of bytes, and thereceiving process consumes (reads from) them.

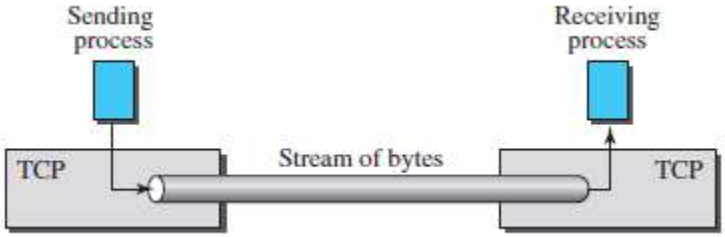


Fig: Stream delivery.

- Sending and Receiving Buffers Because the sending and the receiving processes maynot write or read data at the same speed, TCP needs buffers for storage. buffers are also necessary for flow and error control mechanisms.

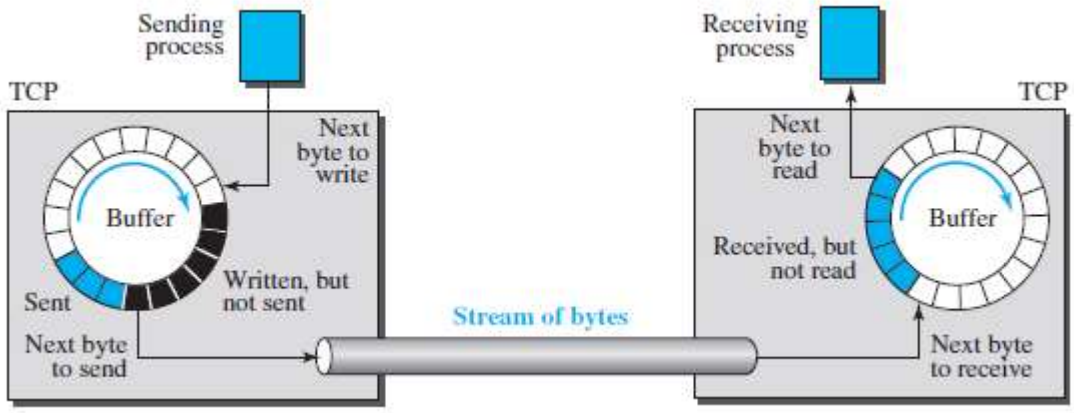


Fig: Sending and receiving buffers.

- At the sending site, the buffer has three types of chambers. The white section contains empty chambers that can be filled by the sending process (producer).
- The gray area holds bytes that have been sent but not yet acknowledged. TCP keeps these bytes in the buffer until it receives an acknowledgment. The colored area contains bytes to be sent by the sending TCP.
- At the receiver site is simpler. The circular buffer is divided into two areas (shown as white and colored). The white area contains empty chambers to be filled by bytes received from the network. The colored sections contain received bytes that can be read by the receiving process.

Segments:

- TCP groups a number of bytes together into a packet called a segment.TCP adds a header to each segment (for control purposes) and delivers the segment to theIP layer for transmission.

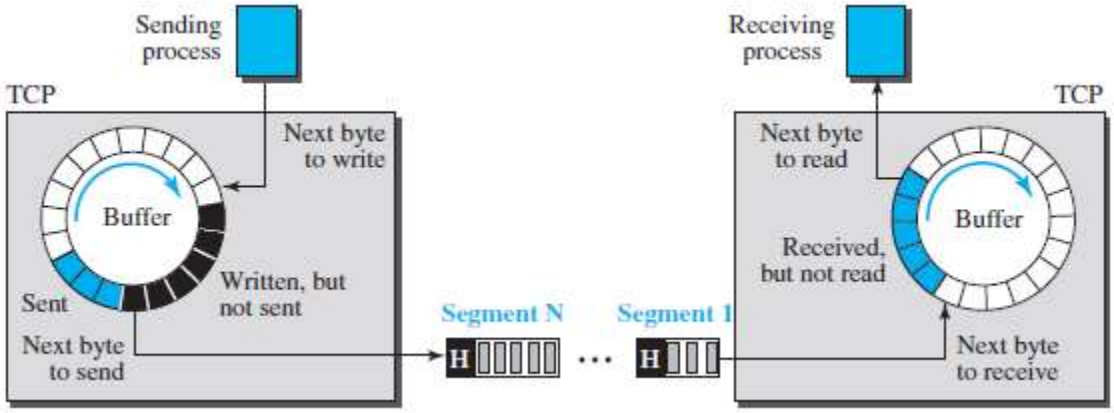


Fig: TCP segments.

Full-Duplex Communication:

TCP offers full-duplex service, in which data can flow in both directions at the same time.

Connection-Oriented Service:

- TCP, is a connection-oriented protocol. When a process at site A wants to send and receive data from another process at site B, the following occurs:

1. The two TCPs establish a connection between them.
2. Data are exchanged in both directions.
3. The connection is terminated.

Reliable Service:

- TCP is a reliable transport protocol. It uses an acknowledgment mechanism to check the safe and sound arrival of data.

TCP Features:

Numbering System:

- There are two fields called the sequence number and the acknowledgment number.

Byte Number:

- The bytes of data being transferred in each connection are numbered by TCP. The numbering starts with a randomly generated number.

Sequence Number:

- After the bytes have been numbered, TCP assigns a sequence number to each segment that is being sent. The sequence number for each segment is the number of the first byte carried in that segment.
- The value in the sequence number field of a segment defines the number of the first data byte contained in that segment.

Acknowledgment Number:

- 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.

Flow Control:

- TCP, unlike UDP, provides *flow control.* This is done to prevent the receiver from being over whelmed with data.

Error Control

- To provide reliable service, TCP implements an error control mechanism.

Congestion Control:

- The amount of data sent by a sender is not only controlled by the receiver (flow control), but is also determined by the level of congestion in the network.

Segment:

- ✓ A packet in TCP is called a segment.

Format:

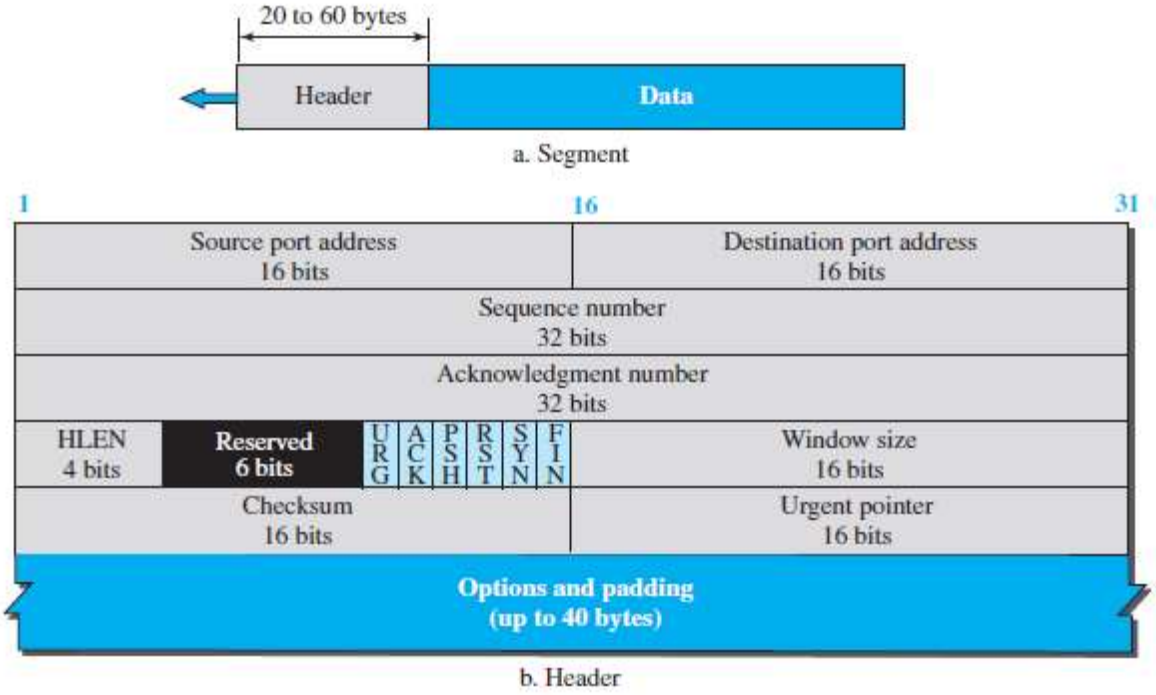


Fig: TCP segment format.

- **Source port address:**

  This is a 16-bit field that defines the port number of the application program in the host that is sending the segment.

- **Destination port address:**

  This is a 16-bit field that defines the port number of the application program in the host that is receiving the segment.

- **Sequence address:**

  This 32-bit field defines the number assigned to the first byte of data contained in this segment.

- **Acknowledgment number:**

  This 32-bit field defines the byte number that the receiver of the segment is expecting to receive from the other party.

- **Header Length:**

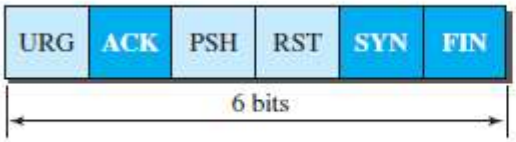
  This 4-bit field indicates the number of 4-byte words in the TCP header.

- **Reserved:**

  This is a 6-bit field reserved for future use.

- **Control:**

This field defines 6 different control bits or flags.



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

Fig: Control field.

Table: Description of flags in the control field

Flag	Description
URG	The value of the urgent pointer field is valid.
ACK	The value of the acknowledgment field is valid.
PSH	Push the data.
RST	Reset the connection.
SYN	Synchronize sequence numbers during connection.
FIN	Terminate the connection.