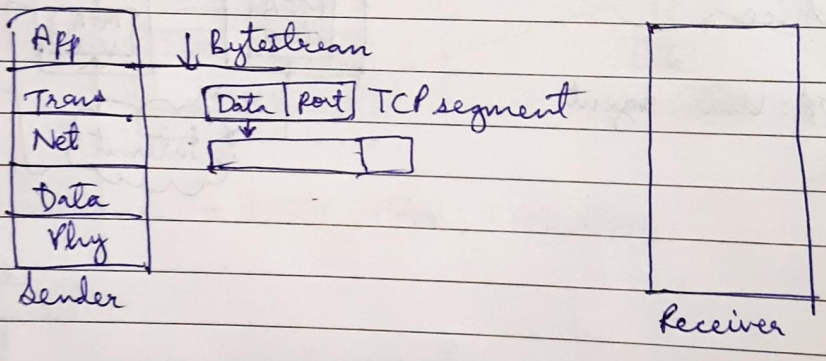
→ Transport layer
↳ TCP and UDP
↓ ↳ User Datagram Protocol
Transmission control protocol

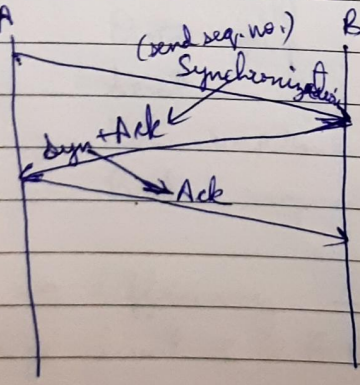
Q: How TCP set up a connection?
Q: How TCP segments look like?
Q: How two computers reliably transfer data?

↳ checksum, cyclic redundancy, message authentication codes or protocols

→ TCP/IP protocol suite - application layer, transport layer, network layer, data-link layer, physical layer



↳ TCP is reliable (end to end reliability)



3-way handshake supported by TCP

↳ Initial sequence number (ISN) generated by OS varies from 0 → 4294967295

→ Connection tear down

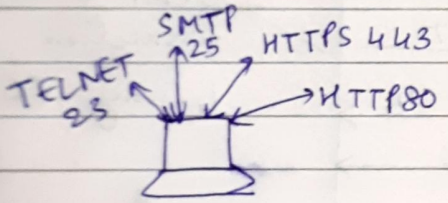
→ Properties of Transport layer
↳ supports stream of byte → reliable byte delivery service

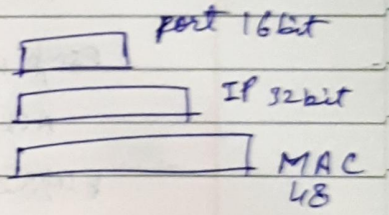
↳ reliable delivery - acknowledgement
↳ indicates correct delivery
- checksum detect corrupted data
- sequence number to detect missing data
- flow control prevent overrunning receiver

Inseqence → Data delivered to application in sequence transmitted

checksum → covers header & data

→ Port





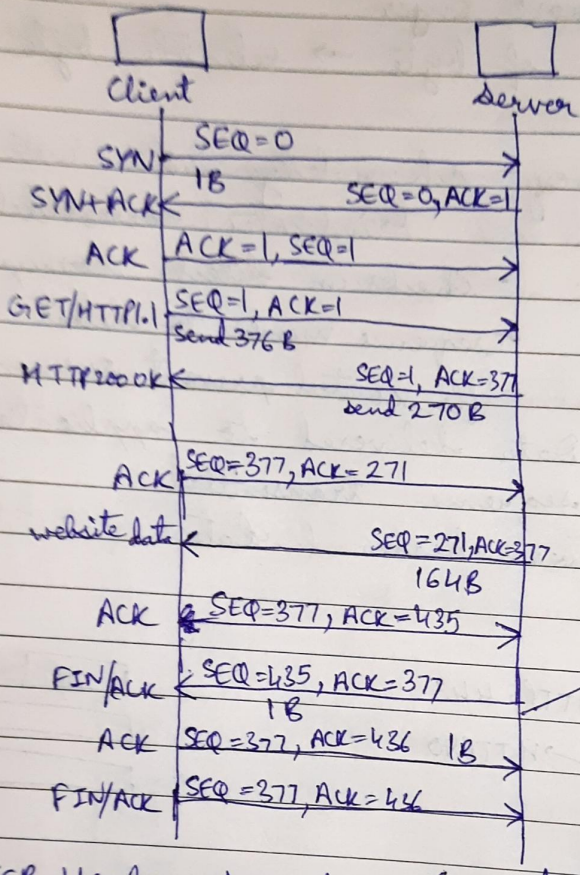
Port 16 bit
$2^{16} - 1 = 65535$
Well known ports 0 – 1023 by IANA
↳ Internet Assigned Number

Registered ports 1024 – 49151
Private port 49152 – 65535

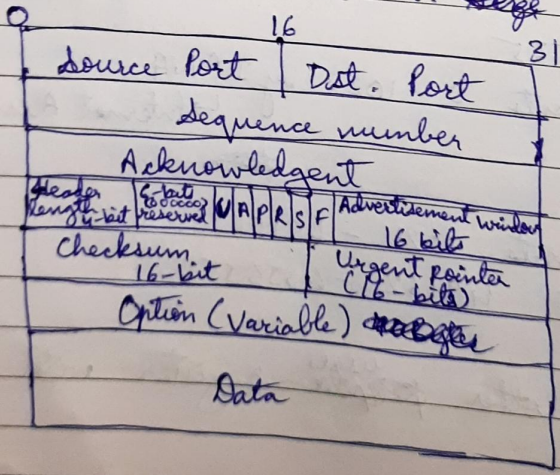
→ Company & other register with ICANN

Connection setup time + Data transfer time + Connection tear down time
↳ send "finish"

→ Sequence no. , Cummulative Ack



→ TCP Header format (Min. header length 20 bytes)



↳ U A P R S F flags uses

Urgent Ack PSH Reset Syn Fin

→ TCP checksum
↳ TCP header + TCP body + pseudo IP header
- → source IP
- → Destination IP
- → TCP/UDP segment length
- → Protocol (Type of protocol)
- → Fixed 8-bit (00000000)

Pseudo IP Header

Source IP (32 bits)		
Dst. IP (32 bits)		
Fixed 8 bit	Protocol field 8 bits	TCP segment length

→ Header length
min - 20 Bytes = 4 x 5
max - 60 Bytes = 4 x 15
(multiple of 4)
do use 4-bits to store 0 to 15
If not multiple of 4, add padding bits

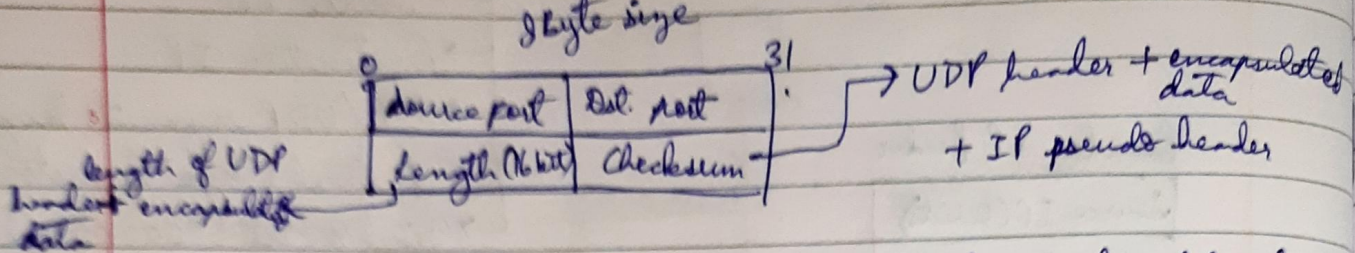
→ ~~PSH bit used~~

→ Window size used in flow control
↳ contains the size of the receiving window of the sender.
↳ it advertises how much data in bytes the sender can receive without acknowledgement
↳ changes dynamically → use option if more than 16 bit

→ Option → Timestamp
→ Window size extension
→ Parameter negotiation
→ Padding
→ Max. segment size

↳ UDP - User Datagram Protocol

↳ simplest transport layer Protocol



↳ Takes data from network layer & adds header.

↳ Broadcast, streaming, etc.

↳ Connection less protocol

↳ Stateless

↳ unreliable, fast

↳ min. transport service

↳ almost null protocol

↳ don't guarantee inorder delivery

↳ doesn't provide congestion control

↳ avoid TCP overhead

↳ Applications :-

- → DNS
- → RIP & OSPF
  - ↓ Routing information protocol
- → TFTP
- → Streaming, video conferencing
- → SNMT
- → Boot & DHCP

→ Flow - control both in transport and data-link layer

↓ windowing concept

↳ Flow - control is the process of managing the rate of data transmission between 2 nodes (to prevent loss of data) to prevent a fast

sender from overwhelming a slow receiver
↳ Congestion control is different from flow-control
↳ if congestion occurs then control flow of data
↳ Stop & wait flow control technique
↳ Windowing flow control technique

↳ Stop & wait
↳ simple protocol
↳ sender transmits single frame at a time & then waits for acknowledgement
↳ receiver transmits ack.

Q: In stop & wait protocol, every 4th packet is lost & we need to send total 90 packets. How many transmissions it took to send all the packets?

Ans 13

1 2 3 4 4 5 6 7 7 8 9 10 10
↑ ↑ ↑

Q: In stop & wait protocol if error prob. is p & no. of packets to send is n, how many packets we have to send?

Ans $n + np + np^2 + \dots = \frac{n}{1-p}$

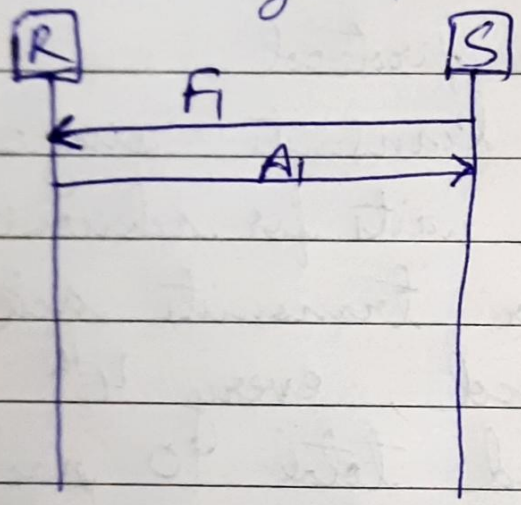
↳ Demerits of stop & wait
↳ transmission & propagation delay, channel under utilized, no-pipelining
↳ if ack. lost even if data is sent, duplicate data is sent
↳ delayed ack

↳ Sliding window

↳ Method of flow control in which a receiver gives a transmitter permission to transmit data until a window is full.

↳ Windowing :- Controls how much information is transferred from one end to the other.

eg:- Window size = 1



Window size = 3