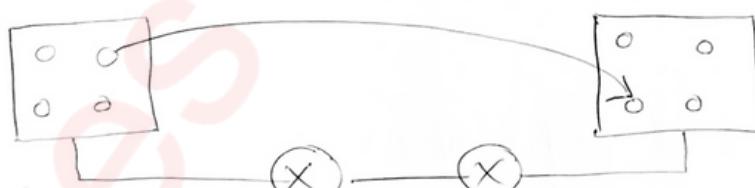


* Transport Layer (4th layer ↑)

→ End - to - End Delivery
(port - to - port)



(process - to - process)

⇒ TCP & UDP at TL
connectionless & unreliable
more reliable
Inorder

⇒ Error control (checksum)

⇒ flow control

⇒ congestion control

o Port Number

→ 16 bit number

Internet
Assigned
Numbers
Authority

$$(0 \rightarrow 2^{16} - 1)$$

↓
65535

o WR 1024
 ||
 1023

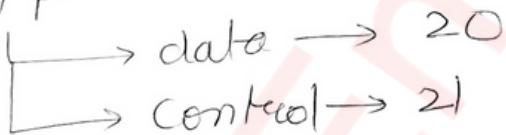
Registered

49151 Dynamic 65535
||
49152

(Applications)

- eg:- DNS → 53
 POP3 → 110

FTP



SMTP → 25

HTTPS → 443
(SSL)

o Socket Addresses

→ IP + Port
address Number
 ↓ ↓
(201.10.20.5 20)

* Transmission Control Protocol

Header

SP(16)	DPC(16)	4B
Sequence Number(32)		4B
Acknowledgement Number(32)		4B
H(4) L(6) R G	R C K H S T P N I N	Window size(16)
Checksum(16)	Urgent Pointer(16)	4B
Options(0-40B)		
Data		

TL → Segment = Header + Data/Payload

NL → Datagram

DLL → Frame

$$\text{Max size} = 20 + 40 = 60B$$

$$\text{Min size} = 20B$$

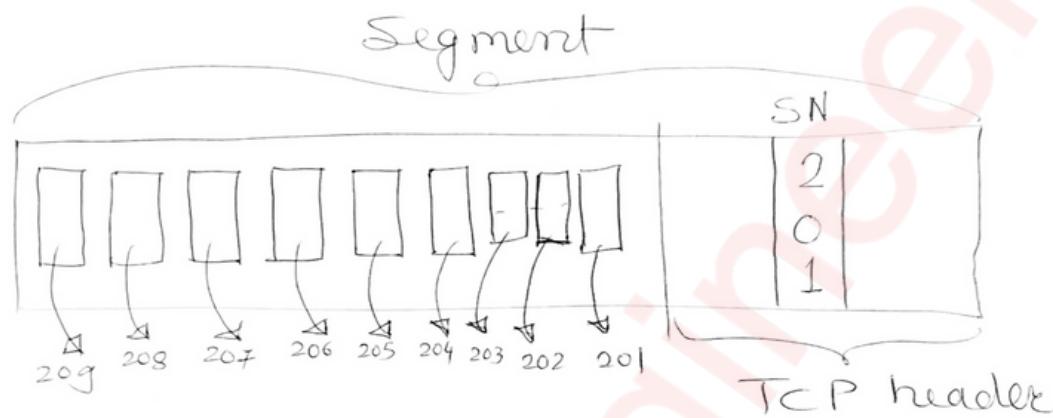


• Sequence Numbers (32 bit)

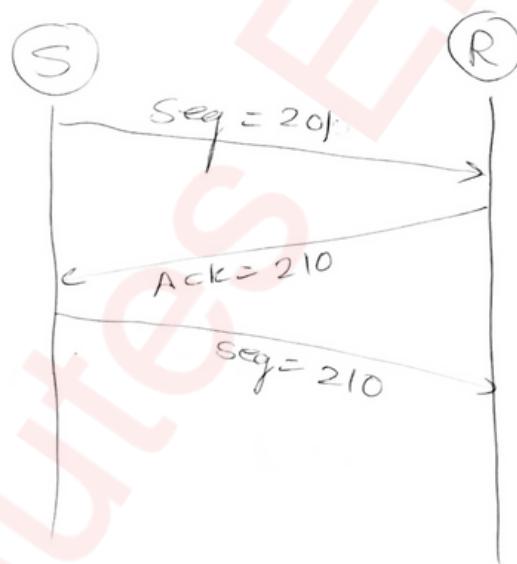
TCP is Byte stream protocol

IP is packet stream protocol.

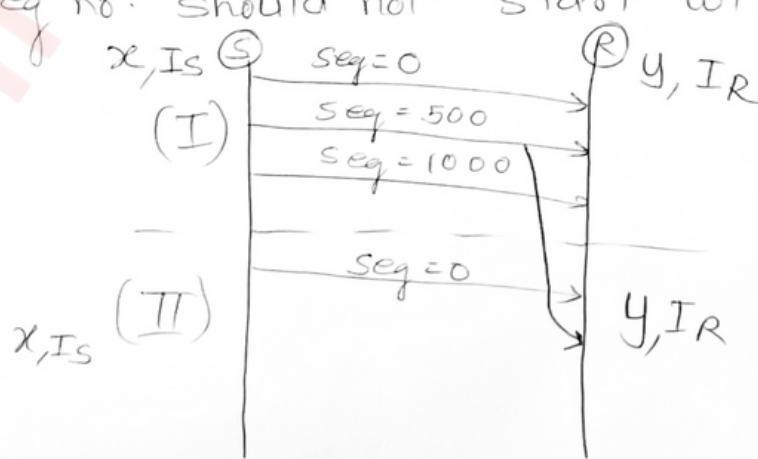
"Assigning a number to every byte"



• Acknowledgment Number (32 bit)



→ seq no. should not start with '0'

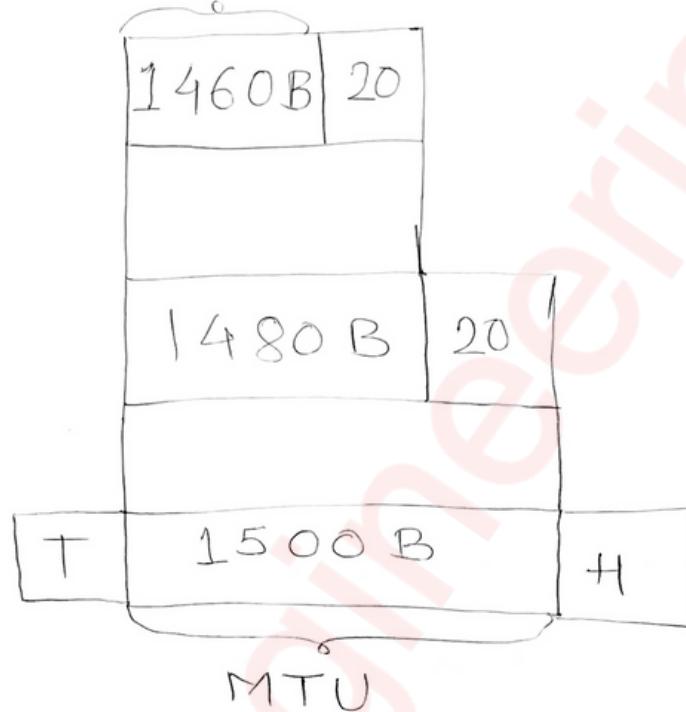


• Maximum Segment Size ↗

TL →
(segment)

NL →
(Datagram)

DLL →
(frame)



• Header length (4 bit) → 0 0 0 0 0
 \downarrow \downarrow
 $(20B - 60B)$ 1 1 1 15

$\frac{60}{15} \rightarrow 4$ ← scaling factor.

$$\textcircled{1} \quad TL - HL = x$$

$$\textcircled{2} \quad x - TCP\ HL$$

$$\textcircled{3} \quad 100 + y - 1$$

$$100 + 6 - 1$$

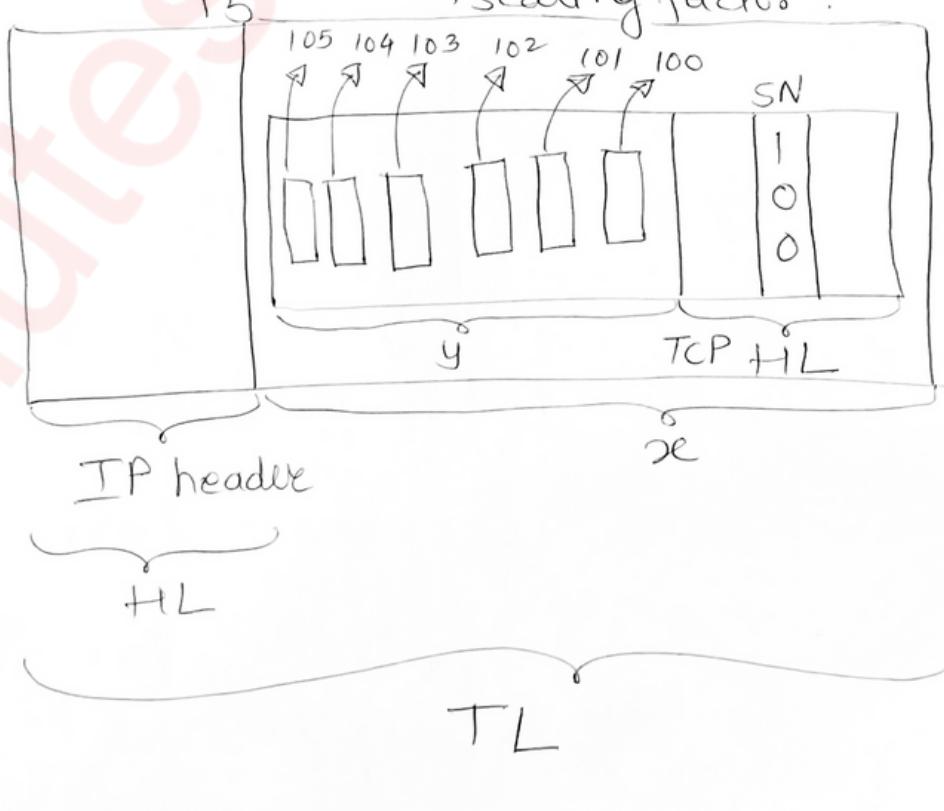
$$\hookrightarrow 105$$

$$+$$

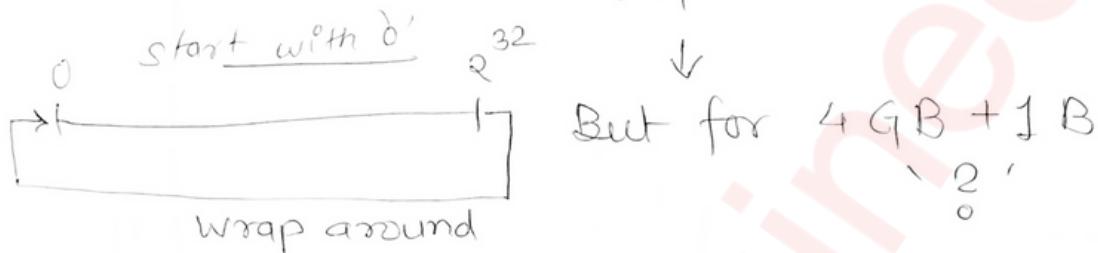
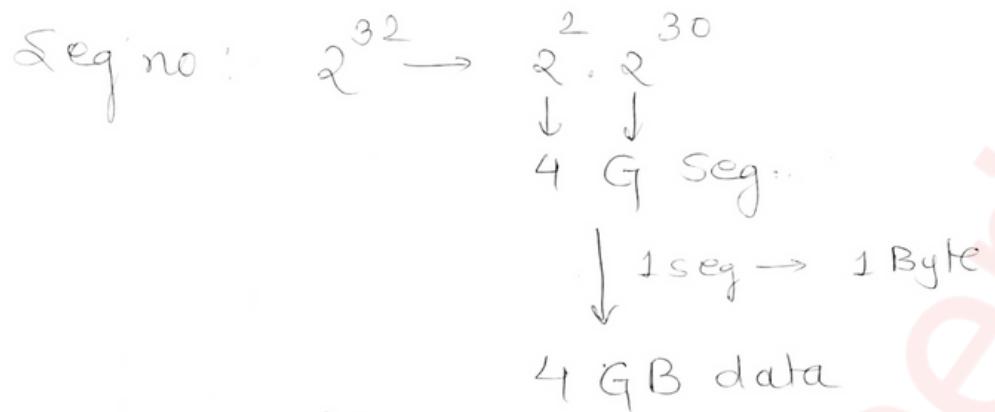
$$1$$

Ack num

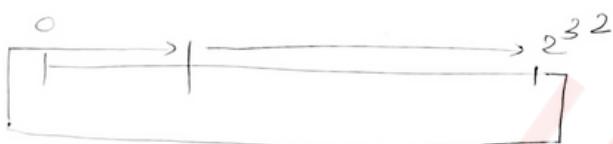
$$(106)$$



° Wrap Around Time



Not start with '0'



WAT

Time taken
to repeat/reuse
the same seq no.
again.



$$WAT \propto B/W$$

$$\begin{aligned} B/W &= 1 \text{ Mbps} \\ &= 10^6 B - 1 \text{ sec} \end{aligned}$$

$$10^6 \text{ seq no} - 1 \text{ sec}$$

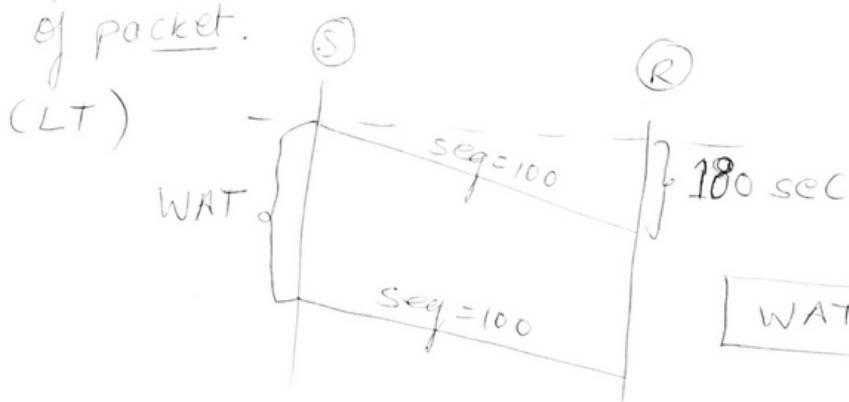
$$1 \text{ seq no} = \frac{1}{10^6} \text{ sec}$$

$$so, 2^{32} \text{ seq no} = \frac{2^{32}}{10^6} \text{ sec}$$

$$WAT = 4294.96729 \text{ sec}$$

Lifetime: 3 min (180 sec)

of packet.



But if $B/w = 1 \text{ Gbps}$

$$10^9 B \rightarrow 1 \text{ sec}$$

$$10^9 \text{ segno} \rightarrow 1 \text{ sec}$$

$$\cdot 2^{32} \text{ seg} = \frac{2^{32}}{10^9} \text{ sec}$$

$$\boxed{\text{WAT} = 4.29496 \text{ sec}}$$

$$\boxed{LT > WAT} \times$$

so'

$$B/w = 1 \text{ Gbps}$$

$$LT = 180 \text{ sec}$$

$$\boxed{\lceil \log_2 B/w \times LT \rceil}$$

$$1 \text{ seq} \rightarrow 10^9 \text{ seg nos}$$

$$180 \text{ sec} \rightarrow x$$

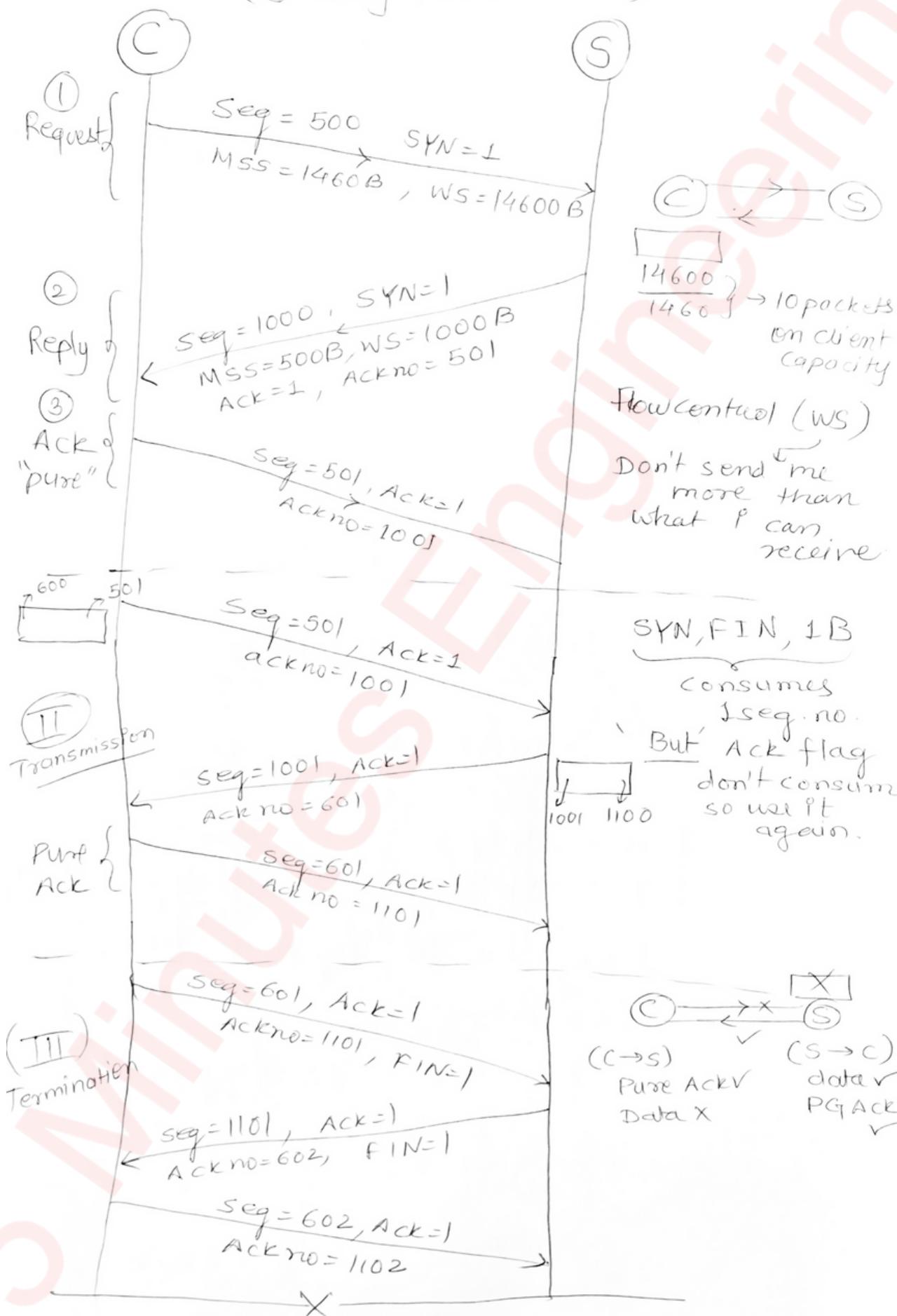
$$x = \lceil 10^9 \times 180 \rceil \text{ seq no.}$$

but seq no (32 bits) $\xrightarrow{+6} 38 \text{ bits}$.

option field (6 bits).

I Connection Establishment

(3-way handshake)



SYN

1

1

0

0

ACK

0

1

0

1

→

Request Packet
(I)

→

Reply Packet
(II)

→ X Not possible

→ Transmission or
Termination

* URG Flag & Urgent Pointer

AL

TL

NL

DLL

PL



M3 | URG=1 |

M3 | Priority=7 |

URG

M3 M2 M1

NL

DLL

PL



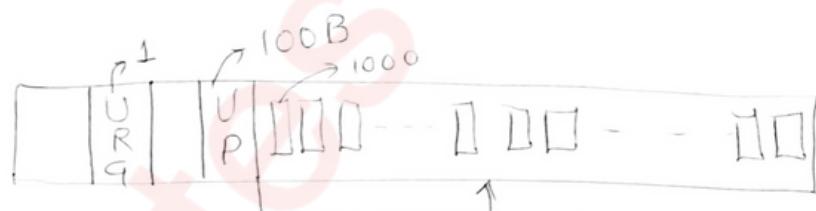
AL

TL

NL

DLL

PL

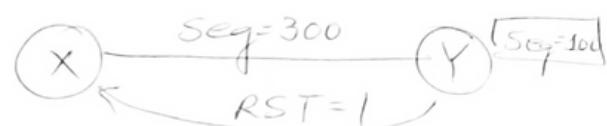


1000 → (1000 + 100)

↓
1100

Urgent data.

* RST flag

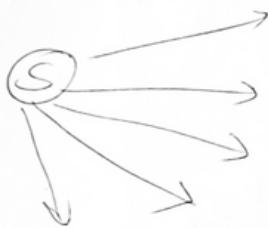


* User Datagram Protocol (UDP)

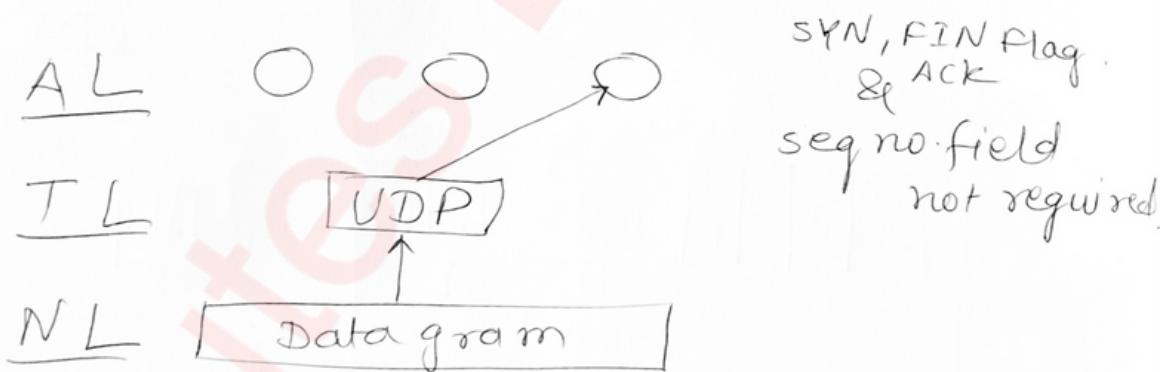
- Connectionless
- Unreliable

$TCP \rightarrow CE + DT + CT$ (\times) not required in UDP
Eg:- Pen required in exam hall
UDP works (yes/no).

Eg: Broadcast (TCP would be expensive)



Eg: Games, multimedia (speed required)



UDP →
header

S P (16)	D P (16)
(16) Length (H+D)	checksum (16)

8 Byte header size

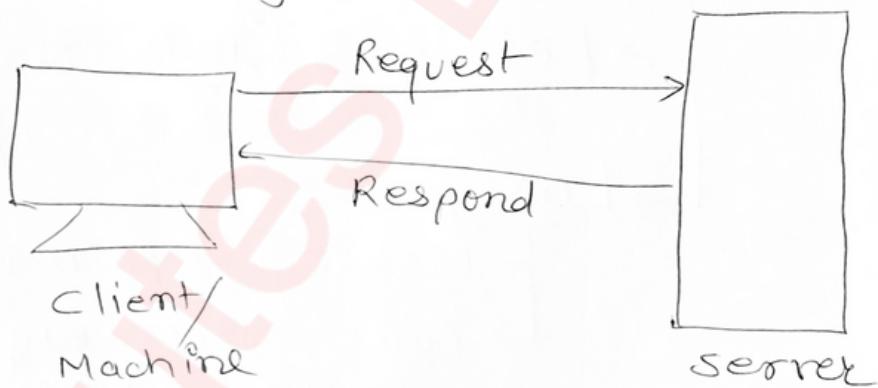
- TCP

- ① Connection oriented
- ② Reliable (\uparrow)
- ③ In order
- ④ Slow
- ⑤ EC is mandatory
- ⑥ HL = $(20-60)B$
variable
- ⑦ Byte stream
- ⑧ high overhead

VS

UDP

- ① Connectionless
- ② Low/Less reliable
- ③ No order
- ④ fast
- ⑤ EC is optional.
- ⑥ HL = 8 B
fixed
- ⑦ Message stream
- ⑧ Low overhead

* * Session Layer

- Authentication
- Authorization
- Session mgmt (synchronization)
- Checkpoint [Session Restoration]
- session establishment
- Dialog mgmt (log data of connection)