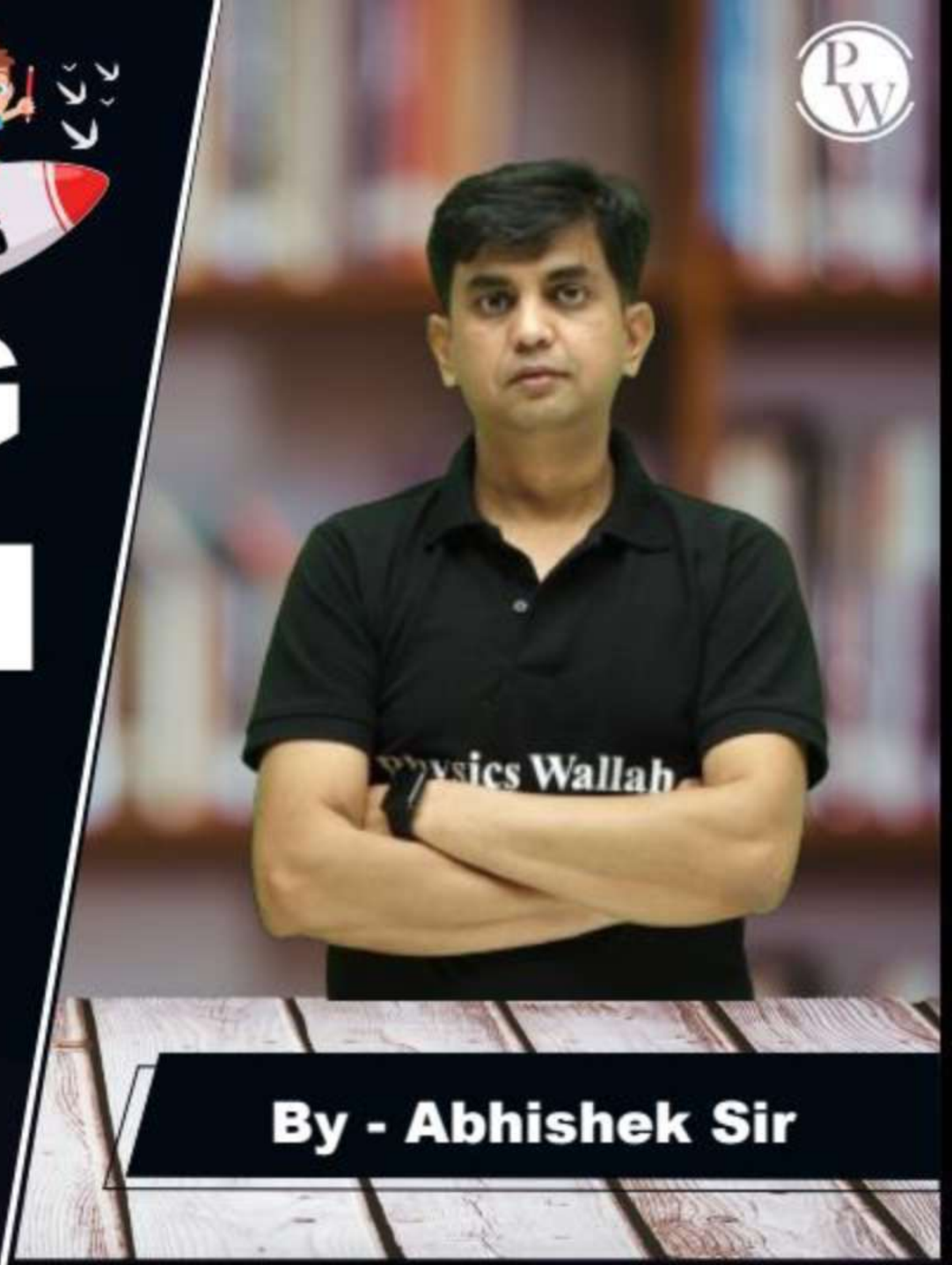
# CS & IT ENGINEERING


## Computer Network

## Transport Layer

Lecture No. - 05



By - Abhishek Sir

# Recap of Previous Lecture

Topic Maximum Segment Lifetime

Topic TCP Connection Establishment

# Topics to be Covered

- Topic: TCP Connection Establishment
- Topic: TCP Connection Release
- Topic: Socket Programming

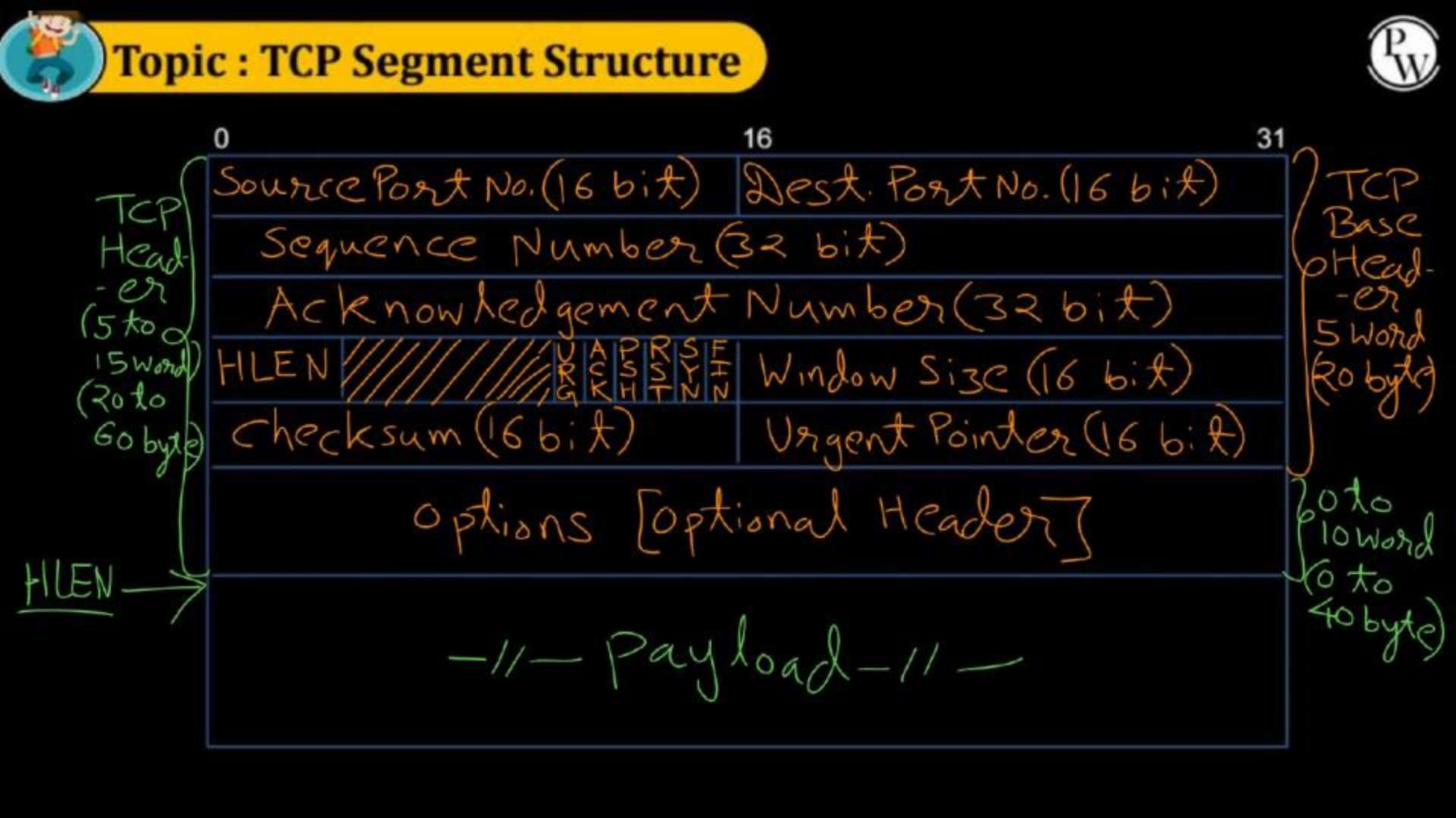
# ABOUT ME

**Hello, I'm Abhishek**

- GATE CS AIR - 96
- M.Tech (CS) - IIT Kharagpur
- 12 years of GATE CS teaching experience


**Telegram Link : https://t.me/abhisheksirCS_PW**

# Topic : TCP Segment Structure



[MSQ]

#Q. Suppose you are asked to design a new reliable byte-stream transport protocol like TCP. This protocol, named my TCP, runs over a 100 Mbps network with a Round Trip Time of 150 milliseconds and a maximum segment lifetime of 2 minutes. Which of the following is/are valid lengths of the Sequence Number field in the my TCP header? [GATE-2023]

(A) 30 bits

(B) 32 bits

(C) 34 bits

(D) 36 bits

Bandwidth = 100 Mbps = $10^8$ bits/sec

MSL = 2 min = 120 sec

Max^m no. of bytes can be transmitted in one MSL

= MSL * Bandwidth = 120 sec * $10^8$ bits/sec

= $15 * 10^8$ bytes

Min^m no. of bits required for sequence no. field

= $\lceil \log_2(15 * 10^8) \rceil$ bits = $\lceil 30.48 \rceil$ bits = 31 bits

Ans: B, C & D

# Topic : TCP Connection Establishment

→ Connection establishment between TCP client and TCP server

→ 3-way handshake process

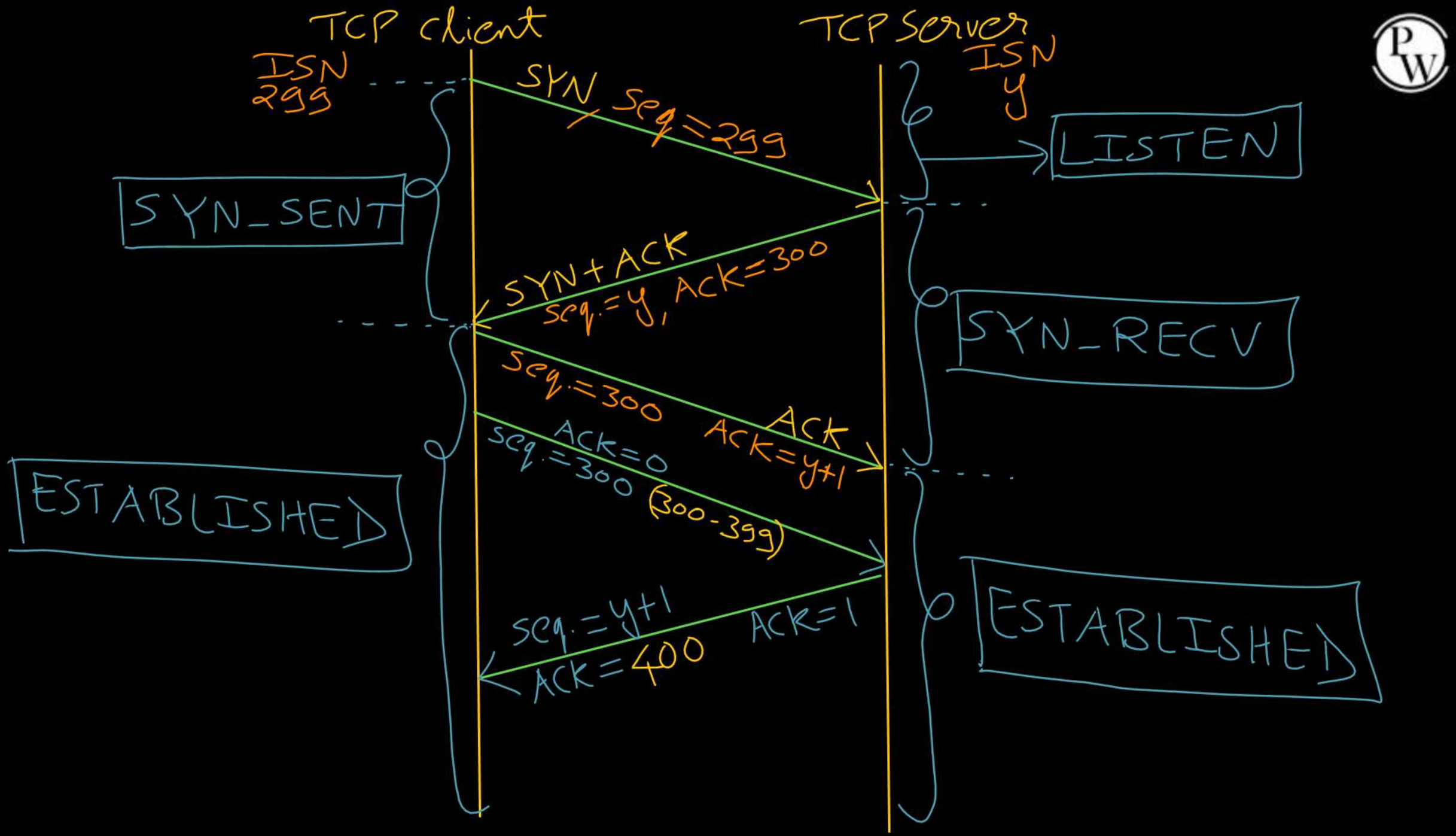
→ Always TCP client initiate the connection request to TCP server

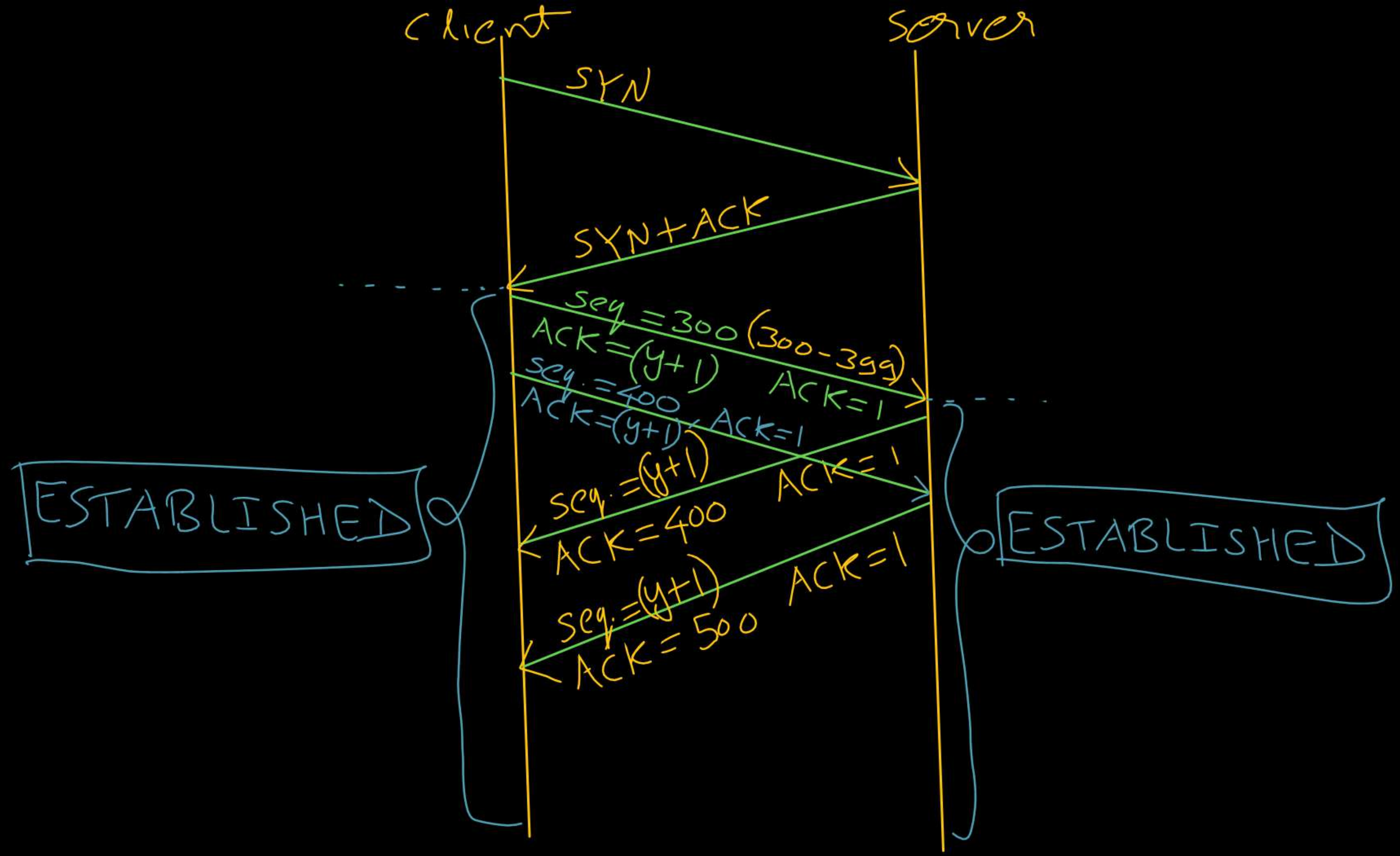
# Topic : TCP Connection Establishment

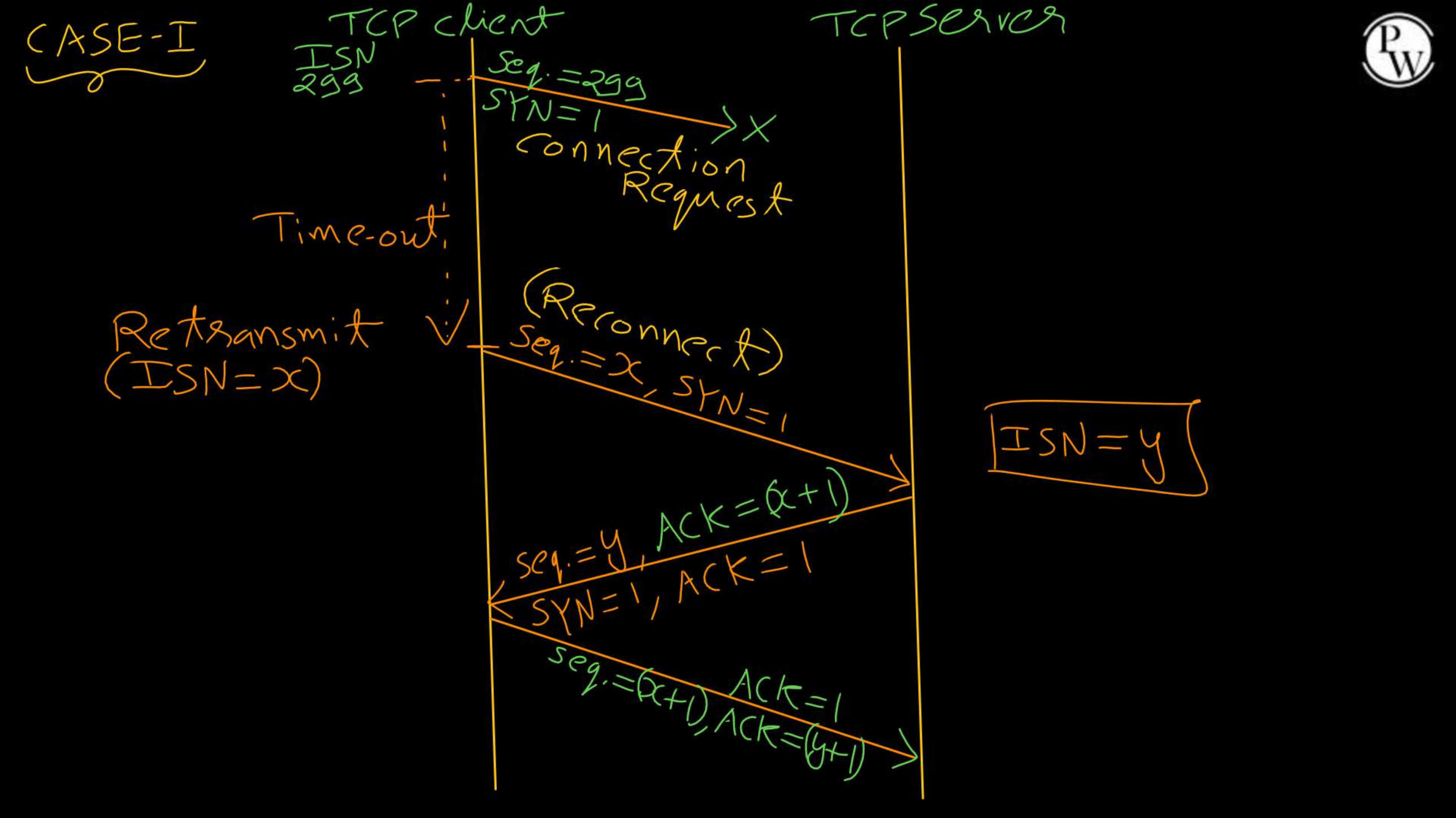
→ Initial Sequence Number : if SYN flag is on [ISN]
[both TCP client and server randomly chooses their initial sequence number, to prevent from some kind of attacks]

→ SYN packet consume one sequence number

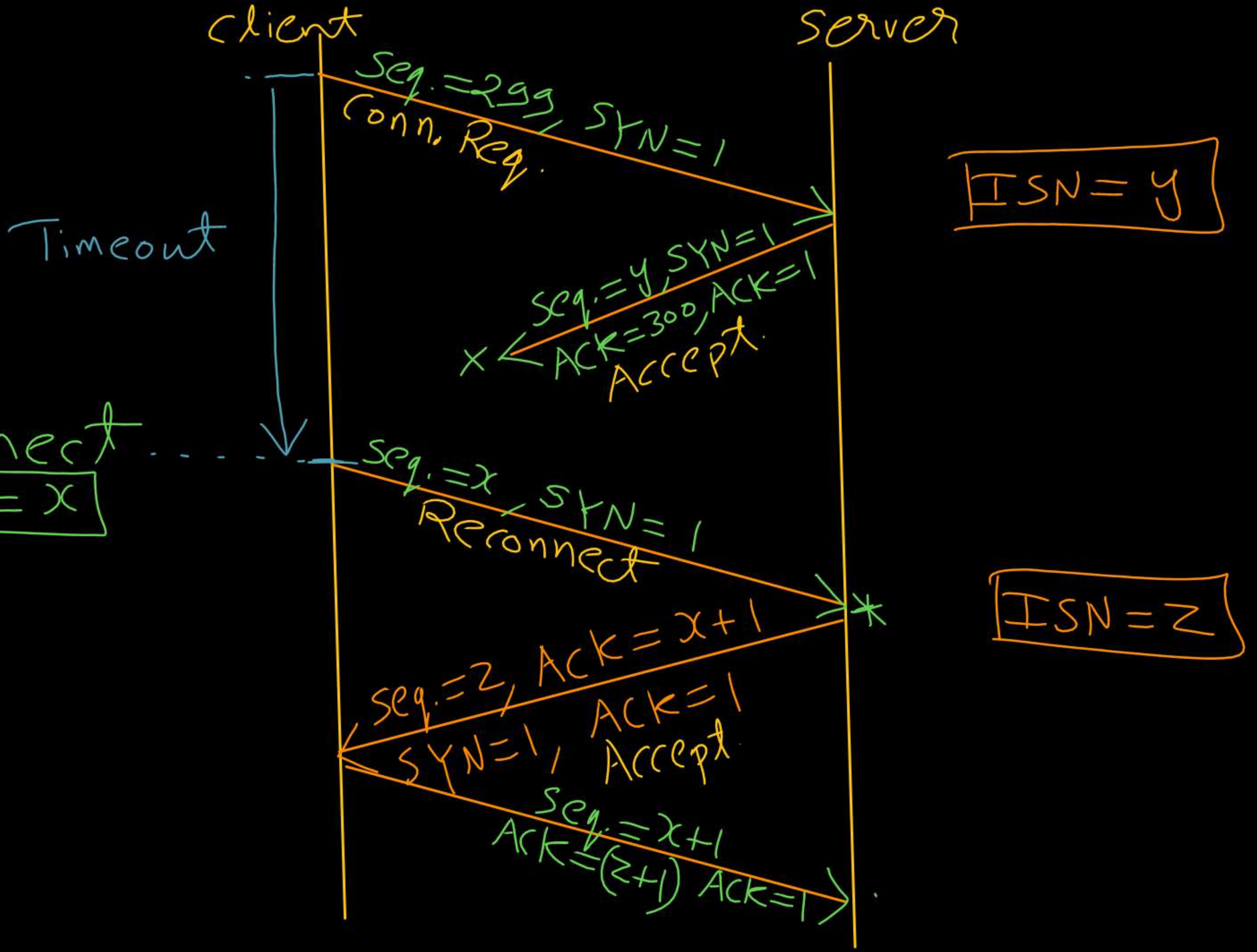
→ SYN packet do not carry user data [no any payload]

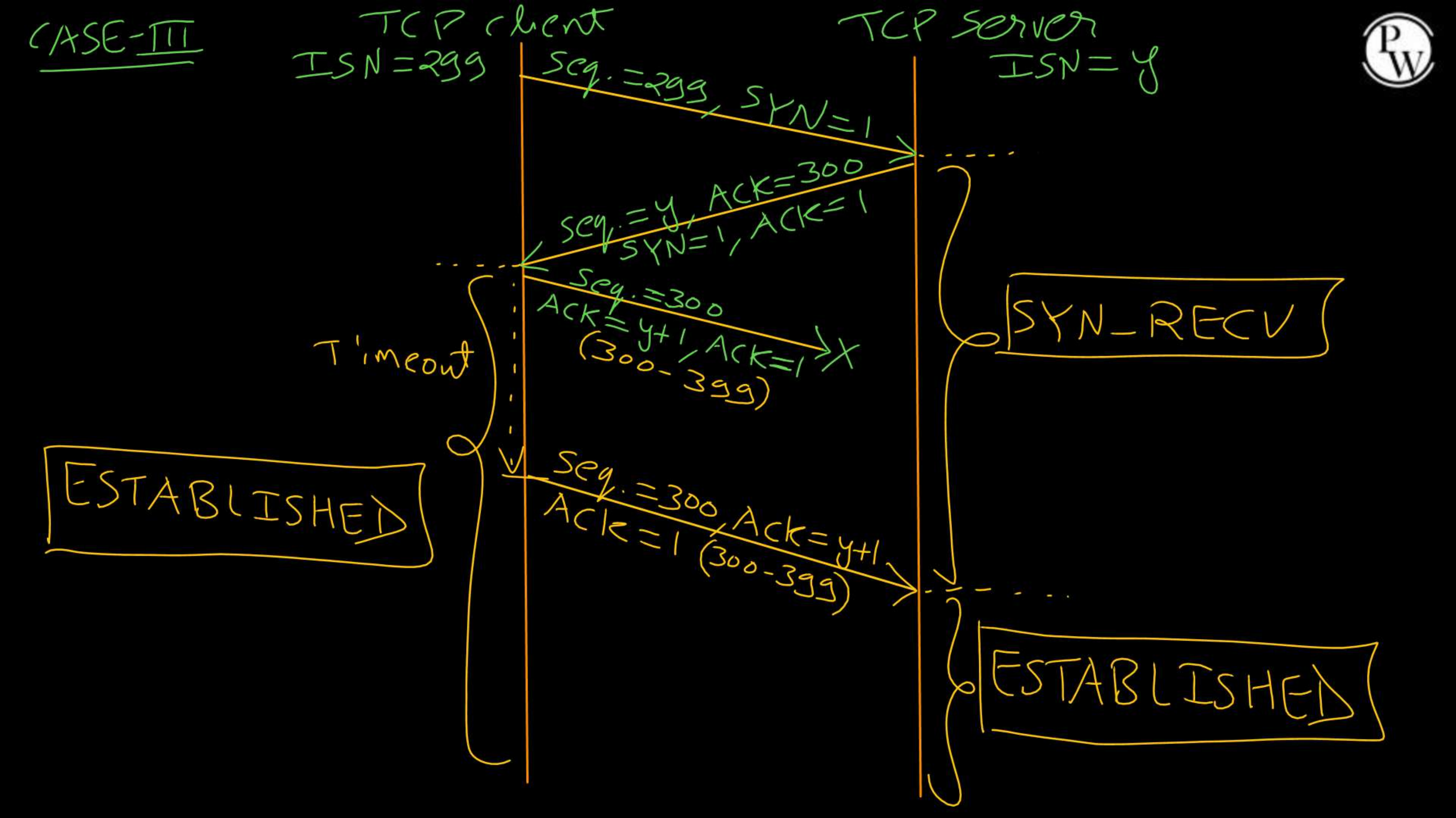

TCP client
TCP Server
ISN
299
SYN, seq=299
ISN
y
LISTEN
SYN_SENT
SYN+ACK
seq.=y, ACK=300
SYN_RECV
seq.=300
ACK
ACK=y+1
ACK=0
seq.=300 (300-399)
ESTABLISHED
seq.=y+1
ACK=1
ACK=400
ESTABLISHED


Client
Server
SYN
SYN+ACK
seq=300 (300-399)
ACK=(y+1)
ACK=1
seq.=400
ACK=(y+1)
ACK=1
seq.=(y+1)
ACK=400
ACK=1
seq.=(y+1)
ACK=500
ACK=1
ESTABLISHED
ESTABLISHED


CASE-I
TCP client
TCP Server
ISN
299
seq.=299
SYN=1
connection
Request
X
Time-out
Retransmit
(ISN=x)
(Reconnect)
seq.=x, SYN=1
ISN=y
seq.=y, ACK=(x+1)
SYN=1, ACK=1
seq.=(x+1), ACK=(y+1)
ACK=1

CASE-II


client
server
Seq.=299, SYN=1
Conn. Req.
ISN=y
Timeout
seq.=y, SYN=1
ACK=300, ACK=1
Accept.
Reconnect
ISN=x
seq.=x, SYN=1
Reconnect
ISN=z
Ack=x+1
seq.=z, Ack=1
SYN=1, Accept.
seq.=x+1
Ack=(z+1) ACK=1


CASE-III
TCP client
ISN=299
TCP server
ISN=y
seq.=299, SYN=1
seq.=y, ACK=300
SYN=1, ACK=1
seq.=300
ACK=y+1, ACK=1
(300-399)
Timeout
SYN_RECV
ESTABLISHED
seq.=300, Ack=y+1
Ack=1 (300-399)
ESTABLISHED

#Q. Which of the following statements are TRUE for 'three way handshake' for TCP connection establishment ?

(S1) Loss of SYN + ACK from the server will not establish a connection TRUE (CASE II)

(S2) Loss of ACK from the client cannot establish the connection FALSE (CASE III)

(S3) The server moves LISTEN → SYN_RCVD → SYN_SENT → ESTABLISHED in the state machine on no packet loss FALSE

(S4) The server moves LISTEN → SYN_RCVD → ESTABLISHED in the state machine on no packet loss. TRUE

[GATE-2008]

(A) S2 and S3 only

(B) S1 and S4 only

(C) S1 and S3 only

(D) S2 and S4 only

Ans: B

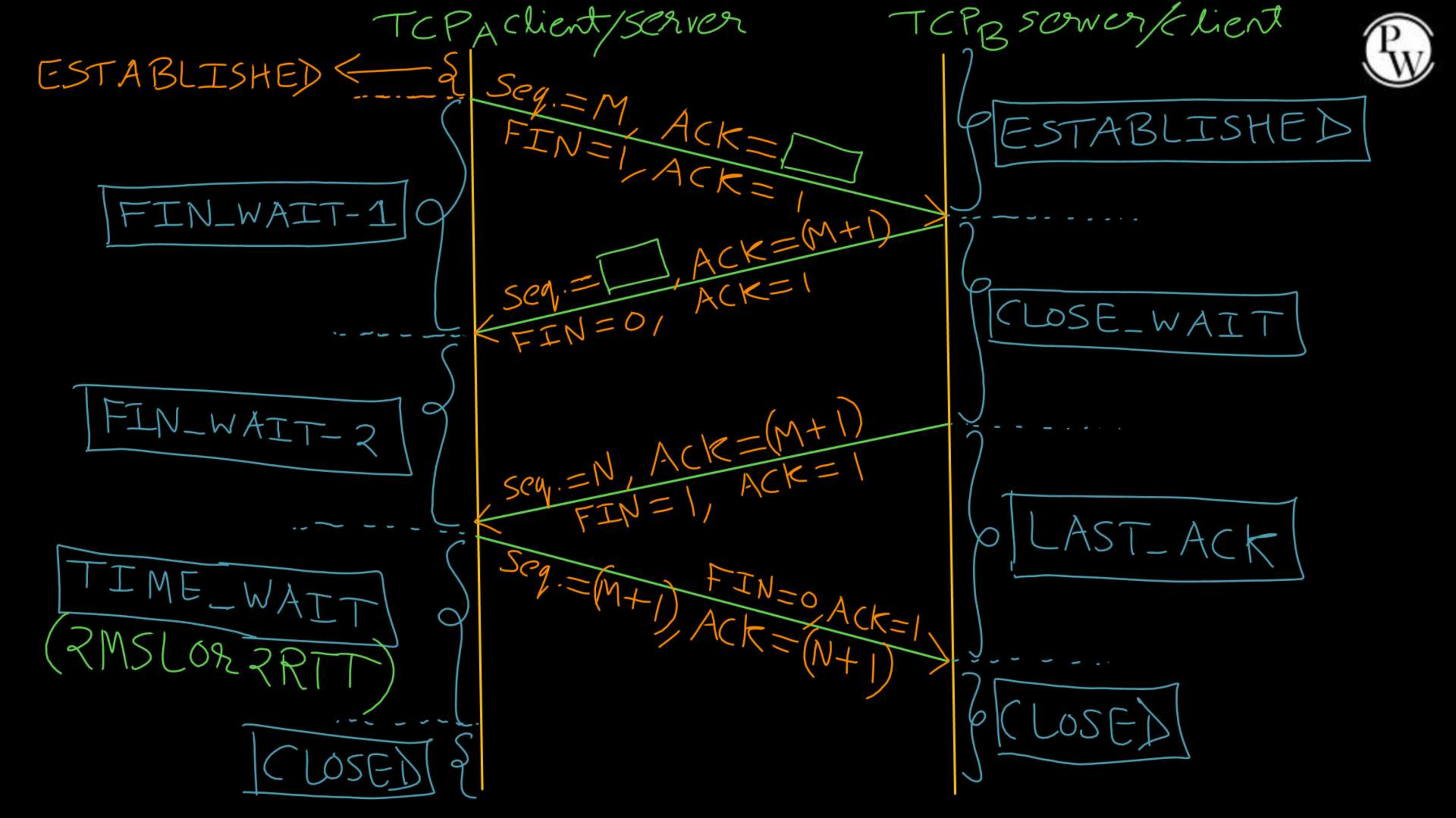
# Topic : TCP Connection Close

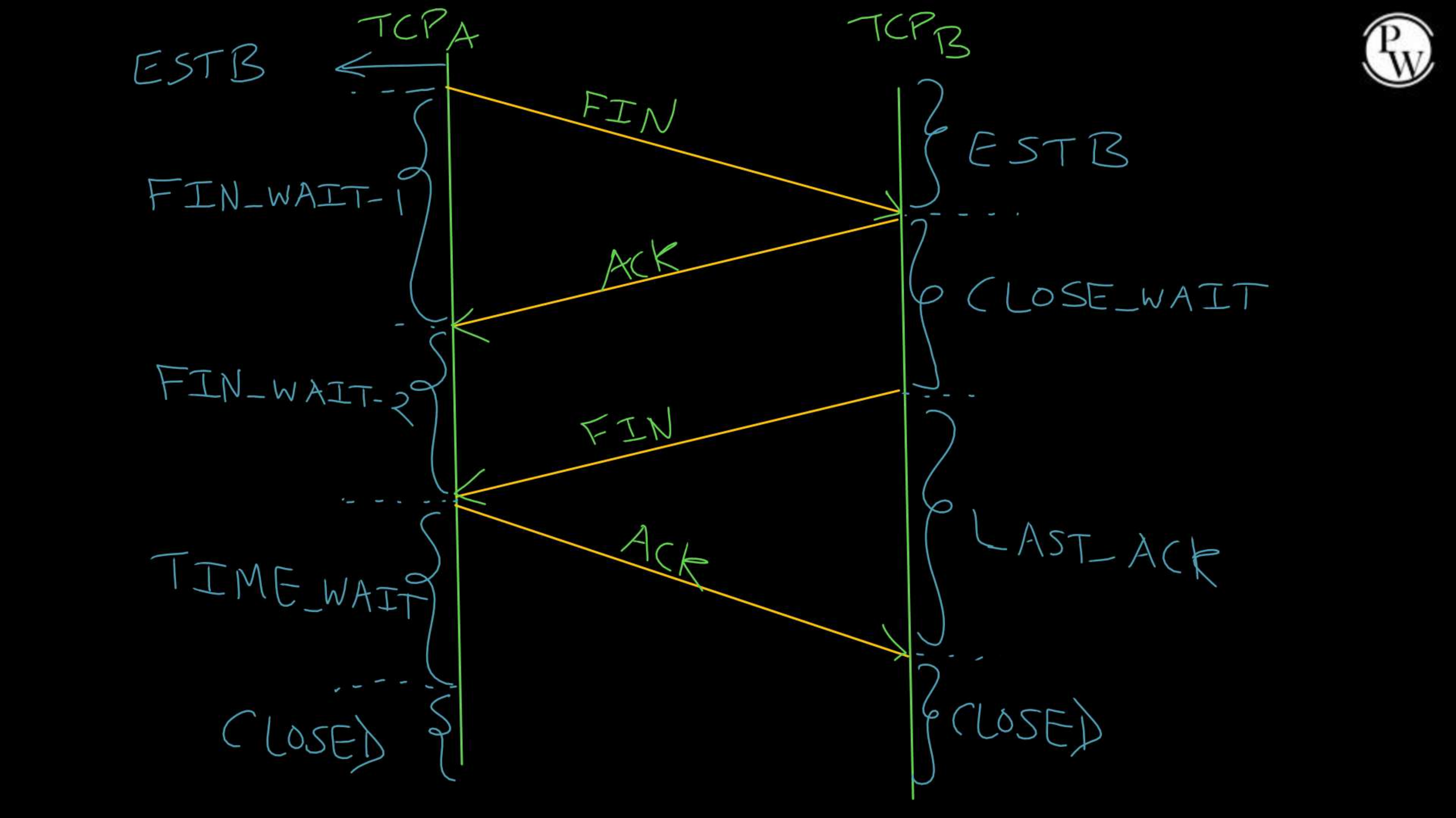
→ Connection close between TCP client and TCP server

→ 4-way handshake process

→ TCP client or TCP server any one can initiate the connection close request

2-way handshake → half close
2-// — // — → half close


TCP A client/server
TCP B server/client
ESTABLISHED
Seq.=M, ACK=
FIN=1, ACK=1
ESTABLISHED
FIN_WAIT-1
Seq.= , ACK=(M+1)
FIN=0, ACK=1
CLOSE_WAIT
FIN_WAIT-2
Seq.=N, ACK=(M+1)
FIN=1, ACK=1
LAST_ACK
TIME_WAIT
(2MSL OR 2RTT)
Seq.=(M+1), FIN=0, ACK=1
ACK=(N+1)
CLOSED
CLOSED


TCP A
TCP B
ESTB
FIN
ESTB
FIN_WAIT-1
ACK
CLOSE_WAIT
FIN_WAIT-2
FIN
LAST_ACK
ACK
TIME_WAIT
CLOSED
CLOSED

#Q. Consider a TCP client and a TCP server running on two different machines. After completing data transfer, the TCP client calls close to terminate the connection and a FIN segment is sent to the TCP server. Server-side TCP responds by sending an ACK which is received by the client-side TCP. As per the TCP connection state diagram (RFC 793), in which state does the client side TCP connection wait for the FIN from the server-side TCP?

[GATE-2017, Set-1, 2-Mark]

IIT-R, H.W.

(A) LAST-ACK

(B) TIME-WAIT

(C) FIN-WAIT-1

(D) FIN-WAIT-2

# Topic : TCP States

=> LISTEN :

→ The server is waiting for an incoming call

=> SYN_SENT :

→ The client has started to open a connection

=> SYN_RCVD :

→ A connection request has arrived, wait for ACK

=> ESTABLISHED :

→ Normal data transfer state [client + server]

# Topic : TCP States

=> FIN_WAIT-1 :
→ The client has said it is finished

=> CLOSE_WAIT :
→ The server has initiated a release

=> FIN_WAIT-2 :
→ The server has agreed to release

=> LAST_ACK :
→ Wait for pending packets

=> TIME_WAIT :
→ Wait for pending packets, "2MSL" Wait State

=> CLOSED :
→ No connection is active or pending [client + server]

# 2 mins Summary

Topic TCP Connection Establishment

Topic TCP Connection Release

Topic [illegible]

# THANK - YOU