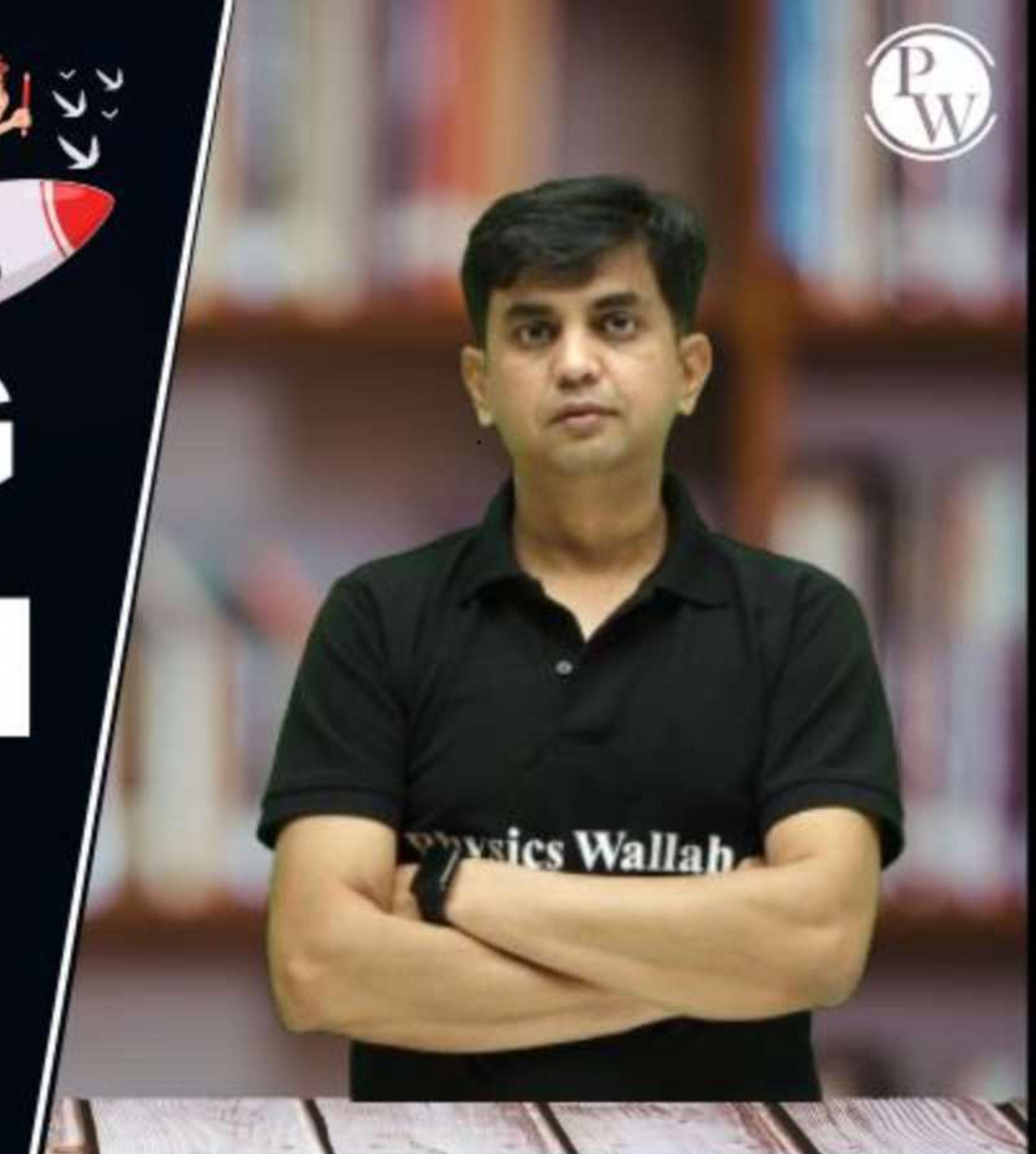
CS & IT ENGINEERING

Computer Network

Flow Control

Lecture No. - 03



By - Abhishek Sir

Recap of Previous Lecture

Topic End to end Delay

Topics to be Covered

Topic Flow Control

ABOUT ME

Hello, I'm Abhishek

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

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Topic : End-to-End Delay

Transmitter (Sender) —— Switch or Router —— Receiver

→ Suppose each link have same bandwidth and same propagation delay

→ Time required for N packet to be transmitted from Transmitter to Receiver

End-to-end delay = (N * Transmission delay) + Propagation delay
+ Queuing delay at device + Processing delay by device
+ Transmission delay + Propagation delay

#Q. Two hosts are connected via a packet switch with 10^7 bits per second links. Each link has a propagation delay of 20 microseconds. The switch begins forwarding a packet 35 microseconds after it receives the same. If 10000 bits of data are to be transmitted between the two hosts using a packet size of 5000 bits, the time elapsed between the transmission of the first bit of data and the reception of the last bit of the data in microseconds is ______.

[GATE 2015]

Solution:-

Packet Size = 5000 bits = $5 * 10^3$ bits

Bandwidth = 10^7 bits / sec

$$t_x = \frac{\text{Packet Size}}{\text{Bandwidth}} = \frac{5 * 10^3 \text{ bits}}{10^7 \text{ bits / sec}} = 500\ \mu s = 500 * 10^{-6} \sec$$

t_p = 20 μs

Processing Delay = 35 μs

Data Size

File Size = 10,000 bits

Packet Size = 5,000 bits

$$\text{Number of packets } (N) = \frac{\text{File Size}}{\text{Packet Size}} = \frac{10000 \text{ bits}}{5000 \text{ bits}} = 2$$

$$\boxed{\text{End-to-end delay} = (N * t_x + t_p) + \text{Processing Delay} + (t_x + t_p)}$$

$$= 1575\ \mu s = (2*500+20)+35+(500+20)$$

#Q. Consider a source computer (S) transmitting a file of size 10^6 bits to a destination computer (D) over a network of two routers (R1 and R2) and three links (L1, L2, and L3). L1 connects S to R1; L2 connects R1 to R2; and L3 connects R2 to D. Let each link be of length 100 km. Assume signals travel over each link at a speed of 10^8 meters per second. Assume that the link bandwidth on each link is 1Mbps. Let the file be broken down into 1000 packets each of size 1000 bits. Find the total sum of transmission and propagation delays in transmitting the file from S to D.

[GATE 2012]

(A) 1005 ms

(B) 1010 ms

(C) 3000 ms

(D) 3003 ms

Ans: A

Solution:-

Packet Size = 1000 bits = 10^3 bits

Bandwidth = 1 Mbps = 10^6 bits / sec

$$t_x = \frac{\text{Packet Size}}{\text{Bandwidth}} = \frac{10^3 \text{ bits}}{10^6 \text{ bits / sec}} = 1 \text{ ms} = 10^{-3} \text{ sec}$$

Distance = 100 Km = 10^5 m

Signal Speed = 10^8 m/s

$$t_p = \frac{\text{Distance}}{\text{Signal Speed}} = \frac{10^5 \text{ m}}{10^8 \text{ m/s}} = 1 \text{ ms} = 10^{-3} \text{ sec}$$

File Size $= 10^6$ bits

Packet Size $= 10^3$ bits

$$\text{Number of packets } (N) = \frac{\text{File Size}}{\text{Packet Size}} = \frac{10^6 \text{ bits}}{10^3 \text{ bits}} = 10^3 = 1000$$

$$\boxed{\text{End-to-end delay} = (N * t_x + t_p) + (t_x + t_p) + (t_x + t_p)}$$

$$= (10^3 * 1 + 1) + (1+1) + (1+1)$$

$$= 1005 \text{ ms}$$

#Q. Consider a network path P—Q—R between nodes P and R via router Q. Node P sends a file of size 10^6 bytes to R via this path by splitting the file into chunks of 10^3 bytes each. Node P sends these chunks one after the other without any wait time between the successive chunk transmissions. Assume that the size of extra headers added to these chunks is negligible, and that the chunk size is less than the MTU.

Each of the links P—Q and Q—R has a bandwidth of 10^6 bits/sec, and negligible propagation latency. Router Q immediately transmits every packet it receives from P to R, with negligible processing and queueing delays. Router Q can simultaneously receive on link P—Q and transmit on link Q—R.

Assume P starts transmitting the chunks at time $t = 0$. Which one of the following options gives the time (in seconds, rounded off to 3 decimal places) at which R receives all the chunks of the file?

[GATE 2024]

(A) 8.000 (B) 8.008 (C) 15.992 (D) 16.000

Ans : B

Solution:-

Packet Size $= 10^3$ bytes $= 8 * 10^3$ bits

Bandwidth $= 10^6$ bits / sec

$$t_x = \frac{\text{Packet Size}}{\text{Bandwidth}} = \frac{8 * 10^3 \text{ bits}}{10^6 \text{ bits / sec}} = 8 * 10^{-3} \text{ sec}$$

$$t_p = 0$$

File Size = 10^6 bytes

Packet Size = 10^3 bytes

$$\text{Number of packets } \underbrace{(N)} = \frac{\text{File Size}}{\text{Packet Size}} = \frac{10^6 \text{ bytes}}{10^3 \text{ bytes}} = \underbrace{10^3}$$

$$\boxed{\text{End-to-end delay} = (N * t_x + t_p) + (t_x + t_p)}$$

$$= (10^3 * 8 * 10^{-3} \text{sec} + 0) + (8 * 10^{-3} \text{sec} + 0)$$

$$= \underbrace{8.008 \text{ sec}}$$

Topic : Flow Control

→ Synchronization between transmitter and receiver to control the flow

→ Flow Control Protocols :

1. Noiseless Channel
   → No chance of error in the link
   → No any 'error detection' required
2. Noisy Channel
   → Chance of error in the link
   → Need of 'error detection' technique

Topic : Flow Control

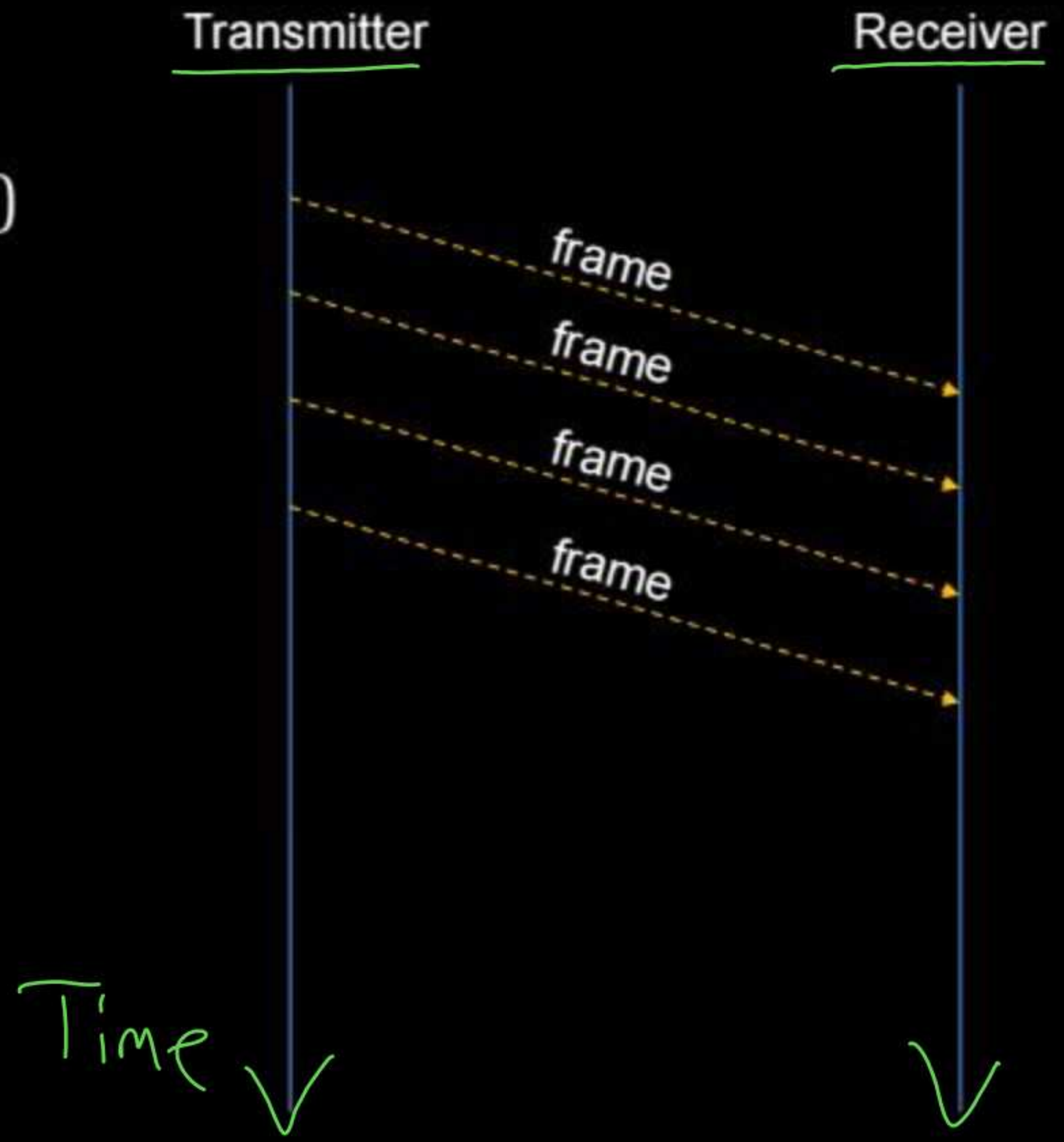
→ Flow Control Protocols for Noiseless Channel :

1. Simplest
2. Stop-and-Wait

Topic : Simplest

→ No any Flow and Error Control

→ Like Simplex Communication (No any ACK)



Topic : Stop-and-Wait

→ Add Flow Control in Simplest

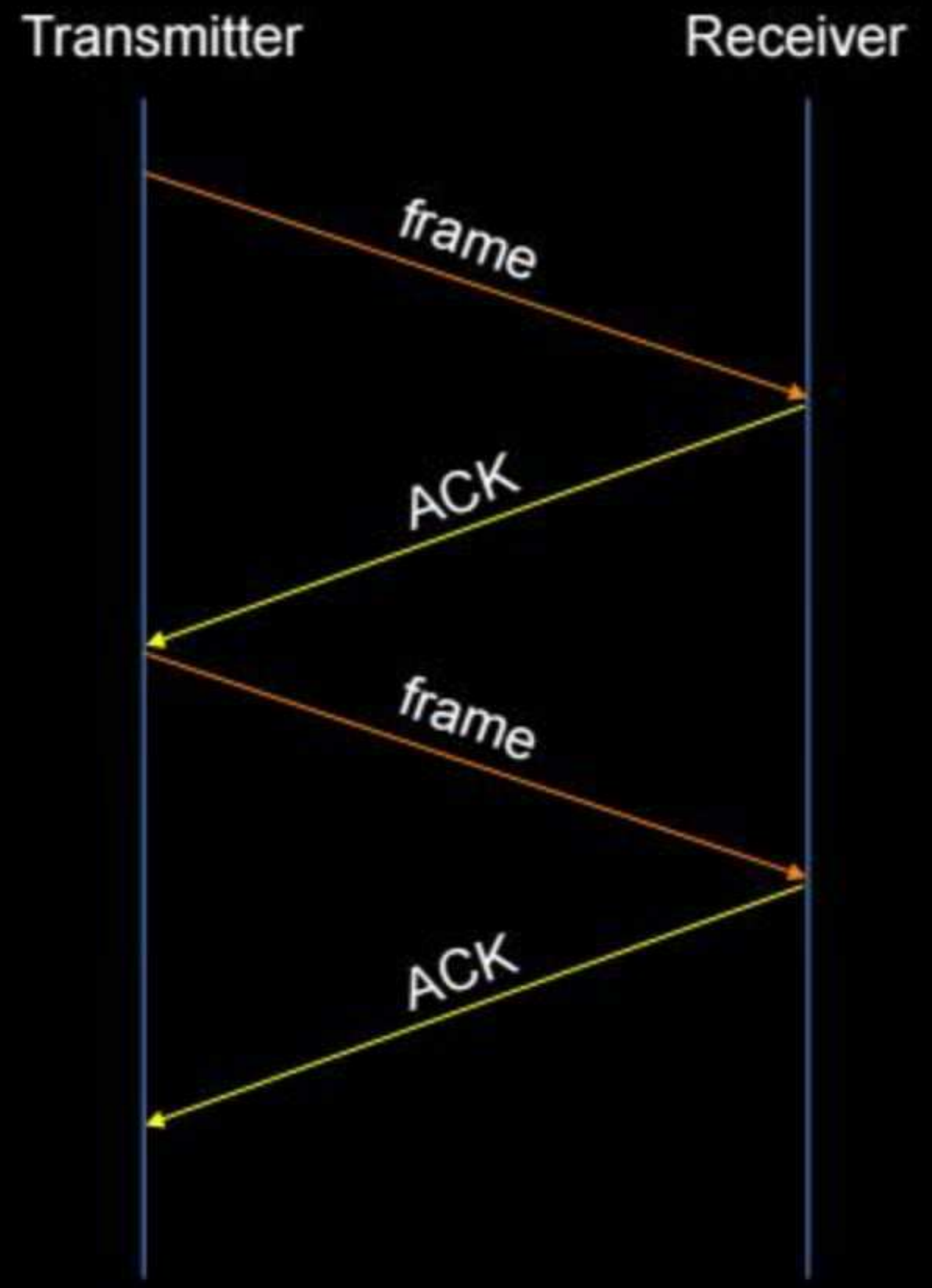
→ No any Error Control

→ Receiver send ACK for every received frame

→ Transmitter transmit one frame and wait for an ACK.

→ Transmitter transmit next frame only after receiving ACK of transmitted frame

→ Like Half Duplex Communication



Topic : Flow Control

→ Flow Control Protocols for Noisy Channel :

1. Stop-and-Wait ARQ
2. Sliding Window ARQ
    - 2.1 Go-Back-N ARQ
    - 2.2 Selective-Repeat ARQ

ARQ : Automatic Repeat Request

Topic : Stop-and-Wait ARQ

→ Transmitter transmit one frame and wait for an ACK

→ Receiver send ACK (positive ACK) for every successfully received frame

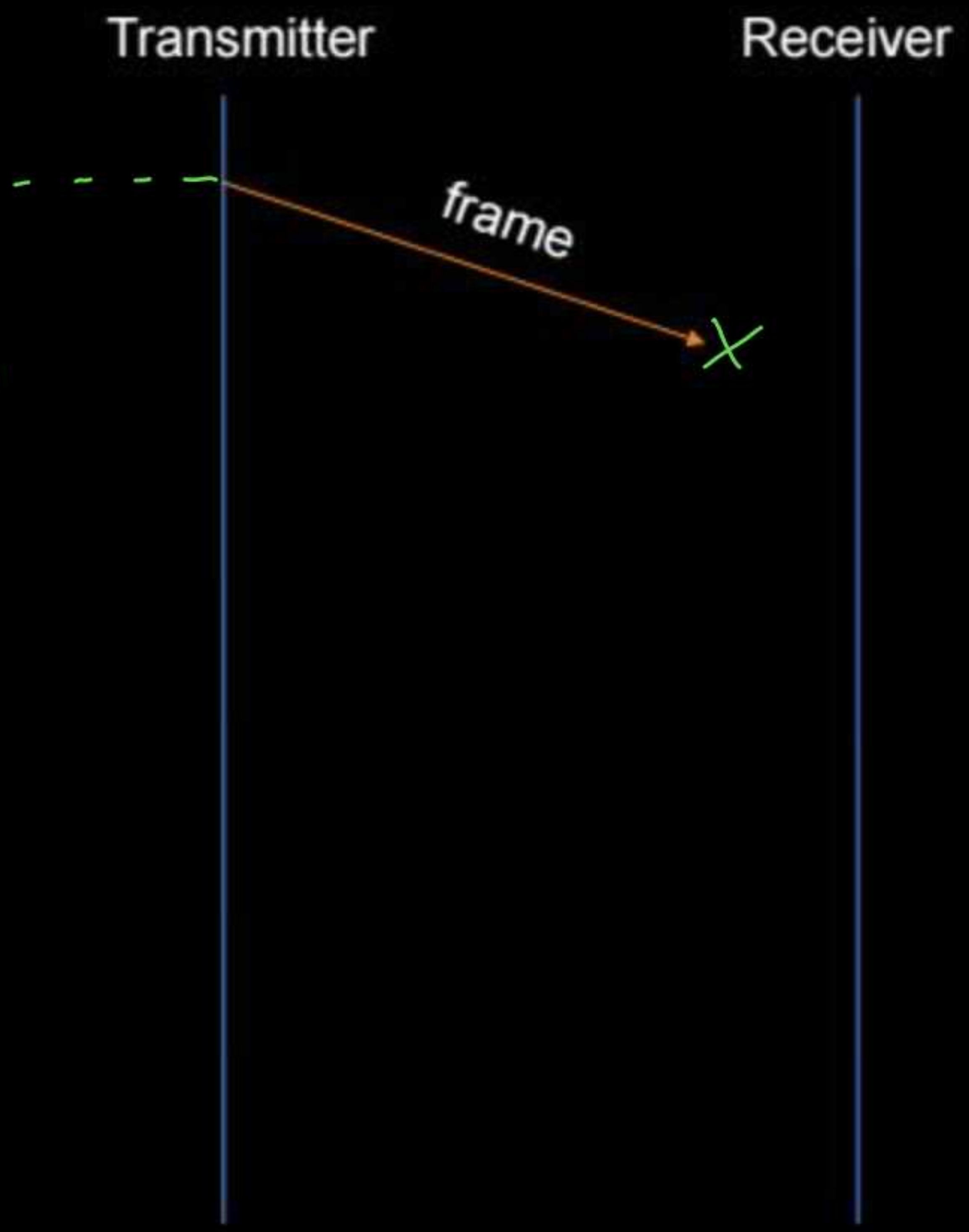
→ Transmitter transmit next frame
only after receiving ACK of transmitted frame

Topic : Stop-and-Wait ARQ

Case I :

→ Either frame or ACK gets lost in the channel

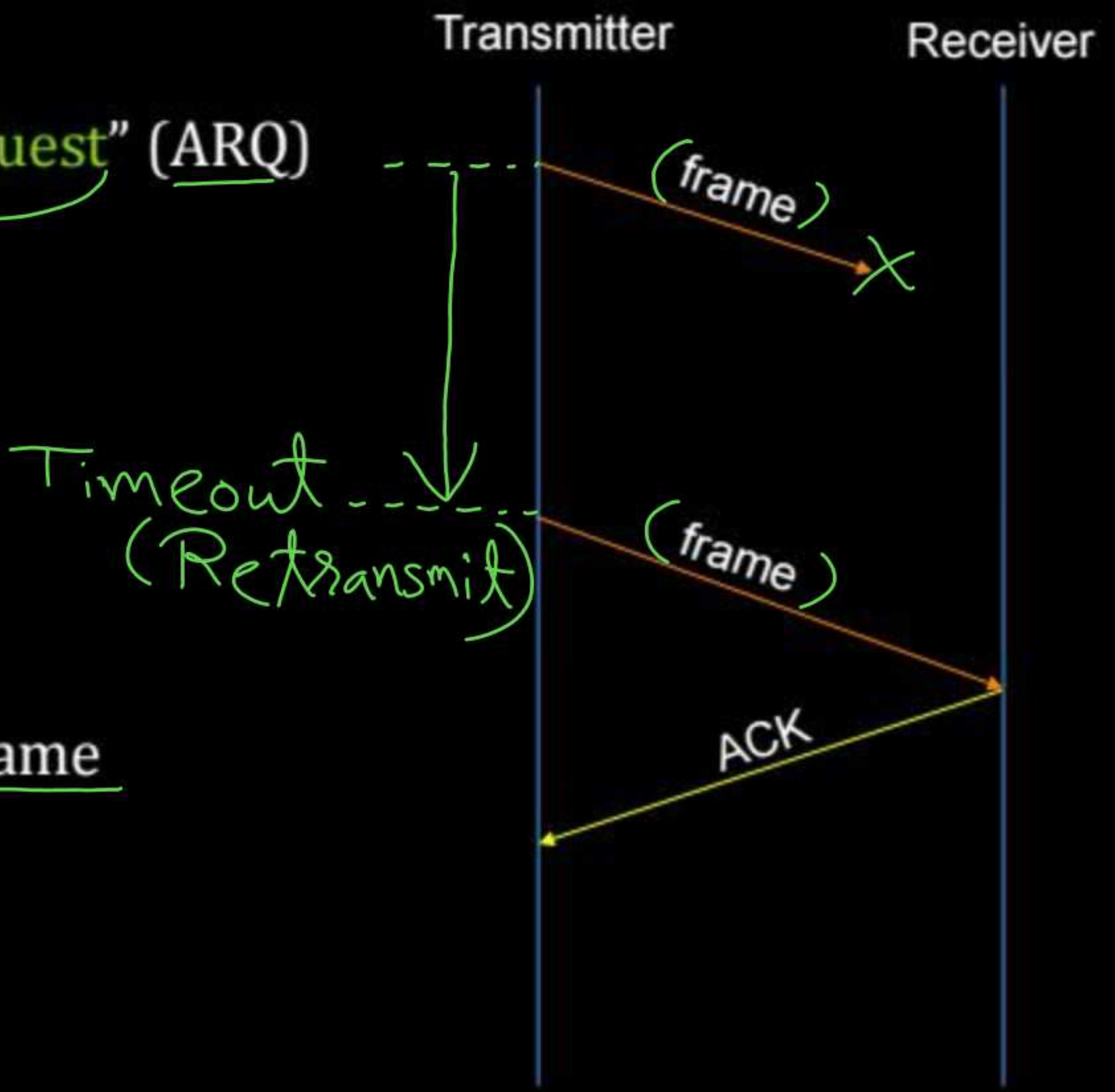
→ Transmitter may goes in indefinite wait for ACK



Topic : Stop-and-Wait ARQ

→ To ~~avoid~~ prevent from indefinite wait time at transmitter

transmitter uses "Automatic Repeat Request" (ARQ)



Automatic Repeat Request (ARQ) :

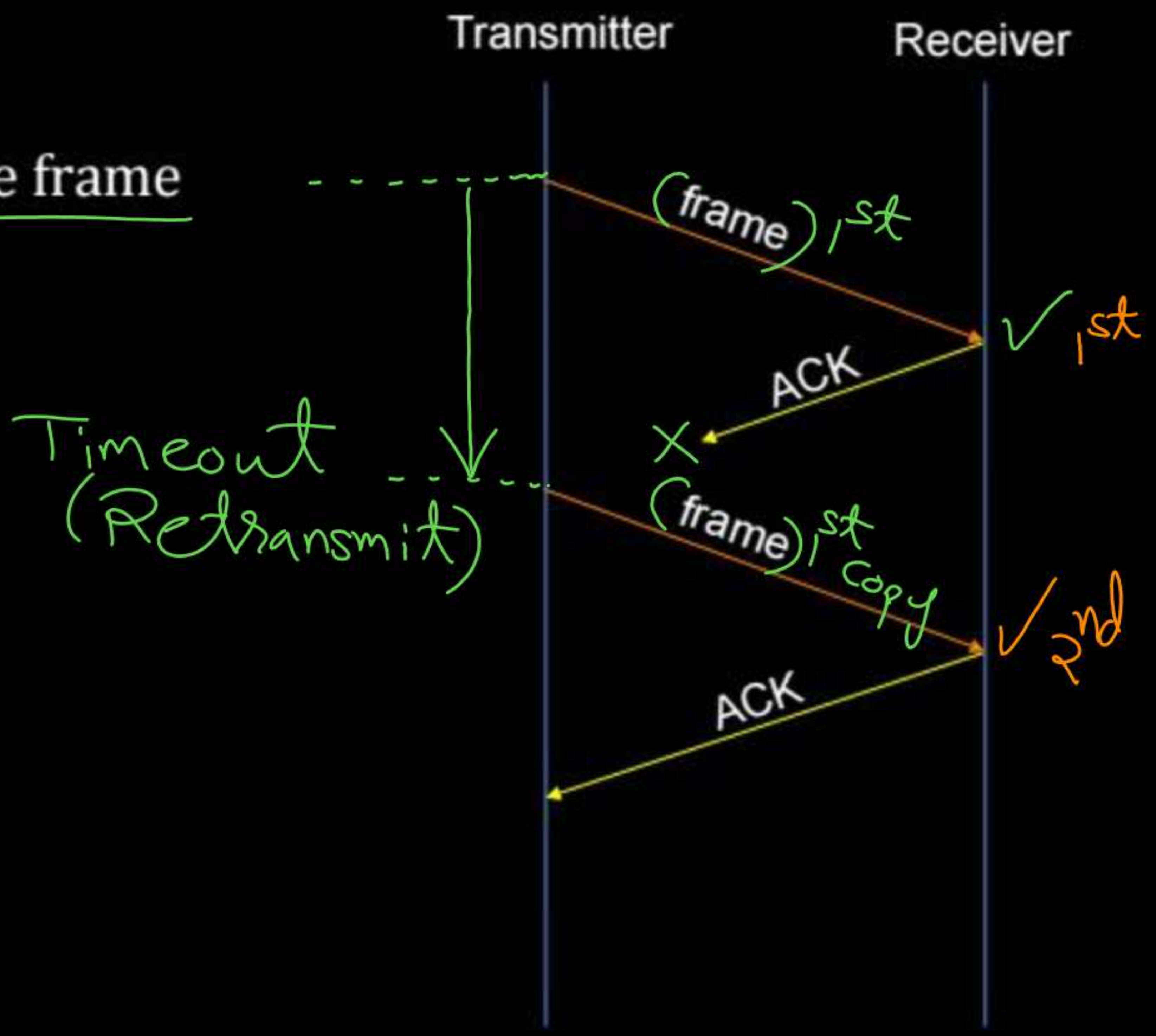
→ After transmission of a frame,
transmitter wait for an ACK upto time-out

→ After time-out, transmitter retransmit the frame

Topic : Stop-and-Wait ARQ

Case II :

→ Receiver may not able to identify duplicate frame



Topic : Stop-and-Wait ARQ

→ To identify duplicate frame at receiver transmitter uses "$\underbrace{\text{Sequence Number}}_{0}$" field in the frame

⇒ one-bit sequence no.

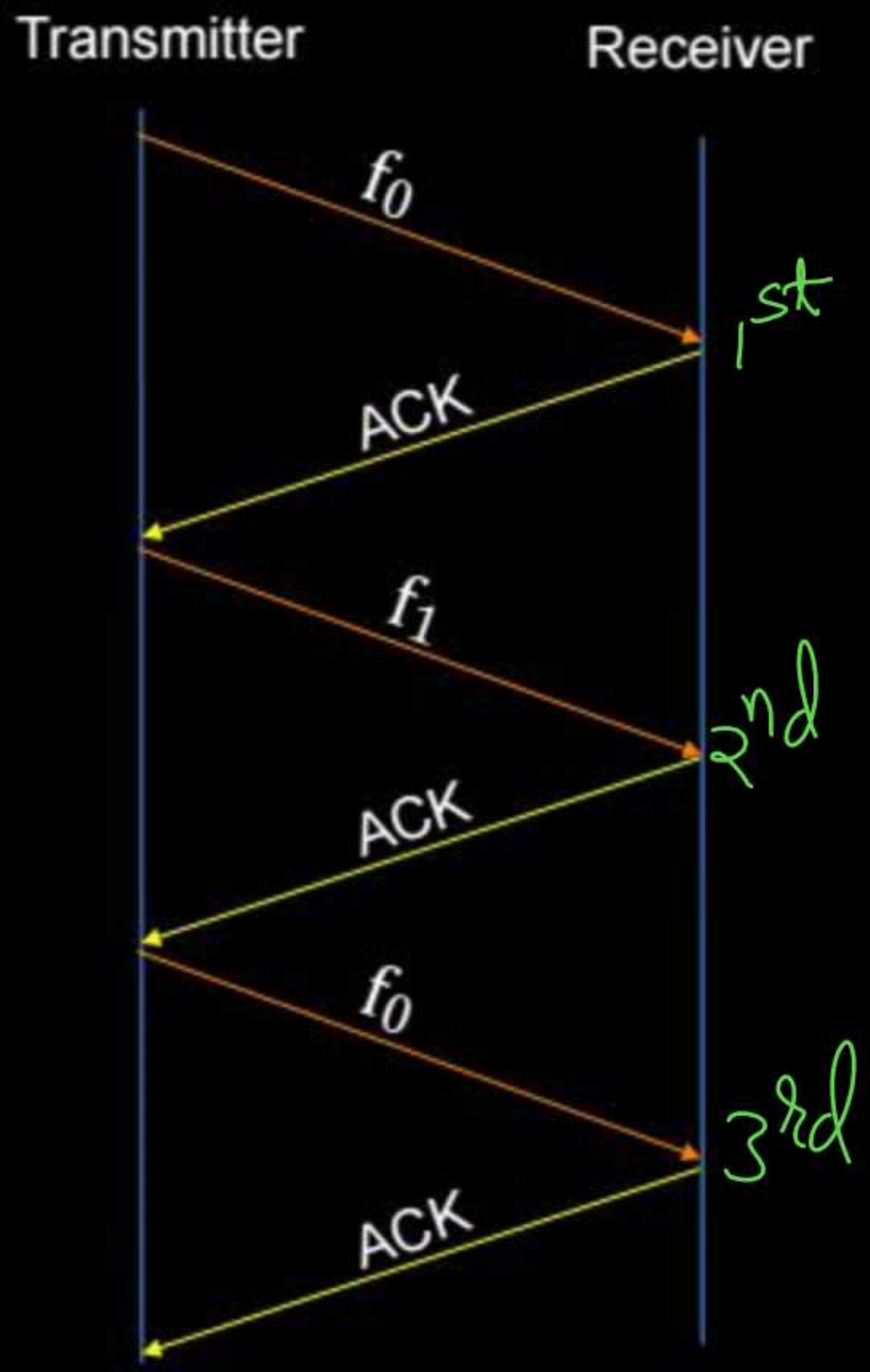
$\boxed{\text{Sequence Number} \leftarrow (\text{Frame Number}) \bmod 2}$

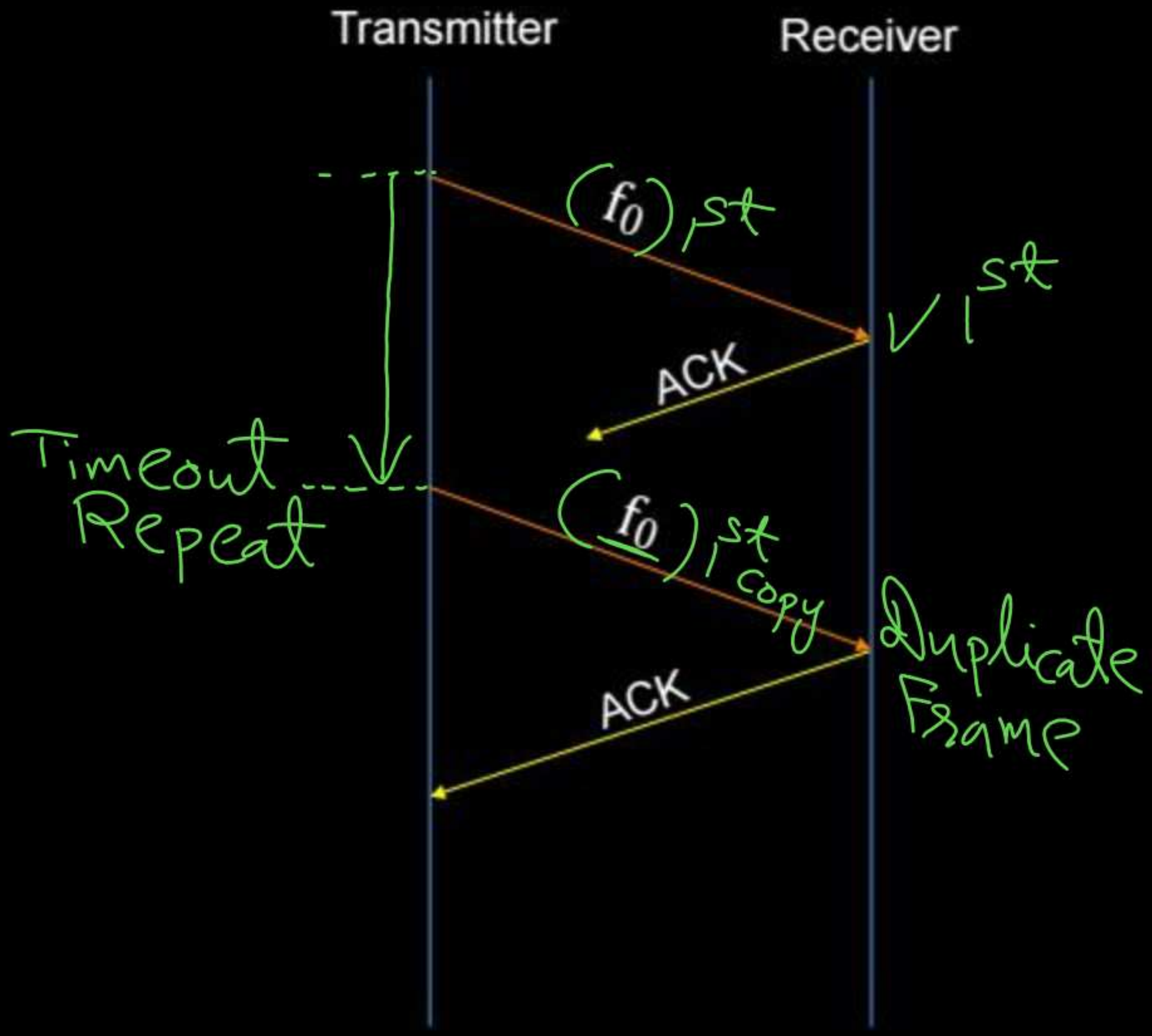
(sender) Queue of frame

F_0	F_1	F_2	F_3	F_4	....	F_{10}	F_{11}	..
0	1	0	1	0		0	1	

→ Stop-and-Wait ARQ is also known as "Alternate bit protocol"

Topic : Stop-and-Wait ARQ





2 mins Summary

Topic ~~Network Delay~~ Flow Control

Topic ~~End to end Delay~~ Stop and Wait ARQ

THANK - YOU