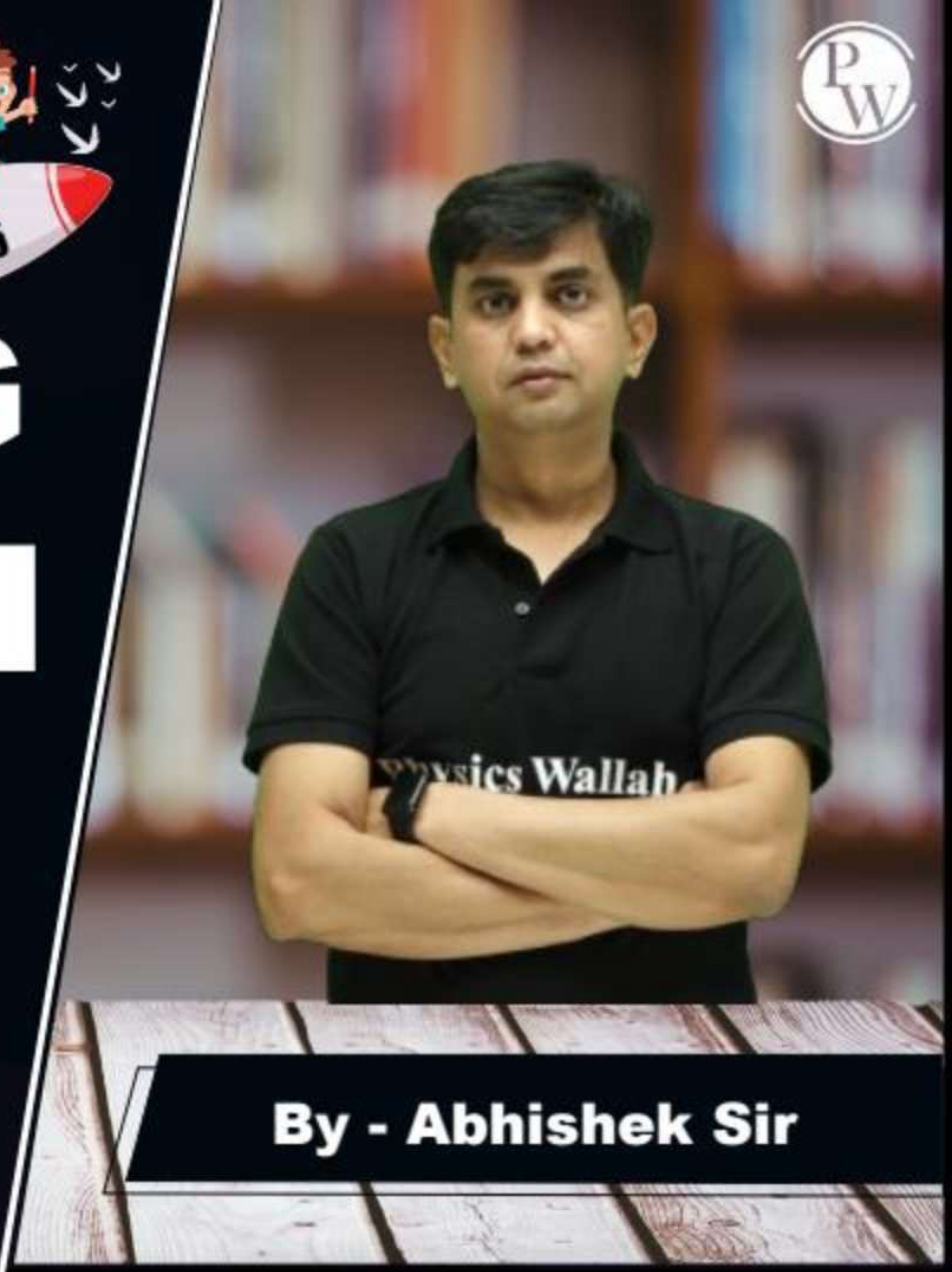
CS & IT ENGINEERING

Computer Network

Flow Control

Lecture No. - 05



By - Abhishek Sir

Recap of Previous Lecture

Topic Stop and Wait ARQ

Topics to be Covered

Topic Stop and Wait ARQ

Topic Sliding Window ARQ

ABOUT ME

Hello, I'm Abhishek

- GATE CS AIR - 96
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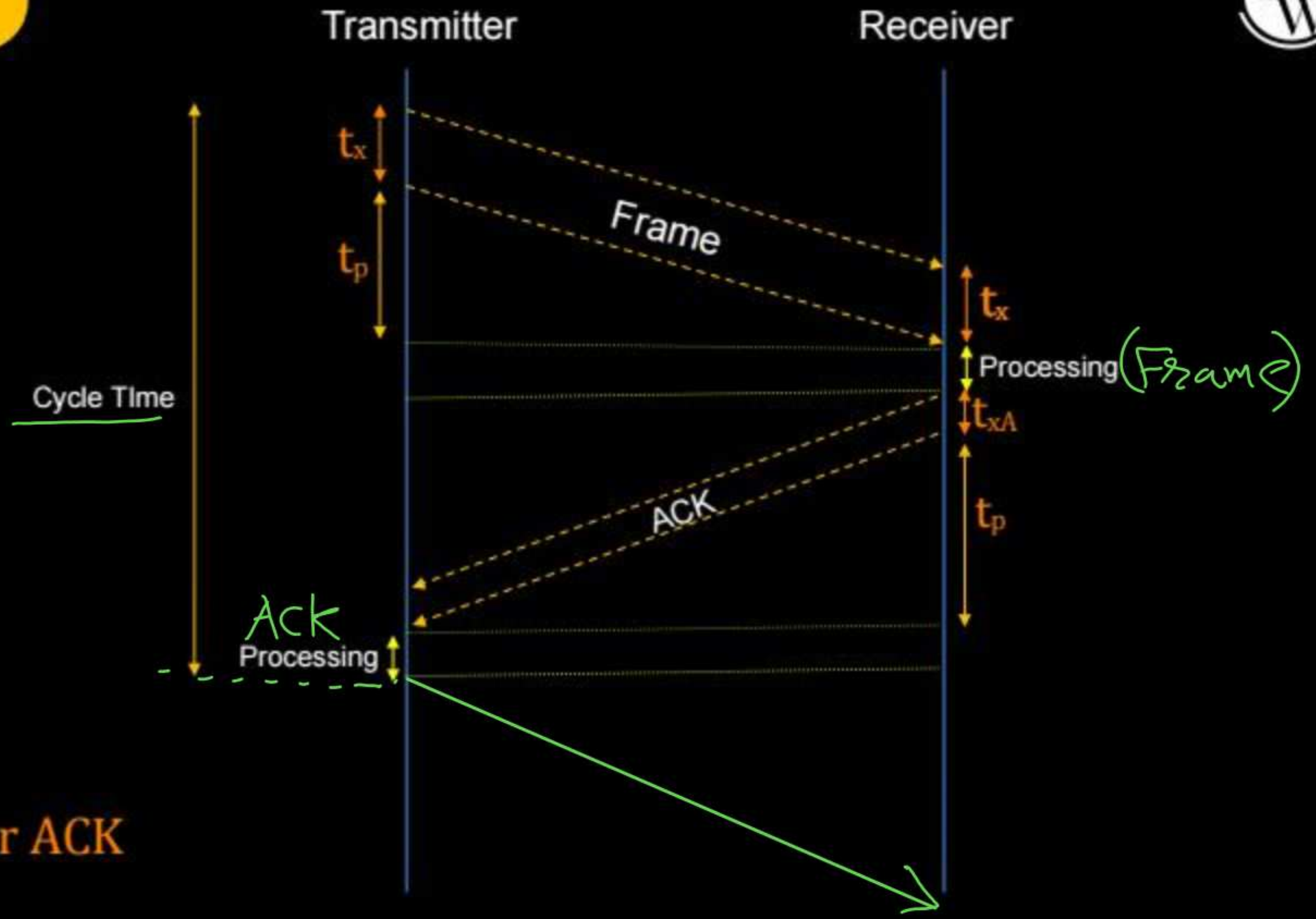
Topic : Cycle Time

Cycle time = Transmission delay + Propagation delay
+ Queuing delay at receiver + Processing delay by receiver for frame
+ Transmission delay for ACK + Propagation delay
+ Queuing delay at transmitter + Processing delay by transmitter for ACK

Topic : Cycle Time



t_{xA} : Transmission delay for ACK

$t_{xA} << t_x$

Topic : Efficiency

→ For Stop-and-Wait ARQ :

$$\text{Efficiency } (\eta) = \frac{\text{Transmission delay}}{\text{Cycle Time}} = \frac{t_x}{\text{cycle time}}$$

$$\text{Efficiency } (\eta) = \frac{\text{Transmission delay}}{\text{Cycle Time}} * 100\ \%$$

Cycle time $= (t_x + 2t_p)$

$$\eta = \frac{t_x}{\text{Cycle time}} = \frac{t_x}{(t_x + 2t_p)}$$

$$\boxed{\eta = \frac{1}{1+2a}}$$

where a is normalized propagation delay

$$\left[a = \frac{t_p}{t_x}\right]$$

#Q. The values of parameters for the Stop-and–Wait ARQ protocol are as given below.

Bit rate of the transmission channel = 1Mbps
Propagation delay from sender to receiver = 0.75 ms
Time to process a frame = 0.25ms
Number of bytes in the information frame = 1980
Number of bytes in the acknowledge frame = 20
Number of overhead bytes in the information frame = 20

Assume that there are no transmission errors. Then the transmission efficiency (expressed in percentage) of the Stop-and–Wait ARQ protocol for the above parameters is _______ (correct to 2 decimal place).

[GATE 2017]

$\boxed{\text{Ans: } 86{\cdot}5 \text{ to } 89{\cdot}5}$

Solution:-

Frame

Packet Size $= \underbrace{(20 + 1980)}$ bytes $=$ 2000 bytes $= \underbrace{16 * 10^3 \text{ bits}}$

ACK Size $=$ 20 bytes $=$ 160 bits

Bandwidth $=$ 1 Mbps $= \underbrace{10^6 \text{ bits / sec}}$

$$t_x = \frac{\text{Packet Size}}{\text{Bandwidth}} = \frac{16 * 10^3 \text{ bits}}{10^6 \text{ bits / sec}} = \underbrace{16 \text{ ms}}$$

$$t_{xA} = \frac{\text{ACK Size}}{\text{Bandwidth}} = \frac{160 \text{ bits}}{10^6 \text{ bits / sec}} = \underbrace{0.16 \text{ ms}}$$

$t_p = 0.75$ ms

Processing Delay = 0.25 ms

$\boxed{\text{Cycle time} = (t_x + t_p) + \text{Processing Delay} + (t_{xA} + t_p)} = \underbrace{17.91 \text{ ms}}$

$= (16 + 0.75) + 0.25 + (0.16 + 0.75)$

For Stop-and-Wait ARQ :

$$\text{Efficiency } (\eta) = \frac{\text{Transmission delay}}{\text{Cycle Time}} * 100\% = \frac{t_x}{\text{Cycle time}} * 100\%$$

$$= \frac{16 \text{ ms}}{17.91 \text{ ms}} * 100\% = 89.335\%$$

$\rightarrow 89.33\%$

$\rightarrow 89.34\%$

$$t_x = \frac{1980 \text{ byte}}{1 \text{ Mbps}} = 15.84 \text{ ms}$$

$$\text{cycle time} = 17.75 \text{ ms}$$

$$\eta = \frac{t_x}{\text{Cycle time}} * 100\%$$

$$= \frac{15.84 \text{ ms}}{17.75 \text{ ms}} * 100\%$$

$$= 89.239\% \begin{cases} \rightarrow 89.23\% \\ \rightarrow 89.24\% \end{cases}$$

#Q. Suppose two hosts are connected by a point-to-point link and they are configured to use Stop-and-Wait protocol for reliable data transfer. Identify in which one of the following scenarios, the utilization of the link is the lowest.

[GATE 2023]

(A) Longer link length and lower transmission rate

(B) Longer link length and higher transmission rate

(C) Shorter link length and lower transmission rate

(D) Shorter link length and higher transmission rate

$\boxed{\text{Ans: B}}$

$$\eta = \frac{1}{1+2a} = \frac{1}{1+2\left(\frac{t_p}{t_x}\right)} = \frac{1}{1+2 * \frac{\text{Distance}}{\text{Signal speed}} * \frac{\text{Data transfer Rate}}{\text{Frame size}}}$$

$$\eta \propto \frac{1}{\text{Distance}}$$

$$\eta \propto \frac{1}{\text{Data transfer Rate}}$$

Topic : Efficiency

→ To achieve 100% utilization ($\eta = 1$) in Stop-and-Wait ARQ

$$\text{Efficiency } (\eta) = \frac{\text{Transmission delay}}{\text{Cycle Time}}$$

$$\boxed{\text{Cycle Time} = \text{Transmission delay}}$$

→ 100% utilization ($\eta = 1$) in Stop-and-Wait ARQ
[Only when propagation delay and other latency are Zero]

Topic : Efficiency

→ To achieve 50% utilization ($\eta = 1/2$) in Stop-and-Wait ARQ

$$\text{Efficiency } (\eta) = \frac{\text{Transmission delay}}{\text{Cycle Time}}$$

$$\boxed{\text{Cycle Time} = 2 * \text{Transmission delay}}$$

$$= 2 * t_x$$

$$\frac{1}{2} = \frac{t_x}{\text{cycle time}}$$

Example 8 :-

Consider two hosts A and B directly connected through point to point link using stop and wait ARQ for flow control. Suppose link bandwidth is 2 Mbps and one-way propagation delay is 8 milisecond. To achieve a link utilization of at least 50% the minimum frame size is ______ bytes .

$$\left(\eta = \frac{1}{2}\right) \qquad \eta = \frac{t_x}{(t_x + 2t_p)}$$

$$\frac{1}{2} = \frac{t_x}{(t_x + 2t_p)}$$

$$(t_x + 2t_p) = 2t_x$$

$$t_x = 2t_p$$

$$\frac{\text{Frame Size}}{\text{Bandwidth}} = 2t_p$$

$$\text{Frame Size} = (2t_p) * \text{Bandwidth}$$

Solution:-

Bandwidth = 2 Mbps = $2 * 10^6$ bits / sec

t_p = 8 ms = $8 * 10^{-3}$ Sec

To achieve 50% utilization in Stop-and-Wait ARQ.

$$\boxed{\text{Cycle time} = 2 * t_x}$$

$$(t_x + 2 * t_p) = 2 * t_x$$

$$\boxed{t_x = 2 * t_p}$$

$$\begin{aligned}\text{Frame Size} &= (2 * t_p) * \text{Bandwidth}\\ &= (2 * 8 * 10^{-3}\,\text{Sec}) * (2 * 10^6\,\text{bits / sec})\\ &= 32 * 10^3\,\text{bits}\\ &= 4 * 10^3\,\text{bytes}\end{aligned}$$

$\boxed{\text{Ans} = 4000}$

#Q. A channel has a bit rate of 4 kbps and one-way propagation delay of 20 ms. The channel uses stop and wait protocol. The transmission time of the acknowledgement frame is negligible. To get a channel efficiency of at least 50%, the minimum frame size should be

[GATE 2005]

IIT-B

H.W.

A 80 bytes

B 80 bits

C 160 bytes

D 160 bits

#Q. Suppose that the stop-and-wait protocol is used on a link with a bit rate of 64 kilobits per second and 20 milliseconds propagation delay. Assume that the transmission time for the acknowledgment and the processing time at nodes are negligible. Then the minimum frame size in bytes to achieve a link utilization of at least 50% is _______.

[GATE 2015]

IIT-K

H.W.

Topic : Efficiency

→ To achieve 25% utilization ($\eta = 1/4$) in Stop-and-Wait ARQ

$$\text{Efficiency } (\eta) = \frac{\text{Transmission delay}}{\text{Cycle Time}}$$

$$\frac{1}{4} = \frac{t_x}{\text{cycle time}}$$

$$\boxed{\text{Cycle Time} = 4 * \text{Transmission delay}}$$

#Q. A link has a transmission speed of 10^6 bits/sec. It uses data packets of size 1000 bytes each. Assume that the acknowledgment has negligible transmission delay, and that its propagation delay is the same as the data propagation delay. Also assume that the processing delays at nodes are negligible. The efficiency of the stop-and-wait protocol in this setup is exactly 25%. The value of the one-way propagation delay (in milliseconds) is ________.

[GATE 2015]

Topic : Channel Utilization

→ Link Utilization or Throughput

$$\text{Throughput} = \frac{\text{Packet Size}}{\text{Cycle Time}}$$

$$= \frac{\left(\frac{\text{Packet size}}{\text{Bandwidth}}\right)}{\text{cycle time}} * \text{Bandwidth}$$

Efficiency/Utilization (Throughput)

1. factor [0 to 1]
2. Percentage [0 to 100%]
3. bits/sec or bytes/sec

$$\text{Throughput} = \text{Efficiency} * \text{Data Transfer Rate (at sender)}$$

Example 9 :-

Consider two hosts A and B directly connected through point to point link using stop and wait ARQ for flow control. Suppose packet size is 50 bytes, link bandwidth is 2 Kbps and one-way propagation delay is 100 milisecond, the sender throughput is ________ bytes/second?

Solution:-

Packet Size = 50 bytes = 400 bits

Bandwidth = 2 Kbps = $2 * 10^3$ bits / sec

$$t_x = \frac{\text{Packet Size}}{\text{Bandwidth}} = \frac{400 \text{ bits}}{2 * 10^3 \text{ bits / sec}} = 200 \text{ ms}$$

$$t_p = 100 \text{ ms}$$

$$\text{Cycle time} = (t_x + t_p) + (t_{xA} + t_p) = 400 \text{ ms}$$

$$= (200 + 100) + (0 + 100) \text{ ms}$$

$$\text{Throughput} = \frac{\text{Packet Size}}{\text{Cycle Time}} = \frac{50 \text{ bytes}}{400 \text{ ms}} = \frac{50 \text{ bytes}}{400 * 10^{-3} \text{ sec}}$$

$$= \frac{50 * 10^{3} \text{ bytes}}{400 \text{ sec}}$$

$$= \boxed{125 \text{ bytes / sec}}$$

$$= \frac{500}{4} \text{ bytes/sec}$$

$$\eta = \frac{t_x}{\text{Cycle time}} = \frac{200 \text{ ms}}{400 \text{ ms}} = \frac{1}{2}$$

$$\text{Throughput} = \eta * \text{Bandwidth}$$

$$= \frac{1}{2} * 2 * 10^{3} \text{ bits/sec} = 1000 \text{ bits/sec}$$

$$\boxed{\text{Ans} = 125}$$

#Q. A sender uses the Stop-and-Wait ARQ protocol for reliable transmission of frames. Frames are of size 1000 bytes and the transmission rate at the sender is 80 Kbps (1Kbps = 1000 bits/second). Size of an acknowledgement is 100 bytes and the transmission rate at the receiver is 8 Kbps. The one-way propagation delay is 100 milliseconds. Assuming no frame is lost, the sender throughput is ________ bytes/second.

[GATE 2016]

IISC

H.W.

Topic : Sliding Window ARQ

→ Transmitter's transmitting window size = N [N>1]

→ Transmitter's transmit N frames continuously without any ACK

→ Overlapping, unlike Stop-and-Wait ARQ
[To increase utilization]

$$\boxed{\text{Efficiency} = \frac{[\text{Window Size} * \text{Packet transmission time}]}{\text{Cycle Time (RTT)}}}$$

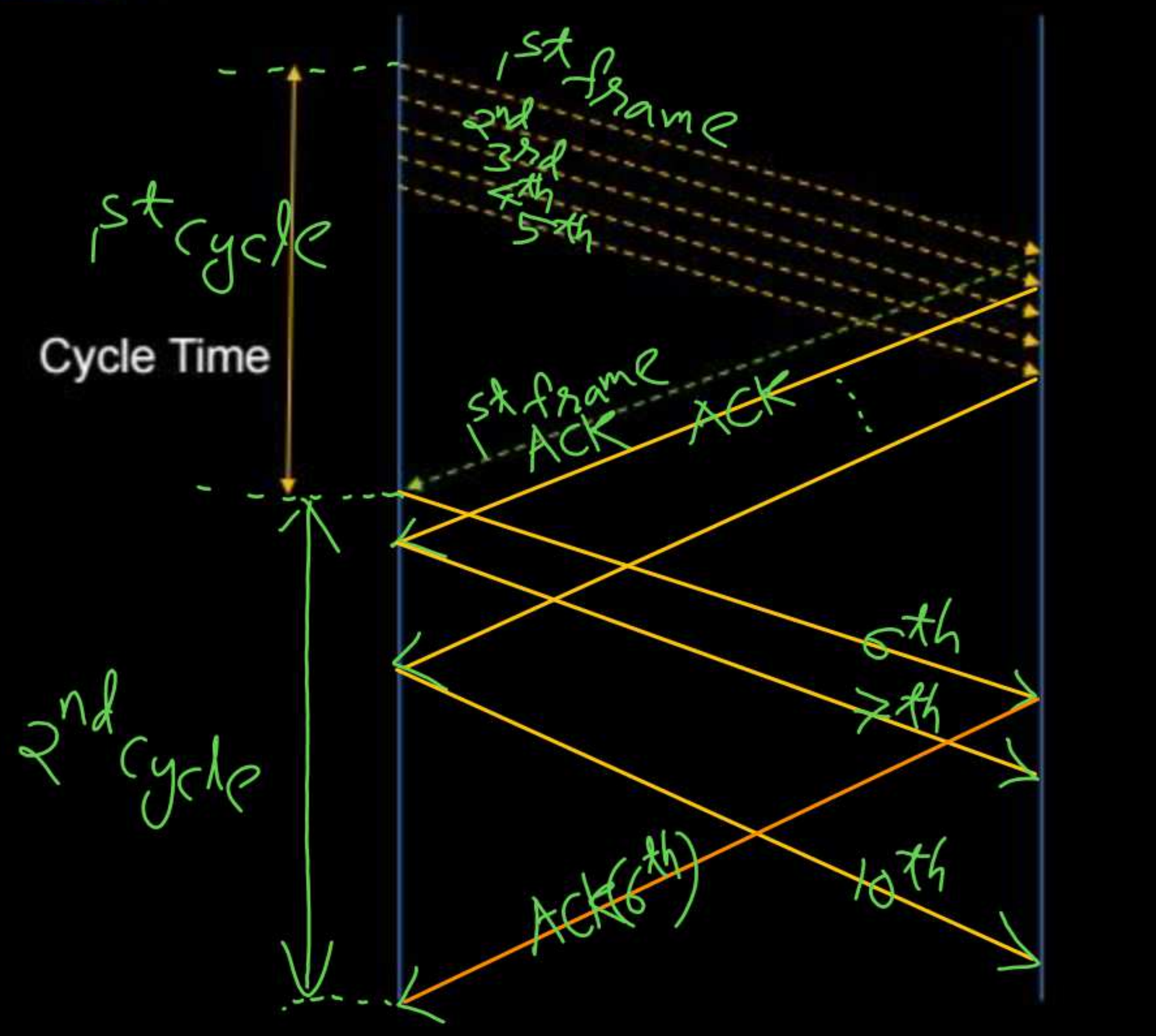
$$\boxed{\eta = \frac{N * t_x}{\text{Cycle time}}}$$

Topic : Sliding Window ARQ

$$\text{Efficiency}_{[\text{Sliding Window}]} = N * \text{Efficiency}_{[\text{Stop-and-Wait}]}$$

$$\eta_{(\text{sliding window})} = N * \frac{t_x}{\text{cycle time}}$$

Topic : Sliding Window ARQ



2 mins Summary

Topic Stop and Wait ARQ

Topic Sliding Window ARQ

THANK - YOU