CS & IT ENGINEERING

COMPUTER NETWORKS

Flow Control

Lecture No-3

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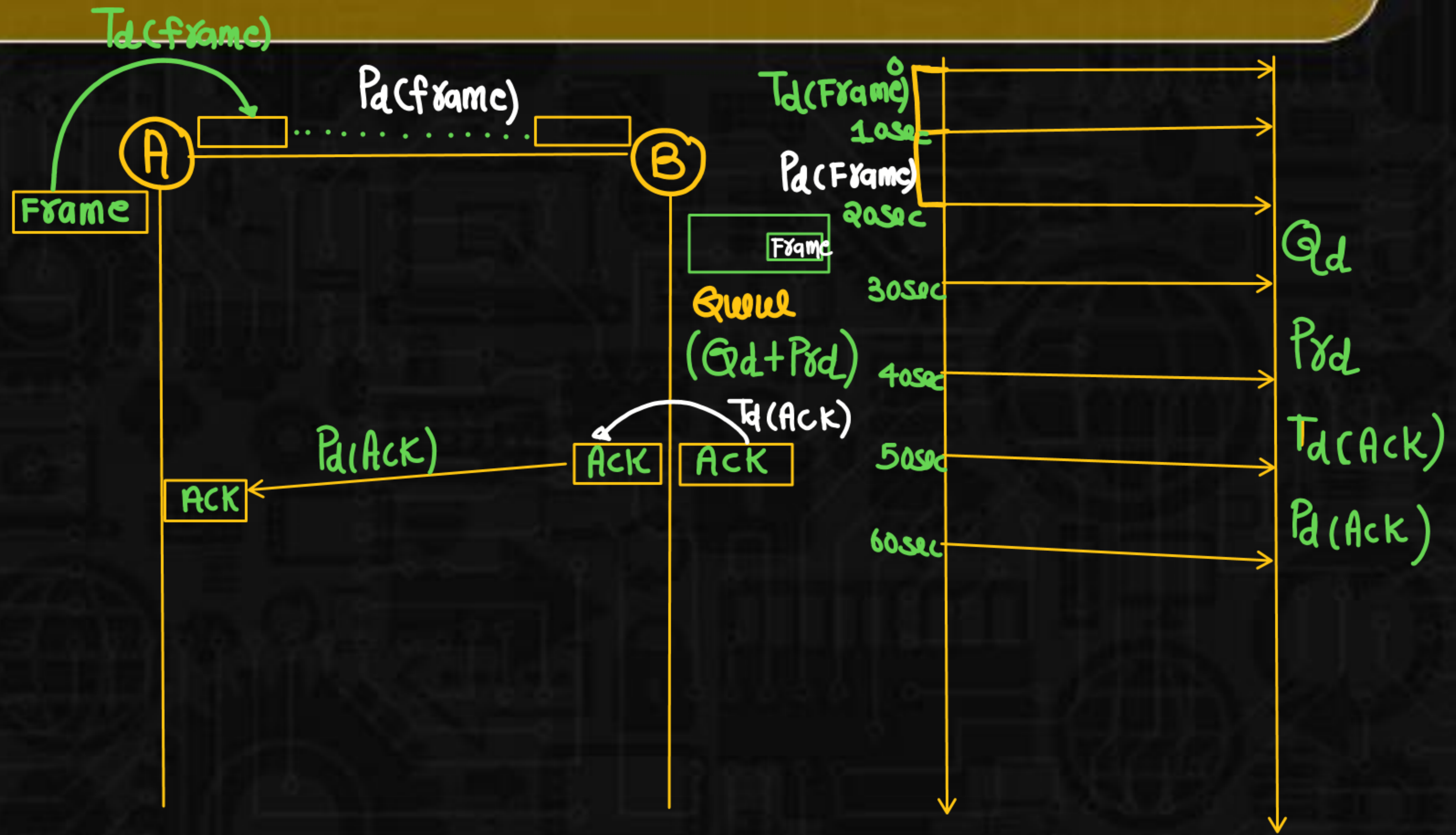
TOPICS TO BE COVERED

- Stop and wait Protocol

Efficiency OR Line utilization OR Link utilization OR Sender utilization



$$\text{Total time} = T_d(\text{frame}) + P_d(\text{frame}) + Q_d + P_{rd} + T_d(\text{Ack}) + P_d(\text{Ack})$$

$$RTT = T_d(\text{frame}) + P_d(\text{frame}) + \cancel{Q_d}^{\approx 0} + \cancel{P_{rd}}^{\approx 0} + T_d(\text{Ack}) + P_d(\text{Ack})$$

$$RTT = T_d(\text{frame}) + P_d(\text{frame}) + T_d(\text{Ack}) + P_d(\text{Ack})$$

$$RTT = T_d(\text{frame}) + 2 * P_d + T_d(\text{Ack})$$

Ack size << Frame size

$$T_d(\text{Ack}) << T_d(\text{frame})$$

$$\boxed{\underset{\text{Total time}}{\overset{}{RTT \text{ or }}} = T_d(\text{frame}) + 2 * P_d}$$

$$\boxed{\text{Total time or RTT} = T_d(\text{frame}) + 2 * P_d + Q_d + P_{rd} + T_d(\text{Ack})}$$

exact Formula

efficiency OF stop & wait Protcol

$$\text{efficiency} = \frac{\text{useFul time}}{\text{total time}}$$

$$\boxed{\text{efficiency} = \frac{T_d(\text{frame})}{T_d(\text{frame}) + 2 * P_d + Q_d + P_{rd} + T_d(\text{Ack})}}$$

exact Formula

OR

$$\boxed{\text{efficiency} = \frac{T_d(\text{Frame})}{RTT}}$$

efficiency or Line utilization or Link utilization or sender utilization

Assume

$Q_d = 0$

$P_{rd} = 0$

$T_d(\text{Ack}) = 0$

$$\text{Total time} = T_d(\text{frame}) + 2 * P_d + \cancel{Q_d}_{0} + \cancel{P_{rd}}_{0} + \cancel{T_d(\text{Ack})}_{0}$$

$$\text{Total time} = T_d(\text{frame}) + 2 * P_d$$

$$\text{efficiency} = \frac{\text{useful time}}{\text{total time}}$$

$$\text{efficiency} = \frac{T_d(\text{frame})}{T_d(\text{frame}) + 2 * P_d}$$

$$= \frac{\cancel{T_d}}{\cancel{T_d}\left[1 + 2 * \frac{P_d}{T_d}\right]}$$

$$\text{efficiency} = \frac{1}{1 + 2 * \frac{P_d}{T_d}}$$

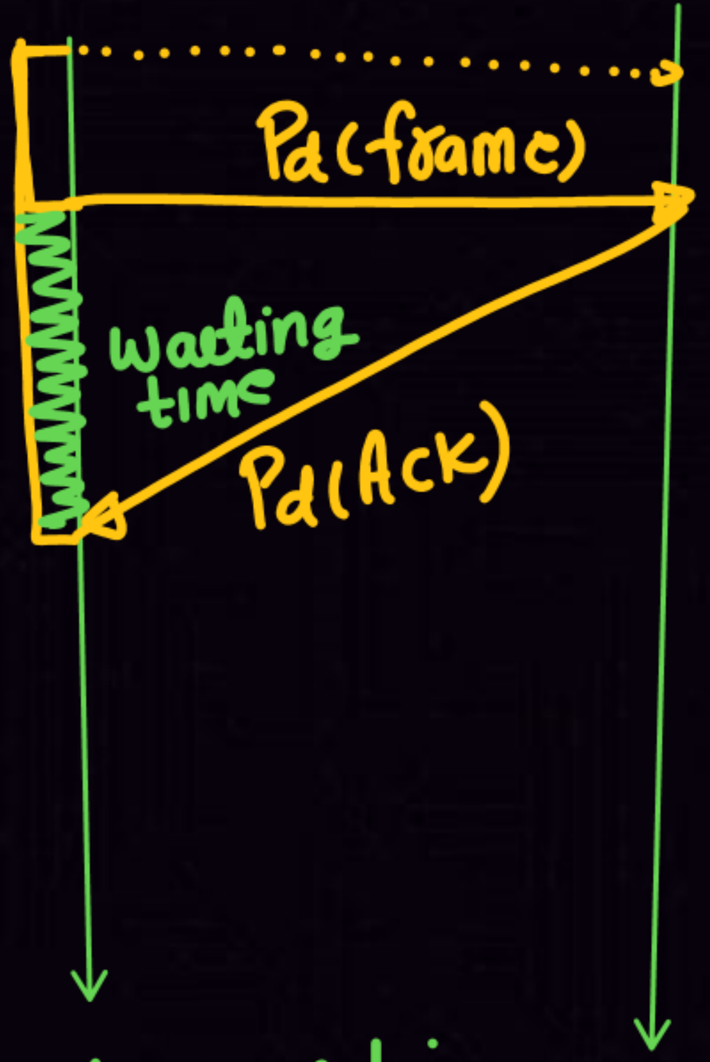
$$\frac{P_d}{T_d} = a$$

$$\boxed{\text{efficiency} = \frac{1}{1 + 2a}} \quad \times$$

Approximate Formula

Useful time $\Rightarrow T_d$

Waiting time $\Rightarrow 2 * P_d$



$$\eta = \frac{\text{Useful time}}{\text{total time}}$$

$$= \frac{T_d}{T_d + 2 * P_d} = \frac{\cancel{T_d}}{\cancel{T_d}\left[1 + 2 * \frac{P_d}{T_d}\right]}$$

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

Throughput OR effective Bandwidth or Bandwidth utilization OR Maximum data rate possible

Total time $\longrightarrow$ 1 Frame

$\underbrace{T_d(\text{frame}) + 2 * P_d + Q_d + P_{rd} + T_d(\text{Ack})}_{10\text{ sec}} \longrightarrow \underbrace{1\text{ Frame}}_{1000\text{ bits}}$

10 sec $\longrightarrow$ 1000 bits

1 sec $\longrightarrow$ $\frac{1000}{10}$ = 100 bits (100 bits/sec)

$$\boxed{\text{throughput} = \frac{\text{Frame size or Length of Frame}}{\text{Total time}}}$$

$$\text{Throughput} = \frac{\text{Length of Frame}}{\text{total time}}$$

$$= \frac{L}{T_d(\text{frame}) + 2 * P_d + Q_d + P_{rd} + T_d(\text{Ack})}$$

$$= \frac{\frac{L}{B} * B}{T_d(\text{frame}) + 2 * P_d + Q_d + P_{rd} + T_d(\text{Ack})}$$

$$= \frac{T_d(\text{frame}) * B}{T_d(\text{frame}) + 2 * P_d + Q_d + P_{rd} + T_d(\text{Ack})}$$

$$\boxed{\text{Throughput} = \text{efficiency} * \text{Bandwidth}}$$

$$\boxed{\text{efficiency} = \frac{\text{Throughput}}{\text{Bandwidth}}}$$

Example

Q. If sender want to send 10 packet and every 4th packet that is being transmitted is lost. By using stop and wait protocol How many total transmission are required____

Sol^n: 1 2 3 ~~4~~ 4 5 6 ~~7~~ 7 8 9 ~~10~~ 10

x x x

Total transmission = 13

No. of retransmission = 3

Example

Q. If sender want to send 500 packets on a link having a error probability 0.2. A stop and wait protocol is used to transfer data across the link then How many total transmission are required 625

A —— $n = 500$ Pkt —— B

error Probability (P) = 0.2

$$\overset{n}{500} + \overset{np}{500(0.2)} + \overset{np \cdot p}{100(0.2)} + \overset{np^2 \cdot p}{20(0.2)}$$

$$\overset{n}{500} + \overset{np}{100} + \overset{np^2}{20} + \overset{np^2}{4} + \cdots$$

$$n + np + np^2 + np^3 + \cdots$$

$$n[1 + p + p^2 + p^3 + \cdots]$$

$$n\left[\frac{1}{1-p}\right] = \frac{n}{1-p}$$

$$\boxed{\text{Total transmission required} = \frac{n}{1-P}}$$

$$= \frac{500}{1-0.2}$$

$$= \frac{5000}{0.8} = \frac{5000}{8} = 625$$

Problem Solving on Stop and Wait protocol

Q.1 Consider the Stop and Wait protocol, if transmission time is 'a' at the source and propagation delay is 'b', then after what time, the sender can send the second packet? Consider data packet and ACK packet of the same size.

(A) 2a + 2b

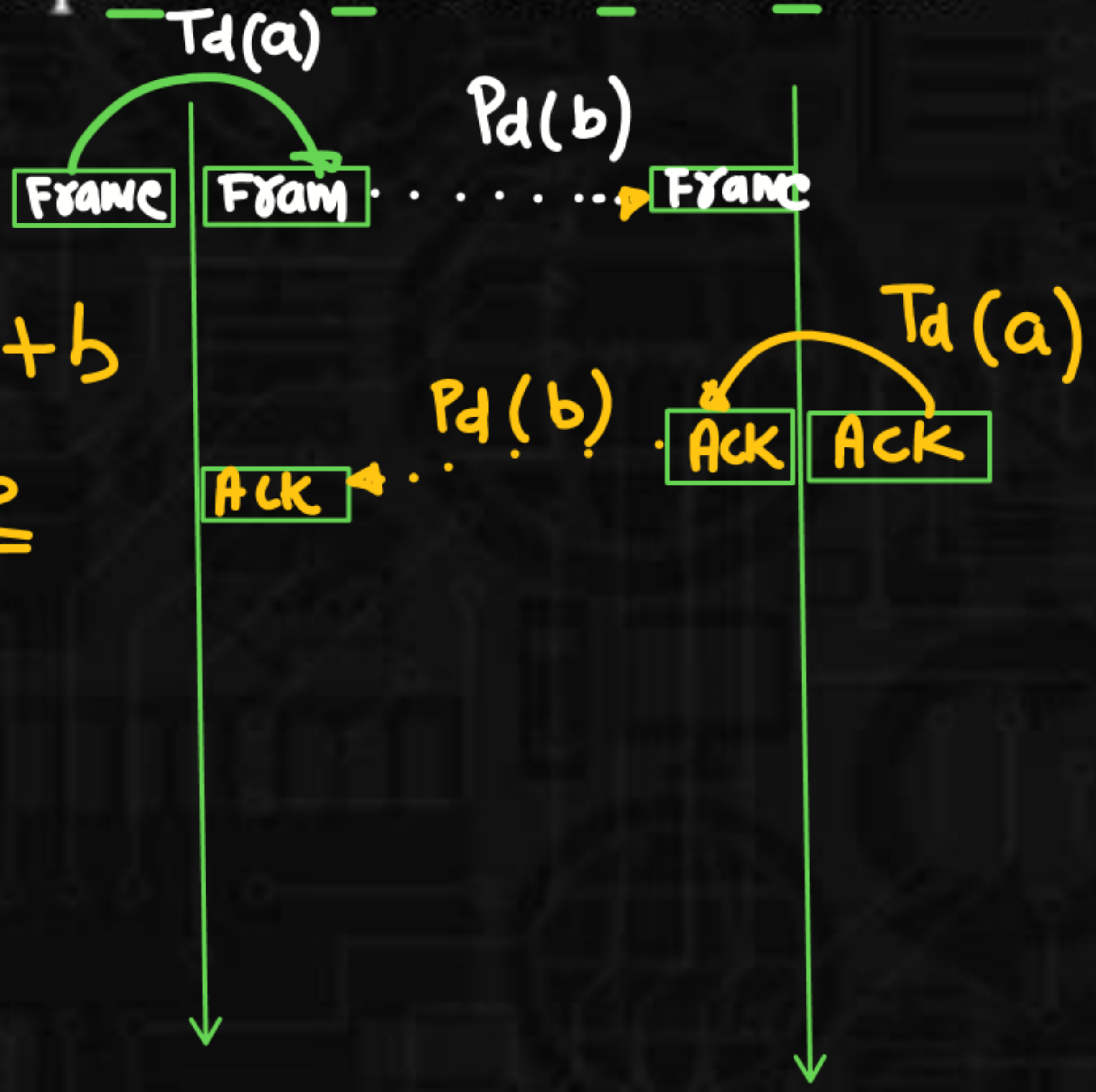
(B) (a + b)/2

(C) 2b + a

(D) a + 2b

a+b+a+b

$\underline{\underline{2a+2b}}$



Q.2 A series of a 1000 bit frame is to be transmitted across a data link of 100 km in length with 20 Mbps. If the link has a velocity of propagation 2×10^8 m/sec, then the efficiency of stop and wait protocol is ______ %.

Frame size = 1000 bits

Bandwidth = 20 mbps

$= 20 * 10^6$ bits/sec

$$T_d(\text{frame}) = \frac{\text{Frame size (L)}}{\text{Bandwidth (B)}}$$

$$= \frac{1\cancel{000}\text{ bi}\cancel{\text{ts}}}{20*10^{\cancel{6}}\text{ b}\cancel{\text{its}}\text{/sec}}$$

$= 0.05 * 10^{-3}$ sec

$= 0.05$ msec

$d = 100$ km

$v = 2*10^8$ m/sec

$v = 2*10^5$ km/sec

$$P_d = \frac{d}{v} = \frac{1\cancel{00}\text{ k}\cancel{\text{m}}}{2*10^{\cancel{5}}\text{ k}\cancel{\text{m}}\text{/sec}}$$

$= 0.5 * 10^{-3}$ sec

$= 0.5$ msec

$$\text{efficiency} = \frac{\text{useful time}}{\text{total time}}$$

$$= \frac{T_d(\text{frame})}{T_d(\text{frame}) + 2*P_d + \cancel{Q_d}^{\,0} + \cancel{P_{rd}}^{\,0} + \cancel{T_d(\text{Ack})}^{\,0}}$$

$$= \frac{0.05 \text{ msec}}{0.05 \text{ msec} + 2*0.5 \text{ msec}}$$

$$= \frac{0.05 \cancel{\text{msec}}}{1.05 \cancel{\text{msec}}}$$

$$= \frac{5}{105} = 0.04761$$

$$\boxed{\eta = 4.761\ \%}$$

Q.3 If the bandwidth of the line is 1.5 Mbps, RTT is 45 ms and Frame size is 8192 bits, then the efficiency in stop and wait protocol is _____ %.

$B = 1.5 \text{ mbps}$

$= 1.5 * 10^6 \text{ bits/sec}$

$RTT = 45 \text{ msec}$

$\text{Frame size} = 8192 \text{ bits}$

$\eta = ?$

$$T_d(\text{frame}) = \frac{\text{Frame size}}{\text{Bandwidth}}$$

$$= \frac{8192 \cancel{\text{bits}}}{1.5 * 10^6 \cancel{\text{bits}}/\text{sec}}$$

$$= 5461.33 * 10^{-6} \text{ sec}$$

$$= 5.461 * 10^{-3} \text{ sec}$$

$$= 5.461 \text{ msec}$$

$$\eta = \frac{\text{useful time}}{\text{total time}}$$

$$= \frac{T_d\,(\text{frame})}{RTT}$$

$$= \frac{5.461\ m\cancel{sec}}{45\ m\cancel{sec}}$$

$$= 0.1213$$

$$\boxed{\eta = 12.13\ \%}$$

Q.4 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 2500 bytes/second.

(GATE 2016-2m)

$P_d = 100\ msec$

$= 100 * 10^{-3}\ sec$

$= 10^{-1}\ sec$

$= \frac{1}{10}\ sec$

Frame size = 1000 Byte
= 8000 bits

B (Sender) $= 80\text{KbPs} = 80 \times 10^3$ bits|sec

$$T_d(\text{frame}) = \frac{\text{Frame size}}{\text{Bandwidth}}$$

$$= \frac{\cancel{8}\cancel{000}\ \cancel{\text{bits}}}{\cancel{8}0 * \cancel{10^3}\ \cancel{\text{bits}}|\text{sec}}$$

$$= \frac{1}{10}\text{sec}$$

Ack size = 100 Byte
= 800 bits

B (Receiver) $= 8\ \text{KbPs} = 8 \times 10^3$ bits|sec

$$T_d(\text{Ack}) = \frac{\text{Ack size}}{\text{Bandwidth}}$$

$$= \frac{\cancel{8}\cancel{00}\ \cancel{\text{bits}}}{\cancel{8} * 10^3\ \cancel{\text{bits}}|\text{sec}}$$

$$= \frac{1}{10}\text{sec}$$

$$\text{Throughput} = \frac{\text{Frame size}}{\text{total time}}$$

$$= \frac{\text{Frame size}}{T_d(\text{frame}) + 2 * P_d + \underbrace{\cancel{Q_d}}_{0} + \underbrace{\cancel{P_{xd}}}_{0} + T_d(\text{Ack})}$$

$$= \frac{8000 \text{ bits}}{\frac{1}{10}\text{sec} + 2 \times \frac{1}{10}\text{sec} + \frac{1}{10}\text{sec}}$$

$$= \frac{8000 \text{ bits}}{0.4 \text{ sec}}$$

$$= 20{,}000 \text{ bits/sec}$$

$$= \frac{20{,}000}{8} \text{ Byte/sec}$$

$$\boxed{\text{Throughput} = 2500 \text{ Byte/sec}}$$


THANK YOU
GW
SOLDIERS !