Flow Control Methods:

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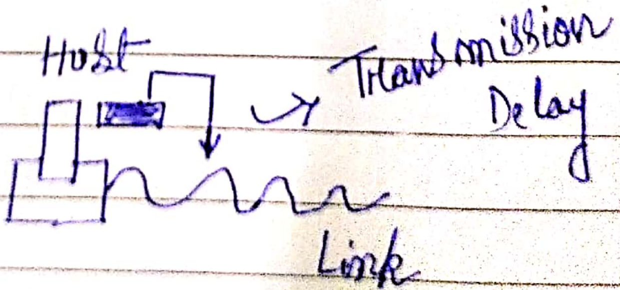
Delays	Notation
(i) Transmission delay	T_t
(ii) Propagation Delay	T_p
(iii) Queuing Delay	T_q

i) Transmission delay: (T_t)



T_t : Time taken to place the packet of a host on the outgoing link

$$\boxed{T_t = \frac{L}{B}} \text{ sec}$$

L → Length of the packets in bits

B → Bandwidth.

Notes

Ex: $L = 2000$ bits

$B = 10\text{Kbps} = 10 \times 10^3$ bps.

$$\therefore T_t = \frac{L}{B} = \frac{2000}{10 \times 10^3} \text{ Sec}$$

$$= 0.2 \text{ Sec}$$

Ex(S): $L = 1000$ bits

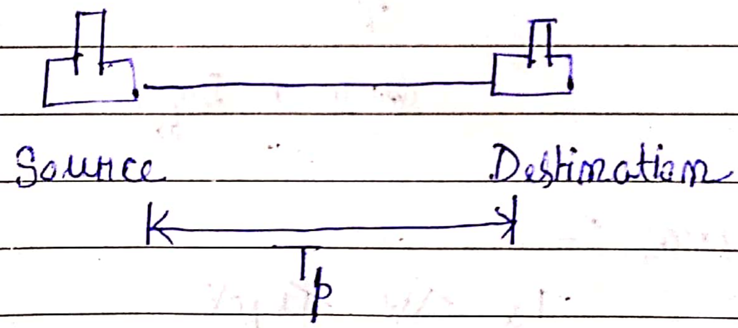
$B = 10$ Mbps

$T_t = ?$

$\Big\}$ Student

ii) **Propagation Delay** :→

T_p



Time taken by a bit to reach from Source (S) to the Destination (R).

$$T_p = \frac{d \rightarrow \text{Distance}}{v \rightarrow \text{Velocity}}$$

Q: In case of optical fibers the speed of the signal is approximately $\boxed{70\%}$ of speed of light. If $\boxed{d = 2.1 \text{ Km}}$ what is T_p

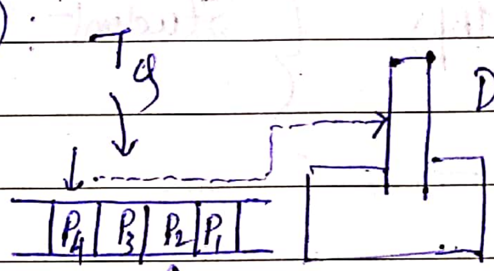
Notes

Note: The total time of propagation from Source to Destination

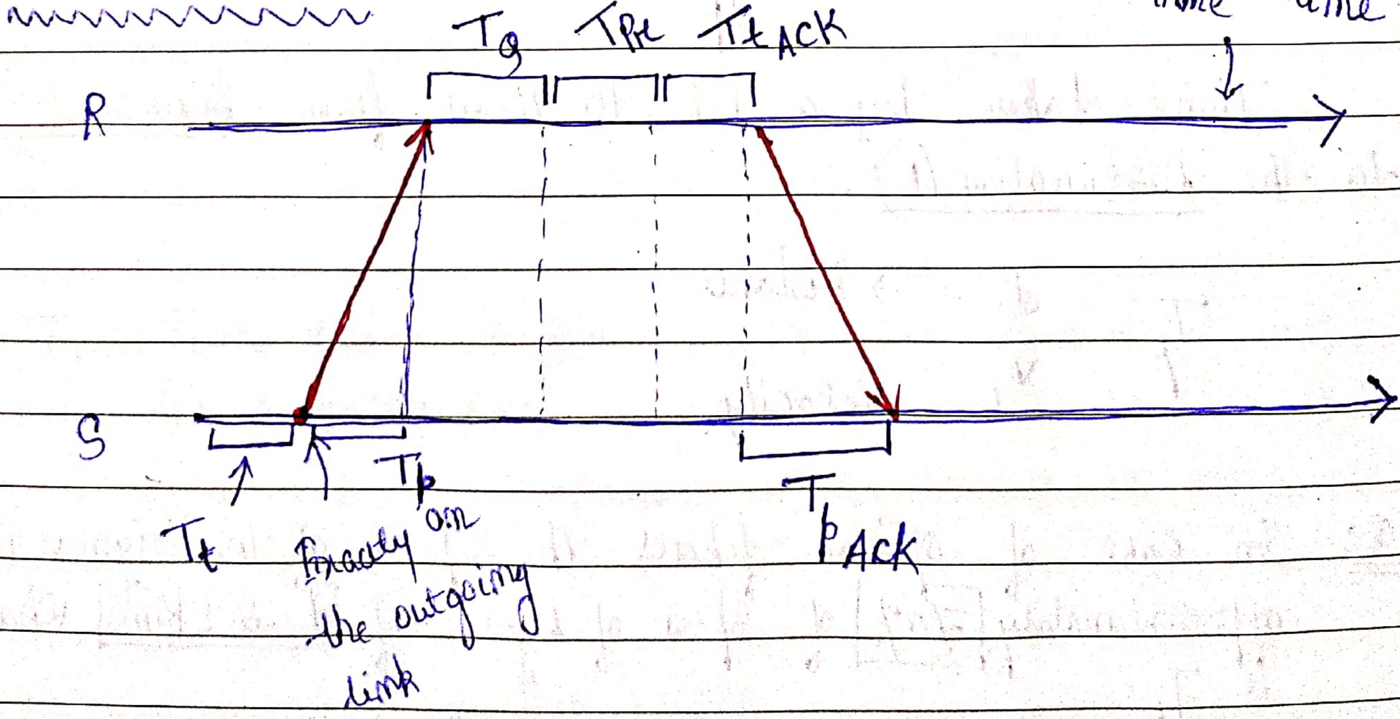
$= \text{Transmission Delay} + \text{Propagation Delay}$

$= T_t + T_p$.

iii) Queuing Delay (T_q):



FLOW CONTROL :→



Notes

$$\text{Total time} = \underline{T_t} + \underline{T_p} + \overset{\approx 0}{T_q} + \overset{\approx 0}{T_{pr}} + \underline{T_{t_{ACK}}} + \underline{\overset{\approx 0}{T_{p_{ACK}}}}$$

$$= T_t + 2T_p$$

$$\boxed{\therefore \text{The total time for Sending '1' packet} = T_t + 2T_p}$$

η : Efficiency or Utilization

$$\eta = \frac{\text{useful time}}{\text{Total time}} = \frac{T_t}{T_t + 2 \times T_p}$$

$$= \frac{1}{1 + 2\left(\frac{T_p}{T_t}\right)}$$

$$= \frac{1}{1+2a} \quad a \to \left(\frac{T_p}{T_t}\right)$$

"Stop and - wait for flow control" | Protocol.

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Notes

Troughput or Effective bandwidth or Bandwidth utilization.

$$= \frac{L}{T_t + 2T_p}$$

$$= \frac{L \times B \times L/B}{T_t + 2T_p}$$

$$= \frac{T_t}{T_t + 2T_p} * BW$$

$$= \frac{1}{1+2a} * BW$$

$$= \eta * BW$$

$\therefore$ $\boxed{\text{Effective bandwidth} = \eta * BW}$

Ex: i) (T_t) Transmission time = 10 mSec
(T_p) Propagation time = 100 m Sec

$\therefore$ Efficiency = ?

ii) T_t = 1 mSec
T_p = 1 mSec

iii) T_t = 2 mSec
T_p = 1 mSec

Notes

Relationship bet^n T_t, T_p if $\eta = 50\%$

$$\eta = \frac{T_t}{T_t + 2T_p}$$

Q:) $B = 6Mbps$

$T_p = 10\ m\,Sec$

$L = ?$

Such that $\eta = 50\%$.

$$\Rightarrow 50\% \leqslant \frac{T_t}{T_t + 2T_p}.$$

$$\Rightarrow \frac{1}{2} \leqslant \frac{T_t}{T_t + 2T_p}.$$

$$\Rightarrow 2T_t \geqslant T_t + 2T_p$$

$$\Rightarrow T_t \geqslant 2T_p.$$

$$\Rightarrow \frac{L}{B} \geqslant 2T_p$$

$$\Rightarrow \boxed{L \geqslant 2 * T_p * B.}$$

Student's task:

$$\eta = \frac{1}{1+2a} = \frac{1}{2+2(T_p/T_t)}$$

$$= \frac{1}{1 + 2 * \frac{d}{V} * \frac{B}{L}}$$

$$\boxed{\eta \propto \frac{1}{d}}$$

$$\boxed{\eta \propto L}$$