CS & IT ENGINEERING

COMPUTER NETWORKS

Switching

Lecture No- 03

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TOPICS TO BE COVERED

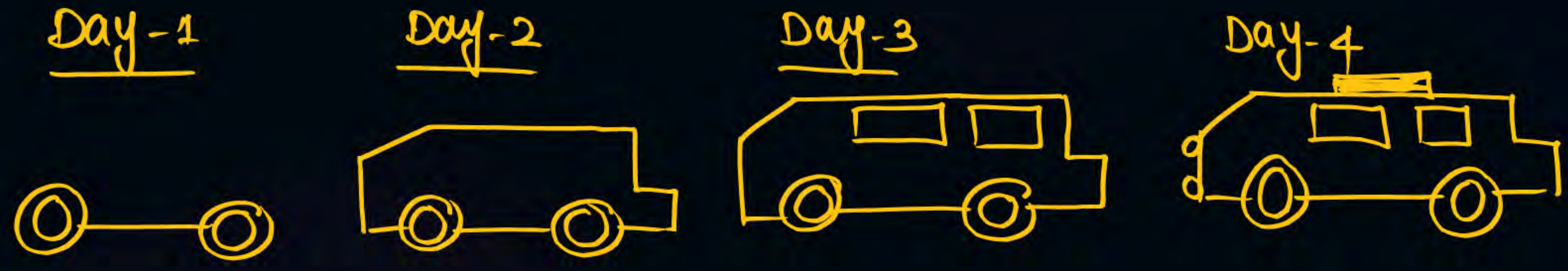
- Packet SWITCHING

Day-1 Day-2 Day-3 Day-4

1 car $\rightarrow$ 4 days

100 car $\rightarrow$ $4 \times 100 = 400$ days

Pipelining



1 car → 4 days
99 car → 99 days

103 days

Problem Solving
On
Packet Switching

Topic : Packetization in packet switching:

- The process of dividing a single message into smaller size packet is called as packetization.
- These smaller size packets are sent one after other.
- It gives the advantage of pipelining and reduce the total time taken to transmit the message.

Topic : Problem solving on Packet Switching

#Q. Consider the store and forward packet switched network given below. Assume that the bandwidth of each link is 10^6 bytes/sec. A user on host A sends a file of size10^3bytes to host B through routers R1 and R2 in three different ways. In the first case a single packet containing the complete file is transmitted from A to B. In the second case, the file is split into 10 equal parts, and these packets are transmitted from A to B. In the third case, the file is split into 20 equal parts and the packets are sent from A to B. Each packet contains 100 bytes of header information along with the user data. Consider only transmission time and ignore processing, queuing and propagation delays. Also assume that there are no errors during transmission. Let T1, T2 and T3 be the times taken to transmit the file in the first, second and third case respectively. Which one of the following is correct?

GATE 2014

A. T1 < T2 < T3

B. T1 > T2 > T3

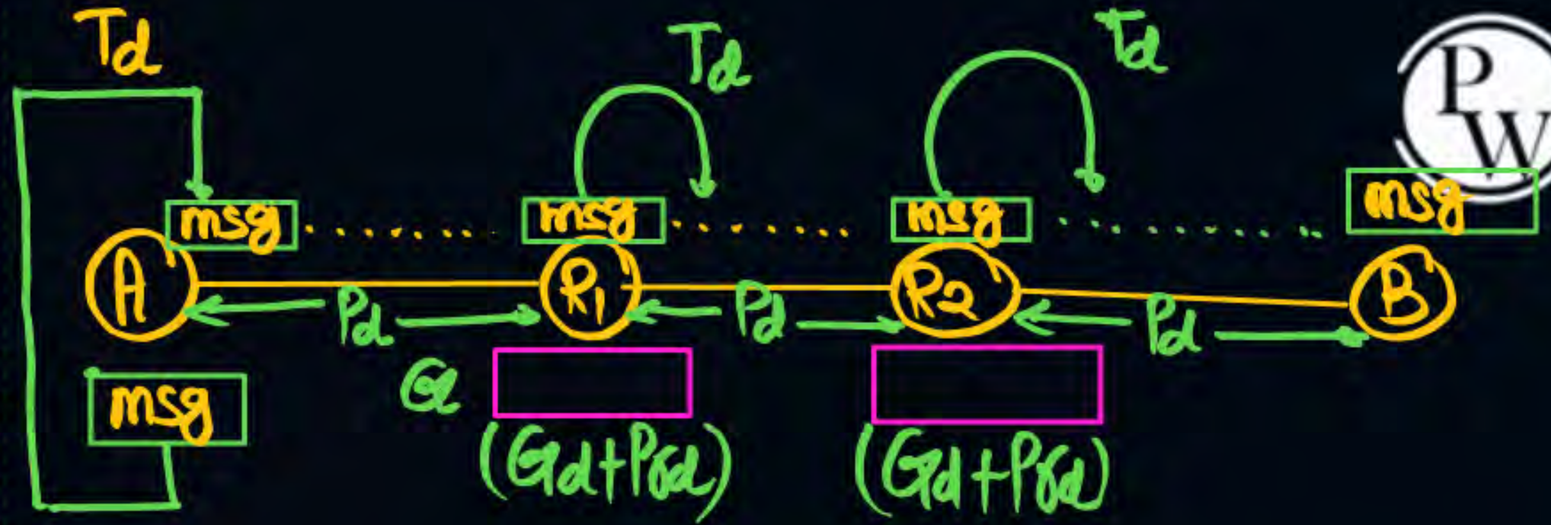
C. T2 = T3, T3 < T1

D. T1 = T3, T3 > T2

$B = 10^6$ Byte/sec

File size $= 10^3$ Bytes $= 1000$ Byte

Header size $= 100$ Byte, $X = 3$ (No. of Hops)



Case I

Packet size = Data + Header

$= 1000\,B + 100\,B$

$= 1100$ Byte

$$T_{d(Pkt)} = \frac{\text{Packet size}}{\text{Bandwidth}} = \frac{1100 \text{ Byte}}{10^6 \text{ Byte/sec}} = 11 * 10^{-4} \text{ sec}$$

$$1.1 * 10^{-3} \text{ sec} = 1.1 \text{ msec}$$

$$\text{Total time} = X \cdot T_d + X \cdot \cancel{P_d}^{\,0} + (X-1)\left[\cancel{Q_d}^{\,0} + \cancel{P_d}^{\,0}\right]$$

$$\text{Total time} = 3 * 1.1 = 3.3 \text{ msec } (T_1)$$

Case II : Sending File in 5 Packets

Data in each Packet $= \frac{1000B}{5} = 200B$

Header size $= 100$ Byte

One Packet size = Data + Header

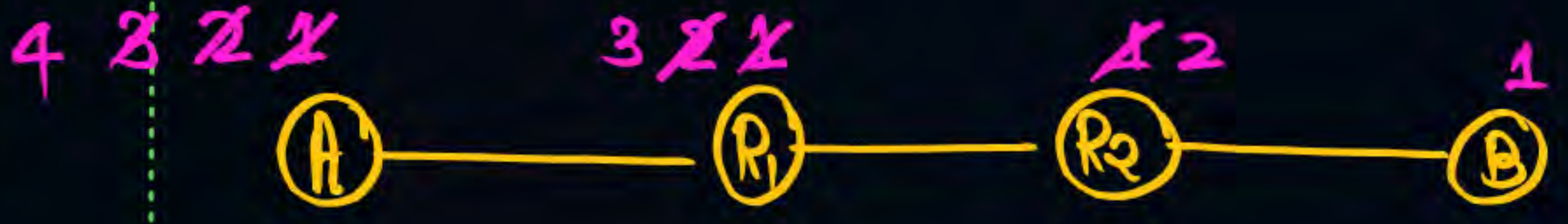
$= 200B + 100B = 300B$

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

$= \frac{300 \text{ Byte}}{10^6 \text{ Byte/sec}}$

$= 3*10^{-4}\text{sec} = 0.3*10^{-3}\text{sec}$

$= 0.3 \text{ msec}$



Time taken to reach 1^{st} Packet From source to destination $= 3*T_d = 3*0.3\text{msec}$

$= 0.9 \text{ msec}$

Time taken to reach remaining 4 'Pkt' to reach From source to Destination $= 4*T_d$

$= 4*0.3\text{msec}$

$= 1.2 \text{ msec}$

Total time $= 0.9\text{msec} + 1.2\text{msec} = 2.1\text{msec}$

Case III: Sending a File in 10 Pkts

Data in each Packet $= \frac{1000B}{10} = 100$ Byte

Header size $= 100$ Byte

one Packet size = Data + Header

$= 100B + 100B = 200B$

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

$$= \frac{200B}{10^6 B/sec}$$

$= 2 * 10^{-4}\,sec = 0.2 * 10^{-3}\,sec$

$= 0.2\,msec$

Time taken to reach 1st Packet From source to Destination $= 3 * T_d = 3 * 0.2\,msec = 0.6\,msec$

Time taken to reach Remaining 9 Pkt From source to Destination $= 9 * T_d = 9 * 0.2$

$= 1.8\,msec$

Total time $= 0.6\,msec + 1.8\,msec$

Total time $= 2.4\,msec$ (T_2)

Case IV Sending a File in 20 Pkts

Data in each Packet $= \frac{\cancel{1000}\text{Byte}}{\cancel{20}} = 50\text{Byte}$

Header size $= 100$ Byte

one Packet size = Data + Header
$= 50B + 100B$
$= 150$ Byte

$$T_d(\text{Pkt}) = \frac{\text{Packet size}}{\text{Bandwidth}} = \frac{150\cancel{B}}{10^6\ \cancel{B}/\text{sec}}$$
$= 150 * 10^{-6}$ sec
$= 0.15 * 10^{-3}$ sec
$= 0.15$ msec

Time taken to reach 1^{st} Packet From source to Destination $= 3 * T_d = 3 * 0.15 = 0.45$ msec

Time taken to reach remaining 19 Packet From source to Destination $= 19 * T_d$
$= 19 * 0.15$
$= 2.85$ msec

Total time $= 0.45$ msec $+ 2.85$ msec
$= 3.3$ msec (T_3)

T_1	T_2	T_3
3.3	2.4	3.3

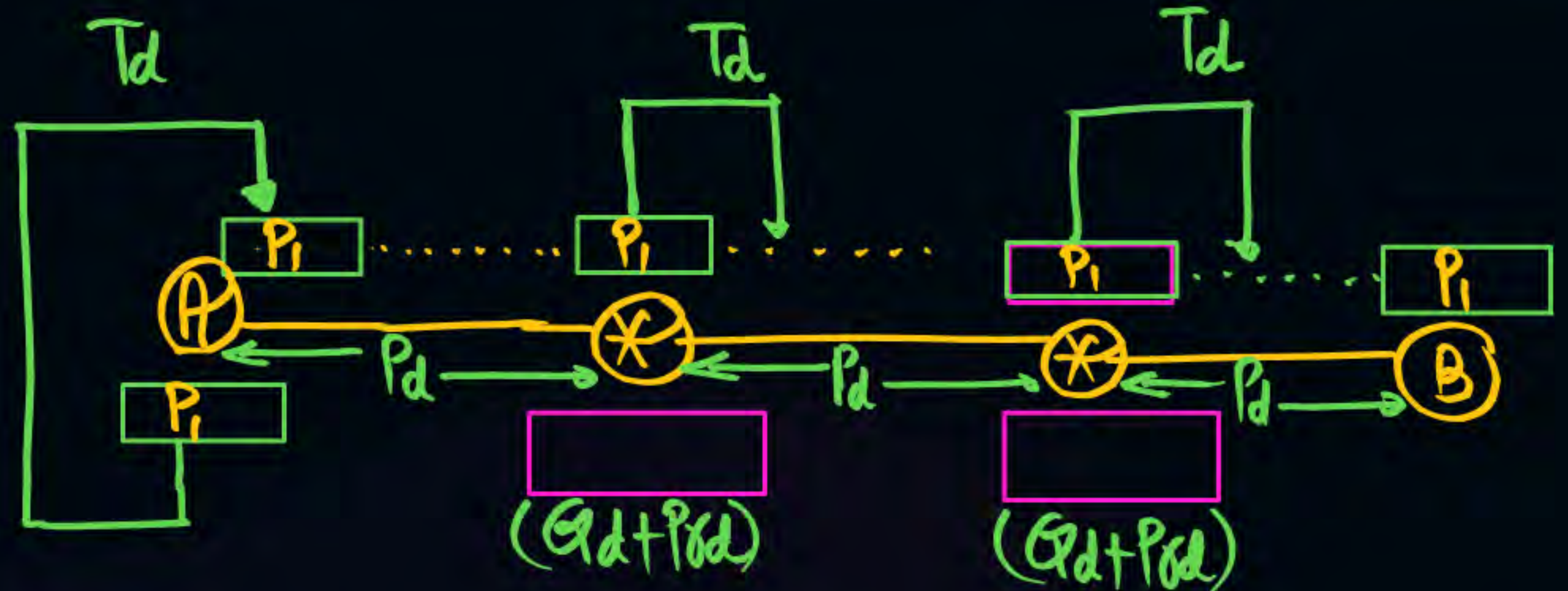
$$\boxed{T_1 = T_3 > T_2}$$

or

$$\boxed{T_2 < T_1 = T_3}$$

Case I	Case II	Case III	Case IV	Case V
single msg	5 Pkts	10 Pkts	20 Pkts	30 Pkt
$\Downarrow$	$\Downarrow$	$\Downarrow$	$\Downarrow$	$\Downarrow$
3.3 msec	2.1 msec	2.4 msec	3.3 msec	>3.3 ms

Total time For 'X' Hop and 'N' Packets



$$p = \sqrt{\frac{mh}{x-1}}$$

$$= \sqrt{\frac{1000 \times 100}{3-1}}$$

$$= \sqrt{50{,}000}$$

$$p = 223.6$$

Total No. of Pkts $= \frac{m}{p} = \frac{1000}{223.6} = 4.47 \simeq 5$ Pkts

Total time = Time For 1st Pkt to reach + Time For remaining (N-1) Packet to reach

$$\boxed{\text{Total time} = X[T_d + P_d] + X-1[Q_d + P_{rd}] + N-1[T_d]}$$

Optimal Packet Size

If the packet size is not chosen properly then it might increase the total time taken to transmit the message. So it is very important to choose the packet size properly.

Topic : Optimal Packet Size

Generalized Formula for optimal packet size

Suppose

M = Message size

h = Header size

p = Payload/Packet data size

assume bandwidth is 'b' bits/sec

Number of Hops = X

Total No. of Packet = M/p

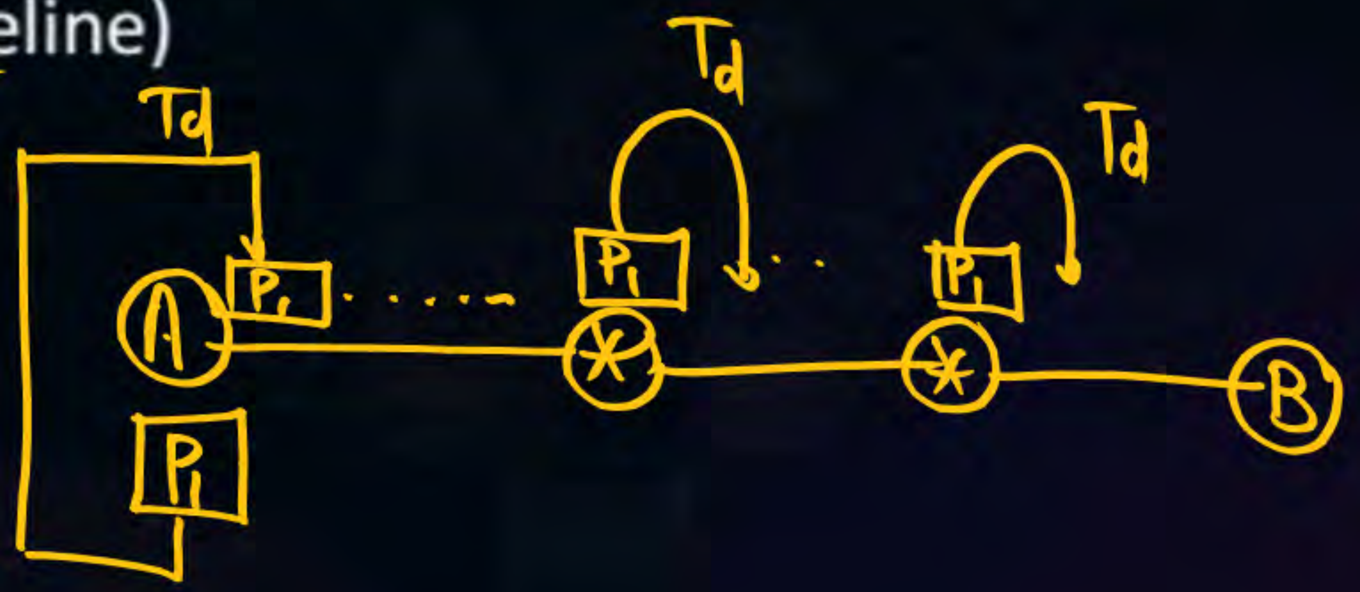
Packet size (P) = $p+h$

$$\left(\frac{M}{P}-1\right) * \frac{p+h}{b}$$

Topic : Optimal Packet Size

When message is Packetized then these are send in a pipelined manner to reduce transmission time but there is a threshold on packet size ‘P’ Hence it may not be more large or more small It must be optimum.

“Now we first derive transmission delay (1st packet takes transmission delay by all the intermediate nodes and source or transmission delay on all hopes and rest all packet take only one hope transmission delay due to pipeline)



Topic : Optimal Packet Size

$Td(Pkt) = \frac{Pkt\,size}{Bandiwidth}$

$= X\left(\frac{p+h}{b}\right)$

$$\text{Transmission time(TT)} = \left(\frac{p+h}{b}\right)X + \left(\frac{M}{p} - 1\right)\left(\frac{p+h}{b}\right)$$

$$= \frac{1}{b}\left[(p+h)\,X + \frac{1}{p}(M-p)(p+h)\right]$$

So resultantly we want to find minimum transmission delay at optimum packet size so differentiate TT w.r.t 'p' we get

$$\frac{d}{dp}TT = \frac{1}{b}\left(X * p^2 - p^2 - Mh\right) = 0$$

so $$\boxed{p^2 = \left(\frac{Mh}{X-1}\right)}$$

$$\boxed{p = \sqrt{\frac{Mh}{X-1}}}$$

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So optimum packet size $\boxed{P = p + h}$

Topic : Problem solving on Packet Switching

#Q. In a packet switching network, packets are routed from source to destination along a single path having two intermediate nodes. If the message size is 24 bytes and each packet contains a header of 3 bytes, then the optimum packet size is:

A. 4

B. 6

C. 7

D. 9 ✓

S — R1 — R2 — D , No. of Hops = 3

GATE 2005

Message size (m) = 24 byte

Header size = 3 Byte

$$p = \sqrt{\frac{mh}{X-1}}$$

$$p = \sqrt{\frac{24*3}{2}}, \quad p = \sqrt{36}, \quad p = 6$$

Packet size (P) = p + h
= 6 + 3
= 9

Total No. of Pkts $= \frac{m}{p} = \frac{24}{6} = 4$

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THANK YOU!