SYED SAKHAWAT

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SECTION "A"

DATA COMMUNICATION

AND NETWORKING

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DATA COMMUNICATION & NETWORKING

ASSIGNMENT #01

TASK #01

R-18) SOLVE :-

Packet Length = 1000 bytes
Distance = 2500 km
Propo. Speed = $2.5 \cdot 10^8$ m/s
Transmission rate = 2 Mbps.

Transmission delay = L/R

$$= \frac{8 \text{ bits/byte} \times 1000 \text{ bytes}}{2{,}000{,}000 \text{ bps}}$$

Transmission delay = $\boxed{4 \text{ ms}}$

Propogation delay = d/s

$$= \frac{2{,}500}{2.5 \times 105}$$

Propogation delay = $\boxed{10 \text{ ms}}$

Total time = 4ms + 10ms = $\boxed{14 \text{ ms}}$ Ans

- No, the delay depend on packet length is not true.
- NO, the delay depend on transmission rate is not true.

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R-19) SOLVE :-

R_1 = 500 Kbps

R_2 = 2 Mbps

R_3 = 1 Mbps

a) The Throughput = min$\{R_1, R_2, R_3\}$

= min$\{$500 Kbps, 2Mbps, 1Mbps$\}$

= 500 Kbps Ans

the throughput for the file transfer = 500 Kbps. Ans

b) The file size = 4 million bytes

Convert mbs to bits = 32000000 bits

The Throughput = 500 kbps

convert into bits = 500000 bits.

Time to transfer file to Host B = file size / throughput for file transfer

" = 32000000 bits / 500000 bps

" = 64 seconds Ans

c) Now R_2 reduced to 100 Kbps.

The throughput = min$\{$500 Kb, 100 Kb, 1 Mb$\}$

" " = ~~min~~ 100 Kbps.

Time to transfer file to Host B = file size / throughput for file transfer

" " = 32000000 bits / 100000 bps

" " = 320 seconds. Ans

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R-20) SOLVE:-

a) Suppose end system A wants to send a large file to end system B.

- Divide file into chunks.
- Create a packet by attach header to chunk.
- Each packet maintain an address of the destination.

b) • Switch uses the destination address
- It is easy to find which packet is forword to the header.

c) • Each packet maintain an address of the destination.
- Reaching packet, packet display outgoing link which road to take to forwarded.

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TASK # 02

1) Circuit Switching.
2) Packet Switching.
3) Frequency division Multiplexing
4) Time division Multiplexing.
5) Network delays.

PROBLEMS :

P2) SOLVE :-

N = Total number of links
R = Transmission rate.
L = Packet length
P = Packets that transmit over "N" link.

The formula of back-to-back delay of sending P Packets, each of length L over N links of transmission rate.

$$R = d_{back\text{-}to\text{-}back} = PN\left(\frac{L}{R}\right)$$ Ans

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P3) SOLVE :-

a) Circuit switched network is the more appropriate for this application, the reason is to Fixed bandwidth and long sessions involved.

b) Consider that a packet-switched network is used and the only traffic in this network comes from such applications as described above. Furthermore, assume that the sum of the application data rates is less than the capacity of each and every link. The reason is that sufficient bandwidth of the link is enabled to completed the task of Application

P4) SOLVE :-

a) Between the switch in the upper left and the switch in the upper right we can have 4 connections, Similarly we can have 4 connections between each of the 3 other pairs of adjacent switches. Thus, this network can support up to 16 connections.

b) We can 4 connections passing through the switch in the upper right hand corner and another 4 connections passing through the switch in the lower left corner, giving a total 8 connections.

c) Yes, For the connection b/w A & C, we route two connections through B and two connections ~~b/w A & C~~ through D. For the connections b/w B and D, we route two connections through A and two connections through C. In this manner, there are at most 4 connections passing through the link.

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P5) SOLVE :-

a) Assume propogation speed of 100 Km/hour

Delay time = total distance / Propogation speed.

" " = 150 Km / 100 Km/h

Delay time = 1.5 hours Ao

Time for taken by 3 toolboths
to reach 10 cars = 2 × 3 = 6 min

So, end-to-end delay = 1 hour 30 min + 6 min

" " " " = 1 hour 36 mins.

b) Time for taken by 3 toolboths
to reach 8 cars = 96 × 3 = 288 = minutes.

= 4 minutes 8 seconds.

So, end-to-end delay = 1 hour 30 minutes + 4 min 48 sec

" " " " = 1 hour 34 minutes 48 seconds

Ao

P6) SOLVE :-

a) The propogation delay, d_{prop} = m/s sec.

b) The transmission time of the patket, d_{trans} = L/R sec

c) The end-to-end delay = (L/R + m/s) sec

d) Suppose host A begins to transmit the packet at time t = 0. At time t = d_{trans}.

e) Suppose d_{prop} is greater than d_{trans}. At time t = d_{trans}
Thus the first bit of the packet is $d_{prop} > d_{trans}$.

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f) Suppose d_{prop} is less than d_{trans}. At time $t = d_{trans}$.
thus, the first bit of the packet is $d_{prop} < d_{trans}$.

g) $m = \frac{L}{R} s = \frac{120}{56 \times 10^3} (2.5 \times 10^8)$

$\boxed{m = 536 \text{ Km}}$ Ans

P8) SOLVE :-

a) $$\text{No of Users} = \frac{\text{Trans rate of link used by user}}{\text{Trans rate req by each user}}$$

$$'' = \frac{3 \text{ Mbps}}{150 \text{ kbps}} \qquad \therefore 1\text{Mb} = 10^6 \text{bps}$$

$$\text{No of Users} = \frac{3000 \text{ Kb}}{150 \text{ Kb}} \Rightarrow 20 \text{ Users.}$$

b) Transmission rate = 10%
probability = 1/10 = 0.1

c) $$P(n) = {}^{N}C_n (P)^n (1-P)^{N-n}$$

$$P(n) = {}^{120}C_n \left(\frac{1}{10}\right)^n \left(\frac{9}{10}\right)^{120-n}$$

$$P(n) = {}^{120}C_n \left(\frac{1}{10}\right)^n \left(\frac{9}{10}\right)^{120-n}$$

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d) $P(21 \text{ or more users}) = 1 - P\left(\sum_{j=1}^{120} X_j \le 10\right)$

$$P\left(\sum_{j=1}^{120} X_j \le 10\right) = P\left(\frac{\sum_{j=1}^{120} X_j - 4}{\sqrt{120 \times 0.1 \times 0.9}} \le \frac{6}{\sqrt{120 \times 0.1 \times 0.9}}\right)$$

$$= P\left(Z \le \frac{6}{\sqrt{10.8}}\right)$$

$$= P(Z \le 1.83)$$

$$= 0.999 \text{ Ans}$$

So, $P(21 \text{ or more users}) = 1 - 0.999 = 0.0001$ (approx)

P9) SOLVE :-

a) No of users = $\frac{\text{Total trans rate}}{\text{Rate of data gene by the user when busy}}$

" " $= \frac{1\,Gb}{100\,kb} \Rightarrow \frac{1000 \times 1000 \times 1000 \text{ bps}}{100 \times 1000 \text{ bps}}$

" $= 1000 \times 10$

No of users = 10000 users.

b) Consider packet switching and a user population of M users.

Formula (in terms of p, M, N)

$$M \sum_{n = N+1} \left(M p^n (1-p)^{M-n}\right) \text{ Ans}$$

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P.10) Solve :-

First link Transmit packet $= L/R_1 = \dfrac{(1500 \times 8)}{2 \times 10^6}$

" " $= \boxed{0.006 \text{ secs}}$ Ans

First propogate of link is $= d_1/S_1 \Rightarrow \dfrac{5000 \times 10^3}{2.5 \times 10^8}$

" " " $= \boxed{0.02 \text{ sec}}$ Ans

Delay time $d_{proc} = 3$ msec,

Second link Transmits packet $= L/R_2 \Rightarrow \dfrac{(1500 \times 8)}{2 \times 10^6}$

" " " $= \boxed{0.006 \text{ sec}}$ Ans

Second propogates link in d_2/S_2 $= \dfrac{4000 \times 10^3}{2.5 \times 10^8}$

" " " $= \boxed{0.016 \text{ sec}}$ Ans

Third link Transmit packet $= L/R_3 \Rightarrow \dfrac{1500 \times 8}{2 \times 10^6}$

" " " $= \boxed{0.006 \text{ sec}}$

~~End~~ last link propagates in d_3/S_3 $= \dfrac{1000 \times 10^3}{2.5 \times 10^8} = \boxed{0.004 \text{ Sec}}$ Ans

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End-to-End delay $= L/R_1 + L/R_2 + L/R_3 + d_1/s_1 + d_2/s_2 + d_3/s_3 + d_{proc} + d_{proc}$

" " " $= 0.006 + 0.006 + 0.006 + 0.02 + 0.016 + 0.004 + 0.003 + 0.003$

End-to End delay $= \boxed{0.064 \text{ sec}}$

Therefore, the End-to-End delay $= 0.064$ sec.

P-11) Solve :-

Because the bits are immediately transmitted, the packet switch does not introduce any delay; in particular, it does not introduce a transmission delay Thus,

$$d_{end-end} = L/R + d_1/s_1 + d_2/s_2 + d_3/s_3$$

For the values in Problem 10,

we get $\Rightarrow 6 + 20 + 16 + 4 = \boxed{46 \text{ sec Ans}}$

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P-12) Solve:-

$L = 1500$ bytes

$R = 2$ Mbps or 2×10^6 Mbps

$x = \frac{1500}{2} = 750$

$n = 4.$

$$\text{Queuing delay} = \frac{[nL + (L-x)]}{R}$$

$$[nL + (L-x)] = (4 \times 1500) + (1500 - 750)$$
$$= 6000 + 750$$
$$= 6750 \text{ bytes}$$

Packets are transmitted at 2Mbps,

$$= 6750 \times 2 \times 4$$
$$= 54000$$

Now,

$$\text{Queuing delay} = \frac{54000}{2 \times 10^6}$$

$$\text{" " } = \boxed{0.027 \text{ sec}}$$ Ans

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P-13) SOLVE :-

a) The first packet queuing delay = 0

The second packet queuing delay = L/R

The third packet queuing delay = $2L/R$

The N^{th} packet queuing delay = $(N-1)L/R$

Average queuing delay of N^{th} packet =

$$\Rightarrow \frac{\left(\frac{L}{R} + 2\frac{L}{R} + 3\frac{L}{R} + \ldots\ldots + (N-1)\frac{L}{R}\right)}{N}$$

$$\Rightarrow \frac{L}{(RN)} \sum_{i-1}^{N-1} i$$

$$\Rightarrow \left(\frac{L}{(RN)}\right) \frac{N(N-1)}{2}$$

$$\Rightarrow (N-1)\frac{L}{2R}$$

b) To transmit N such batches, it takes LN/R seconds. Therefore, a new batch arrives then the queue is empty each time. Thus, the average delay of packet across all batches is the average delay within one batch.

hence, the average queuing delay of a packet $= (N-1)\frac{L}{(2R)}$

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P-24) SOLVE :-

40 terabytes $= 40 \times 10^{12} \times 8$ bits

So, if using the dedicated link, it will take

$40 \times 10^{12} \times 8 / (100 \times 10^{6}) = 3200000$ secs

$\Rightarrow$ 37 days.

But with FedEx overnight delivery, you can guarantee the data arrives in one day, and it should cost less than \$100.

P-25) SOLVE :-

a) The distance b/w host A & B = 20000 Km

$\Rightarrow 2 \times 10^{7}$ m (since 1 km = 10^{3})

Transmission rate of the direct link between A & B = 2Mbps.

$\Rightarrow 2 \times 10^{6}$ bps (1Mbps = 10^{6} bps)

Propogation speed b/w A & B $= 2.5 \times 10^{8}$ m/s.

$$d_{prop} = \frac{\text{Distance}}{\text{speed}} = \frac{2 \times 10^{7}}{2.5 \times 10^{8}} = \boxed{0.08 \text{ sec}}$$

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$$R \times d_{prog} = 2 \times 10^6 \times 0.8$$
$$\Rightarrow 16 \times 10^4 \text{ bits}$$

The bandwidth delay product is 160000 bits.

b) Size of file = 800000 bits $\Rightarrow 8 \times 10^5$ bits

Transmission rate b/w A & B = 2Mbps $\Rightarrow 2 \times 10^6$ bps

$$R \times d_{prog} = 2 \times 10^6 \times 0.08$$
$$\Rightarrow 16 \times 10^4 \text{ bits}$$

The maximum number of bits at a given time will be = 160000 bits.

c) The product of bandwidth delay is equal to the maximum number of bits on the transmission line.

d) $$\text{length of 1 bit} = \frac{\text{Speed}}{\text{Transmission rate}}$$

$$\Rightarrow \frac{2.5 \times 10^8}{2 \times 10^6} \Rightarrow \boxed{125 m/bit}$$

e) General Expression For width $= \dfrac{\text{Transmission rate} \times \text{Speed}}{\text{length of link.}}$

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P-28) Solve:-

a) Length of File = 800, 000 bits

Propogation delay = distance / Speed

" " = $2\times10^7 / 2.5\times10^8$

" " = 0·08 sec ⇒ 80 msec

Transmission delay = $\dfrac{800000 \text{ bits}}{2\times10^6 \text{ bits/sec}}$

" " = 0·4 sec ⇒ 400 msec

Time required = $d_{prop} + d_{trans}$

⇒ 80 + 400 ⇒ $\boxed{480 \text{ msec}}$ Ke

b) The file is divided into 20 packets, so the length of each packet = 40,000 bits.

Transmission delay = $\dfrac{40000 \text{ bits}}{2\times10^6 \text{ bits/sec}}$

⇒ 0·02 sec ⇒ 20 sec.

Total time for N packets:

⇒ $n(2d_{prop} + d_{trans})$ ⇒ $20(2\times80+20)$

⇒ $\boxed{3600 \text{ m sec}}$ Ke

c) The time taken to transfer file from host A to B is 480 msec in part(a)

The time taken to transfer file divided into multiple packets from host A to B is 3600 msec in part (b)

Hence, transmitting the file continously is more efficient than transmitting the file as multiple packets.

P-26) SOLVE:

distance => $d = 20,000\ Km$
$\Rightarrow 2 \times 10^7\ m.$

Transmission rate => $R = 2Mbps$
$= 2 \times 10^6\ bps$

Propogation speed => $S \Rightarrow 2.5 \times 10^8\ m/sec$

length of file = 800,000 bits.

$$m = S/R \quad \text{—— (i)}$$

value of R: $m = d = 2 \times 10^7$

Use equation (i)

$$m = S/R \Rightarrow R = S/m$$

$$R = \frac{2.5 \times 10^8\ m/sec}{2 \times 10^7\ m}.$$

The value of $R = \boxed{12.5\ bps}$ Ae

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P-20) SOLVE :-

R_s = Server link rate
R_c = Client link rate
R = Network link rate
M = Client server pair

Throughput and average throughput are two types of throughput. The server throughput R_c faster than R_s. Networks always depends on client server links (M). The min is a simple two link network links on the network.

Therefore, general expression for throughput is:

$$\{R_s, R_c, R/M\}.$$

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