DATA COMMUNICATION AND NETWORKING

ASSIGNMENT #01

Date:

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R-18

DATA

L = Packet length = 1000 bytes = 1000×8 = 8000 bits
d = Distance = 2500 km = 2500000 m = 2.5×10^6 m
s = Speed = 2.5×10^8 m/s
R = Transmission rate = 2 Mbps = 2×10^6 b/s

SOLUTION:

Transmission delay $= L/R$

$$= \frac{8000}{2 \times 10^6}$$

$$= 4 \times 10^{-3}$$

Transmission delay = 4 msec.

Propagation delay $= d/s$

$$= \frac{2.5 \times 10^6}{2.5 \times 10^8}$$

$$= 1 \times 10^{-2}$$

$$= 10 \times 10^{-3}$$

Propagation delay = 10 msec

- Delay doesnot depend on packet length nor transmission rate.

Date:

R-19

DATA

$R_1 = 500 kbPS$

$R_2 = 2 MbPS$

$R_3 = 1MbPS$

SOLUTION:

a- The throughput for the file transfer is the minimum rate which: is 500kbPS.

b-

File size = 4 million bytes = 4×10^6 byte

file size in bits = $4 \times 10^6 \times 8 = 32 \times 10^6$ bits.

Throughput = 500 kbPS = 500000 bits/second.

$$\text{Time to transfer file} = \frac{\text{File size}}{\text{Throughput}}$$

$$= \frac{32 \times 10^6}{500000}$$

$$\boxed{\text{Time} = 64 \text{secs.}}$$

c-

Now $R_2 = 100KbPS$ so the throughput for file transfer is 100 KbPS.

throughput = 100000 bits/sec.

$$\text{Time to transfer file} = \frac{32 \times 10^6}{100000}$$

$$\boxed{\text{Time} = 320 \text{ seconds.}}$$

R-20

~~DATA~~

Suppose end system A wants to send a large to end system B. It divides the file into small chunks. Create a packet by attach header to chunk. Each packet maintain an address of the destination.

Switch uses the destination address. It is easy to find which packet is forward to the headers.

Each packet maintain an address of the destination. Reaching Packet, packet is displaying outgoing link which road to take to forwarded.

PROBLEMS

P-2

DATA

N = Total no of links.
R = Transmission rate
L = Packet length
P = Packet that transmit over N-Link

The formula for back-to-back delay is

$$\boxed{d_{back\text{-}to\text{-}back} = PN(L/R)}$$

P3)

For giving their bandwidth and session involved Circuit-switching method is more appropriate for this application.

P.

Consider the packet-switched network is used and the only traffic in this path/network comes from such application as described above. Further more 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)

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 pair of adjacent switches. Thus, This network can support upto 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 connections between A and C, we route two connections through B and two connection through D. For the connection between 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.

P-5

propagation speed = s = 100 km/hour.

a-

distance = d = 150 km.

delay time = d/s

$= \frac{150}{100}$

$\boxed{\text{delay time} = 1.5 \text{ hour}}$

b- Time for taken by 3 tollbooths to reach 10 cars = 2 × 3 = 6 min.

end-to-end delay = 1 hour 30 min + 6 min
= 1 hour 36 min.

Time taken by 3 toolbooths to reach 8 cars:
= 96 × 3 = 288 minutes = 4 min 48 seconds.

end-to-end delay = 1h 30 min + 4 min 48 seconds
$\boxed{= 1h\ 34 \text{ min } 48 \text{ seconds.}}$

P6)

a d_{prop} = the propagation delay = $\frac{m}{s}$ sec.

b . The trasmission time to the packed: $d_{trons} = \frac{L}{R}$ sec

c ened-to-end delay: $\frac{L}{R} + \frac{m}{s}$ sec

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

e Suppose d_{prop} is greater than d_{trons}, At time $t = d_{trons}$ Thus the file first bit of the Packet is $d_{props} > d_{trons}$

f Suppose d_{prop} is less than d_{trons}. At time $t = d_{trons}$ thes the first bit of the packet is $d_{prop} < d_{trons}$

g- $m = \left(\frac{L}{R}\right)$ sec $= \frac{120}{156 \times 10^3} \times 2.5 \times 10^8$

$m = 536$ km.

P8

a- no of users = $\dfrac{\text{Trans rate of link used by user}}{\text{Trans rate req by each user}}$

$= \dfrac{3 \text{ Mbps}}{150 \text{ kb/sec}}$

$= \dfrac{300 \text{ kbps}}{150 \text{ kb}}$

b- Transmission rate = 10%.

probability = 1/10 = 0.1

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

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

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

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

$= P\ Z \le \dfrac{6}{\sqrt{10.8}}$

$= 0.9999$

so $P(21$ ore more user $= 1 - 0.999 =$

0.0001 (approx)

P9

No of users = $\frac{\text{Total transmit rate}}{\text{Rate of data generate by the user}}$

$= \frac{1Gb}{100Kb} \Rightarrow \frac{10^9 \text{ bytes}}{100 \times 10^3 \text{ bytes}}$

$= 10^4$ bytes

No of users = 1000 users

Consider packet switching and a user propagation of m users

Formula in terms of P, M, N

$M \sum_n = N+1 \left(M_p (1-P)^{M-n} \right)$

P10

First Link transmit $= \frac{L}{R_1} = \frac{1500 \times 8 \text{ bits}}{2 \text{ Mbps}}$

$= \frac{1500 \times 8}{2 \times 10^6}$

$= 0.006$ secs

First propagation of link $= \frac{d_1}{s_1}$

$= \frac{5000 \text{ km}}{2.5 \times 10^8 \text{ m/s}} = \frac{5000 \times 1000}{2.5 \times 10^8}$

First propagation of Link = 0.02 sec.

delay time = 3msec

Second link transmit packet $= \frac{L}{R_2}$

$= \frac{1500 \text{ bytes}}{2 \text{ Mbps}} = \frac{1500 \times 8}{2 \times 10^6}$

$= 0.006$ sec.

Second propogates link $= \frac{d_2}{s}$

$= \frac{4000 \times 10^3}{2.5 \times 10^8} = 0.016$ sec.

Third link transmit packet $= \frac{L}{R_3} =$

$= \frac{1500 \text{ bytes}}{2 \text{ Mbps}} = \frac{1500 \times 8}{2 \times 10^6}$

$= 0.006$ sec.

Last link propagades in $d_3/s_3 =$

$= \frac{1000 \times 10^3}{2.5 \times 10^8} = 0.004$ sec.

End to End delay: $\frac{L}{R_1} + \frac{L}{R_2} + \frac{L}{R_3} + \frac{d_1}{s_1} +$

$\frac{d_2}{s_2} + \frac{d_3}{s_3} + d_{proc} + d_{proc}$.

$= 0.006 + 0.006 + 0.006 + 0.02 + 0.016 +$

$0.004 + 0.003 + 0.003$

$\boxed{= 0.064 \text{ sec}}$

P11

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

Thus,

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

for the values of P-10

$$d_{end-end} = 0.006 + 0.02 + 0.016 + 0.004$$
$$= 0.046$$
$$\boxed{= 46 \text{ msec}}$$

P12

$L = 1500$ bytes $= 1500 \times 8$ bits $= 12000$ bits

$R = 2$ Mbps $= 2 \times 10^6$ bits/sec

$\frac{L}{4} = x = \frac{1500}{2} = 750$

$n = 4$

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

$$= \frac{4(1500) + (1500 - 750)}{R}$$

$$= \frac{6750 \text{ bytes}}{2 \text{ Mbps}} = \frac{6750 \times 8}{2 \times 10^6}$$

$$\boxed{\text{Queuing delay} = 0.027 \text{ sec}}$$

P-13

a- The first packet queuing delay $= 0$
The second packet queuing delay $= L/R$
The third packet queuing delay $= 2\frac{L}{R}$
The n^{th} packet queuing delay $= (N-1)\frac{L}{R}$

Average queuing delay of n^{th} packet $=$

$$= \frac{\frac{L}{R} + 2\frac{L}{R} + 3\frac{L}{R} + \cdots + (N-1)\frac{L}{R}}{N}$$

$$= \frac{L}{RN} \sum_{i=1}^{n-1} i$$

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

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

b- To transmit N such batches, it takes $\frac{LN}{R}$ 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 with one batch.

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

P24

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

length : $L = 3.2 \times 10^{14}$ bits.

rate = R = 100 Mbps = $100 \times 10^6 = 10^8$ bits/sec.

delay time = $x = \frac{L}{R} = \frac{3.2 \times 10^{14}}{10^8} = 3.2 \times 10^6$ secons.

x = 37 days.

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

P25

a) The distance between host A & B = 20000 km

$L = 20000 \times 10^3 = 2 \times 10^7$ m

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

$R = 2 \times 10^6$ bits/second.

Propagation speed = $s = 2.5 \times 10^8$ m/s.

$$d_{prop} = \frac{L}{s} = \frac{2 \times 10^7}{2.5 \times 10^8} = 0.08 \text{ sec.}$$

bandwidth delay = $R \cdot d_{prop}$

$= (2 \times 10^6)(0.08)$

$= 16 \times 10^4$

The bandwidth delay product is 16×10^4 bits b-

L = Size of file = 800000 bits = 8×10^5 bits
R = 2 Mbps = 2×10^6 bits/second.

$R \times d_{prop} = (2 \times 10^6)(0.08)$
$= 16 \times 10^4$ bits

The maximum no of bits at a give time will be: 16×10^4 bits

c

The product of bandwidth delay is equal to the maximum no of bits on the transmission line.

d

length of 1 bit = $\frac{Speed}{R} = \frac{2.5 \times 10^8}{2 \times 10^6}$ = 125 m/bit

e

General expression for width =
$\frac{\text{Transmition rate} \times \text{Speed}}{\text{length of link}}$
$= \frac{R \times S}{L}$

R-28

a-

L = 800,000 bits = 8×10^5 bits
propagation dalay = distance / speed
$= 2 \times 10^7 / 2.5 \times 10^8$
$d_{prop} = 0.08$ sec.

Transmission delay: $\frac{800000 \text{ bits}}{2 \text{ Mbps}} = \frac{8 \times 10^5}{2 \times 10^6}$

$d_{trans} = 0.4$ sec.

Time required: $d_{prop} + d_{trans}$.
$= 0.08 + 0.4 = 0.48$ sec
$\boxed{= 480 \text{ msec.}}$

b-

The file is divided into 20 packets; so the length of each packet: 40,000 bits

Transmission delay: $\frac{40000 \text{ bits}}{2 \times 10^6 \text{ bits/sec}}$
$= 0.02$ sec.

Total time for N packet: $n(2d_{prop} + d_{trans})$
$= 20(2 \times 0.08 + 0.02)$
$= 3.6$ sec
$\boxed{= 3600 \text{ msec.}}$

C- The time taken to transfer file from hos A to B is 480 msec in part(a)

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

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

P26

distance = d: 20,000 Km = 2×10^7 m

R = 2 mbps = 2×10^6 bits/sec.

propagation speed = s = 2.5×10^8 m/s.

length of file = L: 800,000 bits = 8×10^5 bits

consider the length of the link = m meters

The general expression for the width of bit in terms of propagation speed and transition rate is given below.

$$m = \frac{s}{R}$$

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

R = 12.5 bits/sec

R-20

R_s = server link rate

R_c = Cliend link rate.

R = Network link rate

M = client server pair.

Throughput and average throughput are two types of throughput. The server throughtput Regaster than R_s. Network always depends on client server link (m). The min is a simple two links network links on the network.

Generral expression for throughput is: $\left\{ R_s, R_c, \frac{R}{M} \right\}$