Data Communications - I

HOME WORK - I

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Written Home Work - I

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1) CH 1. Problem 3

Solution: (a) It's given that the application will transmit data at a steady rate for long period of time. Hence 'circuit switched network' would be more appropriate for this application because the rate of transmission of data is steady. And the time is small & fixed. Hence there is not much fluctuation in the flow of data. When the application starts, it'll continue running for a long period of time, hence it's better to allot seperate path for this application using circuit switching for the transmission of data.

(b) Suppose a 'packet-switched' network is used for the given scenario:

when,

sum of application data rate < capacity of each & every link

Congestion control is not needed because there is no need of output buffer or a queue.

Because there is no wait to be transmitted on link. There is no packet loss and the buffer memory will not be filled up.

Hence no congestion control is necessary.

2) CH 1. Problem 5

Propogation speed = 100 km/hr

Distance from the entrance of toll booth 1 & entering toll booth 2 and finishing at toll booth 3 is 150 km

Total number of cars in caravan = 10 cars

Service time for each car at toll booth = 12 sec.

There's same distance b/n the toll booths.

Hence, distance b/n toll booth 1 & 2 is equal to distance between toll boot 2 & 3. which is 75 km

Total service time for all the 10 cars = 10 x 12 sec = 120 sec i.e 2 min

Time required for a car to reach from one toll booth to the next toll booth.

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

$$d_{prop} = \frac{\text{distance b/n two toll booth}}{\text{propogation speed}} = \frac{75 \text{ km}}{100 \text{ km}}$$

$= 0.75$ hrs $= 45$ min

$$d_{trans} = \text{delay} = \frac{\text{no. of cars}}{\text{cars / min}} = \frac{10}{5} = 2 \text{ min.}$$

[NOTE: 1 car → 12 sec & 10 cars → 2 min]

Hence, time to travel for all the cars from toll booth 1 to toll booth 2.

i.e $d_{prop} + d_{trans} = 45$ min $+ 2$ min $= 47$ min.

—(i)

Time required to cars to travel from toll booth 2 to toll booth 3

i.e $d_{prop} + d_{trans} = 45$ min $+ 2$ min $= 47$ min

—(ii)

Time required for the 10 cars to service at toll booth 3 $= 10 \times 12$ sec $= 120$ sec $= 2$ min

—(iii)

End to End Delay $=$ (i) $+$ (ii) $+$ (iii)

$= 47 + 47 + 2 = 96$ min

i.e 1 hr 36 min

(b) For 8 cars in the caravan

Here only the d_{trans} -> serivce total time will vary.

Time required to service 8 cars at a toll booth = 12 sec × 8 = 96 sec = 1.6 min

From toll booth 1 to 2 = 45 + 1.6 = 46.6 min —(i)

From toll booth 2 to 3 = 45 + 1.6 = 46.6 min —(ii)

Service time for 8 cars at toll booth 3

12 sec × 8 = 1.6 min. —(iii)

End to end delay = (i) + (ii) + (iii)

= 46.6 + 46.6 + 1.6

= ~~98.~~ 94.8 min

= 1 hr 34 min 48 sec

3) Problem 6 - CH 1

(a) Propogation delay in terms of m & s

$$d_{prop} = \frac{m}{s} \text{ sec}$$

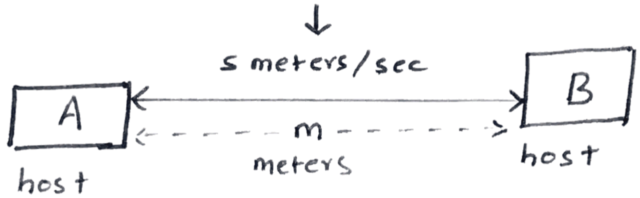


figure 1 A

(b) Transmission time in terms of 'L' & 'R'?

packet of size 'L' → length in bits

Transfer rate b/n link A & B = 'R' bits/sec.

Transmission time $= d_{trans} = \frac{L}{R}$ secs

(c) As we know,

End to End delay $= d_{trans} + d_{prop} + d_{process} + d_{queue}$

Here, we are not considering processing & the queing delay.

Hence, End to End delay $= d_{trans} + d_{prop}$

i.e $\frac{L}{R} + \frac{m}{s}$ seconds

(d) Referring to figure 1 A, we can say that at $t = 0$ and At time $t = d_{trans}$, the last bit of the packet will be at "Host A"

(e) $d_{prop} > d_{trans}$

At time $t = d_{trans}$, the first bit of the packet can be found between HOST A and HOST B. And it can also be calculated by

$$\Rightarrow \frac{L}{R} \times s$$

(f) $d_{prop} < d_{trans}$

$d_{trans} \rightarrow$ Time required for transmitting all the bits of a packet between a link

$d_{prop} \rightarrow$ Time taken by a packet in reaching it's destination from source.

Hence, at $t = d_{trans}$, the first bit of packet would have already reached HOST B

(g) $s = 2.5 \times 10^8$ $\quad L = 120$ bits $\quad R = 56$ kbps $= 56 \times 10^3$ bps

$m = ?$ $\quad d_{prop} = d_{trans}$

i.e $\frac{m}{s} = \frac{L}{R}$ $\quad \therefore m = \frac{L}{R} \times s$

$$\Rightarrow \frac{120}{56 \times 10^3} \times 2.5 \times 10^8 = 5.35714 \times 10^5 \text{ mtr}$$

$$\therefore m = 535.7 \text{ kms}$$

4) Problem 7 - CH 1

Rate at which Host A converts Analogue voice to digital = 64 kbps

Packet Size = 56 bytes

Transmission Rate b/n A & B = 2 Mbps

d_{prop} = 10 ms

Solution:

At host 'A', let d_{conv} be the conversio time for making a packet of size 56 bytes.

$$d_{conv} = \frac{56 \times 8}{64 \times 10^3} = 7 \text{ msec}$$

$$d_{trans} = \frac{L}{R} = \frac{56 \times 8}{2 \times 10^6} = 224 \times 10^{-6} \text{ sec}$$

$$= 0.224 \text{ ms}$$

$$d_{prop} = 10 \text{ ms}$$

∴ Total time required = $d_{conv} + d_{trans} + d_{prop}$

$$= (7 + 0.224 + 10) \text{ ms}$$

$$= 17.224 \text{ ms}$$

6> Problem 24 CH 1

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

$\because$ 1 tb $\simeq$ 1000 GB → 1 GB $\simeq$ 1000 MB

~~1 GB ≃ 1000 KB~~ → 1 MB $\simeq$ 1000 KB

→ 1 KB $\simeq$ 1000 bytes

→ 1 byte $\simeq$ 8 bits

100 Mbps $\simeq 100 \times 10^6$ bps

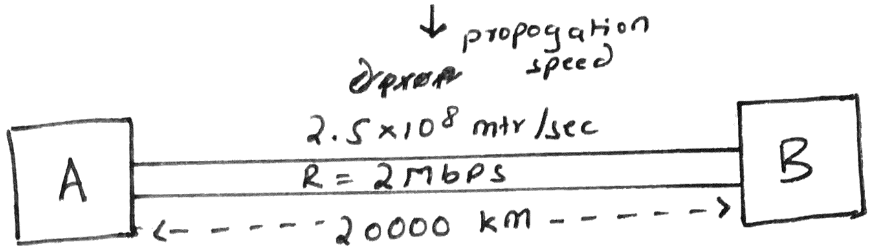
$\therefore$ To transfer 40 TB of data through a 100 Mbps dedicated link, it takes

$$\frac{40 \times 10^{12} \times 8}{100 \times 10^6} \text{ seconds}$$

This will be $\simeq 320 \times 10^4$ seconds, which will be more than a day.

Hence, it's better to send the data ~~the data~~ with the ~~overnight~~ ~~or~~ ~~coe~~ ~~ecom~~ help of Fed-Ex overnight delivery.

7) Problem 25 - CH - 1



(a) Bandwidth delay product

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

$$d_{prop} = \frac{\text{distance}}{\text{propogation speed}} = \frac{20000 \times 10^3}{2.5 \times 10^8}$$

$d_{prop} \Rightarrow 0.08$ m/sec

$$\therefore \quad R \times d_{prop} = 2 \times 10^6 \times 0.08$$

$$= 160000 \text{ bits}$$

(b) Maximum number of bits in link at any given time is given by bandwidth delay product.

i.e $R . d_{prop}$

$$\Rightarrow R \times \frac{\text{distance}}{\text{prop speed}} = 2 \times 10^6 \times \frac{20000 \times 10^3}{2.5 \times 10^8}$$

$\Rightarrow 160000$ bits.

(c) Interpretation of bandwidth delay product.

Bandwidth delay can be described as, the product of link bandwidth and the propogation delay over the link.

i.e Bandwidth delay product = R (Bandwidth) × Prop. delay over the link.

$$= R \times d_{prop}$$

Ex : As we have seen in (a) & (b) before

if $R = 2$ Mbps & $d_{prop} = 0.08$ m/s

then, Bandwidth delay product is,

$$R \times d_{prop} = 2 \times 10^6 \times 0.08$$

$$= 16 \times 10^4 \text{ bits}$$

This gives the answer for maximum number of bits on the link at any given point of time.

(d) width of a bit in link

$$= \frac{\text{length of link}}{\text{Bandwidth delay product}}$$

length of link = 20000 km

$= 2 \times 10^7$ mtrs

Bandwidth delay product = max no of ~~links~~ bits in a link

As seen in problem (a) & (b) = 16×10^4 bits.

$\therefore$ width of bit in a link (in mtrs)

$$= \frac{2 \times 10^7}{16 \times 10^4} = 125 \text{ mtrs}$$

(e)

propogation speed = s

transmission rate = R

length of link = m

WKT, width of a bit $= \dfrac{\text{length of link}}{\text{Bandwidth delay product}}$

$\underline{\text{or}}$ $\dfrac{\text{length of link}}{\text{maximum no. of bits in a link}}$

$\Rightarrow \dfrac{\text{length of link (m)}}{\text{transmission Rate (R)} \times \text{prop. delay}}$

$$\Rightarrow \frac{m}{R \times \left[\frac{\text{length of link}}{\text{propogation speed}}\right]}$$

$$\Rightarrow \frac{\cancel{m}}{R \times \left(\frac{\cancel{m}}{s}\right)} \Rightarrow \frac{s}{R}$$

$\therefore$ width of bit $= \frac{s}{R}$ mtrs.

where, s = propogation speed

R = transmission rate

5) Problem 18 - CH 1

(a) Intra - continent traceout

website → uml.edu

Trial 1 at 10:00pm

Average : $\frac{92 + 22 + 31}{3} = 48.33$

$$\text{Std. deviation} = \sqrt{\frac{(92-48.33)^2 + (22-48.33)^2 + (31-48.33)^2}{3}}$$

$$= \sqrt{\frac{1907.06 + 693.26 + 300.32}{3}}$$

$$= \sqrt{966.88} = 31.09$$

<u>Trial 2</u> at 11:00 pm

$$\text{Average} = \frac{25+24+24}{3} = 24.33$$

$$\text{std. deviation} = \sqrt{\frac{(25-24.33)^2+(24-24.33)^2+(24-24.33)^2}{3}}$$

$$= \sqrt{\frac{0.4489+0.1089+0.1089}{3}} = \sqrt{0.2222}$$

$$= 0.4713$$

<u>Trial 3</u> at 11:55 pm

$$\text{Average} = \frac{23+18+19}{3} = 20$$

$$\text{std. deviation} = \sqrt{\frac{(23-20)^2+(18-20)^2+(19-20)^2}{3}}$$

$$= \sqrt{\frac{9+4+1}{3}} = \sqrt{4.66} = 2.1587$$

(b) Number of routers in path

Trace 1 at → 10:00pm → 11 routers

Trace 2 at → 11:00pm → 11 routers

Trace 3 at → 11:55pm → 11 routers.

The router paths have changed during different time of trace outs.

(d) Inter - continent trace out

Trial 1 at 10:00pm

$$\text{Average: } \frac{274 + 272 + 276}{3} = 274$$

$$\text{Std. deviation} = \sqrt{\frac{(274-274)^2 + (272-274)^2 + (276-274)^2}{3}}$$

$$= \sqrt{\frac{0 + 4 + 4}{3}} = \sqrt{2.66} = 1.6309$$

Trial 2 at 11:00pm

$$\text{Average} = \frac{276 + 282 + 277}{3} = 278.33$$

$$\text{Std. deviation} = \sqrt{\frac{(276-278.33)^2 + (282-278.33)^2 + (277-278.3}{3}}$$

$$= \sqrt{\frac{1.7689 + 13.4689 + 5.4289}{3}} = \sqrt{6.889}$$

$$= 2.6246$$

<u>Trial 3</u> at 11:55 PM

$$\text{Average} = \frac{272 + 272 + 277}{3} = 273.66$$

$$\text{Std. deviation} = \sqrt{\frac{(272-273.66)^2 + (272-273.66)^2 + (277-273.66)^2}{3}}$$

$$\sqrt{\frac{2.75 + 2.75 + 11.15}{3}} = \sqrt{5.55}$$

$$= 2.3558$$

(b) for inter continent:

Trace 1 at → 10:00pm → 12 routers

Trace 2 at → 11:00pm → 12 routers

Trace 3 at → 11:55pm → 12 routers.

The router paths have not changed.

(c) Inter continent traceout: for "flipkart.com"

[ISP networks → traceout go through source to destination]

1. 10.0.0.1
2. 96.120.64.29
3. ge-3-2-ur01-rutland.vt.boston.comcast.net
4. be-63-ar01.woburn.ma.boston.comcast.net
5. be-1002-pe02.onesummer.ma.ibone.comcast.net
6. 50.248.118.6

7. nyk-bb1-link. telia.net
8. nyk-b6-link. telia.net
9. bharatiairtel-ic-316560-nyk-b6.c.telia.net
10. 182.79.252.202
11. 125.17.245.162
12. 163.53.78.58

for "uml.edu"

1. 10.0.0.1
2. 96.120.64.29
3. te-0-7-0-10-sur02.lowell.ma.boston.comcast.net
4. be-22-sur03.lowell.ma.boston.comcast.net
5. be-63-ar01.woburn.ma.boston.comcast.net
6. Bundle-Ether61-sur02.boston.ma.boston.comcast.net
7. nox1sumgw1-comcast.nox.org
8. miti-cps-~~nox~~1sumgw1.nox.org
9. 69.16.3.6
10. 129.63.235.201
11. uml.com.kw

Yes, largest delay occurs at peering interfaces ~~b/w~~ between adjacent ISP's.

Intra Continent	Inter-continent
1. Average is less	1. Average is more
2. Routers involved is less	2. Routers involved is more.
3. Number of hops between source & destination is less	3. Number of hops between source and destination is more.