EE 450 Homework #1

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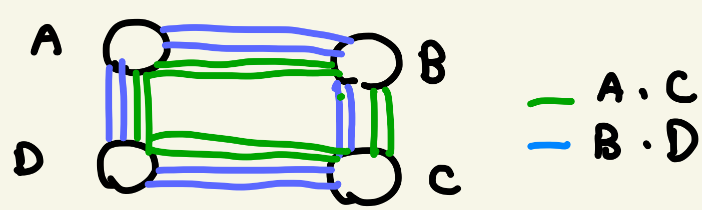
P4.

a. For each pair of adjacent switches, we can have at most 4 connections. Now, we have 4 pairs of adjacent switches (AB, BC, CD, DA). Hence, the maximum number of connections is $\underline{4 \times 4 = 16}$ *

b. There are at most 4 connections for A-B-C. Similarly, there are at most 4 connections for A-D-C. The maximum number of connections is $\underline{4+4=8}$ *

c. <u>Yes</u>. The following image illustrates how to route the calls. For A and C, 2 connections through B and 2 through D. For B and D, 2 through A and 2 through C.



P5.

a.

$$d_t = \frac{12 \times 10}{60 \times 60} \times \overset{\text{3 tollboots}}{3} = 0.1 \text{ (hr)}$$

$$d_{prop} = \frac{175}{100} = 1.75 \text{ (hr)}$$

End-to-end Delay $= d_t + d_{prop}$

$$= 0.1 + 1.75 = \underline{1.85 \text{ (hr)}} \#$$

b.

$$d_t = \frac{12 \times 8}{60 \times 60} \times 3 = 0.08 \text{ (hr)}$$

$$d_{prop} = 1.75 \text{ (hr)}$$

End-to-end Delay $= 0.08 + 1.75 = \underline{1.83 \text{ (hr)}} \#$

P6.

a. $d_{prop} = \underline{\dfrac{m}{s} \text{ (sec)}}$ #

b. $d_{trans} = \underline{\dfrac{L}{R} \text{ (sec)}}$ #

c. $d_{end\text{-}to\text{-}end} = d_{trans} + d_{prop} = \underline{\dfrac{m}{s} + \dfrac{L}{R} \text{ (sec)}}$ #

d. The last bit of packet is just leaving Host A.

e. $\because d_{prop} > d_{trans}$

$\therefore$ the first bit hasn't reached Host B when $t = d_{trans}$

f. $\because d_{prop} < d_{trans}$.

$\therefore$ the first bit has reached Host B when $t = d_{trans}$

g. $d_{prop} = \dfrac{m}{2.5\times10^8} = \dfrac{1500\times8}{10\times10^6} = d_{trans}$ ← 1 byte = 8 bits

$\Rightarrow m = 8\times25\times1500 = \underline{3\times10^5 \text{ (m)}}$ #

P7.

1byte = 8 bits

sec to msec

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

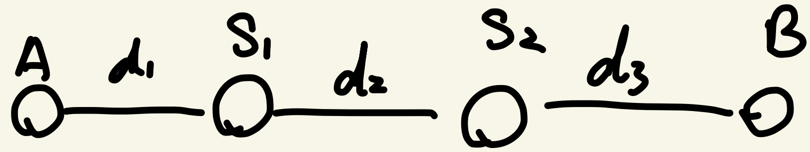
$$T = \text{conversion time} + d_{prop} + d_{trans}$$

$$= 7 + 10 + \frac{56 \times 8}{10 \times 10^{6}} \times 10^{3}$$

$$= 7 + 10 + 4.48 \times 10^{-2}$$

$$= \underline{17.0448 \text{ msec}}$$

P10.



(1)

$$\text{end-to-end delay} = d_{prop} + d_{trans} + 2\,d_{proc}$$

$$= \underline{\left(\frac{d_1}{s_1} + \frac{d_2}{s_2} + \frac{d_3}{s_3}\right) + \left(\frac{L}{R_1} + \frac{L}{R_2} + \frac{L}{R_3}\right) + 2d_{proc}}$$ ※

(2)

$$\text{end-to-end delay} = d_{prop} + d_{trans} + 2\,d_{proc}$$

10^4

$$= \frac{(5000+4000+1000)\times 10^3}{2.5\times 10^8} + \frac{1500\times 8\times 3}{2.5\times 10^6} + 2\times 3\times 10^{-3}$$

$$= 0.04 + 0.0144 + 0.006$$

$$= \underline{0.0604\ (\text{sec})}$$ ※

P12.

(1) 4.5 packets should be transmitted

$$\Rightarrow d_{queue} = \frac{4.5 \times 1500 \times 8}{2.5 \times 10^6} = \underline{2.16 \times 10^{-2} \text{(sec)}} \#$$

(2) n packets and (L-x) bits should be transmitted

$$\Rightarrow d_{queue} = \underline{\frac{nL + (L-x)}{R} \text{ (sec)}} \#$$

P20.

$$\text{throughput} = \underline{\min\left\{R_s,\ R_c,\ \frac{R}{M}\right\}} \ *$$

P21.

(1)

path k limit $= \min_{n=1}^{N} \{R_n^k\}$

$\Rightarrow$ max. throughput that server can achieve is the max. limit of all paths

$$\Rightarrow \underline{\max_{k=1}^{M} \left\{ \min_{n=1}^{N} \{R_n^k\} \right\}} \text{※}$$

(2) Since we can use all the paths, the maximum throughput is the sum over the limits of the paths

$$\Rightarrow \underline{\sum_{k=1}^{M} \min_{n=1}^{N} \{R_n^k\}} \text{※}$$

P25.

a. $R \cdot d_{prop}$

$$= 5\times10^6 \times \frac{2\times10^4\times10^3}{2.5\times10^8} = \underline{4\times10^5 \text{ (bits)}}_{\#}$$

b. Since bandwidth-delay product is the maximum number of bits that can be in the link.

and $4\times10^5 < 8\times10^6$

$\Rightarrow$ the maximum number of bits is $\underline{4\times10^5 \text{ (bits)}}$ #

c. Bandwidth-delay product is the maximum number of bits that can be in the link at any given time.

d. (1) $$\text{width} = \frac{2\times10^4\times10^3}{4\times10^5} = \underline{50 \text{ m}}_{\#}$$

(2) assume a football field is 120 yards $\doteq$ 109.7(m)

$\Rightarrow$ <u>No.</u> # shorter than a football field

P_{25}
(cont.)

e.

$$\text{width} = \frac{m}{R \cdot d_{prop}}$$

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

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

P28.

a.

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

$$= \frac{8\times10^5}{5\times10^6} + \frac{2\times10^4\times10^3}{2.5\times10^8}$$

$$= 0.16 + 0.08 = \underline{0.24\,(sec)}$$ #

b.

$$T = 20\times(2d_{prop} + d_{trans})$$

$$= 20\left(2\times\frac{2\times10^7}{2.5\times10^8} + \frac{4\times10^4}{5\times10^6}\right)$$

$$= 20\times(0.16 + 0.008)$$

$$= \underline{3.36\ (sec)}$$ #

c.

(b) is much longer than (a.)

⇒ sending files continuously is more efficient