EE 450 HW #1 Yuhang Xiao

P4.

a. Between the switch A and B, four connections could be established. It's also true for A and D, B and C, and C and D. So the maximum number can be 16.

b. 4 connections could be established along A-B-C or A-D-C. Thus, maximum number is 8.

c. Yes. For $A \to C$, randomly choose 2 connections along $A \to B \to C$ and $A \to D \to C$. Now, we established 4 connections for $A \to C$. Use the remaining 2 connections along $B \to C \to D$ and $B \to A \to D$ to make 4 connections for $B \to D$.

P5.

a.

$$d_{prop} = \frac{175}{100} = 1.75 \text{ hours} = 105 \text{ min}$$

$$d_{tran} = 10/5 = 2 \text{ min}$$

$$d_{end\text{-}to\text{-}end} = d_{prop} + 3 d_{tran} = 111 \text{ min}$$

b.

$$d_{tran} = 8/5 = 1.6 \text{ min}, \quad d_{prop} = 105 \text{ min}$$

$$d_{end\text{-}to\text{-}end} = d_{prop} + 3 d_{tran} = 109.8 \text{ min}$$

$$= 109 \text{ min } 48 \text{ sec}$$

P6.

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

b. $d_{tran} = L/R$ sec

c. $d_{e\text{-}to\text{-}e} = d_{prop} + d_{tran} = \frac{m}{s} + \frac{L}{R}$ sec.

d. The last bit just left Host A.

e. The first bit is still in the link.

f. The first bit has arrived Host B.

g. $d_{prop} = d_{tran} \Rightarrow \frac{m}{s} = \frac{L}{R}$

Thus, $m = \frac{Ls}{R} = \frac{1500 \times 8 \times 2.5 \times 10^8}{10 \times 10^6} = 3 \times 10^5$ meters

P7.

$$d = d_{proc} + d_{tran} + d_{prop}$$
$$= \frac{56 \times 8}{64 \times 10^3} + \frac{56 \times 8}{10^7} + 10 \text{ msec}$$
$$= 7 \text{ msec} + 0.0448 \text{ msec} + 10 \text{ msec}$$
$$= 17.0448 \text{ msec}$$

P10.

$$d_{e\text{-}to\text{-}e} = d_{tran} + 2d_{proc} + d_{prop}$$
$$= \sum_i \frac{L}{R_i} + 2d_{proc} + \sum_i \frac{d_i}{s_i}$$
$$= 14.4 \text{ msec} + 6 \text{ msec} + 40 \text{ msec}$$
$$= 60.4 \text{ msec}$$

P12.

$$d_{queue} = \frac{nL + (L-x)}{R} \rightarrow \text{general equation}$$

$$= \frac{4\times1500\times8 + (1500\times8 - 0.5\times1500\times8)}{2.5\times10^6}$$

$$= 21.6 \text{ msec}$$

P20.

$$\text{Throughput} = \min\left\{R_s, R_c, \frac{R}{M}\right\}$$

P21.

one path: $\text{Throughput} = \max\{\min\{R_1^1, \ldots, R_N^1\}, \min\{R_1^2, \ldots R_N^2\}, \ldots, \min\{R_1^M, \ldots, R_N^M\}\}$

all paths: $\text{Throughput} = \sum_{k=1}^{M} \min\{R_1^k, R_2^k, \ldots, R_N^k\}$

P25.

a. $R \cdot d_{prop} = 5 \text{ Mbps} \cdot \frac{2\times10^7}{2.5\times10^8} = 0.4 \text{ Mbps}$

b. because 800000 > 400000, so the maximum bits are 400000 bits

c. Maximum number of bits that can stay in the link

d. $\text{width} = \frac{2\times10^7}{4\times10^5} = 50 \text{ m}$

not longer than a football field (91.44 m)

e. $\text{width} = \dfrac{m}{R \cdot \frac{m}{s}} = \dfrac{s}{R}$

P28.

a. $d = d_{tran} + d_{prop} = \dfrac{8\times10^5}{5\times10^6} + \dfrac{2\times10^7}{2.5\times10^8} = 0.24\,s$

b. $d = 20\,RTT = 20\,(d_{tran} + 2d_{prop})$

$= 20\,\left(\dfrac{4\times10^4}{5\times10^6} + 2\cdot0.08\right)$

$= 3.36\,s$

c. Packet sending takes way longer time than continuous sending because the next packet should wait $2 \cdot d_{prop}$ seconds for previous packet to get acknowledged, and then it can be sent.