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CS 132 Homework 1

Problem 1: Statistical Multiplexing

a. 3 Mbps / 150 kbps

   = 3000 kbps / 150 kbps

   = 20 users can be supported

b. i) P(a given user is transmitting) = 0.1

   ii) P(exactly n users transmitting simultaneously, given 120 users)

   $= \binom{120}{n} p^n (1-p)^{120-n}$

   $= \binom{120}{n} 0.1^n * 0.9^{120-n}$

   iii) P(21 users or more transmitting)

   $= \sum_{n=21}^{120} \binom{120}{n} p^n (1-p)^{120-n}$

   $= \sum_{n=21}^{120} \binom{120}{n} 0.1^n * 0.9^{120-n}$

   $= 1 - \sum_{n=0}^{20} \binom{120}{n} 0.1^n * 0.9^{120-n}$

   $\approx$ 0.992

Problem 2

1. Expressions for delay and throughput for Circuit Switching:

$$D_{CS} = 2k(\frac{H}{W} + \tau) + \frac{nL}{W} + k\tau$$

$$T_{CS} = \frac{L}{2k(\frac{H}{W}+\tau) + \frac{nL}{W} + 2(\frac{nH}{W}+k\tau)}$$

2. Expressions for delay and throughput for Message Switching:

$$D_{MS} = k(\frac{L+H}{W} + \tau)$$

$$T_{MS} = (\frac{L}{L+H})W$$

3. Expressions for delay and throughput for Packet Switching, where n = L/P:

$$D_{PS} = n\,(\frac{P+H}{W}) + (k-1)(\frac{P+H}{W}) + k\tau$$

$$T_{PS} = (\frac{P}{H+P})W$$

4. Throughput results, given $\tau = 0,\ n = 1$:

$$T_{CS} = \frac{L}{2k(\frac{H}{W}+\tau) + \frac{nL}{W} + 2(\frac{nH}{W}+k\tau)}$$

$$= \frac{L}{2k(\frac{H}{W}) + \frac{L}{W} + 2(\frac{H}{W})}$$

$$T_{MS} = (\frac{L}{L+H})W$$

$$T_{PS} = \left(\frac{P}{H+P}\right)W$$

Thus, MS > PS > CS

5. Delay results, given $\tau = 0$, $n = 1$, $H < P$, and k is very large :

$$D_{CS} = 2k\left(\frac{H}{W} + \tau\right) + \frac{nL}{W} + k\tau$$

$$= 2k\left(\frac{H}{W}\right) + \frac{L}{W}$$

$$D_{MS} = k\left(\frac{L+H}{W} + \tau\right)$$

$$= k\left(\frac{L+H}{W}\right)$$

$$D_{PS} = n\left(\frac{P+H}{W}\right) + (k-1)\left(\frac{P+H}{W}\right) + k\tau$$

$$= \left(\frac{P+H}{W}\right) + (k-1)\left(\frac{P+H}{W}\right)$$

Thus, CS < PS < MS.

6. Given the following equation that is used to calculate end-to-end delay for packet switching:

$$D_{PS} = n\left(\frac{P+H}{W}\right) + (k-1)\left(\frac{P+H}{W}\right) + k\tau$$

Assuming that we want to minimize the end-to-end delay and L, H, k, W, and τ are all fixed, then having P as the smallest value possible would be the ideal. Then we would want to simplify to the following:

$$P = \frac{k * \tau * W}{-n - (k-1)} - H$$