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COMP-4320-002

Homework 1

1. a. A packet-switched network would be more appropriate for this application, because this network can handle varying bit rates.

   b. Since the overall bit rate of the network (1.5 + 3 + 1 = 5.5 MBps) is less than the capacity (10 MBps), no form of congestion control is needed.

2. a. When circuit switching is used, 20 users can be supported because $\frac{30}{1.5} = 20$.

   b. Since the user transmits only 15 percent of the time, there is a 15% probability that the given user is transmitting.

   c. Using binomial distribution, the probability n users are transmitting is equal to this distribution equation: ${}^{80}C_n * (0.15)^n * (0.85)^{80-n}$

   d. The equation for finding this probability is ${}^{n}C_{20} * (0.15)^{20} * (0.85)^{n-20}$. If we are still assuming there are 80 total users, the probability 20 or more are transmitting is: ${}^{80}C_{20} * (0.15)^{20} * (0.85)^{80-20} = 1.315\%$.

3. For these values, the end-to-end delay is $\frac{(1500*8)}{2*10^6} + \frac{(1500*8)}{2*10^6} + \frac{(1500*8)}{2*10^6} + \frac{5000*10^3}{2.5*10^8} + \frac{4000*10^3}{2.5*10^8} + \frac{1000*10^3}{2.5*10^8} + 0.003 + 0.003 = 0.064\ seconds = 64\ milliseconds$

4. The queing delay for this problem is $\frac{\left(2000*(8+1)-\frac{2000}{20}\right)}{20*10^6*\frac{1}{8}} = 7.16\ milliseconds$. More generally, the equation would be $\frac{n*L+(L-k)}{R}$.

5. If the server uses a single path to send data to the client, the maximum throughput = R_1^i. If the server uses all S paths to send data to the client the maximum throughput = $\min(R_1^i, R_2^i, R_3^i, \ldots, R_N^i)$

6. a. Total delay = $\frac{TR}{R(1-T)} + \frac{P}{R} + \frac{\frac{P}{R}}{1-I}$

   b. Total delay = $\frac{\frac{P}{R}}{1-\alpha(\frac{P}{R})}$

   c. Total delay = $\frac{\frac{P}{R}}{1-I} = \frac{\frac{P}{R}}{1-\alpha\frac{P}{R}} = \frac{\frac{1}{\rho}}{1-\frac{\alpha}{\rho}} = \frac{1}{\rho-\alpha}$

7. a. Time it takes to move the message from the source to the first packet switch = $\frac{8*10^6}{2*10^6} = 4\ seconds$. Time it takes to move the message from source host to destination host = $4 * 3 = 12\ seconds$.

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b. Time it takes to move the first packet from the source host to the first switch = $\frac{1*10^4}{2*10^6} = 10\ milliseconds$. The time when the second packet will be fully received at the first switch = $5 * 2 = 10\ milliseconds$.

c. Time it takes to move the file from source host to destination host when message segmentation is used = $5 * 3 = 15\ millisecconds$, and then every 5 seconds after this. It is significantly faster (nearly 100x).

d. Drawbacks to message segmentation are if one packet is missing, the file becomes corrupted, it requires a queuing system for the packets, and it requires more bandwidth.