King Fahd University of Petroleum and Minerals
College of Computer Sciences and Engineering
Department of Computer Engineering

COE 344 – Computer Networks (T121)

Homework # 01 (*due date & time: Saturday 22/09/2012 during class period*)

Late homework submission will NOT be accepted

***** Show all your work. No credit will be given if work is not shown! *****

For all problems: 1 kbits = 1,000 bits, 1 Mbits = 1,000,000 bits

Problem # 1 (10 points; 5 points each):
Review the ten-car caravan analogy in Section 1.4 of the textbook. Assume a propagation speed of 100 km/hour. Suppose that the each tollbooth services a car at a rate of one car per 10 seconds, and that the caravan's cars are the only cars on the highway.

a. Suppose the caravan travels 200 km, beginning in front of one tollbooth, passing through a second tollbooth, and finishing just before a third tollbooth. What is the end-to-end delay? Assume that the second tollbooth is midway between the first and the third tollbooths.
b. Repeat (a), now assuming that there are five cars in the caravan instead of ten.

Problem # 2 (30 points; 10 points each): Consider **two hosts** connected to the same router. Each host sends a file of $F = M * L$ bits to the same destination host over a path of Q links. Each link transmits at $\boldsymbol{R}$ bps and has a propagation delay of $\boldsymbol{t_{prop}}$. The network is lightly loaded so that there are no queuing delays. Assume that the processing delay is negligible. Packet switching is used and the $M * L$ bits are broken up into M packets, each packet with L bits. Assume that the transmissions of the two hosts alternate on each of the Q links of the path (i.e. on each link, the transmission of a packet of the first host is always followed by the transmission of a packet of the second host).

a. Suppose the network is a packet-switched virtual-circuit network. Denote the VC set-up time by $\boldsymbol{t_s}$ seconds. Suppose to each packet the sending layers add a total of $\boldsymbol{h}$ bits of header. How long does it take to send the file from each source to destination?
b. Suppose the network is a packet-switched datagram network, and a connectionless service is used. Now suppose each packet has **2*h*** bits of header. How long does it take to send the file from each host?
c. Repeat (b), but assume message switching is used (i.e., **2*h*** bits are added to the message, and the message is not segmented).

Problem # 3 (20 points; 5 points each): Consider sending a file of 29.4 Mbits over a path of 4 links. Each link transmits at a rate of 2 Mbps. The network is lightly loaded so that there are no queuing delays. Assume that the processing delay at each node is negligible, and that the propagation delay on each link is 6 milliseconds.

a. Suppose the network is a packet-switched virtual-circuit network with a VC set-up time of 500 milliseconds. Suppose that the file is broken into 6,000 packets. Further, suppose that to each packet the sending layers add a total of 100 bits of header. How long does it take to send the file from source to destination?

b. Suppose the network is a packet-switched datagram network, and a connectionless service is used. Suppose that the file is broken into 6,000 packets. Now suppose each packet has 200 bits of header. How long does it take to send the file?
c. Repeat (b), but assume <u>message</u> switching is used (i.e., 200 bits are added to the message, and the message is not segmented).
d. Finally, suppose that the network is a circuit switched network. Further suppose that the transmission rate of the circuit between source and destination is 2 Mbps. Assuming 500 milliseconds set-up time and 100 bits of header appended to the entire file, how long does it take to send the file?

Problem # 4 (40 points; 10 points each):

Suppose users share a 10 Mbps link. Also suppose each user requires 2.5 Mbps when transmitting, but each user transmits only 20% of the time.

a. When circuit switching is used, how many users can be supported?
b. For the remainder of the problem, suppose packet switching is used. Find the probability that a given user is transmitting.
c. Suppose there are 30 users. Find the probability that at any given time, exactly *n* users are transmitting simultaneously. (*Hint*: Use the binomial distribution.)
d. Find the probability that there are 5 or more users transmitting simultaneously.