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

COE 344 – Computer Networks (T131)

Homework # 01 (*due date & time: Tuesday 17/09/2013 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): Suppose N packets arrive simultaneously to a link at which no packets are currently being transmitted or queued. Each packet is of length L and the link has transmission rate R. Calculate the **average** queuing delay for the N packets.

Problem # 2 (20 points): Solve problem P12 on page 101 of the **5th edition** of the textbook.

P12. Consider a packet of length L which begins at end system A, travels over one link to a packet switch, and travels from the packet switch over a second link to a destination end system. Let d_i, s_i, and R_i denote the length, propagation speed, and the transmission rate of link i, for $i = 1,2$. The packet switch delays each packet by d_{proc}. Assuming no queuing delays, in terms of d_i, s_i, R_i, $(i = 1,2)$, and L, what is the total end-to-end delay for the packet? Suppose now the packet is 1,000 bytes, the propagation speed on both links is $2.5 \cdot 10^8$ m/s, the transmission rates of both links is 1 Mbps, the packet length is 1,000 bytes, the packet switch processing delay is 1 msec, the length of the first link is 4,000 km, and the length of the last link is 1,000 km. For these values, what is the end-to-end delay?

Problem # 3 (20 points): Solve problem P25 on page 104 of the **5th edition** of the textbook.

P25. Consider sending a large file of F bits from Host A to Host B. There are two links (and one switch) between A and B, and the links are uncongested (that is, no queuing delays). Host A segments the file into segments of S bits each and adds 40 bits of header to each segment, forming packets of $L = 40 + S$ bits. Each link has a transmission rate of R bps. Find the value of S that minimizes the delay of moving the file from Host A to Host B. Disregard propagation delay.

Problem # 4 (20 points; 5 points each): Consider sending a file of 29.4 Mbits over a path of 3 links. Each link transmits at a rate of 1.2 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 10 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 15,000 packets. Further, suppose that to each packet the sending layers add a total of 140 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 15,000 packets. Now suppose each packet has 240 bits of header. How long does it take to send the file?
c. Repeat (b), but assume message switching is used (i.e., 240 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 1.2 Mbps. Assuming 500 milliseconds set-up time and 140 bits of header appended to the entire file, how long does it take to send the file?

Problem # 5 (30 points):
Suppose users share a 25 Mbps link. Also suppose each user requires 5 Mbps when transmitting, but each user transmits only 5% of the time.
a. **(5 points)** When circuit switching is used, how many users can be supported?
b. **(5 points)** For the remainder of the problem, suppose packet switching is used. Find the probability that a given user is transmitting.
c. **(10 points)** Suppose there are 20 users. Find the probability that at any given time, exactly *n* users are transmitting simultaneously. (*Hint*: Use the binomial distribution.)
d. **(10 points)** Find the probability that there are 6 or more users transmitting simultaneously.