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

COE 344 – Computer Networks (T122)

Homework # 01 (*due date & time: Saturday 16/02/2013 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; 10 points each): 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 (30 points; 10 points each): Consider a host is sending a file of $F = M * L$ bits to a destination host over a path of Q links. Each link transmits at R bps and has a propagation delay of t_{prop}. The network is lightly loaded so that there are no queuing delays. Assume that the processing delay is t_{proc}. Packet switching is used and the $M * L$ bits are broken up into M packets, each packet with L bits.
a. Suppose the network is a packet-switched virtual-circuit network. Denote the VC set-up time by t_s seconds. Suppose to each packet the sending layers add a total of 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 **2h** bits of header. How long does it take to send the file from each host?
c. Repeat (b), but assume <u>message</u> switching is used (i.e., **2h** 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 <u>propagation delay</u> on each link is 5 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 12,000 packets. Further, suppose that to each packet the sending layers add a total of 150 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 12,000 packets. Now suppose each packet has 250 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., 250 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 150 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 15 Mbps link. Also suppose each user requires 2.5 Mbps when transmitting, but each user transmits only 10% 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 20 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 7 or more users transmitting simultaneously.