CS422 Homework 1

due Friday, October 12th (11:59pm)

October 5, 2012

NOTE: Some of the answers to the following problems may be found on the Internet. Do not go searching on the internet for the answers. Work them out on your own, by discussing it with your fellow students, TA, and professor, using Piazza. Collaboration is allowed as discussed below, but this is an INDIVIDUAL assignment, to be written up completely on your own.

Submit your homework electronically in a text or PDF file. Upload your solution to Blackboard by 11:59pm on Friday, October 12th. Late submission beyond the course policy will not be accepted, nor will collaboration.

Collaboration on the homeworks is allowed, provided that the homework explicitly state who collaboration was done with, and that the homework is written up completely independently. Questions about this homework should be directed to Piazza. Questions that may give away question answers should be marked as private.

Answers should be justified and work shown. Answers with no justification will not receive credit.

Problem 1 (10 pts)

Suppose users share a 9Mbps link. Also suppose each user transmits continuously at 1.5Mbps when transmitting, but each user transmits only 25% of the time.

a. When circuit switching is used, how many users can be supported?

b. For the remainder of this problem, suppose packet switching is used. Why will there be essentially no queueing delay before the link if six or fewer users transmit at the same time? Why will there be a queueing delay if seven users transmit at the same time?

c. Suppose there are 10 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.

Problem 2 (10 pts)

Consider two hosts A and B, connected by a single link of rate R bps. Suppose that the two hosts are separated by m meters, and suppose the propagation speed along the link is s meters/sec. Host A is to send a packet of size L bits to hose B.

a. Express the propagation delay, d_{prop}, in terms of m and s.

b. Determine the transmission time of the packet, d_{trans}, in terms of L and R.

c. Ignoring processing and queueing delays, obtain an expression for the end-to-end delay.

d. Suppose host A begins to transmit the packet at time $t = 0$. At time $t = d_{trans}$, where is the last bit of the packet?

e. Suppose d_{prop} is less than d_{trans}. At time $t = d_{trans}$, where is the first bit of the packet?

f. Suppose d_{prop} is greater than d_{trans}. At time $t = d_{trans}$, where is the first bit of the packet?

g. Suppose $s = 2.5 \times 10^8$, $L = 300$ bits, and $R = 56$ kbps. Find the distance m so that d_{prop} equals d_{trans}.

Problem 3 (10 pts)

Suppose two hosts, A and B, are separated by 15,000 kilometers and are connected by a direct link of $R = 1$ Mbps. Suppose the propagation speed over the link is 2.5×10^8 meters/sec.

a. Calculate the bandwidth-delay product, $R \times d_{prop}$.

b. Consider sending a file of 600,000 bits from host A to host B. Suppose the file is sent continuously as one large message. What is the maximum number of bits that will be in the link at any given time?

c. Provide an interpretation of bandwidth-delay product.

d. What is the width (in meters) of a bit in the link? Is it longer than a football field (a football field is 100 yards)?

e. Derive a general expression for the width of a bit in terms of the propagation speed s, the transmission rate R, and the length of a link m.

Problem 4 (10 pts)

Give two examples of why the address given in an "RCPT TO:" SMTP command would differ from the "To:" field in the email body.

Problem 5 (10 pts)

Consider distributing a file of F bits to N peers using a P2P architecture. Assume a fluid model. For simplicity assume that d_{min} is very large, so that peer download bandwidth is never a bottleneck.

a. Suppose that $u_s \leq (u_s + u_1 + \ldots + u_N)/N$. Specify a distribution scheme that has a distribution time of F/u_s.

b. Suppose that $u_s \geq (u_s + u_1 + \ldots + u_N)/N$. Specify a distribution scheme that has a distribution time of $NF/(u_s + u_1 + \ldots + u_N)$.

c. Conclude that the minimum distribution time is in general given by $max\{F/u_s, NF/(u_s + u_1 + \ldots + u_N)\}$.

Problem 6 (10 pts)

Suppose a 10 Mbps adapter sends into a channel an infinite stream of 1s using a Manchester encoding. The signal merging from the adaptor has how many transitions per second? What is one advantage of Manchester encoding, and one disadvantage?

Problem 7 (10 pts)

Suppose you are transmitting a signal of up to 80 units, with noise of up to 10 units. How many distinguishable energy levels are there in principle? How many bits can therefore be transferred in a single energy pulse?

Problem 8 (10 pts)

If a system has an input power level of 60, an average noise level 20, and a bandwidth of 100 MHz, what is the effective limit on channel capacity? (See Nyquist/Shannon bounds).

Problem 9 (10 pts)

RS232 is very suited for interactive keyboard input and character output. Why? If an email is being sent over an RS232 connection, how many bits per character would ideally be used for transmission? What is the overhead rate of transmitting an email over RS232 using the ideal character size?

Problem 10 (10 pts)

What are the three kinds of modulation that can be applied to a carrier wave? Which is most susceptible to noise, and why?