CS536 Homework 1

due Tue, Feb 17th, 1:30pm

February 9, 2009

(Revision 1) Submit your homework electronically in a text or PDF file. Email your solution to the professor by 1:30pm on Tuesday, Feb 17th. Late submission will not be accepted, nor will collaboration.

To receive credit, all submissions should contain this statement at the beginning: "By turning in this homework submission, I certify that this work was done solely by me." Questions about this homework should be directed to the TAs or the Professor, not to fellow classmates.

Problem 1 (20 pts)

End-to-End Argument. Consider the design of e-mail. Apply the principle of the end-to-end argument and evaluate whether e-mail reinforces or violates it and why. Argue your conclusions for the first problem.

Problem 2 (10 pts)

Suppose users share a 6Mbps link. Also suppose each user transmits continuously at 2Mbps 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 three or fewer users transmit at the same time? Why will there be a queueing delay if four 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 4 or more users transmitting simultaneously.

Problem 3 (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 greater than d_{trans}. At time $t = d_{trans}$, where is the first bit of the packet?

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

g. Suppose $s = 2.3 \times 10^8$, $L = 300$ bits, and $R = 56$ kbps. Find the distance m so that d_{prop} equals d_{trans}.

Problem 4 (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 2.3×10^8 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?

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 5 (20 pts)

Akamai. DNS is a major component of how Akamai works. In what ways does Akamai's implementation of DNS differ from the traditional implementation?

Problem 6 (10 pts)

Consider a short, 10-meter link, over which a sender can transmit at a rate of 120 bits/sec in both directions. Suppose that packets containing data are 150,000 bits long, and packets containing only control (e.g ACK or handshaking) are 240 bits long. Assume that N parallel connections each get $1/N$ of the link bandwidth. Now consider the HTTP protocol, and suppose that each downloaded object is 120 Kbits long, and that the initial downloaded object contains 10 referenced objects from the same sender. Would parallel downloads via parallel instances of non-persistent HTTP make sense in this case? Now consider persistent HTTP. Do you expect significant gains over the non-persistent case? Justify and explain your answer.

Problem 7 (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 8 (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 $max\{F/u_s, NF/(u_s + u_1 + \ldots + u_N)\}$.