Homework 1 – Whirlwind Intro

Assigned: Wed, Sep 6, 2006

Due: Wed, Sep 13, 2006 *at the beginning of class*

New Honor Policy for Written Homework: You may talk about the written homework problems with other students, but each student must write up the solutions *in their own words*. **You must include the names of the students you worked with in your homework submission.** Since the exam questions will be similar in style to the written homework, it is your responsibility to make sure that you understand how to answer each question on your own. *This policy does not extend to programming assignments, which must be completed on your own.*

Review Questions

1. Describe the principle characteristics of the Internet's connection-oriented and connectionless services. Make sure that you distinguish between the two.

2. Explain the difference between flow control and congestion control.

3. Explain how packets using datagram routing over a packet-switched network can arrive to the destination in a different order than they were sent.

4. Explain the differences between propagation delay, transmission delay, and queuing delay. For a fixed network path and a fixed packet size, which of these three can vary? Why?

5. What are some differences between TCP and UDP? Which is connectionless? Which is connection-oriented?

6. List the five Internet protocol layers (top to bottom) and give an example protocol for each.

7. Which of the five Internet protocol layers does a router typically process? An end system?

Problems

8. 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 that the propagation speed along the link is s meters/sec. Host A is to send a packet of size L bits to Host 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 queuing delays, give 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?

9. Suppose two hosts, A and B, are separated by 10,000 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, $R * d_{\text{prop}}$.

    b. Consider sending a file of 400,000 bits from Host A to Host B. Suppose the file is sent continuously as one big message. What is the maximum number of bits that will be in the link at any given time?

    c. How long does it take to send the 400,000-bit file, assuming it is sent continuously?

    d. **[CS 555 only]** Suppose the 400,000-bit file is broken up into 10 packets with each packet containing 40,000 bits (no header information is added to the packet). Suppose that each packet is acknowledged by the receiver and the transmission time of an acknowledgement packet is negligible. Finally, assume that the sender cannot send a packet until the preceding one is acknowledged. How long does it take to send the file?

    e. **[CS 555 only]** Suppose that the 400,000-bit file is broken up into packets, each with a maximum size (including the header) of 40,000 bits. The sender must append a 500-bit header on each packet before sending. How many packets will it take to send the file?

10. Perform a `traceroute` between a source and far-away destination at three different hours of the same day.

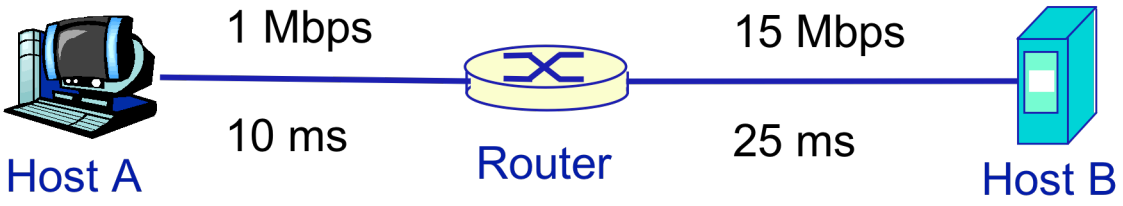
    a. Give the IP address of the source and the time of day each traceroute was run. Submit a printout of the output of the three traceroutes.

    b. What is the average and standard deviation of the round-trip delays at each of the three hours?

    c. How many routers were in the path at each of the three hours? Did the paths change between any of the hours?

    d. **[CS 555 only]** Are link layer switches included in traceroute output? Why or why not?

11. Consider the following network. Host A sends a 1500-byte packet to Host B.



    a. Compute the transmission delay of the packet from Host A.

    b. Compute the transmission delay of the packet from the router.

    c. Assume Host A sends the packet at time 0. When will the *first* bit arrive at Host B? **Hint:** Remember that the network is store-and-forward.

    d. Assume Host A send the packet at time 0. When will the *last* bit arrive at Host B? **Hint:** Remember that the network is store-and-forward.