Homework 1 – Whirlwind Intro

Assigned: Mon, Sep 4, 2007

Due: *no earlier than* Wed, Sep 13, 2007 *at the beginning of class*

Review Questions

1. Why is it said that packet switching employs statistical multiplexing? Contrast statistical multiplexing with the multiplexing that takes place in TDM.

2. Suppose users share a 2 Mbps link. Also suppose each user requires 1 Mbps when transmitting, but each user transmits only 20% of the time.

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

    b. If packet switching is used, can more users be supported than with circuit switching? How?

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

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

5. Consider sending a single packet from a source host to a destination host over a fixed route. List the delay components in the end-to-end delay. Which of these delays are constant and which are variable?

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

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

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

9. What is the difference between a virus, a worm, and a Trojan horse?

Problems

10. 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 greater than d_{trans}. At time $t = d_{trans}$, where is the first bit of the packet (at Host A, in the network, or at Host B)?

11. Suppose two hosts, A and B, are separated by 5,000 kilometers and are connected by a direct link of $R = 5$ 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 300,000 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. Assuming the file is sent continuously, how long does it take before the receiver has received the entire 300,000-bit file?

    d. **[CS 555 only]** Suppose the 300,000-bit file is broken up into 10 packets with each packet containing 30,000 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 and receive the final acknowledgement?

    e. **[CS 555 only]** Suppose that the 300,000-bit file is broken up into packets, each with a maximum size (including the header) of 15,000 bits. The sender must append a 500-bit header on each packet before sending. How many packets will it take to send the file?

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

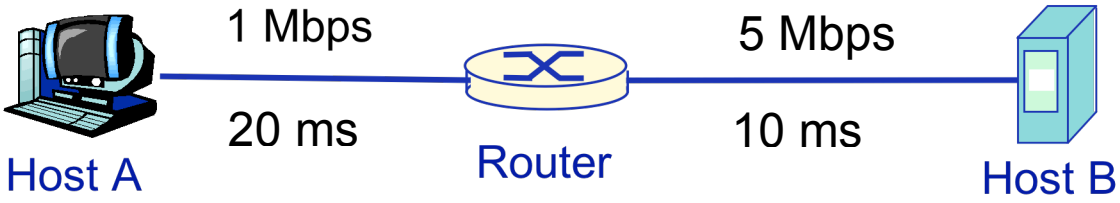
    a. Give the IP address of the source and the time of day each traceroute was run. Submit a printout of the output of the three traceroutes.

    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?

13. Consider the following network. Host A sends a 1500-byte packet to Host B. You may assume that the transmission time for a single bit is 0.



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