Homework Assignment #1 - Due: Sept. 16th @ 4pm

EE122: Introduction to Communication Networks (Fall 2009)
Department of Electrical Engineering and Computer Sciences
College of Engineering
University of California, Berkeley

Please submit your solutions using BSpace (https://bspace.berkeley.edu/). Log in to BSpace with your CalNet ID, click on the EL ENG 122 Fa09 tab, and click on Assignments under Course Tools. Assignments should be submitted in one of the following formats: .txt, .pdf, or .ps.

1. For the following questions, assume the topology presented below, where nodes A and B are end hosts.

   ![Topology Diagram]

   a. If most Internet applications transmitted data at constant rates and for long durations, would circuit or packet switching be preferred? Why? [5 points]

   b. Assume every link between the end hosts has a transmission rate of 100 Mbps and can handle up to 20 simultaneous circuits. Nodes A and B establish a connection. What will be their maximum transmission rate? [4 points]

   c. Now assume that packet switching is being used. If end hosts A and B are sending messages on an otherwise idle network, what will be their transmission rate? [4 points]

   d. Suddenly, other end hosts start communicating over the same links used by A and B. How would your answers to (b) and (c) change? For both the circuit switched and packet switched cases, would the network delays experienced by A and C be constant or time-varying? [7 points]

2. You have been tasked with building a file transfer application on top of a network that has a hop-by-hop retransmission mechanism.

   a. Would you still have to implement an end-to-end retransmission mechanism to achieve your goal? Why or why not? [5 points]

   b. What are the possible disadvantages of providing a hop-by-hop retransmission mechanism? [5 points]

   c. Deciding that a hop-by-hop retransmission mechanism is really unnecessary, you disable it. This causes the per-hop reliability to drop to 80%. If packets are traveling 10 hops, what is the probability that each packet sent by the source will be successfully received by the
destination? Do you think that the hop-by-hop retransmission mechanism should be re-enabled? Why or why not? [6 points]

3. Your friend analyzes some packet traces and comes to the conclusion that storing connection state in routers would significantly decrease network utilization.
   a. What might have caused him to reach that conclusion? [5 points]
   b. What is the primary disadvantage of this proposition? [5 points]

4. For the following questions, we will use the topology presented below. In this topology, nodes A and B are end hosts and nodes X, Y, and Z are routers. Each link is 100 m long and has a transmission rate of 1000Mbps. Signals propagate through the links at speeds of 2 \times 10^8 m/s. Every packet transmitted from node A to node B is 1000 bytes long.

   a. If node A generates and transmits one packet (and there are no other packets in the system), how long will it take for the packet to travel to node B? For this question, assume that there is no processing delay. [5 points]
   b. Now, assume the application at node A generates 100 packets instantaneously. How long will the first packet wait in node A’s queue before being transmitted? How long will the 100th packet wait in node A’s queue before being transmitted? (Assume that these are the only packets in the system). [5 points]
   c. The user of node A decides to close the previous application and open a new one. Node A starts sending 500 packets every 100 ms. What is the throughput it achieves, assuming no packet losses? [5 points]
   d. Finally, assume that the transmission rate of the link between nodes X and Y is now 20 Mbps. What is the maximum throughput that node A can hope to achieve? What will happen if node A attempts to transmit packets at a higher rate for a sustained period of time (please be specific)? [5 points]

5. To answer these questions, use the topology shown below. In this topology, nodes A, B, and C are end hosts.
a. Say you are using window flow control and have fine-tuned the parameters to obtain the desired throughput for the A -> B connection. However, when you try to use the same parameters for an A -> C connection, your throughput drops by half. What differences does this imply between the connections from A -> B and A -> C? (Assume that congestion is not caused in either scenario). [5 points]
b. How would you remedy this situation to once again have your desired throughput? (Assume you can achieve the desired throughput without causing congestion). [5 points]

6. Measurements of your company’s Internet connection have shown that the traffic intensity (defined in section 1.4) never gets much higher than 25%. One day, you learn that the company is planning to cut costs by reducing the speed of its Internet connection. The plan is to make the Internet connection just fast enough to ensure that the traffic intensity always stays under 50%.
   a. What types of applications will be affected most by this change? Why? [6 points]
   b. What types of applications will be affected least by this change? Why? [6 points]

7. You are moving into a new apartment and have to decide whether to use Cable or DSL for high-speed Internet.
   a. Which option would be best if you have privacy concerns? Why? [6 points]
   b. If connection speed were the most important factor in your decision, what question would you like to ask the company providing Cable Internet? (Hint: This is a question you would not need to ask the company providing DSL Internet.) [6 points]