EECS 563

Homework #5

1. This problem explores the relationships among Link Rate-R (b/s), One-way Propagation Delay-τ (sec), and Packet Size L (bits).

The time to clock a packet onto the link is L/R.
The number of packets in a round trip time (RTT) is $\frac{2*\tau}{(L/R)}$.
The time to transmit a packet an receive its acknowledgment is $\frac{L}{R} + 2\tau$ (assumes no errors in packet and ack and zero length acknowledgment packet).

The delay bandwidth product, DBP = 2τR.

The interactive graphs on the class web site can be used to answer this question

a. How many packet are in a RTT for a one-way propagation delay of 200 ms, link capacity of 1.4 Mb/s, and a packet length of 28,000 bits?

b. What is the time to transmit a packet and receive its acknowledgment if the number of packet are in a RTT is 20, link capacity of 1.4 Mb/s, one-way propagation delay of 200 ms, and a packet length of 28,000 bits?

2. For a packet length of 2.5 KB and one-way propagation delay τ =200 ms plot the time to transmit a packet an receive its acknowledgment as a function of link rate. At what link rate does the packet transmission time cause the time to transmit a packet an receive its acknowledgment to be 1.0025*RTT the propagation delay. At this link rate the propagation delay dominates the time transmit a packet an receive its acknowledgment.

3. How long does it take to transmit a file of 11KB assuming τ =200ms and the link rate found above in Problem 2 (meaning the clocking time <<2τ), no packet errors, a packet size of 2.5 KB/packet. the protocol uses a handshake of one RTT (set up time) before the first packet is transmitted. The protocol allows one packet to be send and acknowledged (1 packet sent during an RTT), then 2 packets to be send and acknowledged (2 packets sent during the second RTT), then 4 packets to be send and acknowledged (4 packets sent during the third RTT), then 8 packets to be send and acknowledged (8 packets sent during the fourth RTT).

4. How many packets are in a DBP for a packet size of 1500 Bytes, C = 500 Mb/s, and τ = 1 ms?

5. The distance between two building on the KU campus is 6 km, the buildings are connected by a 100 Gb/s fiber link (c=2x10^8 m/s).

a. What is the round trip propagation time in μs.

b. What is the message transmission time for a 1000 MB file.

Here the message transmission time in μs means the time to transmit the message to destination and know it was received correctly, i.e., the receiver getting acknowledgment back from the destination that the message was correctly received.

6. For a 1000 Gb/s link with a BER of 10^{-13} or 1 bit error in 10^{13} bits transmitted, what is the time between bit errors?

7. Network topologies:

a. Draw a 5 node ring network, how many links are in the 5 node ring network.

b. Draw a 5 node full mesh network, how many links are in the 5 node full mesh network.

c. The reliability of ring network is higher than the reliability of full mesh network, TRUE or FALSE

8. A voice over IP system uses the following parameters:
Voice sample rate = 8000 samples/sec, 4 bits/sample, 20 ms/voice packet, 4 Overhead bytes/packet.

a. What is the data rate for this VoIP packet stream?

b. The network delay varies between 40 ms and 140 ms. How many packets does the jitter buffer have to store to insure no packet loss due to network delay variation?

9. A sequence of fixed-length packets carrying digital audio signal is transmitted over a packet network. A packet is produced every 10 ms.
The transfer delays incurred by the first 5 packets are 45 ms, 50 ms, 53 ms, 46 ms, 30 ms.

Find the delay that is inserted at the receiver (by the jitter buffer) to produce a fixed end-to-end delay of 75 ms.

10. Consider an application in which information that is generated at a constant rate is transferred over a packet network with a random delay and timing recovery is required at the receiver.

a. As the maximum acceptable delay increases and the size of the jitter buffer in Bytes increases or decreases?

b. What happens if the jitter buffer is too small?

c. What happens if the jitter buffer is too large?