**Comp 2322 Computer Networking**

**Tutorial One**

**Questions:**

1. Consider the circuit-switched network in Figure. Recall that there are 4 circuits on each link.

Label the four switches A, B, C and D.



A

B

C

D

1. What is the maximum number of simultaneous connections that can be in progress at any one time in this network?
2. Suppose that all connections are between switches A and C. What is the maximum number of simultaneous connections that can be in progress?
3. Suppose we want to make four connections between switches A and C, and another four connections between switches B and D. Can we route these calls through the four links to accommodate all eight connections?
4. 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 Host B.
5. Express the propagation delay, , in terms of *m* and *s*.
6. Determine the transmission time of the packet, , in terms of *L* and *R*.
7. Ignoring processing and queuing delays, obtain an expression for the end-to-end delay.
8. Suppose Host A begins to transmit the packet at time *t* = 0. At time *t* = , where is the last bit of the packet?
9. Suppose is greater than . At time *t* = , where is the first bit of the packet?
10. Suppose is less than . At time *t* = , where is the first bit of the packet?
11. Suppose *s* = 2.5×108, *L* = 120 bits, and *R* = 56 kbps. Find the distance m so that equals .
12. Consider a VoIP system that sends real-time voice from Host A to Host B over a packet switched network. There is one link between Hosts A and B; its transmission rate is 2Mbps and its propagation delay is 10 msec. Host A converts analog voice to a digital 64 kbps bit stream on the fly. Host A then groups the bits into 56-byte packets. As soon as Host A gathers a packet, it sends it to Host B. As soon as Host B receives an entire packet, it converts the packet’s bits to an analog signal. How much time elapses from the time a bit is created (from the original analog signal at Host A) until the bit is decoded (as part of the analog signal at Host B)?
13. Suppose an end to end path from a server to a client contains N links. Each link has a packet loss probability p, and the packet loss probabilities for these links are independent.
14. What is the probability that a packet (sent by the server) is successfully received by the client?
15. If a packet is lost in the path from the server to the client, then the server will re-transmit the packet. On average, how many times will the server re-transmit the packet in order for the client to successfully receive the packet?
16. Suppose users share a 3 Mbps link. Also suppose each user requires 150 kbps when transmitting, but each user transmits only 10 percent of the time.
    1. When circuit switching is used, how many users can be supported?
    2. Suppose there are 120 users. Find the probability that at any given time, exactly n users are transmitting simultaneously.
    3. Under the above condition (b), find the probability that there are 21 or more users transmitting simultaneously.