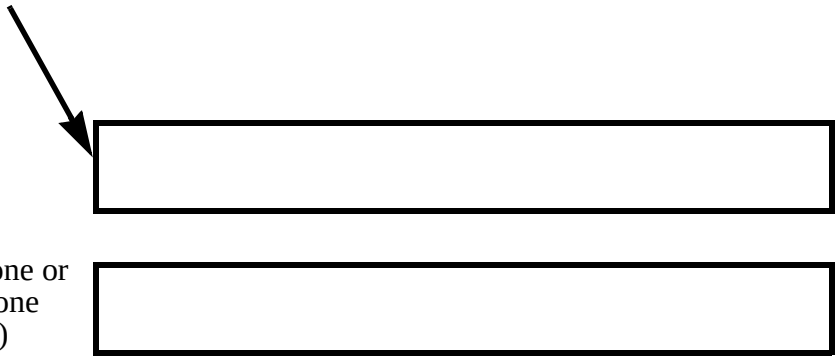
Check to be sure that there are 5 problems on 5 pages. You are encouraged to answer all 5 problems. Your grade will be based on the four best answers. You have 2 hours and 30 minutes. Note that some problems are more time-consuming than others. Use your time wisely. This is an open book and open note examine.

Show all your work. If a problem statement is unclear to you, state your assumptions. If you use additional sheets of paper, identify them and arrange them in sequence.

Write down your name here



work phone or home phone (optional)

Problem 1. Token Ring

Consider a 2Gbps token ring with 20 stations **equally separated**. Assume the signal propagation speed is 200m/μsec, 8000bits per frame, and every station has data to send.

a) 3pts. If the bit stream are delayed by the 1-bit delays, how far two bits will be separated in terms of meter?

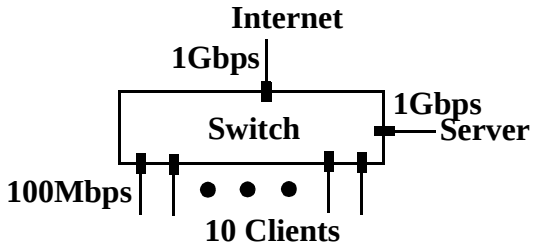
b) 3pts. What is the minimum length of the ring that can avoid the insertion of the artificial delay?

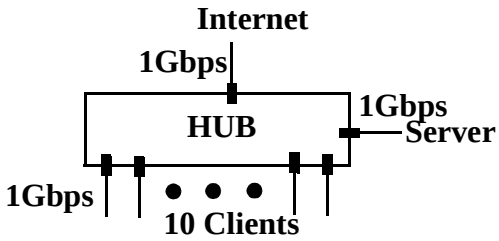
c) 3pts. Given a 10000-meter ring, how long will it takes for the first bit of the frame to return to the sender?

d) 8pts. Given a 10000-meter ring, what is the system throughput when it operates on single token mode?

e) 8pts. Given a 10000-meter hat is the system throughput when it operates on multiple token mode?

Problem 2. CSMA-CD and Ethernet Switch





Assume we have two network devices, each with 1Gbps connection to Internet, 1Gbps connection to a local server. The Ethernet switch connects to 10 client machines with 100Mbps Ethernet. The 1Gbps Ethernet HUB connects to 10 client machines with 1Gbps Ethernet interface. The switch has 3.2 Gbps capacity to switch frames between ports.

a) 6pts. Describe two cases where a client on the switch can not enjoy 100Mbps transmission speed.
Ans: Case 1: The client tries to connect to Internet with 100Mbps but an Internet user connects to the server with 901 Mbps.
Case 2: The client tries to connect to a local client with 100 Mbps but the other client is simultaneously downloading a movie from Internet with 1Mbps.

b) 6pts. Assume the server can deliver data with speed greater than 1Gbps, all switch connections are operated at full duplex mode, and all 10 clients have large files to download from the local server. Which one has better system throughput? Explain.
Ans: The switch will have better system throughput. The 1Gbps HUB will have a lot of collisions thus its system throughput will be lower than 1Gbps. The switch with each port supporting dedicated 100Mbps will have close to 1Gbps system throughput.

c) 6pts. Assume a High Definitive TV session (with one local user and a remote Internet user) requires 100Mbps upstream and 100Mbps downstream bandwidth. How many sessions can the switch support? How many can the hub support? Given an upper bound number.
Ans: Assume that the HDTV session is unidirectional. The switch can support 20 sessions. A client can receive one session and transmit a session. The hub can only support 10 sessions.

d) 7pts. Is bigger frame more efficient in CSMA/CD? Explain it using the formula.
Ans: Yes. Bigger frame is more efficient.
Channel efficiency =

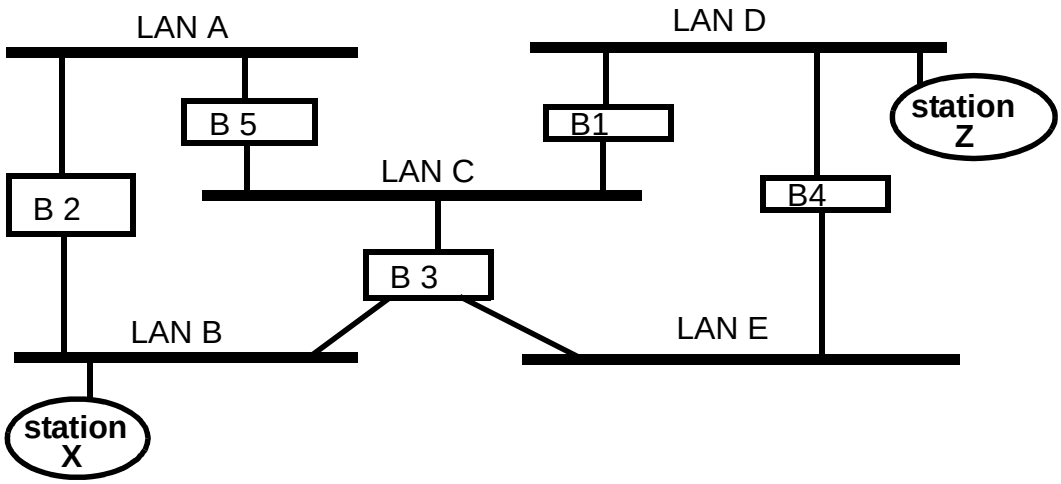
$$\frac{P}{P+(2\tau)/A} = \frac{F/B}{F/B+\left(2\frac{L}{c}\right)/\left(\frac{1}{e}\right)} = \frac{1}{1+(2BLe)/(cF)}$$

where F=frame length, B=network bandwidth, L=cable length, P=F/B, c=the speed of signal propagation, and optimal case of e contention slots

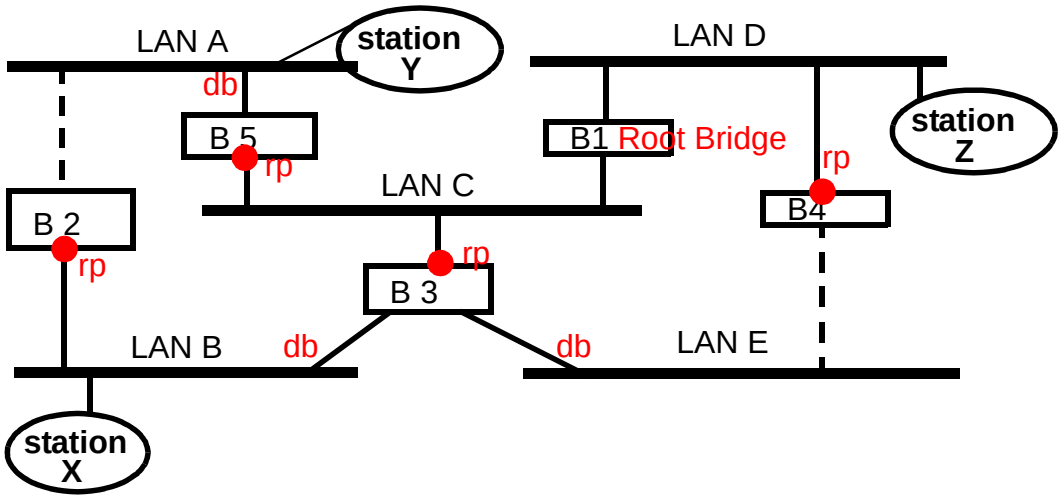
per frame. From the above formula, as F increases, the channel efficiency increases.

Problem 3. Routing with Bridges.

For the following network,



a) 15 pts. Assume the delay over any bridge port or LAN is the same one unit. Specify the spanning tree generated by the 802.1 spanning tree algorithm by marking the root bridge, the root port in each bridge and the designated bridge for each LAN. If there is a tie, use the bridge with the lower ID.



Assume no bridge learning (or station Z has been quiet for some time.) For a message sent by X to Z,

b) 5 pts. How many copies of the same message will be generated in this intranest?

Ans: There wil be 5 copies of the same message. Each copy appear in each LAN segment exactly once.

Cycle 1. Station X sends the frame on LAN B. This is Copy 1.

Cycle 2. Both B2 and B3 will receive it, but only B3 recognizes that it is the designated bridge for LAN B, B3 forward the frame over to LANs connected to B3, i.e., LAN C and LAN E. These are Copy 2 and Copy 3.

Cycle 3. The frame appears on LAN E and LAN C. B1, B4, and B5 receives the frame. B1

forwards the frame to LAN D since it is the designated bridge for LAN D. This is Copy 4. B4 will not forward the frame to LAN D since it is not the designated bridge for LAN E. B5 will forward the frame to LAN A since it is the designated bridge for LAN A. This is copy 5.

c) 2 pts. How many copies of the same message will be observed by Bridge B3?
Ans: Only one copy received from LAN B. Assume the sending frames does not count.

d) 3 pts. How many copies of the same message will B3 forward?
Ans: Just one.

Note that without bridge learning, the frame from X to Y will go through B3 and B5. With bridge learning, it will be faster and go throught B4.

Problem 4. Wireless LAN and CDMA.

25 pts. Given the following chip sequences for mobile stations A, B, C, and D.

A: (-1 -1 -1 +1 +1 -1 +1 +1)
B: (-1 -1 +1 -1 +1 +1 +1 -1)
C: (-1 +1 -1 +1 +1 +1 -1 -1)
D: (-1 +1 -1 -1 -1 -1 -1 -1)

A CDMA basestation receives the following signal: (-1 +1 +1 -3 -1 +1 +1 -3). For each mobile station, describe whether it sends at all, and if it did send, what is the bit sent.

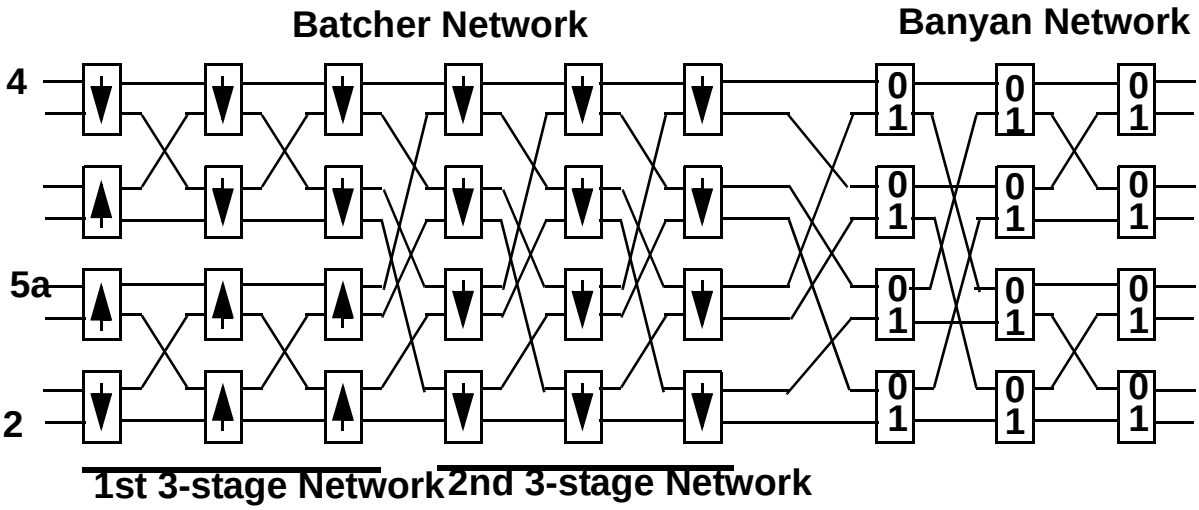
Ans:

a sent 0
b sent 1

c sent nothing
d sent 1.

Problem 5. Switching and ARQ.

a) 12 pts. Given the following 8x8 batcher banyan network and the 3 cell with routing tag. Mark



the 2x2 switch configurations (cross-over, or straight through) along their routes to destination ports.

b) 6 pts. How the out of sequence frames are treated in selective repeat ARQ?
Ans: It will be saved in the buffer. When a missing frame is received, those frames in the buffer with the following sequence numbers will be delivered to the upper layer.

c) 7pts. Beside delivering or discarding the frame, what other actions will be taken by the receiver of a frame?
Ans: Set and reset piggyback timer. Send ACK or NAK frame. Update RN sequence number.