CSE 123: Computer Networks
Homework 2
Out: 4/20, Due: 4/27

Instructions
1. Turn in a physical copy at the beginning of the class on 4/27
2. Ensure the HW cover page has the following information clearly written
   a. Name
   b. UCSD email
   c. PID

Problems
1. High Frequency Trading
   Companies like Goldman Sachs put a high value on using very low latency network switches to engage in high frequency trading because even an extra delay of a few milliseconds in their switches can lose them tons of money.
   Calculate the latency (from first bit sent to last bit received) for the following:
   a. 30-Mbps Ethernet with a single store-and-forward switch in the path and a packet size of 6,000 bits. Assume that each link introduces a propagation delay of 50 µs and that the switch begins retransmitting immediately after it has finished receiving the packet.
   b. Same as (a) but with three switches.
   c. Same as (a), but assume the switch implements “cut-through” switching; it is able to begin retransmitting the packet after the first 300 bits have been received. What is the time savings of using “cut-through” switching?

2. Sliding Window Protocol
   Draw a timeline diagram for the sliding window algorithm with SWS = RWS = 3 frames, for the following two situations. Use a timeout interval of about $2 \times \text{RTT}$. Assume fast retransmission with selective retransmission is implemented and that packets with sequence numbers 1-6 will be sent. For fast retransmission, if more than 1 duplicate ACK is received, only retransmit on the first duplicate ACK.
   a. Frame 4 is lost on the first transmission.
   b. Frames 3 and 6 are lost on their first transmissions.
3. **Sharing the Ethernet**

Consider the following scenario. Suppose there are some hosts A, B, and C on a LAN using the Ethernet protocol. A and B make their first carrier sense while C is transmitting. The initial transmission attempts are in the order A, B. Successful transmissions are in the order B, A. There are 2 total collisions that occur. This example can be depicted as in the diagram following. The light blue boxes with a letter in them means that the host with that letter is successfully transmitting on the channel. The red boxes indicate that a collision has occurred.

Now consider a slightly more complicated problem. Suppose there are hosts A, B, and C that all make their first carrier sense, as part of an attempt to transmit, while a fourth station D is transmitting. Draw a timeline (like above) showing one possible sequence of transmissions, attempts, collisions, and exponential backoff choices. Your timeline should also meet the following criteria:

(i) initial transmission attempts should be in the order C, A, B
(ii) successful transmissions should be in the order A, B, C
(iii) there should be at least four collisions.
4. **IP Checksum and Endianness**
   
a. The following IPv4 header, show in hex below, is received for an IP packet at its destination. Refer to the IPv4 header diagram below.

   4500 05c8 1c46 25c8 4017 c311 aca8 0101 aca8 0102

![IPv4 Header Diagram]

   *IPv4 Header*

b. What is the header checksum? (You can find it by mapping the hex values to the IPv4 header diagram)

c. Using the Internet checksum algorithm, determine if there were any errors in the transmission (show work).

d. What would this packet which is network byte order look like when stored in the memory of a big-endian system? (Assume that the packet is stored in an array of (32-bit) integers in memory.)

e. How about in the memory of a little-endian system? (Again assume that the packet is stored in an array of integers in memory)
5. Spanning Tree Question
Given the extended LAN shown below, indicate which ports are not selected by the spanning tree algorithm.
6. Learning Bridges

Use the diagram below to answer the following questions. Assume the circles are bridges and the rectangles are LANs with only one host defined by their letter. All bridges have empty tables at the beginning and the events below occur in the order presented.

a. E sends a packet to F, who receives the packet?
b. C sends a packet to E, who receives the packet?
c. D sends a packet to C, who receives the packet?
d. E sends another packet to F, who receives the packet?
e. G sends a packet to C, who receives the packet?
f. F sends a packet to D, who receives the packet?