CSE 461 Midterm Exam
February 8, 2013

Your Name: ________________________________

Student ID: ________________________________

General Information:

This is a closed book examination. You have **50 minutes** to answer as many questions as possible. The number in parentheses at the beginning of each question indicates the number of points given to the question. There are **10 pages** on this exam (check to make sure you have all of them), and there are a total of **70 points**. Write all of your answers directly on this paper. Make your answers as concise as possible. If there is something in the question that you believe is open to interpretation, then please go ahead and interpret, but state your assumptions in your answer.

Problem 1: Multiple choice (10 points)

For each of the following questions, circle the letter corresponding to the **one** correct answer.

1. Which one of the following is **<u>not</u>** true for both wired ethernet and wireless mediums?
    a. the speed of light is a potential limiting factor in end-to-end latency
    b. exponential back-off could be used to deal with contention
    c. if packets collide, all hosts will be able to detect the collision
    d. efficient packet flooding is possible

2. Which one of the following statements is true?
    a. every IP packet must be carried in the payload of an Ethernet frame
    b. every wireless ethernet message contains an IP packet in its payload
    c. IP packet headers indicate which higher-level transport protocol is associated with the data in the IP packet payload
    d. it is always possible for a sender to determine if an IP packet it sent was received successfully

3. Which one of the following is true assertion about the spanning tree algorithm?
    a. at all times, at most one switch believes it is the root
    b. at all times, at least one switch believes it is the root
    c. at all times, every host connected to the switched network can communicate with every other host connected to the network (without resorting to flooding or broadcasting packets)
    d. none of the above

    (Note that if the root of the tree fails, then there won't be a root till a new one is elected.)

4. In a wireless network, which one of the following statements is **<u>not</u>** true?
    a. a wireless node might observe a packet sent to some other node, but might not observe the acknowledgement
    b. a wireless node might observe the acknowledgement for a packet without having observed the original packet
    c. the sender of a packet can determine whether it collided with another packet
    d. two nearby nodes can receive two different packets simultaneously

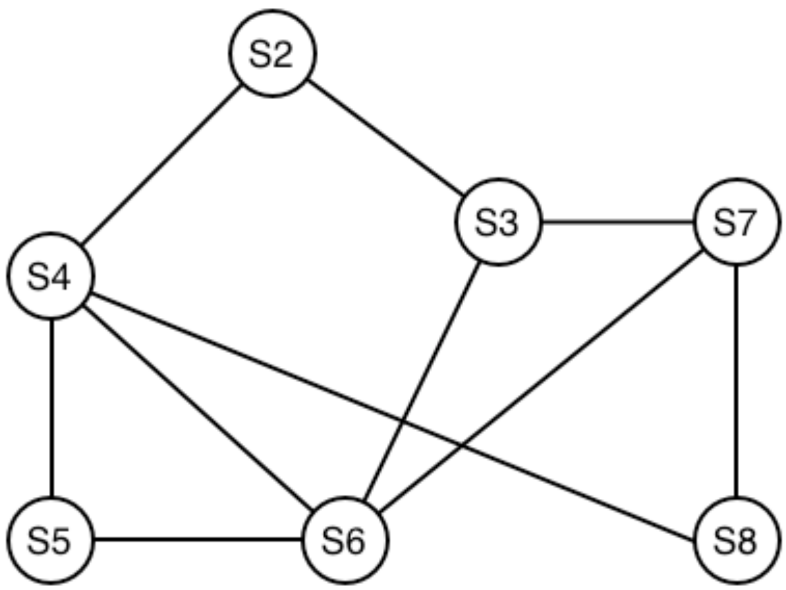
5. Which one of the following statements is true?
    a. a packet transmitted over a 1 Gb/s network will always have lower packet delivery latency than the same packet transmitted over a 14.4 Kb/s modem
    b. a packet transmitted over a 10-foot-long network link will always have a lower packet delivery latency than a same size packet transmitted over a 10-mile-long network link
    c. if you measure the round-trip time between two hosts on the Internet, and afterwards you measure the one-way latency between the same two hosts on

the Internet, the measured one-way latency will be half the measured round-trip time

d. none of the above

Problem 2: Spanning trees (10 points)

Suppose you have a switched Ethernet network with the following topology:



The circles represent switches, the thick lines represent connections between the switches, and the id of a switch is the number encoded in the switch name (i.e., id of switch S4 is 4, and S4 has a lower numbered id than S7).

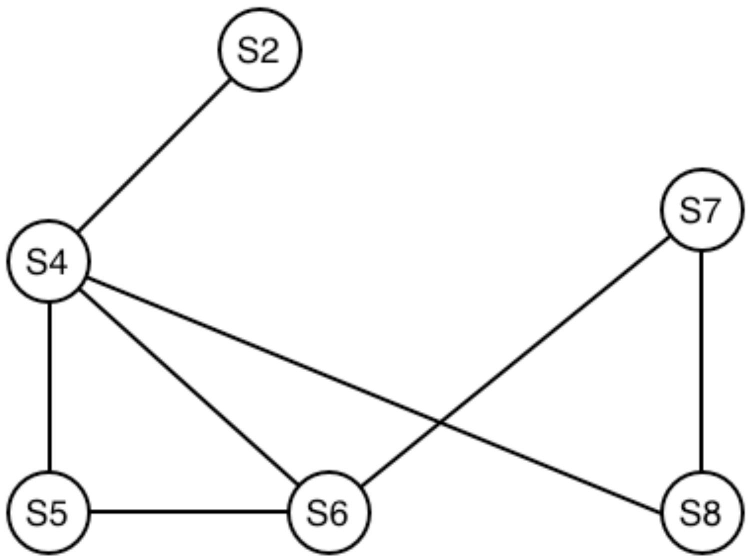
a. **(2 points)** Which node eventually becomes the root of the tree?

S2

b. (**4 points)** Using your pen/pencil, darken the lines on the diagram that remain enabled for forwarding messages after the spanning tree algorithm has stabilized.

Enabled links: S2-S3, S2-S4, S4-S5, S4-S8, S3-S6, S3-S7

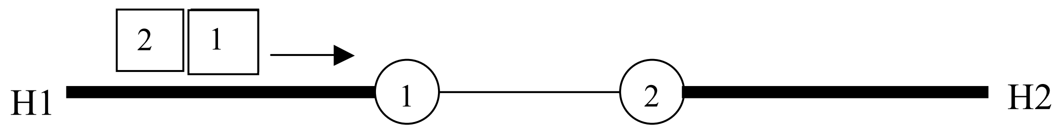
c. (**4 points**) Switch S3 fails. Using your pen/pencil, darken the lines on the diagram below that correspond to links that remain enabled for forwarding messages, after the spanning tree algorithm has once again stabilized.



Enabled links: S2-S4, S4-S5, S4-S6, S4-S8, S6-S7

Problem 3: Network links (20 points)

Suppose you have the following network topology, where lines are links, circles are routers, squares are packets, and H1/H2 are hosts:



Packet 1 and packet 2 are both 125 bytes long, and they are sent in a back-to-back "packet train" by H1: as soon as H1 finishes transmitting packet 1, it begins transmitting packet 2. Both packets are destined for host H2. Assume that H1 begins transmitting packet 1 at time t=0 seconds.

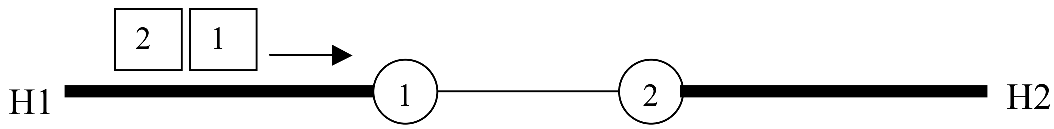
The "thick" network links (between each host and its adjacent router) are 1 Mb/s (1 million bits per second). The "thin" network link (between the routers) is 100 Kb/s (100 kilobits per second). The propagation delay across each network link is 1 second. Note that there are three network links between H1 and H2.

Assume that the routers behave as store and forward nodes; as an incoming packet arrives at a router, it is drained off of the incoming link and placed into a queue. Once the packet has fully drained into the router queue, it then immediately becomes eligible for transmission on the outgoing link. If the second packet arrives at a router before the router has finished placing the first packet on the outgoing link, the second packet will queue up inside the router, waiting for its turn to start going onto the outgoing link. Assume that the routing operations are instantaneous and that there is no other cross traffic other than these two packets.

Answer the following questions. (Pay attention to the fact that packets are 125 BYTES and the line rates are in bits per second.)

a) (**3 points)** When does packet 1 finish arriving at router 1? ["time Ta"]

1.001 secs



b) **(3 points)** When does packet 2 finish arriving at router 1? ["time Tb"]
Note that Tb – Ta is called the "interarrival time" of packets 1 and 2 at router 1.

1.002 secs

Packet 2 can be transmitted immediately after packet 1 is transmitted.

c) **(3 points)** When does packet 1 finish arriving at H2? ["time Tc"]

3.012 secs

d) **(3 points)** When does packet 2 finish arriving at H2? ["time Td"]

3.022 secs

Packet 2 is behind packet 1 by 0.01 seconds. This is the transmission delay for packet 1 across the second link. For the third link, packet 2 will not face any additional delays.

e) **(2 points)** Calculate the following number: the size of packet 1 (in **bits**) divided by the interarrival time of packets 1 and 2 at host H2. (*Note that the interarrival time is the difference between the times at which the packets were received by H2.*)

100 Kb/s

f) **(3 points)** If we asked you to redo calculation e), but for the scenario in which the link between H1 and router 1 was upgraded to 1 Gb/s, would the answer change? (Say yes or no and justify your answer.)

Note that packet 2 is delayed by packet 1 at the bottleneck link. The additional speed of link 3 does not affect this delay.

100 Kb/s

g) **(3 points)** If we asked you to redo calculation e), but for the scenario in which the link between router 1 and router 2 was upgraded to 200 Kb/s, would the answer change?

Making the bottleneck link go faster, reduces the delay experienced by packet 2 in traversing link 2.

200 Kb/s

Problem 4: Hamming code (10 points)

Consider the Hamming code discussed in lectures, with 3 check bits for 4 data bits. Recall that the check bits occupy positions 1, 2, and 4 in the transmitted code word.

In addition to these 7 bits, assume that each code word sends an additional parity bit that covers all of the bits in the code word, i.e., the 8^{th} bit is a parity bit that covers the remaining 7 bits. (Recall that the check bits in the Hamming code cover only a subset of the bits in the code word. This additional bit covers **all** bits.)

a) (**3 point)** What is the code word used to transmit the following data: 1001?

0 0 1 1 0 0 1 1

b) (**3 point)** What is the code word used to transmit the following data: 1000?

1 1 1 0 0 0 0 1

c) (**4 point)** Discuss how this variant compares with the original Hamming code.

The proposed extension has a hamming distance of 4, which makes it robust to even three bit errors (i.e., it can detect 3 bit errors). It can still do only 1-bit error correction. The original Hamming code has a hamming distance of 3 in contrast.

Problem 5: Bandwidth (5 points)

Assume that there is a transmission medium that has a signal to noise ratio of 3, i.e., S/N is 3. Let us say that a device is able to achieve 10 Mbps over this transmission medium. Calculate what is the bandwidth (i.e., width of the frequency spectrum) associated with the channel.

5 Mhz using Shannon's limit theorem.

Problem 6: Wireless Medium Access (15 points)

Consider six wireless stations, A, B, C, D, E, and F. Stations A, B, C, and D can communicate with each other, i.e., A's transmissions can be heard by B, C, and D, B's transmissions can be heard by A, C, and D, etc. In addition, stations D, E, and F can communicate with each other. In addition, B and E can communicate with each other. All other communications are not possible. For example, E cannot communicate with A. Given this setting, determine whether each of the following simultaneous communications are possible. (Answer yes/no with a reason.)

The physical layout implied by these communication patterns is:

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A  B
C  D  E
      F
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a) **(3 points)** A sends data to B and F sends data to E.

Yes, no interference.

b) **(3 point)** B sends data to C and D sends data to E.

No, D's transmissions interfere at C.

c) **(3 points)** B sends data to C and D sends data to F.

No, D's transmissions interfere at C.

d) **(3 points)** When B is transmitting data to some node in the system, F can transmit data to some other node in the system.

No, F will not be able to communicate with D or E.

e) **(3 points)** When B is transmitting data to some node in the system, E can transmit data to some other node in the system.

Yes, E can transmit to F.