Networks and Distributed Systems **Homework 2**
CS3700 Spring 2020

This homework is due at 11:59:59 PM on October 9, 2020 and is worth 3% of your grade.

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Problem	Possible	Score
1	30	
2	15	
3	15	
4	15	
5	25	
Total	100	

1a. Which layer is responsible for converting data packets from the data link layer into electrical signals? (5 pts)

This is the responsibility of the physical layer.

1b. What is the purpose of the data link layer? (5 pts)

The data link layer transmits blocks of data a.k.a. frames between devices. It also regulates access to the physical medium. Depending on the "implementation" it can attempt to delineate frames, detect errors, recover from/avoid collisions and control device access.

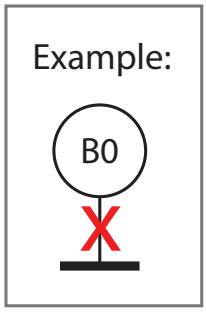
1c. Which layer do MAC Addresses work on? What is their purpose? (10 pts)

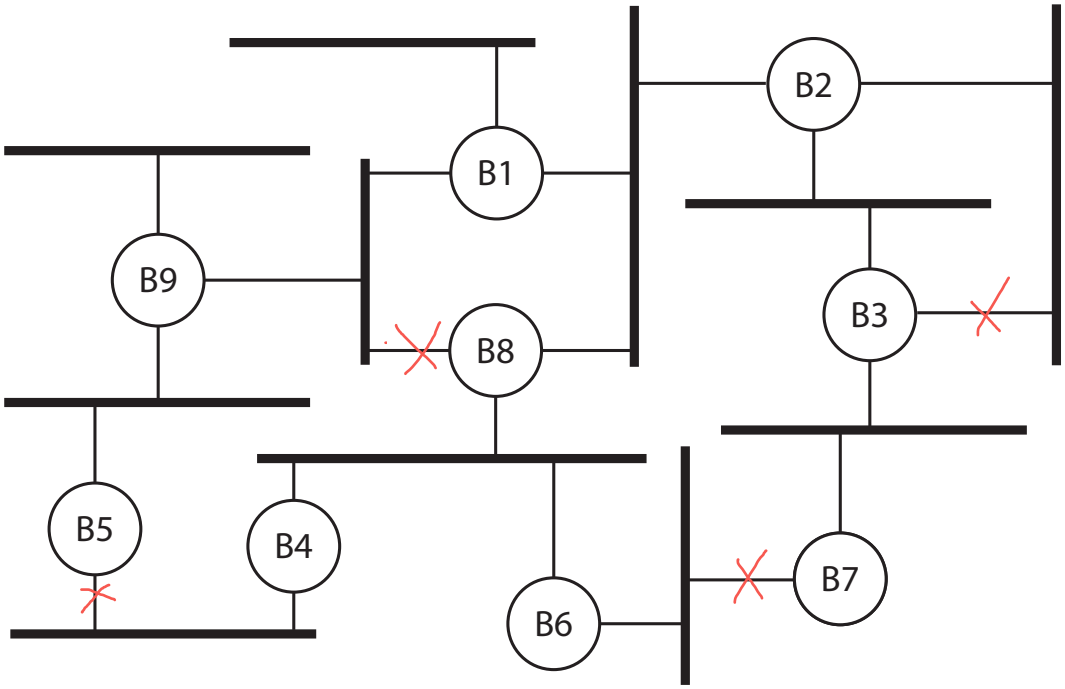
Mac Addresses work on the Data Link layer. Their purpose is to serve as unique identifiers for devices that connect to the network.

1d. What are the main differences between a Bridge and a Switch? Make sure to go into detail. (10 pts)

A switch is a special case of a bridge. The biggest difference between the two is that the switch only has one host/device connected to each port (could be a client machine or a another switch). As a result, there are no collision domains. So, switches do not need to worry about CSMA/CD, which is another difference because Bridges do need to worry about this. Furthermore, switches can have ports with different speeds.

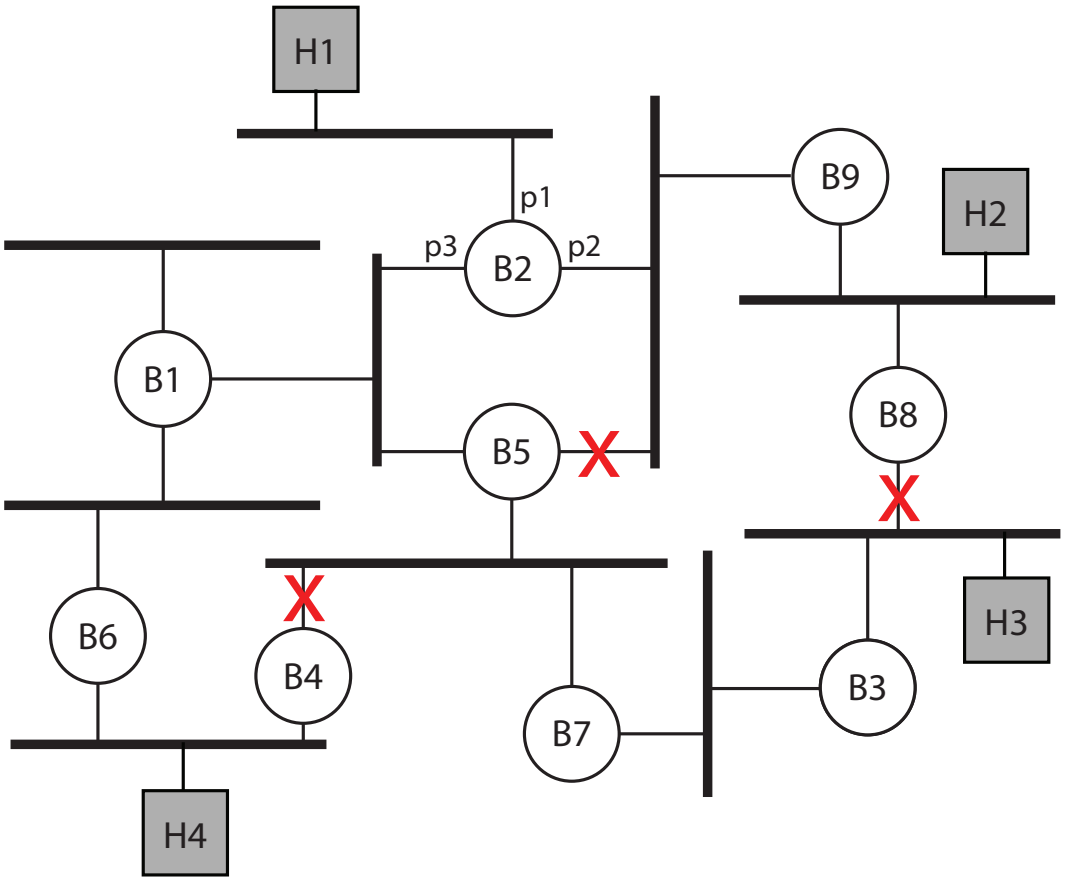
2. Consider the bridged Ethernet shown below.





Indicate which ports are blocked by the bridge spanning tree protocol by putting an "**X**" over the corresponding ports. The bridge IDs are the numeric values. Feel free to label the ports with port numbers, if necessary. (15 pts)

3. Consider another bridged Ethernet shown below. Assume the spanning tree protocol has already finished its computations. The ports not selected by the spanning tree protocol are marked by "**X**". The ports of bridge B2 are labeled p1, p2, p3 respectively. There are 4 computers H1, H2, H3, and H4 in the network. Assume the forwarding tables of all bridges are currently empty. Suppose H1 transmits a single packet addressed to H3, and H2 transmits a single packet addressed to H4.



The questions on the next page refer to this diagram.

3a. Explain how the Ethernet bridges in this example forward these two packets and how they learn forwarding table entries. (5 pts)

h1 first sends it's packet to B2, over p1. B2's table is empty and it updates with the entry of h1 @ p1. Since B2 doesn't have a path for H3, it broadcasts the packet to both p2 and p3. From p3, B1 and B5 get the packet. Since their routing tables are empty, they assign the h1 address to the right port and the left port respectively and they broadcast the packet to all other ports. For B5, this means sending the packet along the bottom port, which leads to B7. Since B7 has an empty table, it updates the table with the h1 address being on it's top port. Again, it broadcasts to it's remaining ports since it doesn't have an h3 address port yet. This means B3 gets the packet and updates it's table with the h1 address being on B3's left port. It broadcasts to it's top port and from this port the packet reaches H3.

h2 sends its packet and this is received by B8 which updates its table but has no other open ports to send the packet. B9 also receives the packet from h3, so B9's table updates with h2 being located on B9's bottom port. B9 then broadcasts this packet and the packet is received by B2 on port2. B2's table isn't empty, but it doesn't have an entry for h2, so it puts h2 in the table with p2. B2 then broadcasts across p1 and p3. From here the packet is received by B1 and B5. B1's table is not empty because it knows that H1 is found on it's right port. However, it broadcasts the packet since it doesn't have a port for H4. B6 receives this packet from it's top port and add's H2 to its table since the only address in it's table is H1. B6 doesn't have an address though for H4, so it broadcasts and from this broadcast the packet reaches H4.

3b. After the transmissions of the two packets have been completed and the network is idle, what is the content of the forwarding table at bridge B2? (10 pts)

B2 has an entry H1 @ p1 from the first packet transmission from h1 to h3. It also has an entry H2 @ p2 from the second packet transmission from h2 to h4.

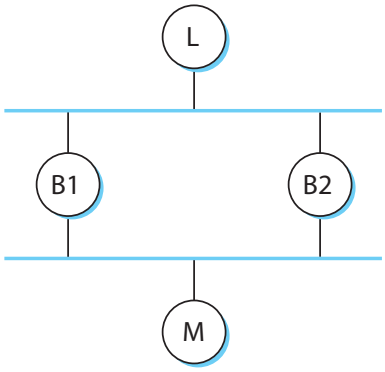
4a. State **three** reasons why bridged Ethernet, where all hosts on the network share one single wire and CSMA/CD (carrier sense multiple access/collision detect) cannot be scaled to a network the size of the Internet. (15 pts)

The most immediate reason is that the physical medium must be shared in this example. As the number of hosts increases, the limited bandwith will be ever increasingly limited, greatly degrading performance.

Another reason has to due with collision detection. Collision detection depends on a defined maximum propogation/time delay as well as a minim size for the packets. What this means is that as the size of the medium grows (distance of the network), the minimum packet size is required to increase. As a result, sending small packets will be increasingly inefficient.

Finally, as more and more hosts connect to the network, more collisions are likely to happen. Eventually the network will be virtually unusable because at any one moment, multiple hosts will try to send packets resulting in perpetual collisions.

5a. Suppose learning bridges B1 and B2 are as shown below, and do *not* implement the spanning tree algorithm. Each bridge maintains a single table of $< address, interface >$ pairs.



What will happen if M sends to L? (10 pts)

This will result in an infinite loop where B1 and B2 update their tables with M and the incoming port. They will each broadcast through the other port since they don't have an address for . However, the connection is looped so they will each receive the broadcast from the other, receive the same packet sent from M but from a DIFFERENT port. They will then update their table and broadcast again since their table's dont have an address for L. This cycle will continue infinitely.

5b. Suppose a short while later L replies to M. Give a sequence of events that leads to one packet from M and one packet from L circling the loop in opposite directions. (15 pts)

The infinite loop that happens in 5a has B1 and B2 switching their ports back and forth for M from the correct port to the incorrect port. If L's packet reaches B1 and B2 when their respective tables have the correct address for M, then L will send the packet in the right direction. However, if the time between this broadcast and the retrieval of the broadcasts by the opposite bridges is longer than the time for M to loop back around, M's packet will change the address to be erroneasouly pointing towards L, and L's packet currently being broadcast to M will be erroneously sent to L and this whole process will cycle.