TEAM NUMBER:

NAME(S):

INDIVIDUAL/GROUP PLEDGE SIGNATURES:

CS/ECE 4457 Assignment 10 (Wireless and Mobile Networks)

IInstructions:

- Due date/time:
  - Individual submission: Copy into your team box folder only at the start of class on Nov. 16
  - Team submission: Nov. 16 end of class; Submit completed paper copy
- Pledge:
  - Group Pledge: *On our honor as students, we have neither given nor received aid on this assignment.* (Sign above).
  - We affirm that we have only accessed course notes posted on the Course materials Web site, the textbook, and textbook Companion Web site. We have not accessed any other materials from the Web, and have not conducted Web searches with the specific intent of finding answers to these particular questions. We have not consulted answer keys. (Sign above).
- Number of points: 12

Problem 1. (2 points)

In an IEEE 802.11b LAN, RTS frames are 20 bytes long. CTS frames are 14 bytes long. ACK frames are 14 bytes long. The transmission rate is 11 Mbps. Suppose the 802.11b stations are configured to always reserve the channel with the RTS/CTS sequence before sending data. Suppose station A wants to transmit 1000 bytes of user data, and all other stations are idle at this time. SIFS is $10\mu s$, and DIFS is $50\mu s$. Ignore propagation delay, and assume that there were no bit errors and no collisions.

a. What is the total time incurred to send the 1000-byte user data from station A to the access point and to receive an ACK?

b. In the transmission of the 1000-byte user data described in Part (a), what is the efficiency with which the 11 Mbps wireless link is being utilized? Express as a percentage.

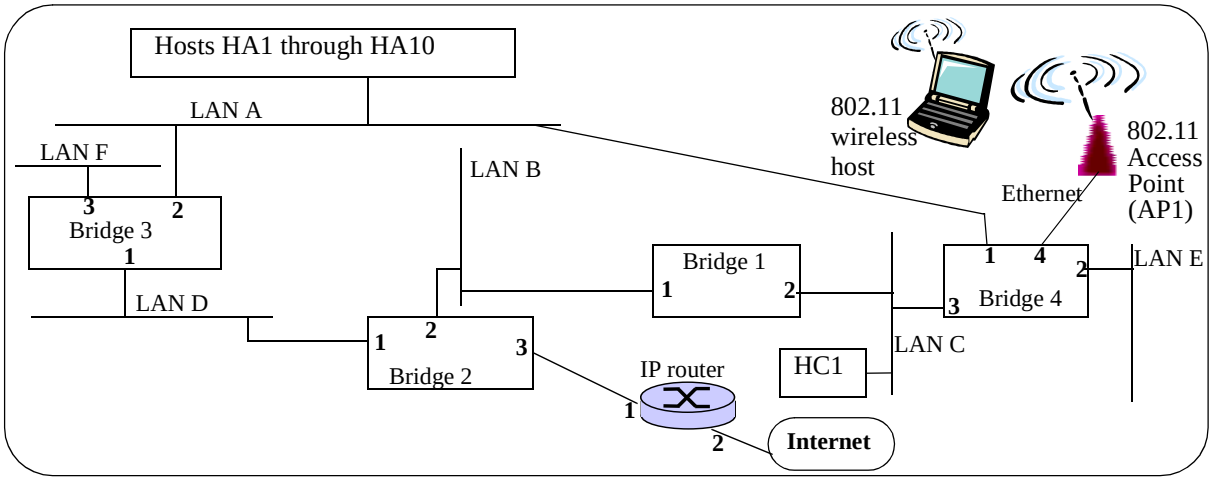
Problem 2. (2 points)

Assume the contention window size in an 802.11 LAN is 31 slot times, where slot time (denoted $SlotTime$) is $20\mu s$. SIFS is $10\mu s$, and DIFS is $50\mu s$. Consider how your answer to Problem 1(a) will change if the medium is busy when the sending station (station A) first sensed the medium. Specifically, if the station is able to transmit its frame on its first attempt without collisions, what is the <u>average</u> additional time required for successful transmission of the 1000-byte payload relative to your answer in Problem 1(a)? [Hint: Find mean backoff interval by using probabilities.]

For Grading Purposes:

1:	2:	3:	4:	5:

Problem 3. (4 points)



All networks marked as LANs are hubbed Ethernet LANs, and all bridges are Ethernet switches. Hubbed LANs have multiple hosts (e.g., HA1 ... HA10 on LAN A) and one or more hubs. Assume that HA1 through HA10 are the MAC addresses of the host interfaces. An IEEE 802.11 access point is connected to port 4 of bridge 4 via an Ethernet link. An IP router is connected to port 3 of bridge 2. Assume switch (forwarding) tables are all empty at the start, and bridges learn MAC addresses and add entries to their switch tables.

a. If host HA1 sends an Ethernet frame destined to host HC1, the frame will reach all LANs because no bridge will have an entry corresponding to HC1 in its switch table. Therefore the access point will receive the Ethernet frame. Will it forward this frame on its wireless interface?

b. If the 802.11 wireless host shown in the network is associated with access point AP1 (i.e., it has sent an Association Request and received an Association Response), and it sends an 802.11 frame carrying an IP datagram destined to a host connected to the Internet as shown in the network above, then what values are carried in the Address1, Address2, and Address3 fields of the 802.11 header?

c. If the wireless host shown in the network is associated with access point AP1, and it sends an 802.11 frame carrying an IP datagram destined to host HA5, then what values are carried in the Address1, Address2, and Address3 fields of the 802.11 header?

d. How does the wireless host decide whether to send an 802.11 frame carrying an IP datagram to the router or directly to a host within its subnet?

e. When the access point receives the 802.11 frame sent by the wireless host in part (b), it sends the payload of the frame in an Ethernet frame to bridge 4. What address value is placed in the source MAC address field of this Ethernet frame?

f. The wireless host uses DHCP to acquire an IP address, subnet mask, and default gateway. It is assigned the IP address of the router's port 1 as the default gateway IP address. What can be said about the IP address and subnet mask assigned to the wireless host (for its 802.11 interface) when compared to the IP address and subnet mask of the router's port 1?

g. Do the bridges in the network learn the MAC address of the wireless host and store entries corresponding to this MAC address in their switch tables?

h. Assume a second access point (AP2) is connected to another port (say port 5) of bridge 4 (not shown in the figure), and the wireless host moves to the coverage area of this access point (AP2). Assume that the wireless host had sent frames in its original position (when it was in the coverage area of AP1) before it moved into the coverage area of AP2. Will Ethernet frames destined for the wireless host be sent out by bridge 4 on the wrong port (i.e., port 4), or will these Ethernet frames be properly forwarded to port 5? Answer this question for two cases: the frame destined to the wireless host arrives at bridge 4 before and after the wireless host has itself sent an Ethernet frame destined to some other host within the network or on the Internet from its new location?

Problem 4. (2 points)

Let's say the FCC allocated a total of 40 MHz for a new service and divided this into two 20 MHz bands, one for the upstream direction and the second for the downstream direction. This service is bidirectional, with each communication session requiring one 20 kHz channel in each direction. It is an FDMA/FDD system. Assume that 20 channels are set aside in each direction for control messages (which means these channels are unavailable to carry user data). Assume that a service provider was able to purchase the full 40 MHz band for a coverage area of 96 cells to provide this service. The service provider chooses a reuse factor of 4. What is the maximum number of simultaneous bidirectional communication sessions that can be supported by this service provider?

Problem 5. (2 points) [unrelated parts]

a. Assume a cell phone user with a Manhattan phone number, e.g., 212-512-8501, is visiting Charlottesville where the area code is 434. If a Washington DC phone customer with a 202 number calls 212-512-8501, how is the call routed? Specifically which mobile switching centers are involved?

b. What number is used to route calls from the home network to the visiting network in cellular networks?

c. Do telephone network switches use aggregated (summarized) address ranges in their routing (switch) tables? In other words, is there a single entry in the Washington telephone network switch for routing calls to all telephone numbers with area code 212?