Consider the 802.11 MAC protocol.

a**. What is an RTS frame? (5 points)**

The RTS is Request to Send frame that is used to reduce frame collision. If a large data collides at the end of transmission, it will waste a lot of time. Therefore, senders need to reserve a channel by first send a request called RTS.

b. Describe how the RTS threshold works. (5 points)

The methods for activating RTS could be set in the user interface. If the packet transmitted with AP is larger than the threshold, the RTS mechanism will activate otherwise it will not activate.

c. What is a CTS frame? (5 points)

The RTS is received by AP/base station and the AP/base station will reply with a CTS or Clear to Send frame. This frame is broadcasted to every node such that other node know that the channel has been reserved.

d. What is a DATA frame? (5 points)

After the sender get the CTS frame, it can transmit the data using DATA frame. These are frames that carry higher-level protocol data in the body to transmit this higher-layer data.

e. What is an ACK frame? (5 points)

After the receiver successfully receive the data fragment from the sender, the AP/base station will broadcast the ACK frame to let nodes know the transmission has finished. If the sender need to send more than one data fragment, it has to wait a random time after each data transfer.

2. Consider five wireless nodes (V, W, X, Y, and Z) in a network with the following characteristics.

- All nodes can hear transmissions from V.

- V, X, and Z can hear transmissions from W.

- V, W, and Y can hear transmissions from X.

- V, X, and Z can hear transmissions from Y.

- V, W, and Y can hear transmissions from Z.

For non-interfering transmission, we need to require that there exist an unique sender that communicate the receiver to ensure nothing interfering the transmission. Therefore:

a. While V is transmitting to W, what other non-interfering transmissions are possible? (5 points)

It is not possible, when V send data to W, it cannot receive data from other nodes. Moreover, it will interfere with X,Y,Z as well.

b. While W is transmitting to V, what other non-interfering transmissions are possible? (10 points)

It is not possible.

X,Z cannot receive data since they receive from W.

Y→ V is not possible because V will be interfered.

V→Y is not possible because V cannot send/receive at the same time.

Z→Y and X→ Y are not possible, because it will interfere V.

c. While W is transmitting to X, what other non-interfering transmissions are possible? (10 points)

When W sending to X, Z and V cannot receive data. Therefore, Y can receive data from Z without interfering. V→Y is not possible since interfering and X→Y is not possible since it cannot send/receive at the same time.

3. Mobile networking.

a. Explain the distinction between a permanent address and a care-of address in terms of direct and indirect mobile routing. (15 points)

COA or care-of address is a temporary IP address for mobile node. While the permanent address is the address the devices will use in its home network.

For direct routing, the correspondent agent first send query to home agent and the home agent will reply with the location of the mobile nodes by using COA. Once it get the location of the mobile node, the correspondent agent will send packet to foreign agent and the mobile node directly.

For indirect routing, correspondent will send whole packet to home agent and home agent will encapsulate the packet to bigger datagram and then send to the foreign agent. The foreign agent will decapsulate the packet and forward to mobile node using COA. And up to here, the mobile node knows the information of correspondent and therefore can send reply to correspondent.

b. Suppose that you have two access points A and B connected to the same Ethernet switch S. When some mobile node X moves from A 's cell to B 's cell, B sends a frame with a fake MAC address to get S to correctly forward frames destined for X. What fake MAC address does B use? Explain why B sends a frame with a fake MAC address. (10 points)

If node X is initially in A, then a datagram destined to X will be directed to X using A. However, once X associate with B, then B will send a broadcast Ethernet **frame with X's source address** to the switch. The switch will update the forwarding table and before the updating, the switch continue to send packet to X using A.

4.Consider the following 802.11 wireless network scenario.

- 56 Mbps channel data rate

- RTS, CTS, and ACK frames are all 280 bits

- DATA frames are all 1610 bytes (including header and footer)

- DIFS is 50 microseconds

- SIFS is 10 microseconds

Assuming no errors and no propagation delay, how long would it take to send a data frame to the access point and receive an acknowledgement? (25 points)

Time = (RTS + CTS + ACK) + DIFS+ SIFS(for CTS) + DATA + SIFS(for ACK) + SIFS(for DATA)

= 3*280 bits/56 Mbps + 50 microseconds + 30 microseconds + 1610 bytes/56 Mbps

= 325 microseconds