

Midsemester Examination
Wireless Networks
Duration: 1 hour
Full Marks 35

Q1. Suppose in a wireless channel CDMA is employed, user A's code is 1 0 1 1 0 0 and user B's code is 1 1 0 0 0 0. Suppose CDMA encodes 0 as -1. Now user A wants to send 0 and user B wants to send 1 at the same time. [2+2]

- a. Show whether the receiver will be able to detect it, show the procedure.
- b. Now suppose A's code is same as before but B's code is changed to 00 1100. Will the receiver be able to decode user A and B's code, show the procedure?

Q2. Suppose in a WLAN there is a node that operates at MCS 6 i.e., 54Mbps (OFDM: 64 subcarriers, 48 data carriers, QAM 64, coding technique $\frac{3}{4}$). [3 + 2+ 3]

- a. What is the total time taken to transmit a 500B TCP payload frame. Include the time taken for the DIFS, physical layer preamble, SIFS, and link-layer ACK.
- b. Suppose the total time to transmit a frame as computed above is T, and the time that is spent in actually sending the OFDM symbols corresponding to the link layer frame is t. Then, we define the efficiency of the link layer as the fraction t/T . What is the efficiency of the link layer in transmitting the frame in part (a) above?
- c. Suppose we had the ability to turn on frame aggregation What is the minimum number of frames that must be aggregated to achieve a link layer efficiency of 90%?

Q3. Continuing from Q2, now suppose there are 4 nodes, all of them want to transmit same sized frame as of Q2. All of their MCS is 6 i.e., QAM 64, $3/4$. [2 + 2 + 3 + 4]

- a. If the nodes transmit their using CSMA/CA and OFDM without aggregation what will be the channel efficiency. Assume average backoff for all.
- b. Now, suppose the WLAN is upgraded to IEEE 802.11ax that supports OFDMA. OFDMA has 262 subcarriers in comparison to 64 subcarriers in OFDM. Suppose the guard band is 0.8us. Compute OFDMA symbol duration.
- c. Now, suppose the AP allocates 52 tone to 4 users. Compute how many OFDMA symbols would be needed to transmit 500B TCP payload at the link layer using 52 tones.
- d. What will be the channel efficiency if they transmit using OFDMA. Assume the trigger frame requires 2 OFDMA symbols and ACK takes 1 OFDMA symbol and Block ACK takes 4 OFDMA symbols

Q4. Consider the following combination of SampleRate and YaRaa, algorithm discussed in class, called SampleYaRaa. SampleYaRaa is similar to SampleRate in all aspects except one: while SampleRate sends every 10th packet which provides lower lossless transmission time than the current one, and samples at lower rate only $\text{diff-time} < \text{threshold}$ and samples at higher rate if the diff time $> \text{threshold}$ it samples at bitrate higher than the current one else not. Remember the diff time indicates the duration for which backoff timer was frozen due to other transmissions.

Consider a 802.11g wireless link running SampleYaRaa, that can operate at 6, 9, 12, 18, 24, 36, 48, and 54 Mbps. Currently, the wireless link between a sender and receiver has the following frame loss rate at each of the bit rates: rates 1 to 18 Mbps are lossless, 24 Mbps has 10% loss, 36 Mbps has 30% loss, 48Mbps has 50% loss and the higher rates do not work at all. The diff-time is 400us and threshold is 1000us Assume that the SampleYaRaa rate adaptation algorithm has stabilized to the best rate for this setting. Now, we will provide two different scenarios in which the wireless channel changes from this current state. In each scenario, specify whether SampleYaRaa leads to better/worse/same throughput as SampleRate after the channel change, and explain your answer. [4+ 4]

- a. The channel becomes better so that 24 Mbps is lossless, 36 Mbps has a 10% loss, 48 Mbps has a 50% loss, and higher rates do not work. The diff time remains same as 400us
- b. The channel becomes worse so that 24 Mbps now has a 20% loss rate, 36 Mbps has 40% loss, and 48Mbps has 50% loss and higher rates do not work. Lower rates are lossless. The diff time now changes to 1500us

Q5. Mark the one(s) TRUE [2]

- a. Given the distance between Tx and Rx, fading can be easily computed
- b. In free space, multipath effect wont be observed
- c. Multipath is more in indoor than in outdoor
- d. AWGN model is applied even in free space

Q6. Match the following [2]

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|---------|--|
| TDMA | is better suited for best effort traffic |
| FDMA | is better suited where synchronization is possible |
| CDMA | is better suited where high bandwidth is available |
| CSMA/CA | is better suited where precise power control is possible |