CS 653 Mobile Computing *Spring 2014*

Problem Set 2 **Due: Feb 14 (Drop it in my office)**

Instructions

1. Submit hand-written answers. No soft copies. No printouts.
2. Clearly mention your name and roll number on the answer sheet.
3. Write down all the steps in your solution. Providing the final answer alone is not enough.
4. You may discuss the problems with your classmates, but you must write up the final solution yourself, without looking at the answers of anyone else. Also, please list the names of your collaborators on the first page of your answer sheet.

Problem 1 [1.5 marks]

Refer to the link-layer throughput calculations for 802.11g that were shown in the class, and to the reference provided on the class website. Using the MAC timing constants as specified in the reference, compute the following.

a. What is the total time taken to transmit a link-layer frame of length 1000 bytes (this length includes the link layer header also) at the bit rate of 54 Mbps? Include the time taken for the DIFS, physical layer preamble, SIFS, and link-layer ACK. Assume that the frame contains UDP data.
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 1000 byte frame in part (a) above, for the bit rate of 54 Mbps?
c. Suppose we had the ability to aggregate multiple 1000 byte frames to be sent at once before eliciting the link layer ACK. What is the minimum number of 1000 byte frames that must be aggregated to achieve a link layer efficiency of 90% at a bit rate of 54 Mbps?

Problem 2 [2.5 marks]

Consider two clients connected to an access point in a WiFi-like system. One of the clients transmits at a bit rate of 6 Mbps and the other at 54 Mbps. Both clients are continuously generating UDP traffic to the AP. Assume no channel losses at the chosen bit rate, and no losses due to collisions. Below we describe four different MAC protocols that can be used by the system. In each case, calculate the average throughput obtained by each client, and the aggregate throughput of the system (over a long period of time, i.e., in steady state) when clients share the medium using the specified MAC protocol. Ignore all MAC-level timing overheads (i.e., a client sending at the 6 Mbps bit rate all the time can be assumed to get a throughput of 6 Mbps). Also ignore any other implementation overheads of the protocols (e.g., the overhead of synchronizing the clients for TDMA).

a. The CSMA MAC protocol, which gives each client equal transmission opportunities.
b. A TDMA-based solution with a round-robin scheduler, where each client gets equal number of time slots to transmit.
c. A TDMA-based solution with max rate scheduling.
d. A TDMA-based solution with proportionally fair scheduling, where the priority of a node is determined as current_rate/average_rate, and the average is computed over a long period of time.

Problem 3 [1 mark]

Consider the following variation of the SampleRate algorithm discussed in class, called SampleRate1. SampleRate1 is similar to SampleRate in all aspects except one: while SampleRate sends every 10^{th} packet at a higher rate than the current best rate, SampleRate1 simply sends the 10^{th} packet also at the current best rate only. That is, SampleRate1 has no special clause to deal with every 10^{th} packet, and picks the bit rate with the lowest average transmission time on all packets.

Consider a 802.11g wireless link running SampleRate1, 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 rates at each of the bit rates: rates 1 to 18 Mbps are lossless, 24 Mbps has 10% loss, 36 Mbps has 50% loss, and the higher rates do not work at all. Assume that the SampleRate1 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 SampleRate1 leads to better/worse/same throughput as SampleRate after the channel change, and explain your answer.

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.
b. The channel becomes worse so that 24 Mbps now has a 50% loss rate, 36 Mbps and higher rates do not work. Also, 18 Mbps now has a 10% loss rate, and lower rates are lossless.