Problem Set 3 (due Tuesday, October 23)

(The problem numbers from the text are the same in both the first and second editions.)

1. (6 points) The DCF mode of IEEE 802.11

An ad Hoc network running 1 Mbps IEEE 802.11 has 4 nodes: N1, N2, N3, N4. Assume that at the beginning the channel is idle (no transmission), and that at time 10 μs, N2 has a packet to be sent to N4. At instant 20 μs, both N1 and N3 have a packet to be sent to N4. Assume that the random number generator (for backoff) will give the following values for N1: 2, 5, ...; for N2: 3, 3, ...; and for N3: 1, 4, ... (These are in slots.)

Show the execution of the DCF mode of IEEE 802.11 for the above transmissions. Assume that SIFS is 10 μs, DIFS 50 μs, and slot time is 20 μs. Assume that we don't use RTS/CTS or fragmentation, and that all data packets have the same length of 125 bytes and that the Ack packet has length 25 bytes. Furthermore the channel bit error rate is assumed to be 0, and 802.11 provides the maximum possible throughput when there are no collisions.

2. (8 points) Mobile IP

Chapter 12, Problem 2.

4. (8 points) Organization of cells in a cellular networks

Problem 10.7.

4. (8 points) Performance analysis of cellular networks

Problem 10.8.

5. (20 points) Access points and handoffs

Consider a network consisting of two access points: AP1 and AP2, located at positions (-100, 0) and (100, 0) on the plane, respectively, where the distance unit is meter. A mobile unit is communicating through this network, which offers a data rate of 1 Mbps, using BPSK modulation and operating at a frequency spectrum centered around 2.4 GHz. Each access point transmits at the level of 100mW and the noise density in the area is 10^{-16} W/Hz. Assume that all packets have the same size: 100 bytes.

(a) Draw a two-dimensional graph that (approximately) indicates the region in which the frame error rate of communication with access point is at least 10%.

(b) Suppose the mobile decides to switch from one access point to another whenever the signal from the newer access point is at least 25% stronger than from the first one. Draw a two-dimensional graph that indicates the points at which a mobile will switch from AP1 to AP2.

(c) Repeat part (b) for the case when the mobile decides to switch whenever the signal from the newer access point is at least 25% stronger than from the first one *and* the frame error rate for communication with the new access point is at most 10%. An approximate curve will suffice.

You may adopt a free-space loss model for idealized isotropic antenna (ignoring gains) and may use the following formula for the Bit-Error-Rate (BER) of BPSK modulation:

$$BER = \int_{\sqrt{2E_b/N_0}}^{\infty} \frac{1}{\sqrt{2\pi}} e^{-\frac{u^2}{2}} du.$$

(To calculate the above numerically, you can use the complement of the error function used in statistical analysis – e.g., the ERFC function in Excel.)