CAS765 Homework Assignment 1

Due date: September 23rd, 2013

Problem 1: Suppose a transmitter produces 30W of power.

a. Express the transmit power in units of dBm and dBW.
b. If the transmitter's power is applied to a unity gain antenna with a 900-MHz carrier frequency, what is the received power in dBm at a free space distance of 100 m?
c. Repeat (b) for a distance of 10km.
d. Repeat (b) (c) under ground reflected model with the height of the transmitter and receiver being 30m and 1m respectively.

Problem 2: Prove that in the two-way ground reflected model, $\Delta = d'' - d' \approx 2h_t h_r/d$. Show when this holds as a good approximation.

Problem 3: Consider seven-cell frequency reuse. Cell B1 is the desired cell and B2 is a co-channel cell as shown in Figure 1(a). For a mobile located in cell B1, find the minimum cell radius R to give a forward link C/I (carrier to interference) ratio of at least 18 dB at least 99% of the time. Assume the following:

Co-channel interference is due to base B2 only.
Carrier frequency, $f_c = 890$MHz.
Reference distance, $d_0 = 1km$ (assume free space propagation from the transmitter to d_0).
Assume omnidirectional antenna for both transmitter and receiver, where $G_{base} = 6$dBi and $G_{mobile} = 3$dBi.
Transmitter power, $P_t = 10W$ (assume equal power for all base stations).
$PL(dB)$ between the mobile and base B1 is given as,

$$\overline{PL}(dB) = \overline{PL}(d_0) + 10(2.5)log(\frac{d_1}{d_0}) - X_\sigma,\ \sigma = 0dB. \tag{1}$$

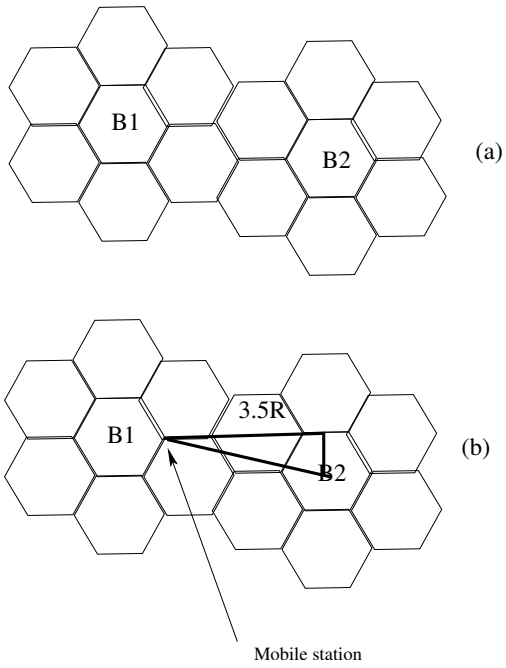

Fig. 1. (a) Seven-cell reuse structure; (b) co-channel interference geometry between B1 and B2

$PL(dB)$ between the mobile and base B2 is given as

$$\overline{PL}(dB) = \overline{PL}(d_0) + 10(4.0)log(\frac{d_2}{d_0}) - X_\sigma,\ \sigma = 7dB. \quad (2)$$

Cell boundaries are shown in Figure 1(b).

Problem 4: When A pair of nodes A and B are sending packets to node C using IEEE 802.11 DCF. All nodes are within transmission and carrier sensing range with one another. Both nodes A and B have many packets pending for node C. Show on a timing diagram the sequence of events that occurs until each of nodes A and B has received ACK for their first packet sent to C, assuming that they pick their successive back-off intervals as follows:
Node A: 3, 4, 8, 4, 2
Node B: 7, 6, 5, 15, 17

Assume that the propagation delay is negligible, and that the two nodes choose their initial back-off exactly at time t0, and that at time t0 channel changes status from busy to idle. In your timing diagram, show one time-line each for hosts A, B and C (Fig. 2). In the time-line, show the various packets sent by the hosts, and back-off slots counted by the hosts and inter-frame spacing. Also, if a packet transmission results in a collision, indicate that as well. *No* RTS/CTS is used prior to Data and ACK, and that in the absence of a collision, all transmissions are received reliably.

Fig. 2. Time-line for host A, B, C