ECE6604: Assignment 1

- Date Assigned: January 19, 2010.
- Date Due: January 28, 2010.

1a) Plot and compare the path loss (dB) for the free-space and flat specular surface models at 800 MHz versus distance on a log-scale for distances from 1 m to 40 km. Assume that the antennas are isotropic and have a height of 10 m.

1b) A brief measurement campaign indicates that the median propagation loss at 420 MHz in a mid-size North American city can be modelled by the following path loss equation

$$L_p = 25 \text{ dB} + 10 \log_{10}(d^{2.8}) \ ,$$

i.e., the path loss exponent is $\beta = 2.8$ and there is a 25 dB fixed loss. Assuming a cell phone receiver sensitivity of -95 dBm, what transmitter power is required to service a circular area of radius 10 km? Suppose the measurements were optimistic and $\beta = 3.1$ is more appropriate. What is the corresponding increase in transmit power (in decibels) that would be required?

2) Consider a cellular system that uses a 7-cell hexagonal reuse cluster. The base stations employ 120^o wide-beam directional antennas and they all have the same antenna height and transmit with the same power level. Consider the forward channel (base-to-mobile). Ignore shadowing and envelope fading and consider only the path loss. A mobile station will experience the lowest co-channel interference ratio, Λ, when it is located in the corner of a cell.

a) Considering only the first tier of co-channel base stations, what is the worst case Λ with a path loss exponent of 4?

b) Considering the first two tiers of co-channel base stations, what is the worst case Λ with path loss exponent of 4?

c) From parts a) and b) what conclusions can you make about the effect of the second-tier co-channel base stations? What happens if the path loss exponent is equal to 3?

Note: In this problem you must use exact radio path distances rather than approximations like we did in class.

3) Suppose that an urban area has three competing trunked mobile networks (systems A, B, and C) to provide cellular service. System A has 400 cells with 15 channels/cell, System B has 50 cells with 100 channels/cell, and System C has 100 cells with 60 channels/cell. Ignore handoff traffic and assume uniform cell traffic loading.

a) Plot the (Erlang-B) blocking probability, $B(\rho, m)$, for each system versus ρ.

b) Find the number of users that can be accommodated by each system for a blocking probability of 2% if the traffic loading offered by each user is 0.1 Erlangs.

4) Show that the area averaged noise outage probability is given by Equation (1.25) in the text.

5) Consider a Rician fading channel with Rice factor K and average envelope power Ω_p. Derive an integral expression for the probability density function of the envelope phase in terms of K and Ω_p.

Note: There is a typo in the 3 expressions for $p_{RV}(r, v)$ on page 691 of the text. The multiplicative factor $\frac{1}{2\pi\sigma^2}$ should be $\frac{r}{2\pi\sigma^2}$; the r is missing.