KFUPM - COMPUTER ENGINEERING DEPARTMENT

COE-543 – Mobile Computing and Wireless Networks
Project Deliverable 2: Due March 27th, 2010.

Student Name:
Student Number:

On the subject of Monte-Carlo Simulations and SIR Statistics for Mobile and Cellular Systems.

Consider the hypothetical (hexagonal) cellular configuration shown in Figure 1. The depicted configuration utilizes a frequency reuse pattern that is equal to three. The cell of interest (the central cell with index 0) is surrounded by two tiers of co-channel interferers numbered 1 to 18.

It is desired to characterize the downlink signal-to-interference ratio (SIR) for users located in the cell of interest for different path loss exponent (α) and standard deviation of the shadowing process (σ_{dB}). In specific, plot the CDF for the SIR for users located randomly in the cell of interest for multiple sets of α and σ_{dB}.

R – cell radius/side
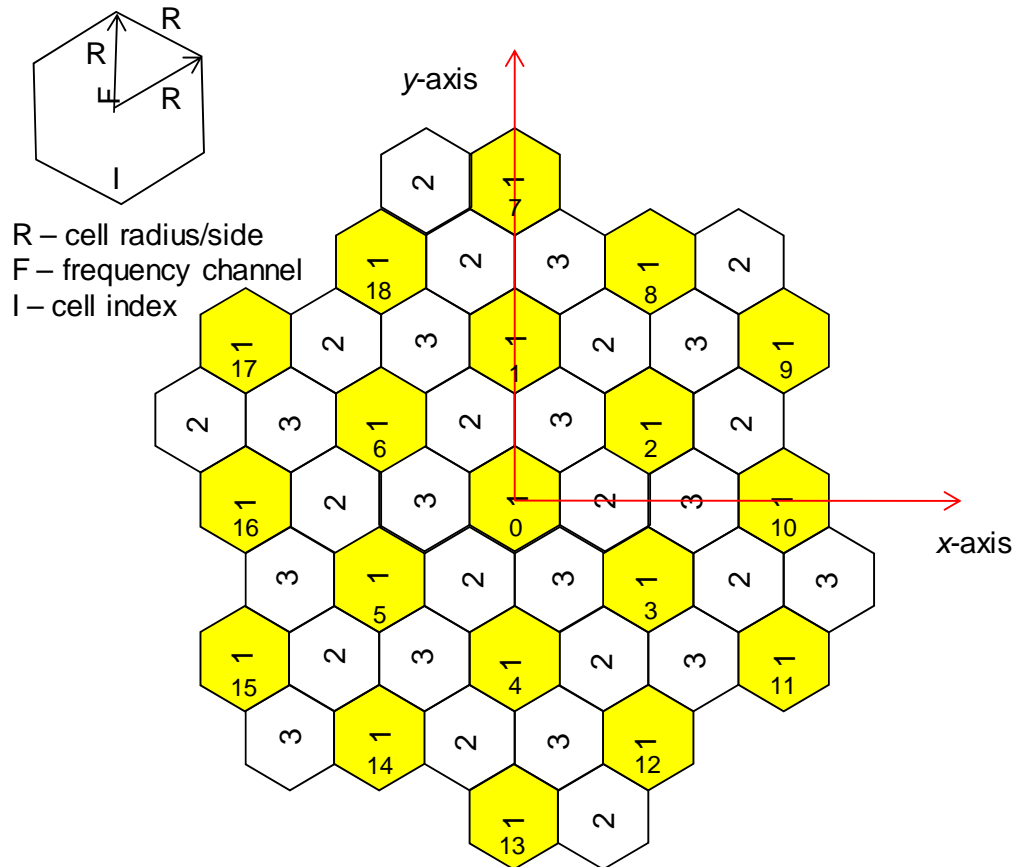F – frequency channel
I – cell index

Figure 1: Idealized cellular configuration utilizing frequency reuse pattern of 3 with two tiers of co-channel of interferers.

Assumptions:

1. Assume an ideal hexagonal cell of radius $R = 1$ length unit.

2. All cell sites transmit the same amount of total power on the downlink. Denote this total power by P_{total}.

3. Users are located randomly (i.e. uniformly) in the cell of interest.

4. The mean received power is calculated using the path loss model $P_r = K/d^\alpha$, where K is a constant, d is the distance between the transmitter and receiver, and α is the path loss exponent. Please note that other path loss models may be used for future implementations of this task.

5. For a user located in the cell of interest, the desired signal power is the signal power received from the central cell; the interference power is the sum of the received powers from all co-channel interfering cells.

6. A receiver located at distance d from the transmitter, receives an amount of power equal to $P_r \times 10^{\zeta/10}$ where P_r is the received mean power as calculated by the path loss model, and ζ is the RANDOM shadowing factor following the normal distribution of zero mean and standard deviation σ_{dB}. It is clear that both the path loss exponent (α) and standard deviation of the shadowing process (σ_{dB}) affect the final received power at the user location.

7. The shadowing factors ζ's corresponding to the signals received from the cell sites 0, 1, 2, …, 18 are independent normal random variables with zero mean and standard deviation given by σ_{dB}.

Proposed Method:

To characterize the SIR for this system, we need to perform a Monte-Carlo simulation and collect the SIR figures (samples) for random user locations in the cell of interest. The collected SIR figures can be then processed to produce information regarding the PDF or CDF of this system and the effect of α and σ_{dB}. Assume it is desired to collect N SIR figures for N randomly (uniformly) located users in the cell of interest. The ith (i = 1, 2, …, N) SIR figure, denoted by SIR_i, is computed using the following procedure:

1. Locate the ith user randomly (uniformly) in the cell of interest (cell 0), let the corresponding coordinates be (x_i, y_i)

2. Calculate the distance of the user from the kth cell. Denote this distance by $d_{i,k}$ for k = 0, 1, 2, …, 18. Note that $d_{i,0}$ is the distance of user from the center of the cell of interest, while $d_{i,j}$ for j = 1, 2, …, 18 is the distance of user from the center of the jth co-channel interfering cell.

3. Calculate the corresponding *mean* received down link powers, $P_{i,k}$, from each of the k = 0, 1, 2, …, 18 cells using the prescribed path loss model.

4. Generate corresponding shadowing factor $\zeta_{i,k}$ between the ith location and each of 19 cell sites.

5. Calculate the received downlink power as $P_{i,k} \times 10^{\zeta_{i,k}/10}$.

6. Form the quantity $SIR_i = \dfrac{P_{i,0} \times 10^{\zeta_{i,0}/10}}{\sum_{k=1}^{18} P_{i,k} \times 10^{\zeta_{i,k}/10}} = \dfrac{d_{i,0}^{-\alpha} \times 10^{\zeta_{i,0}/10}}{\sum_{k=1}^{18} d_{i,k}^{-\alpha} \times 10^{\zeta_{i,k}/10}}$

The Matlab function `hist()` can be utilized to produce the PDF and CDF of the SIR figure for each prescribed set of α and σ_{dB}. This was introduced and utilized in the last project task.

When using Matlab for implementation, the student must try to utilize vector and matrix operations as much as possible and void using loops in order to speed the execution of the Matlab code.