Department of Electrical Engineering

EE 764: Wireless and Mobile Communications (Spring 2018)

Course Instructor: Prof. Abhay Karandikar

Simulation Assignment 1

Due Date: 25^{th} Jan, 2018

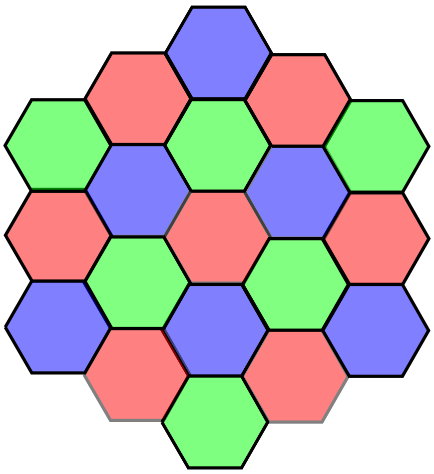
Instructions:

- *Use either MATLAB or SciLab for simulations in this assignment.*
- **Please Note: This assignment is NOT a group assignment and has to be submitted by each student individually.**
- Submit a tarball/zip file with the following files:
  1. Plots wherever asked for.
  2. Discussion of results and your inferences in the form of a PDF file.
  3. Simulation code files for assignment with detailed comments.
- The filename of the uploaded file should be in the format : RollNumber_assign1.

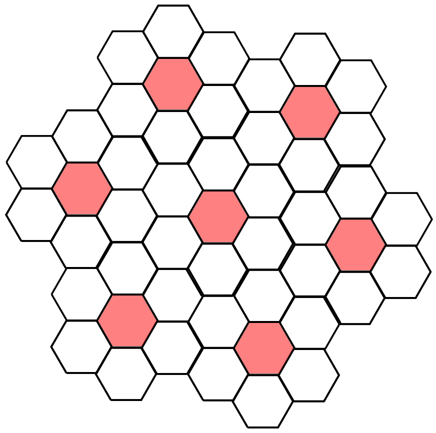
Simulation Settings: Consider a cellular system as shown in Figure 1a. The Base Station (BS) is located at the center of each hexagonal cell. Each BS has $N = 120$ frequency channels available for use. We refer to the cell in the center as the reference cell, which is surrounded by six cells forming the first tier. The users are randomly and uniformly distributed in the reference cell. Consider that there are no users within a distance of 10 meters from the BS. The transmit power of a BS is $P_T = 30$ dBm and the cell radius is $R_c = 1000$ m (For a hexagonal cell, the radius is the distance from the center to each of the six vertices). The power received by any user m from BS i is given by:

$$S = \frac{P_T}{d_{im}^{\gamma}},$$

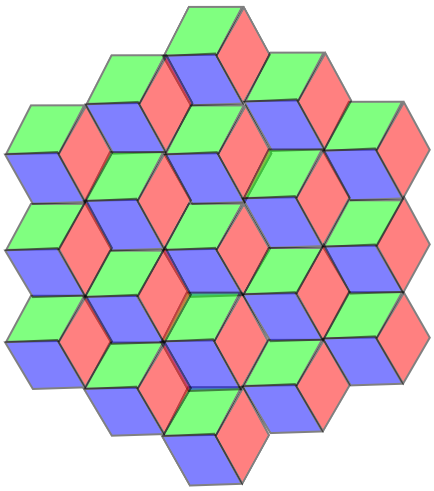
where d_{im} is the distance between BS i and user m in meters and the path loss exponent $\gamma = 3.5$. The total interference experienced by a user is the sum of received power of all the neighboring BSs that are using the same frequency channels. The SIR is equal to the ratio of the received signal power S to the total interference I.



(a) Frequency reuse factor 3



(b) Frequency reuse factor 7



(c) Cell sectoring

Figure 1: Three different configurations of a cellular system

In the following three configurations, unless stated otherwise, the cellular scenario is as explained above.

1. **Reuse factor 3:** Generate a random position of a target user in the reference cell and calculate the SIR experienced by it. Repeat this for a significantly large number of different positions of the target user and plot the Cumulative Distribution Function (CDF) of the SIR. Assume a cluster of 3 cells where each cell has distinct $N/3$ frequency channels as shown in Figure 1a. In this case, the nearest co-channel cells happen to lie in the second tier.

2. **Reuse factor 7:** Now let us assume to have a cluster of 7 cells where each cell has distinct $N/7$ frequency channels as shown in Figure 1b. Cells of the same color use

the same set of frequencies. In this case, the nearest co-channel cells happen to lie in the third tier. Plot the CDF of the SIR following the same procedure and parameters as in Problem 1.

3. **Sectoring:**

   (a) In this configuration, the cellular system has a reuse factor of 1 and 120° sectorized antennas at the BS (refer Figure 1c). Each sector has distinct $N/3$ frequency channels. Plot the CDF of the SIR following the same procedure and parameters as in Problem 1. Consider downlink (BS to user) channels only while doing the simulations.

   Compare all the three configurations and provide your inference.

   (b) Now, consider that the total resources for a single cell are equally distributed among all the sectors, and each user requires one channel for communication. A user is blocked if no channel is available at the BS. We define blocking probability P_B as the fraction of users that are blocked. Vary the number of users in the reference cell (termed as load) from $N/2$ to $3N/2$ and plot P_B with respect to the load for with and without cell sectorization.