Experiment - 2: Effect of cluster size on signal to interference ratio

1. **Aim:** To understand the effect of cluster size on signal to interference ratio

2. **Requirements:** Matlab/Scilab/Python

3. **Pre-Experiment Exercise**

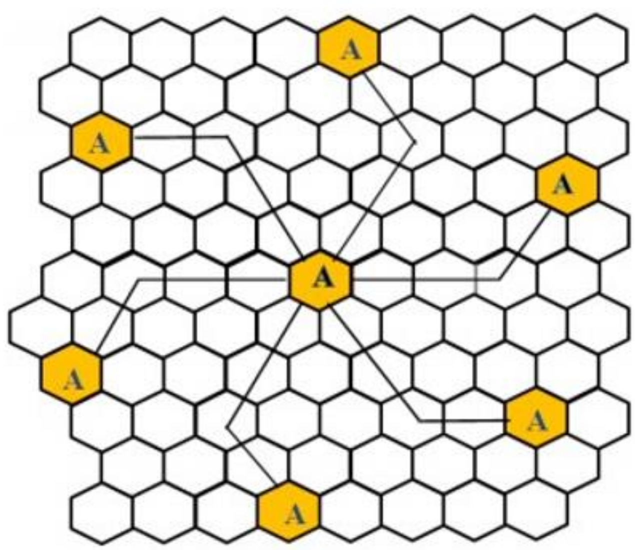
3.1 Brief Theory

Concept of Co-Channel Cells:

Frequency reuse implies that in a given area, there will be cells that use the same set of frequencies. These cells are called Co-channel cells and the interference between these 2 cells is called Co- channel interference. A larger cluster size causes the ratio between the cell radius and the distance between co-channel cells to decrease reducing co-channel interference. The value of N is a function of how much interference a mobile or base station can tolerate while maintaining a sufficient quality of communications. Since each hexagonal cell has six equidistant neighbors and the line joining the centers of any cell and each of its neighbors are separated by multiples of 60 degrees, only certain cluster sizes and cell layouts are possible. To connect without gaps between adjacent cells, the geometry of hexagons is such that the number of cells per cluster, N, can only have values that satisfy,

$$N = i^2 + ij + j^2$$

where i and j are non-negative numbers



In this example, N = 19 (i.e., i = 3, j = 2).

To find the nearest co-channel neighbors of a particular cell,

a. move i cells along any chain of hexagons then,

b. turn 60 degrees counter-clockwise and move j cells.

Relationship between Co-Channel Interference and System Capacity:
To reduce co-channel interference, co-channel cells must be physically separated by a minimum distance to provide sufficient isolation due to propagation.
The parameter Q, called the co-channel reuse ratio, is related to the cluster size and is given by,

$$Q = \frac{D}{R} = \sqrt{3N}$$

A small Q provides larger capacity since the cluster size N is small, whereas a large value of Q improves the transmission quality, due to smaller levels of co-channel interference as the physical distance between 2 co-channel cells increases.
For a hexagonal cell system, assuming only the first layer of interfering cells, if all the interfering base stations are equidistant from the desired base station and if this distance is equal to D which isthe distances between cell centers, then we have,

$$\frac{S}{I} = \frac{({}^{D}/{}_{R})^n}{i_o} = \frac{(\sqrt{3N})^n}{i_o}$$

4. Laboratory Exercise

Part A:

1. What do you understand by Co Channel cells
2. What are the factors to be considered to reduce the Co channel interference

Part B:

Procedure

Cluster Size (N)	Co-channel reuse ratio (Q)	S/I ratio (calculated)
3		
4		
7		
12		
21		

a. Plot a graph for Co-channel reuse ratio (Q) versus Cluster Size (N)
b. Plot a graph for S/I ratio versus Cluster Size (N)

5. Post-experiment Exercise

5.1 Conclusion

5.2 Questions

1. If a signal to interference ratio of 15dB is required for satisfactory forward channel performance of a cellular system, what is the frequency reuse factor and cluster size that should be used for maximum capacity if the pathloss exponent is a) n=4 b) n=3? Assume that there are 6 co channel cells in the first tier and all of them are at the same distance from the mobile.

2. Explain co-channel interference and adjacent channel interference in detail