CO513 - Lab 03

Simulating a mobile network

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Introduction

Here, an area of 10km x10km was considered as the simulation environment, and three base stations were located in such a way that the distance of them becomes maximum.

The simulator is developed using NodeJS, with OOP concepts (under ES6 standards) since it is an asynchronous programming language and it makes the implementation easy and simulations more accurate.

First, need to install the NPM package manager. Then go to the root directory, open the terminal and type the following command to install the dependencies

```
npm install
```

After that can start the simulator using the below command. The simulator will simulate the mobile network and the average number of users for each base station will be printed into the command line after 6 seconds.

```
npm run start
```

The simulator comes with a visualization tool, and a compiled version can be found from **./docs/index.html** or from this link: https://nuwanj.github.io/CO513_lab03/

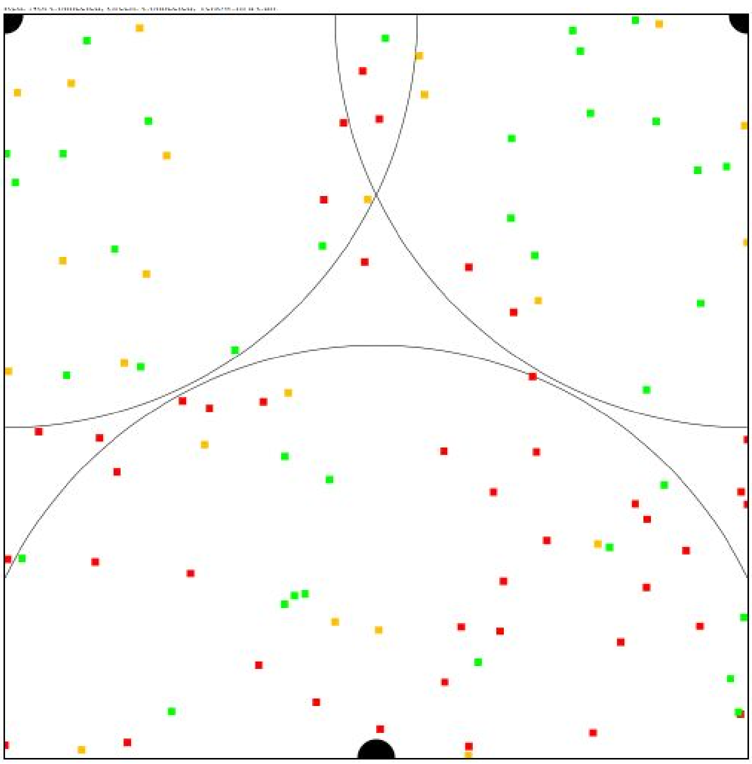

Figure 1: HTML based visualizer (Red: Not Connected, Green: Connected, Yellow:In a Call)

Assumptions and Approaches

1. The Free Space Path Loss model was used to calculate the signal strength.

$$\begin{aligned}\mathrm{FSPL(dB)} &= 10\log_{10}\left(\left(\frac{4\pi d f}{c}\right)^2\right)\\ &= 20\log_{10}\left(\frac{4\pi d f}{c}\right)\\ &= 20\log_{10}(d) + 20\log_{10}(f) + 20\log_{10}\left(\frac{4\pi}{c}\right)\\ &= 20\log_{10}(d) + 20\log_{10}(f) - 147.55,\end{aligned}$$

2. It was assumed that all 3 base stations are operating at the frequency 1800MHz and each base station can handle a maximum of 20 users at any given time.

3. Linear movement with random heading directions is used as the users' mobility model. Updating interval was considered as 500ms, and speed is taken as 50m per update (per 500ms)

4. There is a random call generator, which generates calls for 25% of active users at any time. Each generated call will have a duration between the 30s to 120s. (The simulator operates x10 faster than the real environment, so 30s will be simulated within 3 seconds)

5. Following equation is used to translate between dBm and Watt.

$$P_{(\mathrm{W})} = 1\mathrm{W} \cdot 10^{(P_{(\mathrm{dBm})}/10)} / 1000 = 10^{((P_{(\mathrm{dBm})} - 30)/10)}$$

Results

The following graph will show the variation of the average number of connected users for all three base stations for a 1 minute simulation period for different transmission powers of the base stations.

Since the users allocated into random positions of the environment, three readings for the number of connected users to base stations were taken and calculated the average and plot the following graph.

According to the result of the plot, the best "Transmission Power" for a base station was identified as **2dBm**.

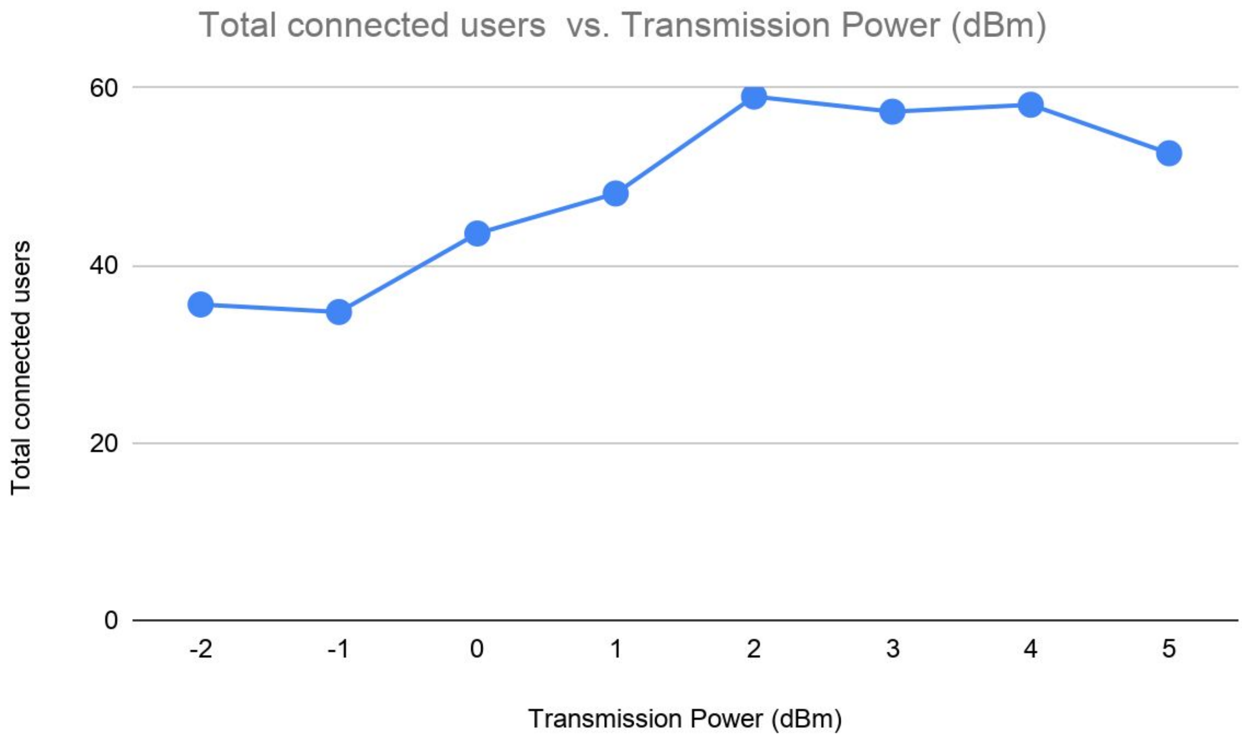

Figure 2: Total connected users against the transmission power of the base stations

Appendix

Coordinates of the base stations:

BS1: { x: 100, y: 100 },
BS2: { x: 10000, y: 100 },
BS3: { x: 5000, y: 10000 }

Data table used to plot the figure 2:

Signal Strength (dBm)	Number of connected users			Total average
	BS1	BS2	BS3	
	20.00	15.00	20.00	
	14.50	17.00	20.00	
5	14.30	17.13	20.00	
	16.27	16.38	20.00	52.64
	20.00	20.00	20.00	
	19.50	20.00	20.00	
4	15.00	19.83	20.00	
	18.17	19.94	20.00	58.11
	20.00	20.00	20.00	
	16.00	19.83	20.00	
3	16.16	20.00	20.00	
	17.39	19.94	20.00	57.33
	19.30	19.00	20.00	
2				

	20.00	20.00	20.00	
	19.30	19.50	20.00	
	19.53	19.50	20.00	59.03
	15.33	20.00	18.50	
	13.50	14.00	20.00	
1	13.00	10.00	20.00	
	13.94	14.67	19.50	48.11
	13.66	13.66	16.66	
	9.00	16.16	20.00	
0	7.50	14.16	20.00	
	10.05	14.66	18.89	43.60
	7.50	14.16	20.00	
	7.33	11.50	10.50	
-1	7.80	6.80	18.66	
	7.54	10.82	16.39	34.75
	11.50	3.60	11.16	
	8.67	8.50	13.83	
-2	14.40	15.30	19.83	
	11.52	9.13	14.94	35.60