CS378: Lab 1 (Wireless Measurements)
Autumn 2024

Marks: 35

Note: This assignment has to be done individually

In this Lab, you will learn about making wireless signal strength measurements. This is related to the Physical (PHY) layer. You may have noticed that sometimes the signal strength (given by the number of bars) shown by your phone is low (for 4G/5G or WiFi). Usually the download data rates and/or voice call quality degrades when signal strength is low.

Cellular providers such as Airtel, Vi, and Jio have to try to ensure that signal strength is good everywhere, to keep their customers happy. They have to place cellular base-stations (called "eNodeB" in 4G-LTE parlance) strategically to ensure this. The wireless signals can face attenuation due to (1) obstacles, and (2) multi-path effect. The latter happens when the signal bounces off many objects and cancels each other, that is "destructively interfere" at the phone of the receiver (more about this in CS348; you can also look it up online if you are curious). Because of this, it is not easy to theoretically predict exactly what the signal strength will be at all locations, given the placement of base-stations.

In this lab, you will use one or more "apps" on your mobile phone to measure signal strength along some path on campus.

How to select the path over which you measure signal strength

1. Go to https://tetsujin1979.github.io/RandomWalk/
2. You will see two slidable bars for "Range" and "Waypoints". **Reduce the Range to 0.5km**. You can keep Waypoints to any number greater than or equal to 5.
3. In the box saying "Post Code", you can type any one of the following, or some other location on IIT Bombay campus:
    a. "IIT Bombay"
    b. "VMCC IIT Bombay"
    c. KRESIT IIT Bombay

This is essentially the starting point of the path over which you will measure signal strength.

4. You will see a path along which you will have to measure signal strength. You must walk over the path from A-B-C-D… etc.
5. In case the path takes you to someplace outside campus, click "Recreate" till the path is entirely on campus.

Note: The idea of using the above website is to generate a unique path for every student.

What your Report should contain: Write a short report (pdf format), which includes the following.

(a) Screenshot obtained from https://tetsujin1979.github.io/RandomWalk/ which depicts the path on IITB campus over which you will measure signal strength. (5 marks)
(b) Record wireless (4G/5G) signal strength by walking along the path you have depicted in (a). In case the path in (a) goes through some point which is not reachable by walking, then you can skip those points. Use colours to say if the signal strength is good or bad etc. (Note: The app you use may do this for you for free). In your report state the range of signal strengths (in dBm) which correspond to different colours. (14 marks)
(c) State which telecom company (e.g. Jio, Airtel etc.) you are getting 4G/5G connectivity from. (Note: We (instructor and TAs) might decide to do a deeper analysis by combining results from many students. Your answer here will help us do this.) (1 mark)
(d) Make a list of all the unique base-stations (eNodeBIDs) your phone was connected to during the measurement. (5 marks)
(e) Try to infer what may have caused poor signal quality in locations where you found this to be the case (you may not know for sure what the reason is, but try to make an intelligent guess). You may find that there are some obstacles, or that the base-station was far away, etc. State in words in your report what you think the reasons for poor signal strength were. If you can annotate your Map to show obstacles etc, that would be even better, but this annotation is not essential. If there are no locations with poor signal then just state this here. (5 marks)
(f) When you are standing in a fixed location (when you are not moving), measure the signal strength. Comment if the signal strength (RSRP: reference signal received power) is steady or if it varies, based on a measurement of a minute's duration. Give a plot of how RSRP varies with time at a fixed location. (5 marks)

Naming of Report: The report should be uploaded to Moodle before the deadline. The filename should have the format: <Roll No. of Member>_lab1.pdf.

Suggested Apps: There are many apps available on Android (and possibly for Apple IoS as well). Here are some suggested apps for Android. Feel free to use any other Apps for doing the assignment.

(i) NetMonitor Cell Signal Logging Lite (https://play.google.com/store/apps/details?id=ru.v_a_v.netmonitor). For this app, under the "Main" tab, you can click on the red button on the top right to record, and then the white square button to stop recording. Each time you do this, a new Session is logged which you can later find under the "Sessions" tab. You can view the details of recorded sessions by going to

"Sessions" → "click on session to view" → "Map icon to the left of the "dustbin" icon".
This should give you a Google Map of signal strength. Clicking on any location of the path on the map will give you a list of measurement points corresponding to that location. Clicking on one of these measurement points will give you the raw data and some plots.
NOTE: You can feel free to use any other app if you like. There may be similar apps available

for iPhones like Network Analyzer.

Apple users: If you have Apple phone and you cannot find suitable apps, then try to borrow a friend's Android phone to do this lab. Contact the instructor if you need help getting an Android phone.

(ii) Open Signal (https://play.google.com/store/apps/details?id=com.staircase3.opensignal). This is a popular app that can help you locate mobile towers. To get a map of cell towers, click on the last icon on the bottom right (looks like an arrow). The click on "Cell Towers". One issue is that the Cell ID information does not correspond to the eNodeBID given by the app mentioned above. Cell ID shown in this app is equal to (256*eNodeBID+CID) where "eNodeBID" and "CID" are given by the app in (i). This app may give you some idea of the locations of base-stations, which may help you figure out why signal strength is good or bad.

(iii) Network Cell Info Lite (https://play.google.com/store/apps/details?id=com.wilysis.cellinfolite): In the "Map" tab it sometimes gives locations of base stations.

Do feel free to suggest other apps by posting information to the MS Team for the course.