

# CS 252: Lab 1

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## About the report

Due to Covid-19 pandemic restrictions, only Devansh was able to take the measurements over a path of more than 1 km. This data was used to answer Part (a), Part (b) and Part (c).

Harshit and Krushnakant did the measurements at (different) fixed locations independently. Harshit's data was used to answer Part (d) and Krushnakant's data is present in the Appendix (Figure 14).

All the team members contributed to the analysis and discussions for all the parts.

Android App Net Monitor Lite was used for collecting the data and Android App Opensignal was used to get the location and information about the cell towers located nearby. For plotting and a basic analysis of the data, Python-3 was used.

### Part (a)

Record signal strength over some geographical area, and pictorially represent it on a map. Use colours to say if the signal strength is good or bad etc. State the range of signal strengths (in dBm) which correspond to different colours. (15 marks)



Figure 1: Area over which the signal strength was recorded

**Color Scheme:**

In the above map, the parts of the path covered by **green** arrows indicate a good signal strength; while those covered by **yellow** indicate a relatively bad signal strength.

The signals received varied from **-92 dBm<sup>1</sup>** to **-52 dBm**, with a mean of **-74.11 dBm** and a standard deviation of **9.66 dBm**

**Ranges covered by different colours:**

**green** covers the range **-50 dBm** to **-85 dBm**

**yellow** covers the range **-85 dBm** to **-105 dBm**

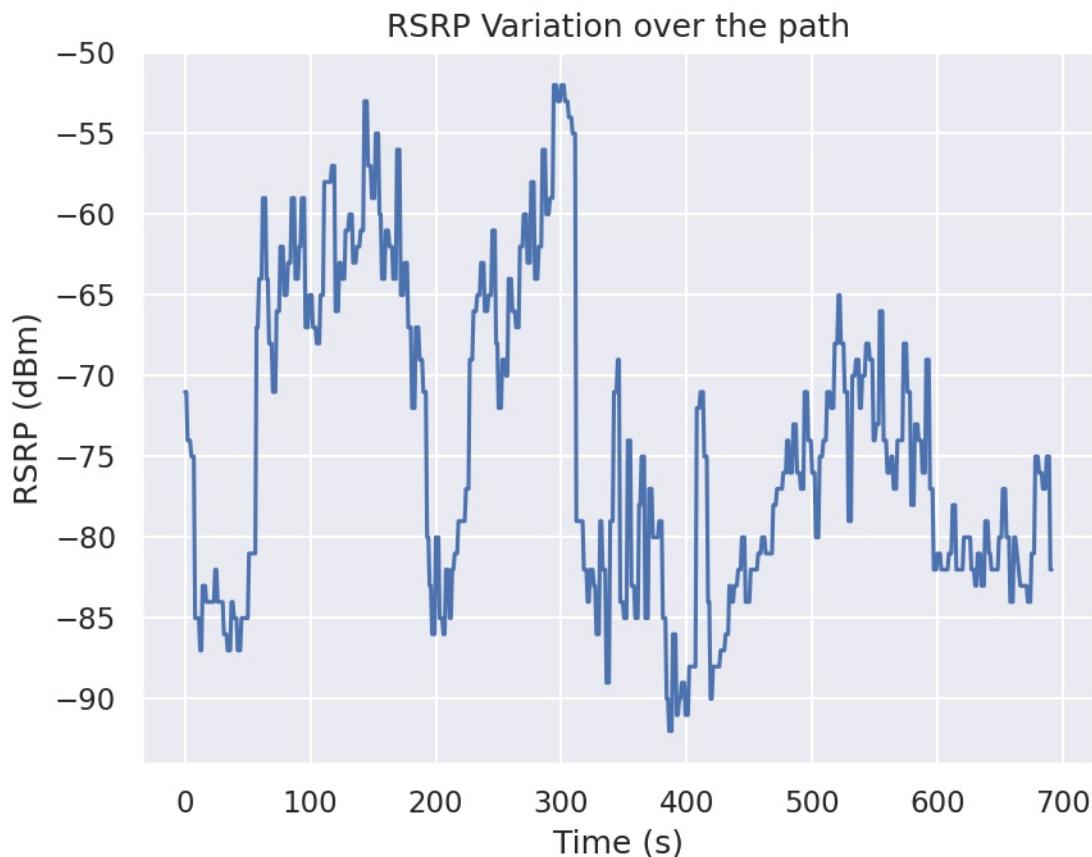


Figure 2: RSRP Variation over the path

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<sup>1</sup>dBm: decibels per milliwatt

## Part (b)

Make a list of all the unique base-stations (*eNodeBIDs*) your phone was connected to, during the measurement. (5 marks)

The set of eNBIDs that the phone connected to are: {5318, 5482, 6378, 12987, 13532}

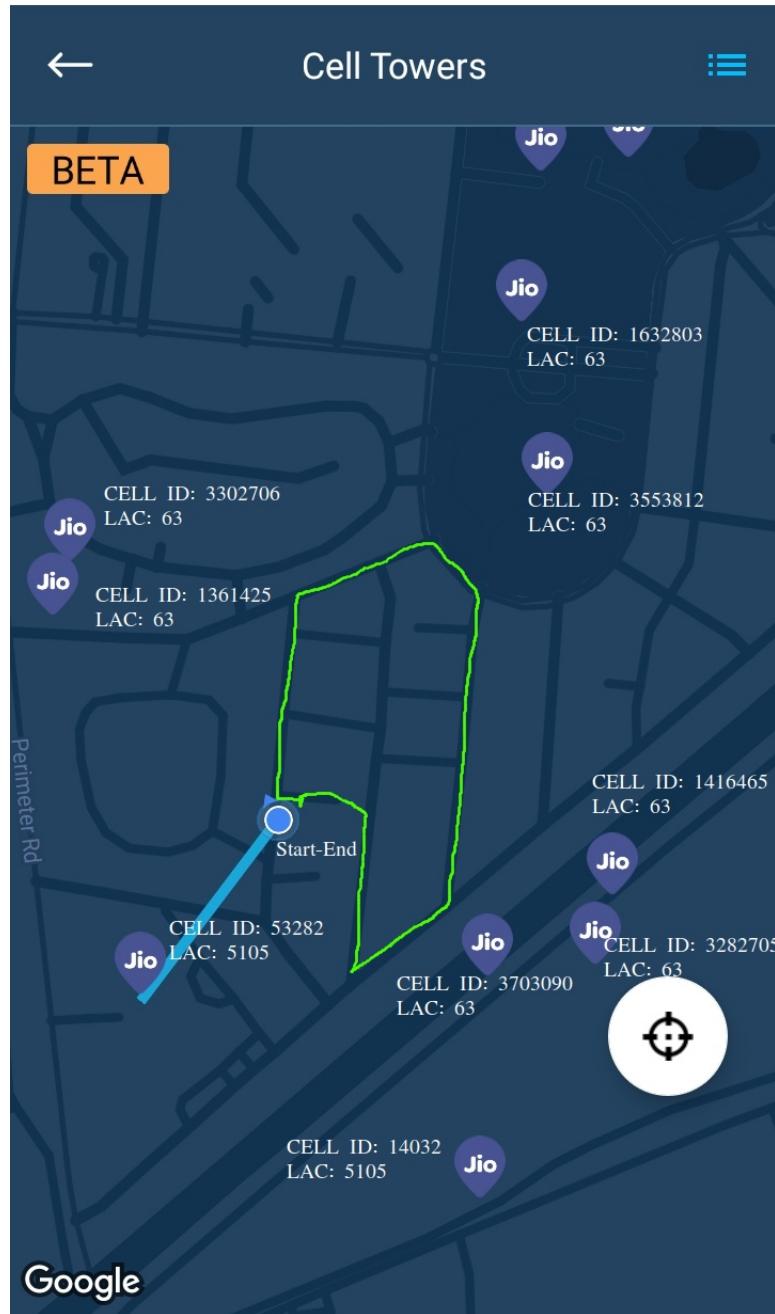


Figure 3: Annotated Cell Towers

### Part (c)

*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 is not essential. (5 marks)*

The yellow signal patch present on the downward journey in Figure 1 can be explained as a consequence of the following two reasons:

1. The path on both sides has **tall buildings** and it is a street road and when we crosscheck it with locations of Base Stations in Figure 3, we can see that they offer obstruction.



Figure 4: Tall buildings obstruct the signals

2. Another possible reason which can be seen by analyzing Figure 3 is that there are no close by base stations (as compared to the previous path segments) and three to four base stations are almost equally spaced from the path

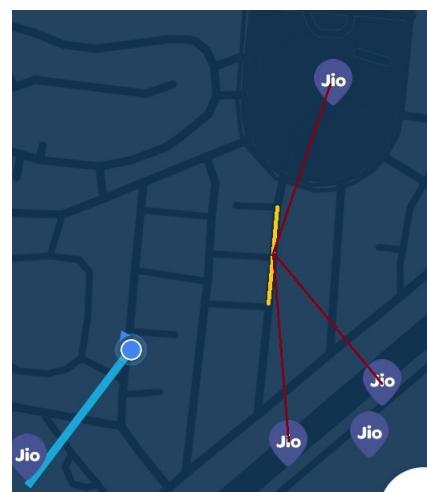


Figure 5: Closest base stations when signal is low

The first reason seems to be more influential as there is a significant dip in signal compared to other regions.

## Part (d)

Comment if when you are standing in a fixed location (when you are not moving) 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)

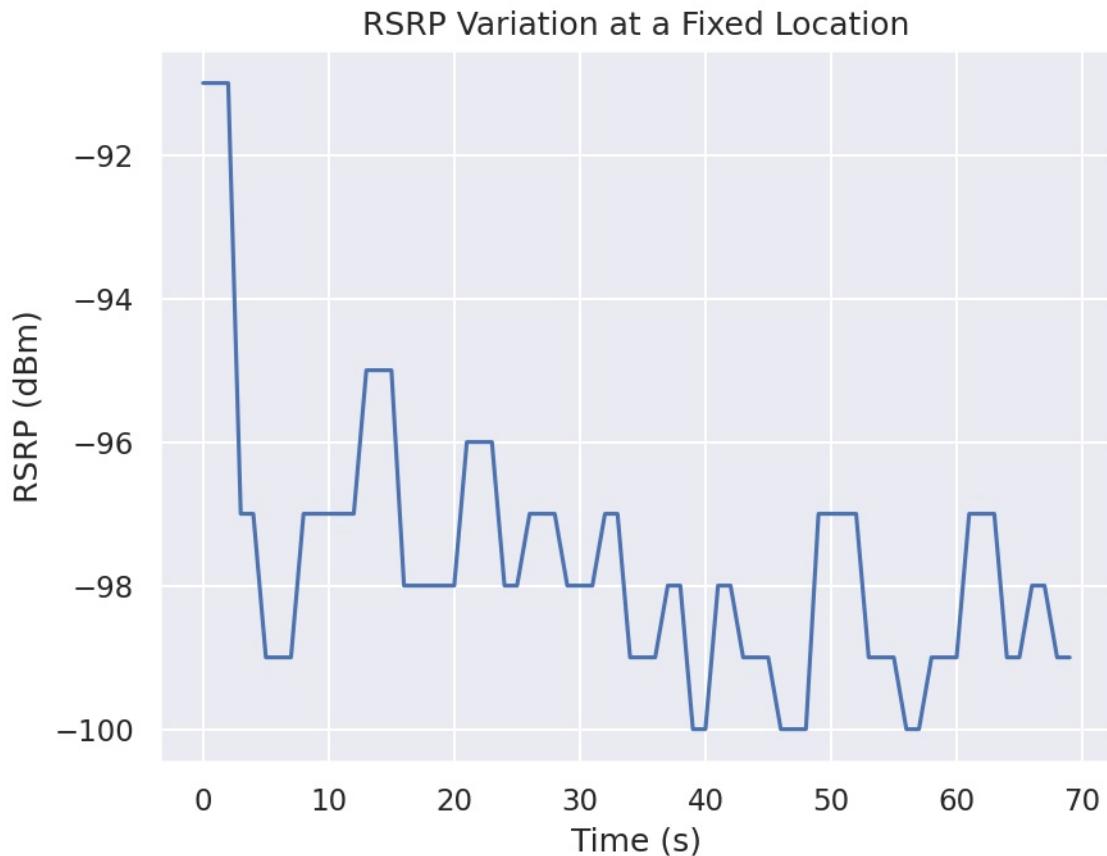


Figure 6: RSRP Variation at a Fixed Location

While standing at a fixed location <sup>1</sup> for about 70 seconds, the signal strength varies between **-100** and **-91** dBm, having a mean value of **-97.69** dBm and a standard deviation of **1.89** dBm

Another set of findings (obtained while standing at a **different** fixed location for about 70 seconds), with a mean of **-84.25** dBm and a standard deviation of **1.34** dBm is plotted in Figure 14.

This is still much less than the variation seen in Part (a), which varied from -92 dBm to -52 dBm, with a mean of -74.11 dBm and a standard deviation of 9.66 dBm

We believe that this small variation, seen at a fixed location can be attributed to:

1. Local interference from neighbouring devices
2. Natural noise while data acquisition

<sup>1</sup>Measurements were taken in a confined space

## Appendix

### Screenshots

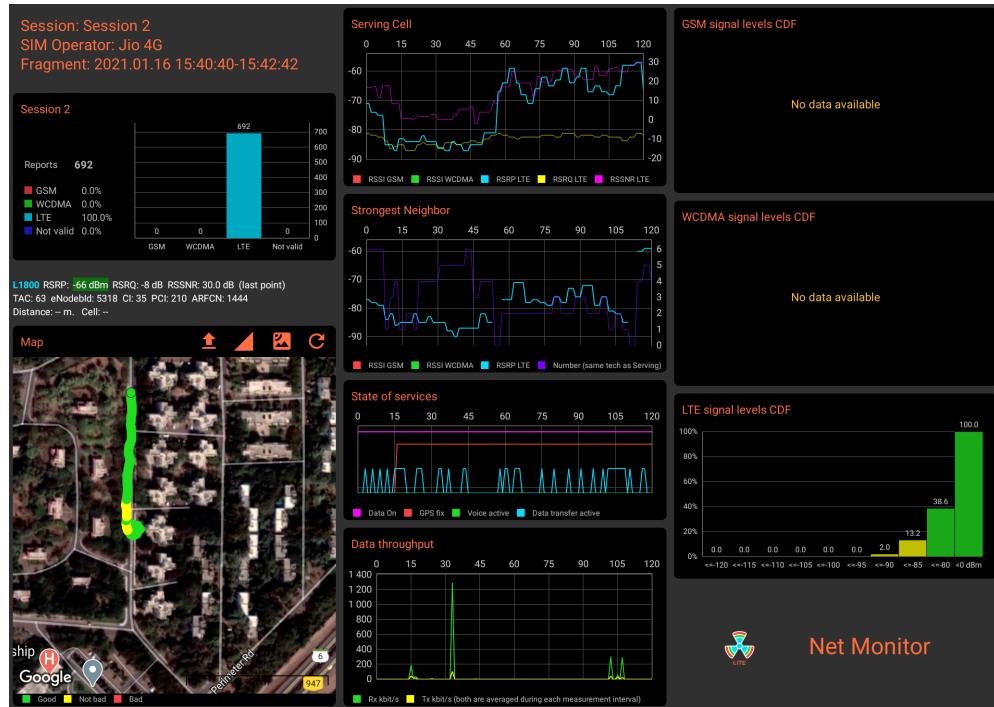


Figure 7: Net Monitor Data over Path (1)

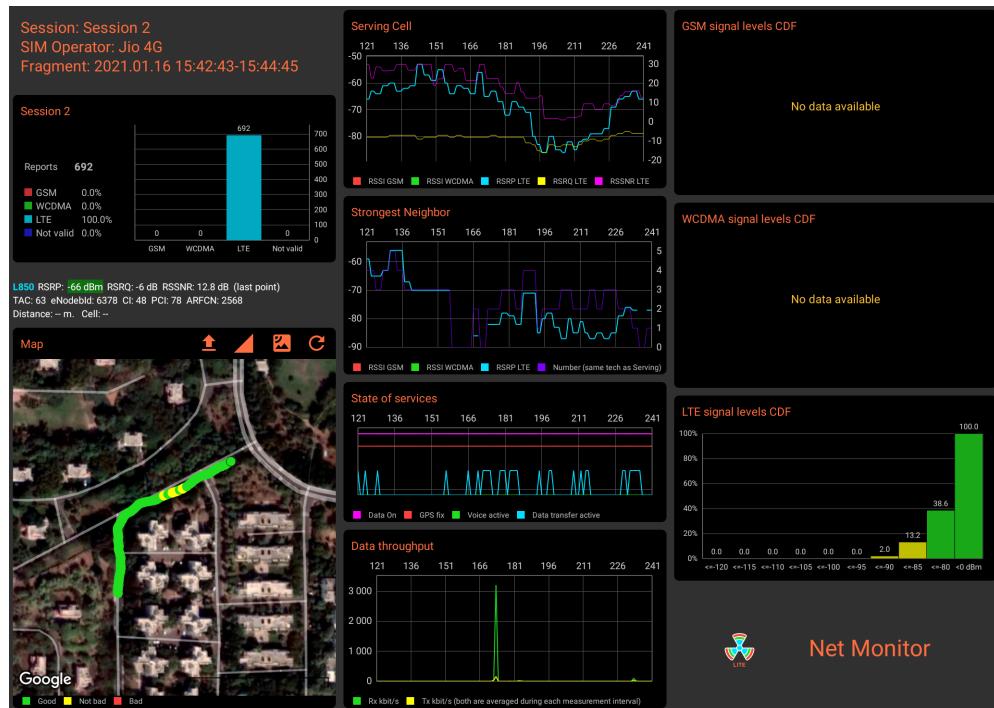


Figure 8: Net Monitor Data over Path (2)

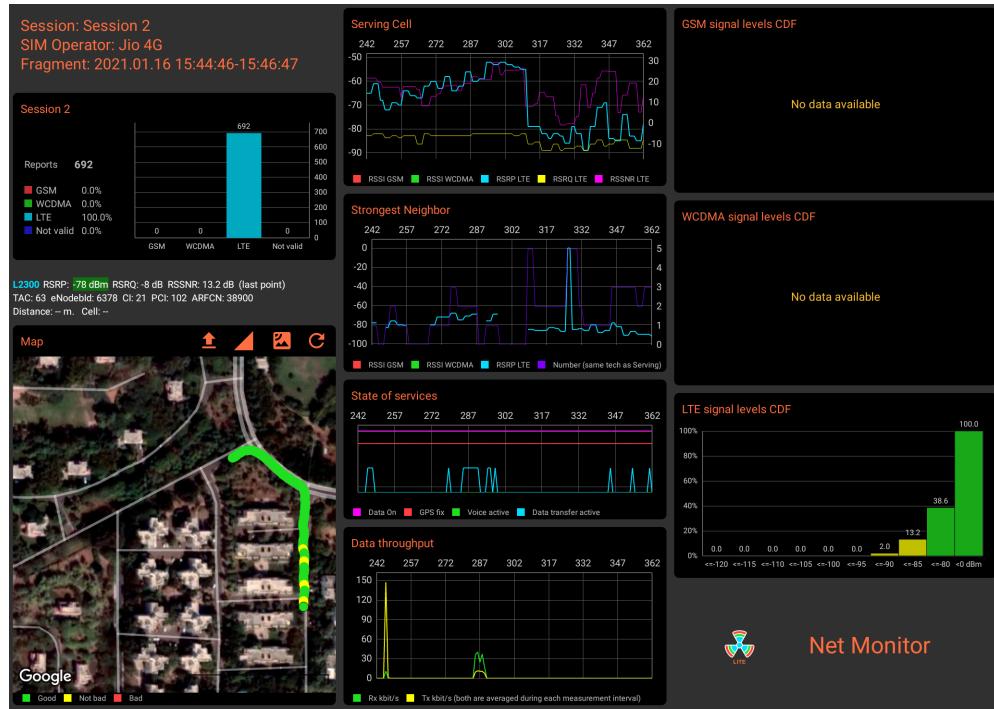


Figure 9: Net Monitor Data over Path (3)

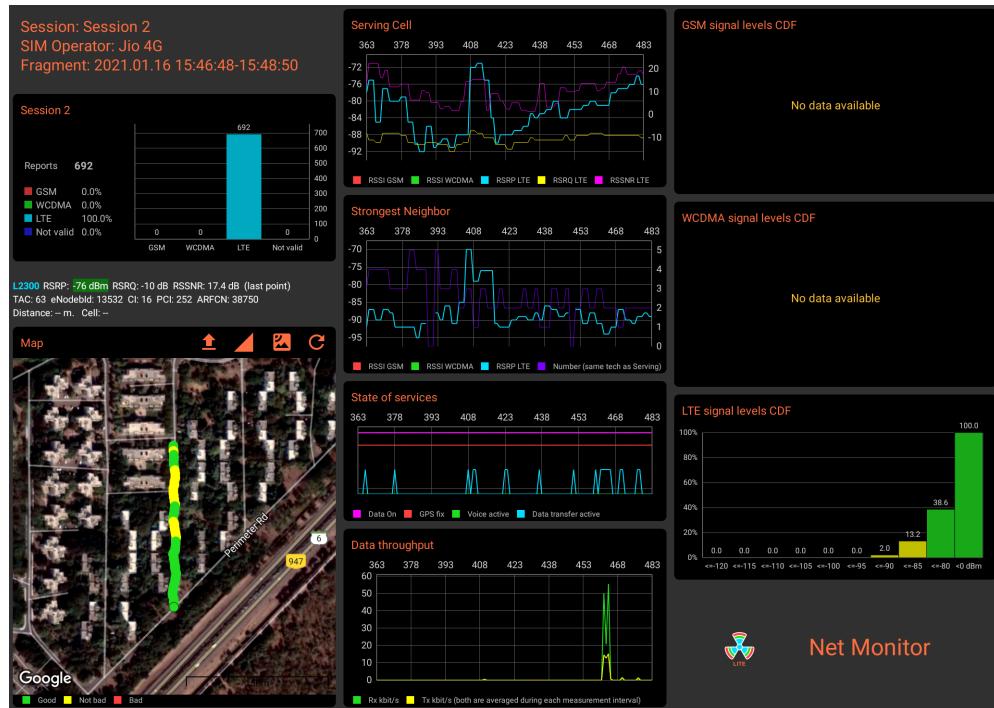


Figure 10: Net Monitor Data over Path (4)

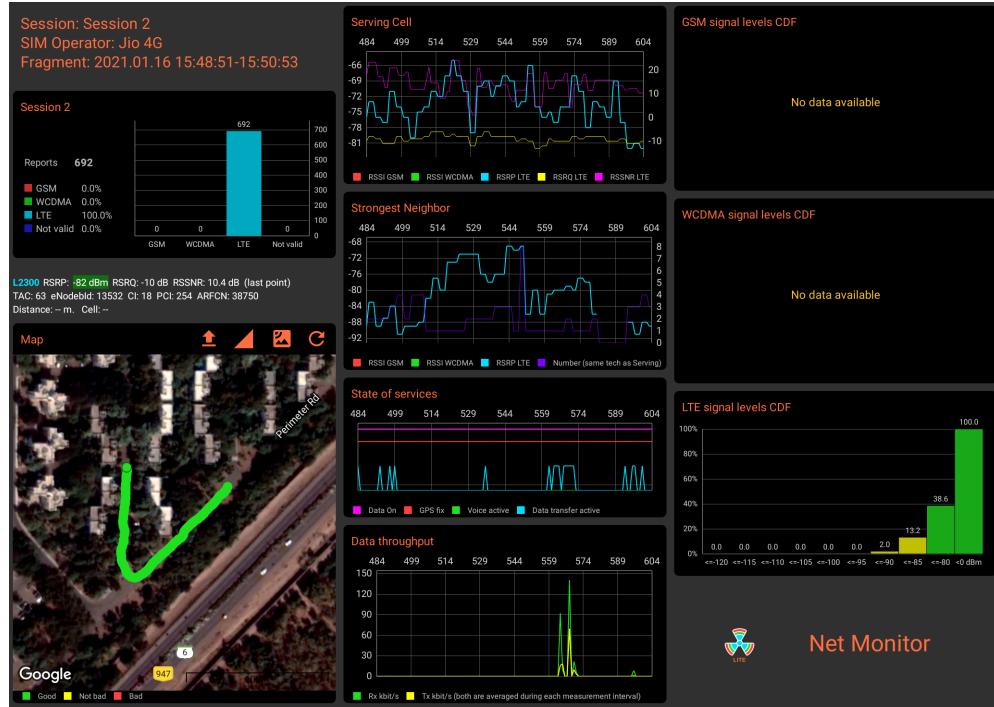


Figure 11: Net Monitor Data over Path (5)

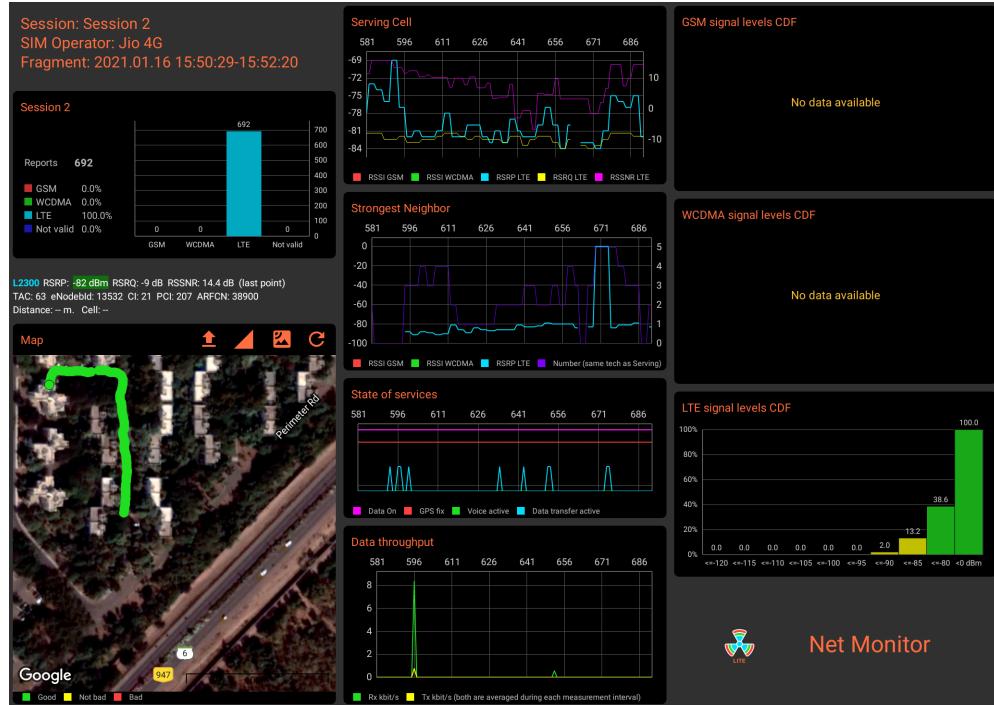


Figure 12: Net Monitor Data over Path (6)

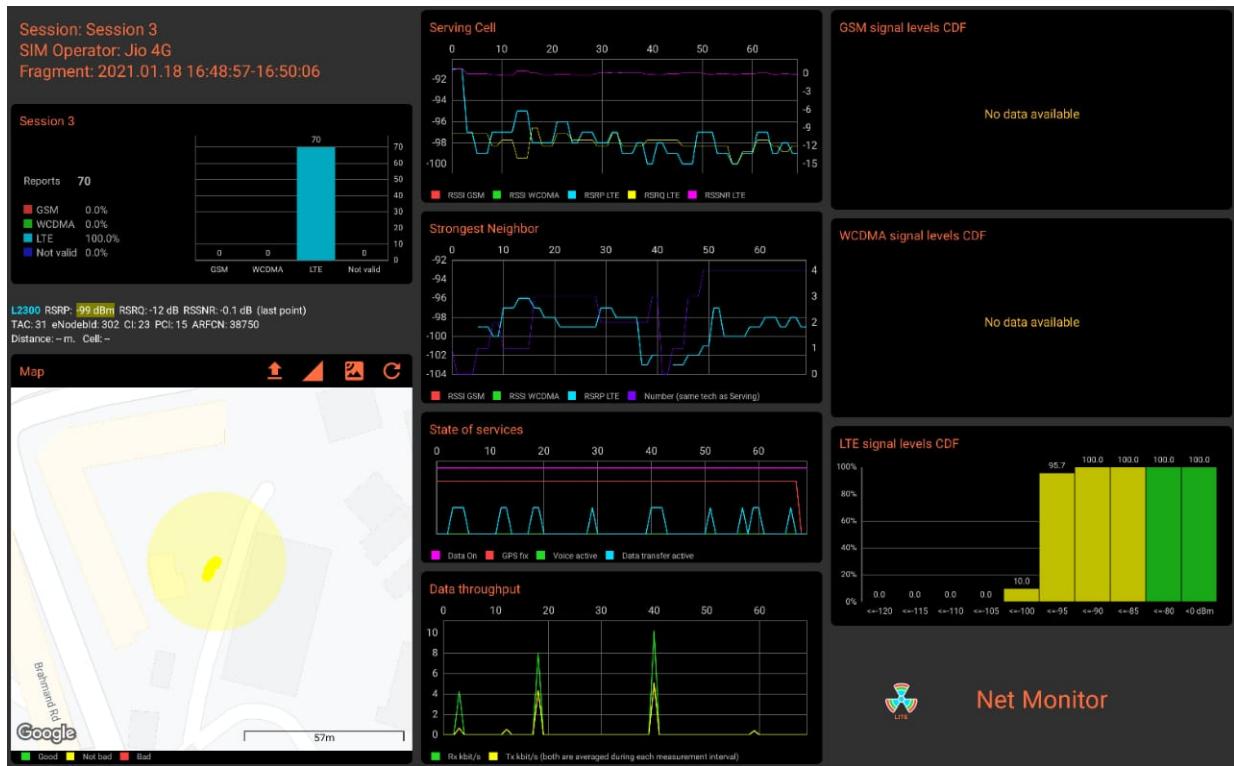


Figure 13: Net Monitor Data at a Fixed Location

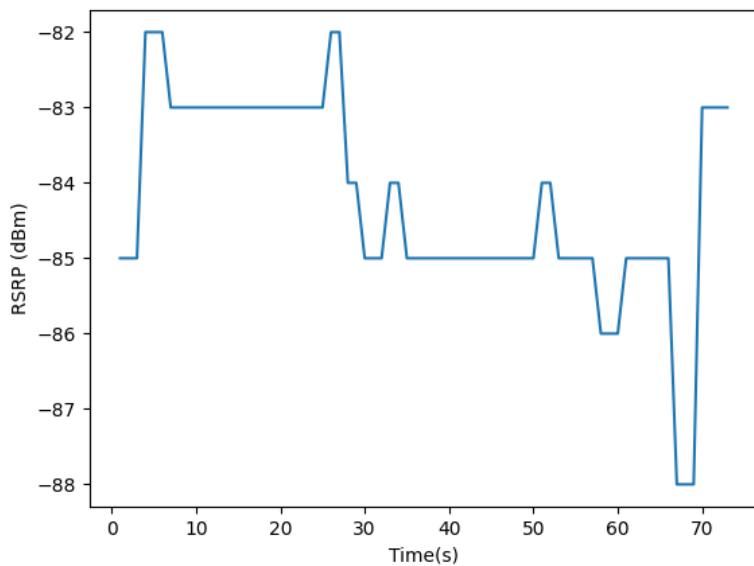


Figure 14: RSRP Variation at a Fixed Location