Project Experiment Report

As part of our ongoing project, we conducted additional field experiments to evaluate the positional accuracy of two mobile phones in an open outdoor environment. The tests were carried out at the basketball ground of Hall 6, IIT Kanpur — a location selected for its relatively open yet partially obstructed space. The area is surrounded by trees, buildings, street lights, and other infrastructure, making it suitable for analyzing how such environmental obstructions affect signal reception. This setup allowed us to assess how each device processes location signals when their paths are hindered by physical barriers in the surroundings.

This experiment aimed to assess how accurately and consistently the two devices determine their location when subjected to identical motion paths and timings in the same environmental conditions.

To provide better context of the test setup and surrounding conditions, we have attached the following resources

- A **Google Maps location link** marking the spot of the experiment
    1. Hall 6, IIT Kanpur
    2. Hockey ground, IIT Kanpur
- A series of **photographs** showcasing the field, surrounding buildings, and nearby infrastructure

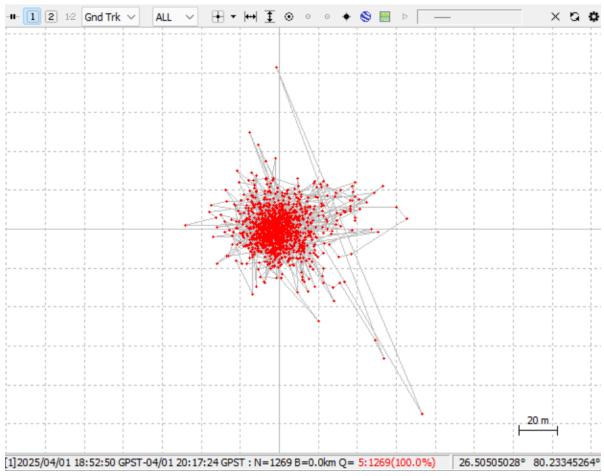
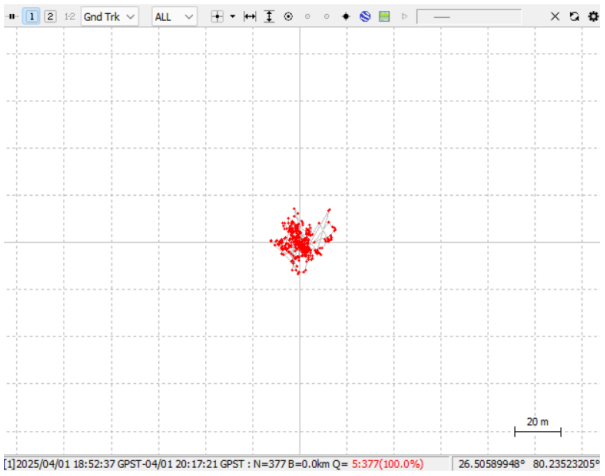
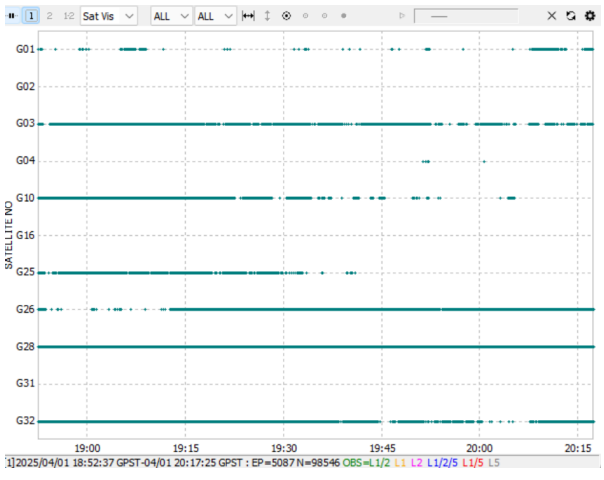
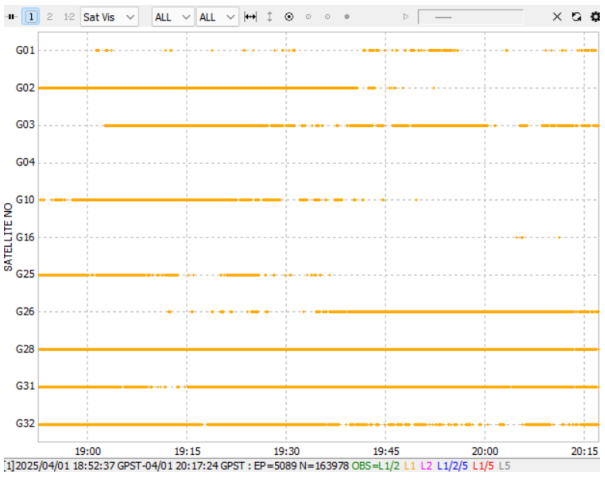
  HOCKEY GROUND

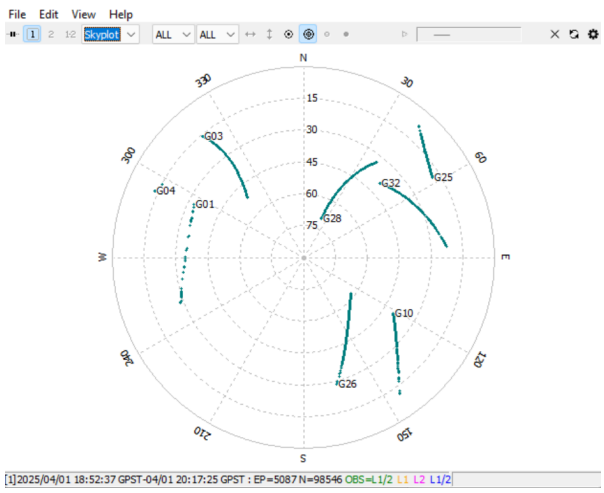
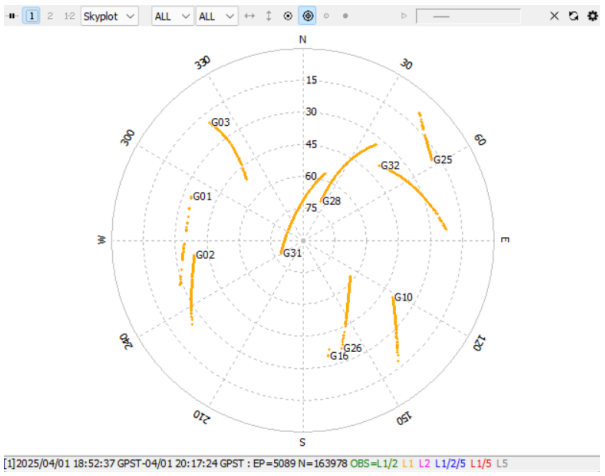
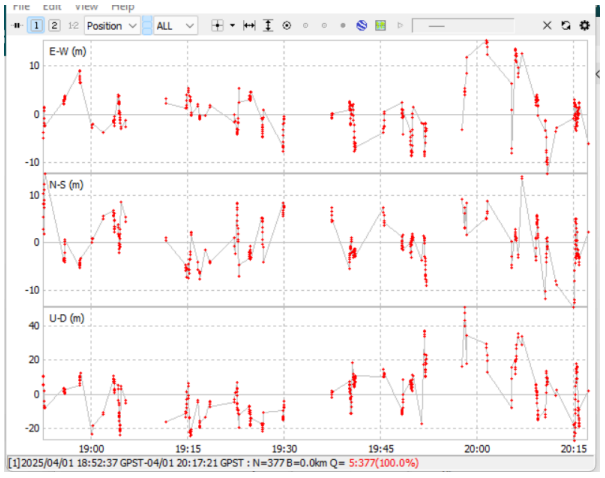
HALL 6 BASKETBALL COURT

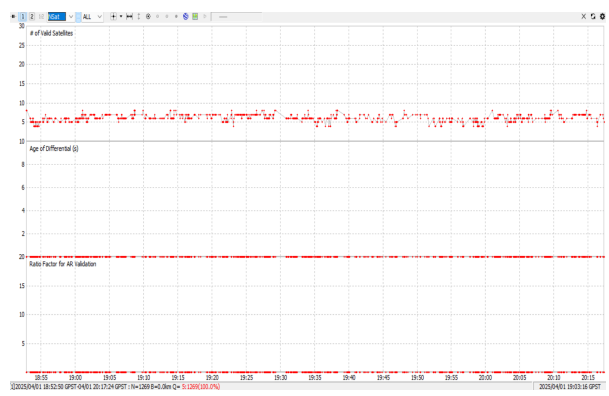
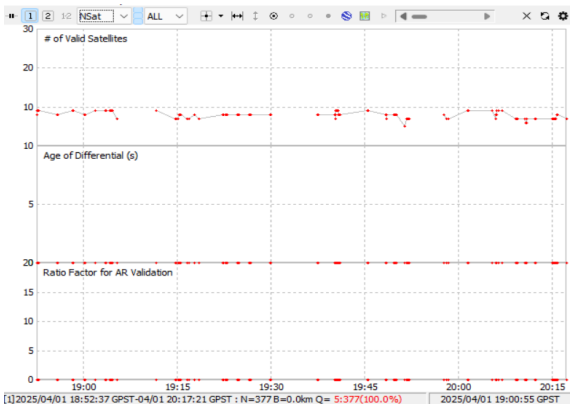
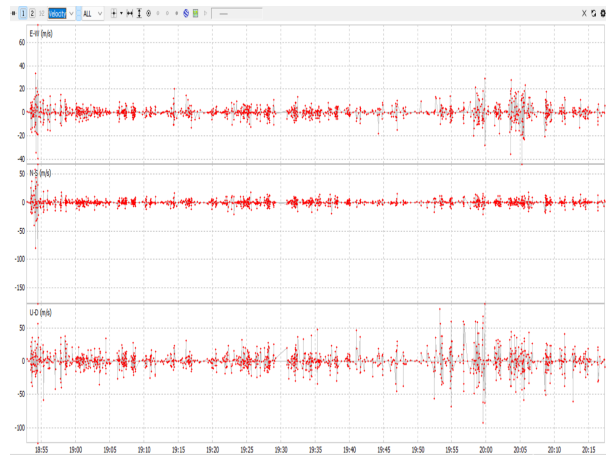
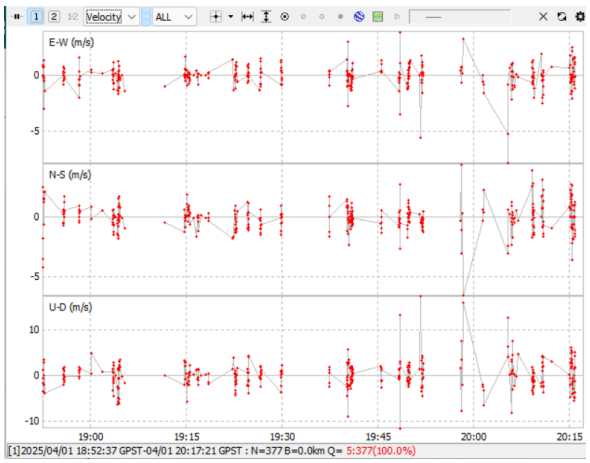
The following observations were made as follows:

- **Date:** 2nd April 2025
- **Location:**Hall 6, Indian Institute of Technology Kanpur
- **Start Time:** 00:22:37 IST
- **End Time:** 01:47:24 IST

- **Orientation:** Horizontal

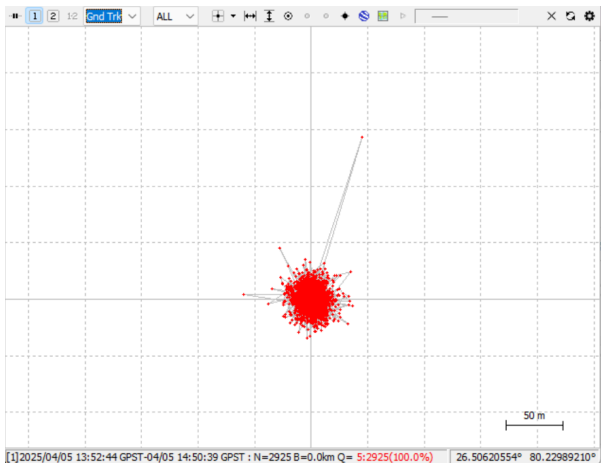
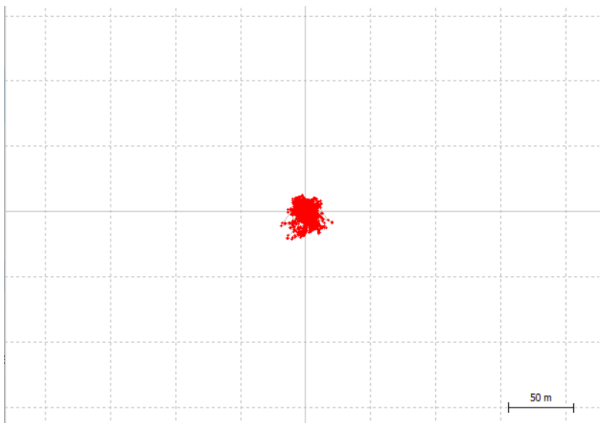
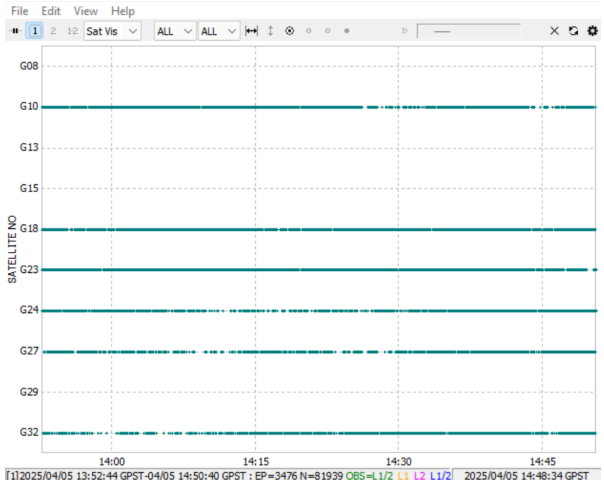
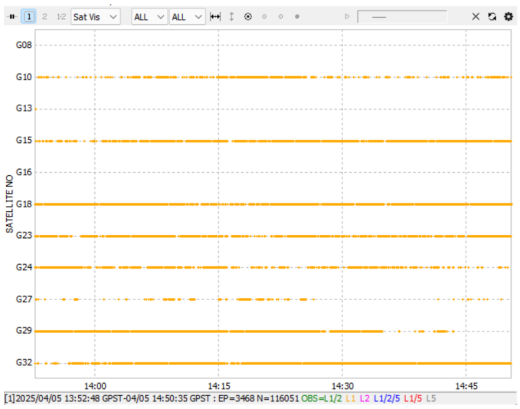
Samsung Galaxy S23 Ultra	Redmi12
	
Observation: The points are more scattered suggesting large and sudden position jumps. **Analysis:** This indicates unstable GPS signal reception.	**Observation:** The cluster is tightly packed, suggesting high positional accuracy and relatively good signal conditions. **Analysis:** The GPS receiver likely had a clear line of sight to multiple satellites, resulting in consistent and precise location data.
	
Observation: The satellite visibility is noticeably inconsistent. Exhibits frequent signal dropouts, with gaps in observation throughout the session.Tracks less number of satellites. **Analysis:** Inferior hardware (e.g., less sensitive	**Observation:** Shows significantly better satellite tracking performance. Most satellites are observed consistently over the entire duration, with minimal signal loss**.** Tracks more number of satellites. **Analysis:** Superior GPS receiver quality, better

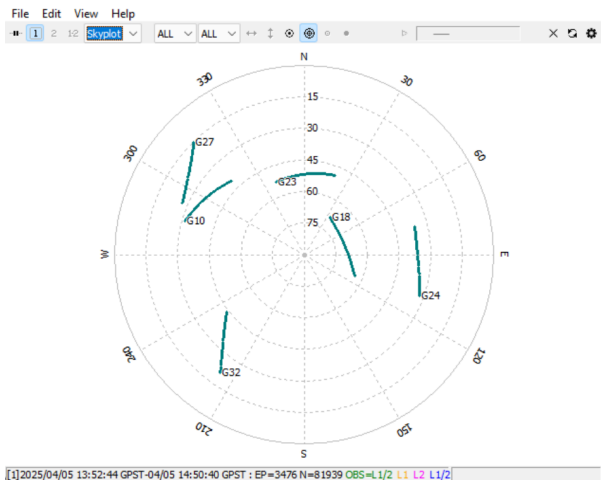
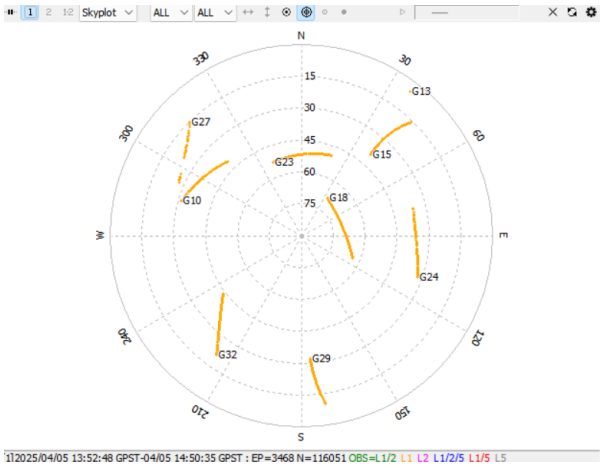
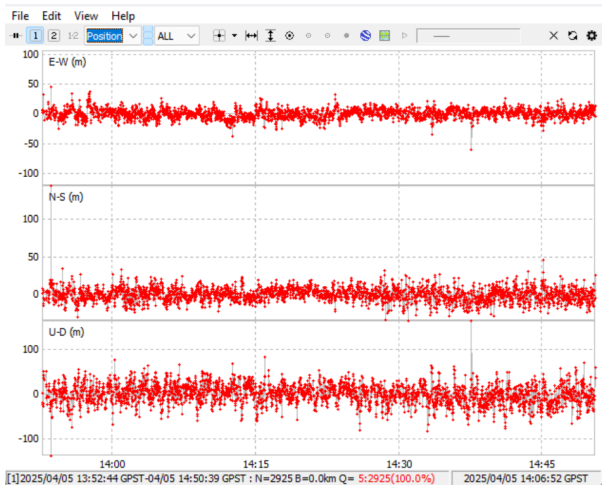
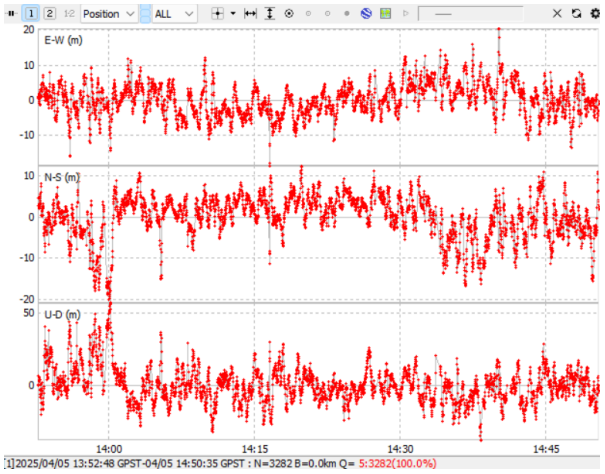
GPS antenna) Limited satellite visibility or struggled with multipath effects, causing erratic jumps in the location data**.**	satellite tracking (possibly more satellites with stronger signals), and more effective filtering of positional noise.
	
Observation: Total 8 number of satellites namely G01,G03,G04,G10,G25,G26,G28,G32. **Analysis:** Poor signal quality or unstable satellite connections. The absence of certain satellites (like G02, G16, G31) implies the phone might have been dealing with intermittent signal reception, inferior GPS processing due to difference in hardware.	**Observation:** Total 10 number of satellites namely G01,G02,G03,G10,G16,G25,G26,G28,G31,G32. **Analysis:** With access to 10 satellites—including additional ones like G02, G16, and G31—this phone benefited from better satellite geometry due to more optimized GPS algorithms within the device.
	
Observation: High variation and unstable signal during some time frame for example 19:50 to 20:05 and 18:30 to 18:55. **Analysis:** Struggles with positional stability, most likely due to a less capable GPS chipset and/or environmental interference.	**Observation:** Less variation in the position. Stable signals within the mentioned time frame. **Analysis:** Shows far superior GPS performance with smoother, more reliable position tracking.

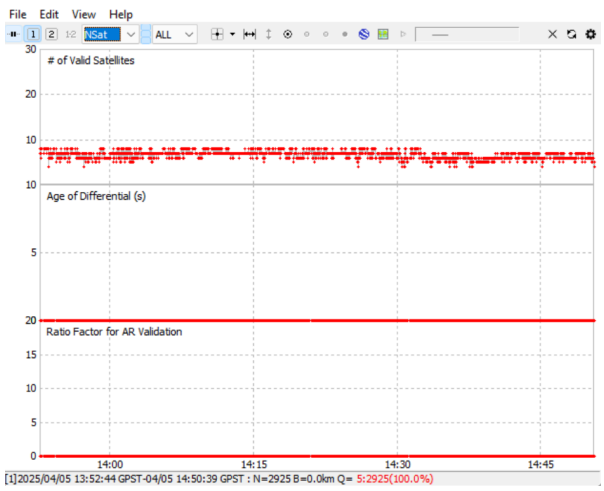
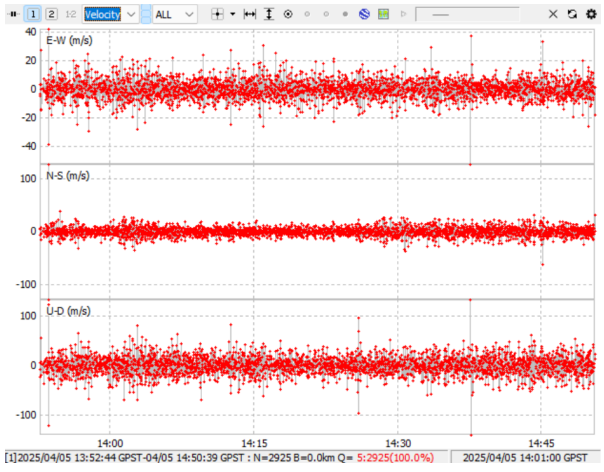
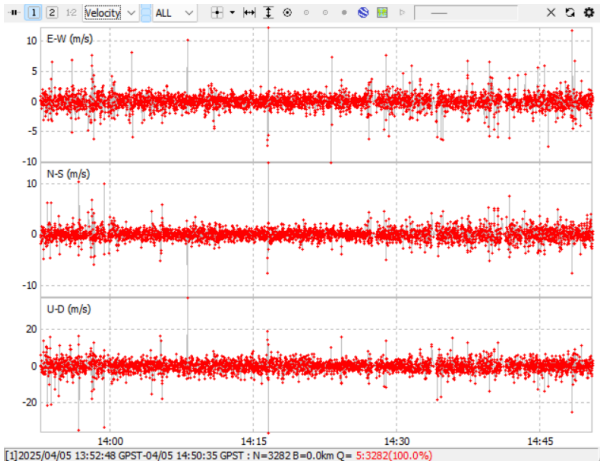
	
Observation: The number of valid satellites hovers between 6 and 8 with slight fluctuations throughout the duration. **Analysis:** The fluctuations indicate unstable satellite visibility, possibly due to device limitations or poor signal handling.	**Observation:** This phone consistently tracks 9 to 10 satellites, showing relatively stable satellite visibility. **Analysis:** Stable tracking across time indicates a stronger and more reliable GNSS receiver, likely with better antenna and signal processing.
	
There is more noise level , more scattering of points . This could be due to multipath effects or poor signal tracking .	There is lower visual noise level or less scattering of points .

- **Date:** 5th April 2025
- **Location:**Hockey Ground, Indian Institute of Technology Kanpur
- **Start Time:** 19:22:44 IST

- **End Time:** 20:20:39 IST
- **Orientation:** Horizontal

Samsung Galaxy S23 Ultra	Redmi12
	
Observation: The points are more scattered suggesting large and sudden position jumps. **Analysis:** This shows us that there is high deviation from actual position due to inferior chipset and hardware.	**Observation:** The cluster is tightly packed, suggesting high positional accuracy and relatively good signal conditions. **Analysis:** This indicates higher position stability and lower deviation from actual position mostly due to better chipset or hardware.
	
Observation: The satellite visibility is relatively better .Most satellites are observed consistently over the entire duration, with minimal signal loss**.**	**Observation:** Shows good satellite tracking performance **.** There is slight inconsistency in the satellite tracking. Tracks more number of

Tracks less number of satellites. **Analysis:** Signals are mostly consistent and regular but some satellites are missing suggests signal is stable here.	satellites. **Analysis:** Although it tracks more number of satellites, some signals are not clear suggesting unstable signal.
	
Observation: Total 6 number of satellites namely G10,G18,G23,G24,G27,G32. **Analysis:** G15 and G29 are missing. Poor signal quality or unstable satellite connections.	**Observation:** Total 8 number of satellites namely G10,G15,G18,G23,G24,G27,G29,G32. **Analysis:** None of the satellites from left are missing here. Better signal and stable satellite reception**.**
	
Observation: More variation in position of signal **Analysis:** Struggles with positional stability, most likely due to a less capable GPS chipset and/or environmental interference.	**Observation:** Less variation in the position. **Analysis:** Shows far superior GPS performance with smoother, more reliable position tracking.

	
Observation: The number of valid satellites hovers between 6 and 9 with relatively more fluctuations throughout the duration. **Analysis:** The fluctuations indicate unstable satellite visibility, possibly due to device limitations or poor signal handling.	**Observation:** This phone consistently tracks 9, showing relatively stable satellite visibility. **Analysis:** Stable tracking across time indicates a stronger and more reliable GNSS receiver, likely with better antenna and signal processing.
	
There is more noise level , more scattering of points . This could be due to multipath effects or poor signal tracking .	There is lower visual noise level or less scattering of points .

Conclusion:

- Conducted a comparative experiment to evaluate GNSS positioning accuracy using two smartphones: Redmi and Samsung.

- Collected satellite tracking data, signal visibility plots, and position logs over a consistent time period and location.

- Analyzed signal consistency, number of satellites tracked, and position fix stability using visualization tools.

Observations:

- The Redmi phone consistently tracked a higher number of satellites and showed stable position fixes throughout the observation period.

- The Samsung phone exhibited noticeable fluctuations in position accuracy.

- During a specific time frame, a sharp deviation in position was observed in the Samsung data, which corresponded to a drop in the number of tracked satellites.

Analysis:

- The drop in accuracy for the Samsung phone during that time frame could be due to:

    - Signal obstruction, possibly caused by nearby trees, light poles, or buildings, resulting in multipath effects or signal loss.

    - Temporary environmental interference affecting signal quality.

- A possible technical reason may be the difference in chipsets or GNSS antenna design:

    - Redmi may be using a more advanced GNSS chipset, capable of dual-frequency (L1/L5) tracking and multi-constellation support (GPS, GLONASS, Galileo, BeiDou), enhancing its accuracy.

    - Redmi devices are also known to use 3DMA GNSS algorithms and PPP (Precise Point Positioning) corrections in some models.

- The Samsung phone may have inferior GNSS hardware or fewer constellation supports, resulting in lower tracking reliability.

- However, these are possible explanations and not definitive, as we do not have exact hardware specifications or chipset-level data for both phones.

- Other factors like software-level optimizations, firmware limitations, or energy-saving settings could also have influenced the GNSS performance.