European Global Navigation Satellite Systems Agency

GNSS Positioning capability of Android based Smartphones: A Study

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Contents

- Android based Cellular phones with GNSS: potential as low-cost geolocation Tools in geospatial applications
- Android Apps with various levels of capabilities
- NMEA data quality of common Cellular phones
- GNSS raw data – indoor and outdoor solution quality- How this can help in the geospatial user community
- Applications and Future Scopes

Introduction

- Android based Cellular Mobile phones with GNSS sensors can be used for geolocation
- Can show instantaneous location and satellite information – snapshot location, fun, basic knowledge about GNSS
- NMEA data can be recorded
  - Can be used for location information collection at low cost within limited accuracy
  - Can be used by geospatial user community
  - Can be used GNSS researchers for basic information
  - Low cost geolocation sensors for crowdsourced data collection real-time
- Raw data can be collected
  - Can be used by GNSS research community.
  - Use by the geospatial community would enhance the userbase
  - For low-cost crowdsourced data collection to create robust GNSS environment related database
- **Enhancement of userbase and crowdsourcing needs sensitization, confidence on solution quality for the users, and ease of use**

Introduction

In this presentation, common/ mass-market, single frequency, low-cost (<120 Euros) Android phones are used to compare solution performances

- from direct NMEA output data
- from GNSS raw measurements

The aim is to enhance the confidence among **common geospatial user community** to use Android based handhelds (Cellular phones, to be more precise) for **training, small projects**: Enhanced userbase of available GNSS/ GNSS raw data

Android based Apps to collect GNSS data (Examples: Non-exhaustive)

LEVEL I: Can show the satellite information and Instantaneous position solution

GPS Essentials

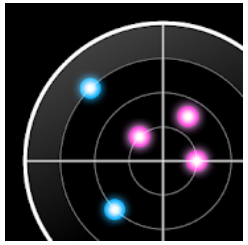
GPS Status and Toolbox

GPS Test

GPSTest

GPS Info

GPS Status



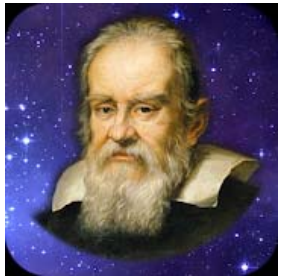
GNSS View

LEVEL II: Can record NMEA data for post processing

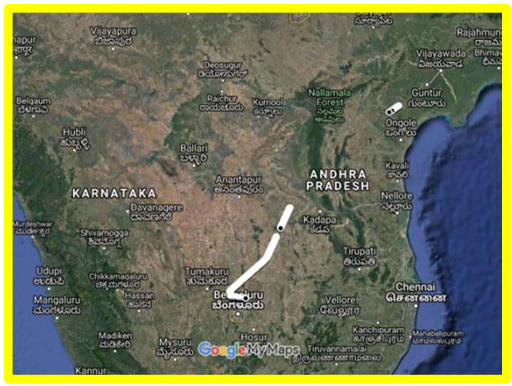
NMEA Tool

GNSSTool

GPS NMEA Tool



Galileo PVT



An example using my phone data collected through the Window of my flight to Bangaluru, App: NMEA Tool

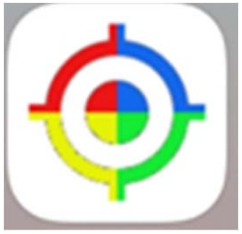
Android based Apps to collect GNSS data (Examples: Non-exhaustive)

LEVEL III: Can collect GNSS raw measurement for postprocessing

GNSS Compare

Geo++ RINEX Logger

rinex ON



GnssLogger

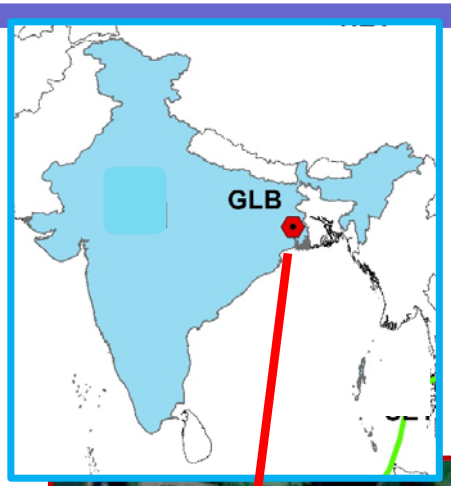
GNSS data recorder

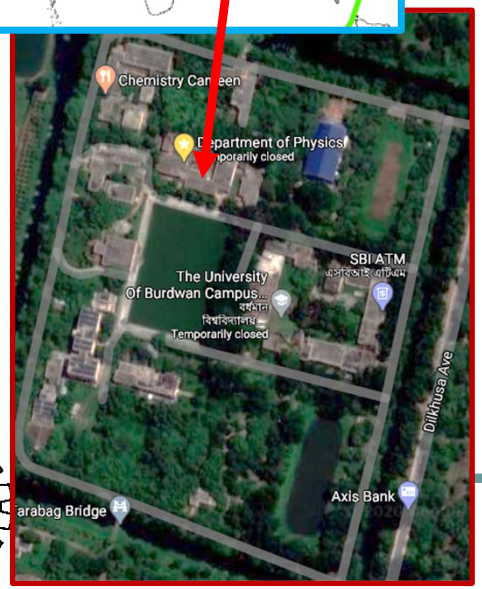
LEVEL IV: Can be used for RTK on the Mobile and enhanced location quality

RTK GPS+

Lefebure
NTRIP Client

Performance comparison of NMEA data from the Cellular Phones

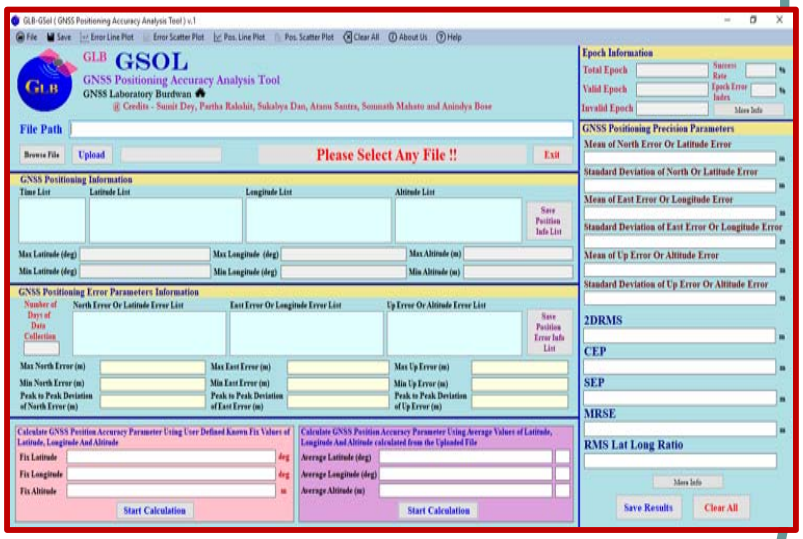




10 single frequency, mass-market phones from 6 manufacturers are used under open-sky, Network support- **OFF**

NMEA data

U-Center



GLB-GSOL software (Windows)

Performance comparison of NMEA data from the Cellular Phones

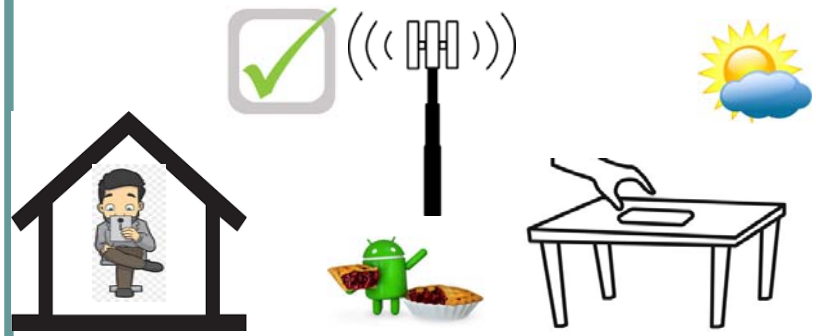
GNSS solution accuracy obtained from smartphones without network support (Cellular network "off", 30 min data); 06 July 2019* and 8 August 2019#								
Make- Model (Android Version)	Mode	Maximum Variation (m)			2DRMS (m)	CEP (m)	SEP (m)	MRSE (m)
		Latitude	Longitude	Altitude				
Xiaomi - NOTE 5* (9.0)	GPS+GAL + GLO	**0.315**	**0.102**	**4.400**	**0.152**	**0.060**	**0.447**	**0.780**
Xiaomi-A2* (9.0)	GPS+GAL + GLO	**0.591**	**0.505**	**1.400**	**0.454**	**0.190**	**0.378**	**0.479**
Xiaomi- NOTE 4* (7.0)	GPS+ GLO	3.467	4.663	9.000	1.481	0.619	1.309	1.690
VIVO-1601* (6.0)	GPS+ GLO	1.111	6.807	8.900	1.019	0.326	0.579	0.757
REALME- RMX1825* (9.0)	GPS+GLO + BDS	**10.186**	**16.677**	**19.200**	**8.494**	**3.285**	**5.978**	**7.397**
Xiaomi-NOTE 7# (9.0)	GPS+GLO+ GAL	0.8482	0.7539	0.2000	0.6328	0.2637	0.2678	0.3266
Xiaomi-5A# (7.1)	GPS+GLO	1.4760	0.8866	1.0000	0.9222	0.3813	0.4950	0.5674
Samsung-J600G# (9.0)	GPS+BDS+ QZSS+ GLO	**0.9371**	**0.8730**	**0.2000**	**0.8092**	**0.3379**	**0.3359**	**0.4140**
Asus -Z010D# (6.0)	GPS+BDS	1.3760	0.8594	2.00	1.0019	0.4130	0.6346	0.7454

HTC Desire, Android 4.4.4 shows no variation

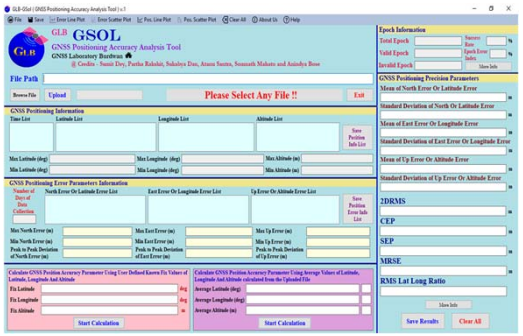
Performance comparison of NMEA data from the Cellular Phons

- For 5 phones from 3 manufacturers with Android version 9.0, 4 provides modest precision varying between less than 4 meters to sub-meter
- Provides Satellite geometry information and signal strength values for the interested users
- Shows the potentials and advantages of convenient and cost-effective use of the smartphones for collection of position data
- Users do not need to incur any cost for the hardware and free or low-cost Android App are easily available for data collection.
- This may support the geospatial community and use of multiple devices for concurrent data collection
- Collected data can be sent over the network for remote processing
- Selection of smartphone (Make, Model) and the Android version is important

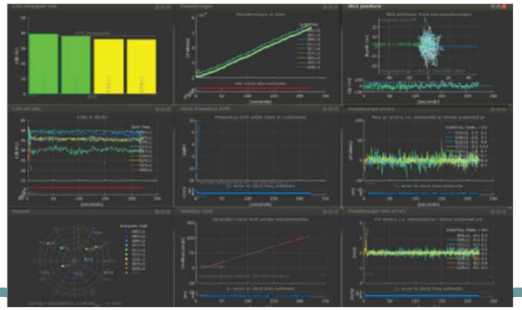
Comparison of solution: NMEA and raw data



- GNSS NMEA data and raw data are collected in Indoor and Outdoor (Open sky) environments
- Network Location support -> ON



GLB-GSOL

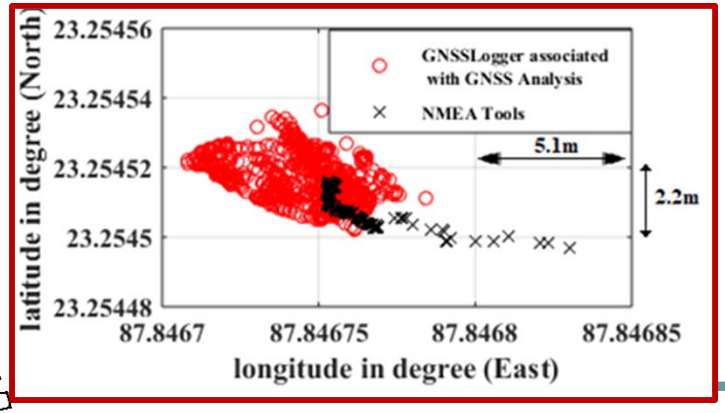


GNSS Analysis v2.6.3.0

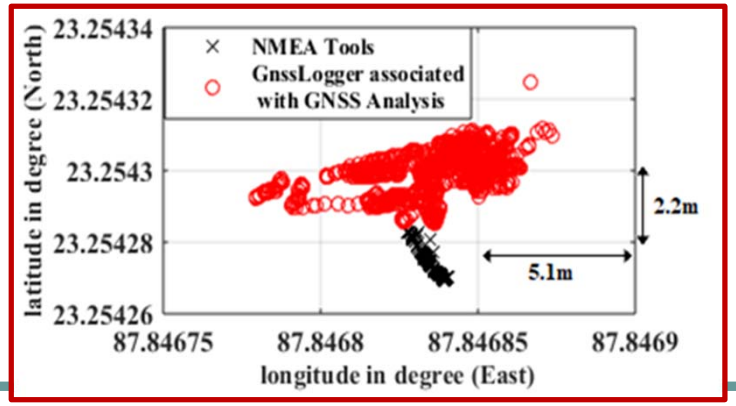
Xiaomi Note 5 Pro
(Android 9.0)

Comparison of solution: NMEA and raw data

Comparison of precision level of GNSS solution obtained using Android apps 'NMEA Tools' and 'GNSS Logger' Static; Device used: Xiaomi MI Note 5 Pro with Android version 9.0								
App Name and Environment		**Maximum Variation (m) in Lat.**	**Maximum Variation (m) in Long.**	**Maximum Variation (m) in Alt.**	**2DRMS (m)**	**CEP (m)**	**SEP (m)**	**MRSE (m)**
NMEA Tools	**Indoor**	5.2875	15.8087	15.700	3.862	1.751	2.891	3.5518
GNSS Logger with GNSS Analysis		19.753	11.398	47.000	8.335	3.473	6.997	8.9039
NMEA Tools	**Outdoor (Open Sky)**	3.799	2.614	5.500	2.1892	0.906	1.543	1.861
GNSS Logger with GNSS Analysis		10.929	19.267	31.000	7.851	3.023	5.726	7.176



Indoor

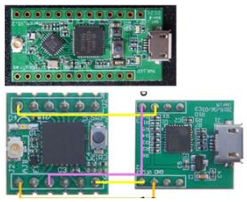
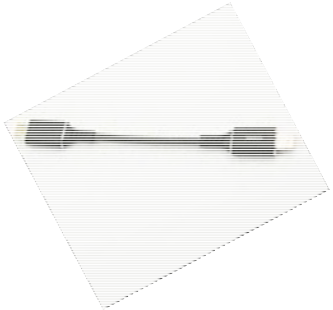
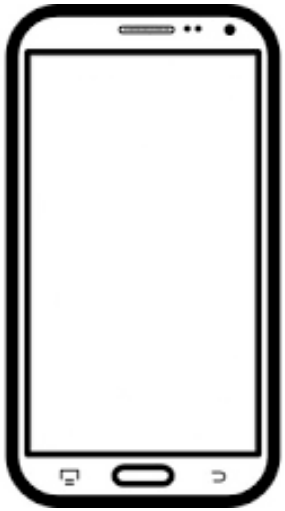


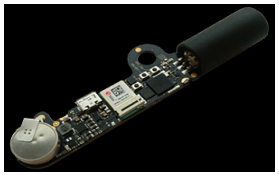
Outdoor

Comparison of solution: NMEA and raw data

- 2DRMS value for the outdoor environment remain around 2m and for the indoor environment within 4m. For the raw data, the 2DRMS values are less than 10m for both the cases,
- Outdoor environment provides slightly better solution quality.
- 3-dimensioanl precision in terms of CEP also follow similar trend.
- The better solution quality for NMEA data may be attributed to the preloaded almanac and AGPS in case of NMEA Tools Pro, generally helping in improved solution.
- The other parameters obtained from the raw data would be useful for GNSS researchers including understanding the GNSS use environment.

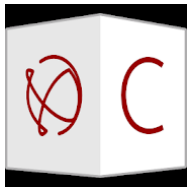
Level V Android based Apps to collect GNSS NMEA data over Bluetooth or USB




Serial USB Terminal

U-Droid Center


PPM Commander


GNSS Surveyor


Bluetooth GPS


GPS 2 Bluetooth

- Compact GNSS modules can be connected to the Cellular phones using Bluetooth or USB for NMEA/ raw data collection
- Low-cost solution using the multi-GNSS GNSS modules for location data collection
- Data can be sent from the field using cellular network
- Ideal for Geospatial applications

Applications and Future Scopes

Application Areas:

- Geospatial students and researchers
- Common people interested to get continuous location data
- Geolocation in case of Emergency; COVID19 situation management may be an example

Future Scopes:

- Training on use of GNSS NMEA data and raw data
- GNSS Analysis version 3.03.0 and 4.0.0.0, when released
- Trials with Android 10 and 11
- Trials with dual frequency phones (Xiaomi K20 Pro/ M8)
- Using NavIC-enabled smartphones (Announced Q2 2020, delayed)

- **Would enhance GNSS userbase,**
- **Would enhance GNSS raw measurement users – from research to real-life applications**
- **Would help in understanding Galileo differentiators**

- **Standardization of Apps and Devices**

THANK YOU

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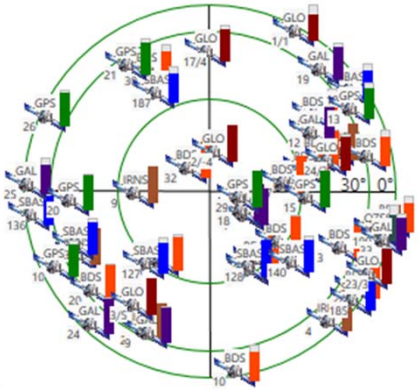
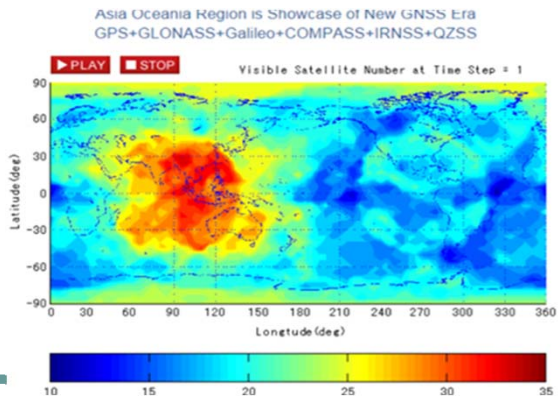
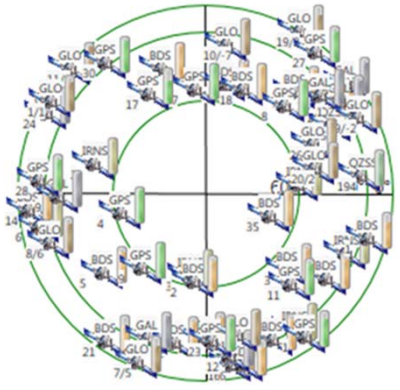
http://bugnss.in



Typical skyplot for Western India
(23 June, 2019: 18:11 hrs IST)
54 satellites in view, 45 used
GNSS receiver screenshot



Simulated Multi-GNSS visibility prediction
(Multi-GNSS Asia- MGA)



Typical skyplot for Eastern India
(04 March, 2019: 15:00 hrs IST)
54 satellites in view
GNSS receiver screenshot