TEST YOUR SATELLITE NAVIGATION PERFORMANCE ON YOUR ANDROID DEVICE

GLOSSARY

European Global Navigation Satellite Systems Agency

GALILEO

THE GLOSSARY

This glossary aims to clarify and explain the acronyms used in GNSS and satellite navigation performance testing on Android devices. It is based on the results combining the app GPSTest©, with Android 7, using a Huawei P10.

While the authors have tried to make the glossary as accurate and comprehensive as possible, it will always be a "work in progress."

The glossary will try to keep up with global satellite navigation evolutions, as well as its new features and applications, should you find missing elements do get in touch with market@gsa.europa.eu.

IS YOUR SMARTPHONE USING GALILEO?

An up to date list of devices using Galileo, the European Global Navigation satellite System (GNSS), can be found on www.UseGalileo.eu.

To test whether your phone uses Galileo download GPSTest application available for Android https://play.google.com/store/apps/details?id=com.android.gpstest and follow the instruction contained in this document.

Once the app is installed, enable the location and launch the app. In a matter of seconds you should be able to see the available satellites providing you positioning data. Most likely your phone use several GNSS for positioning (such as the American GPS, the Russian Glonass, or the Chinese Beidou), if you phone is using also Galileo you should be able to see the Galileo logo (Fig.1 blue flags).

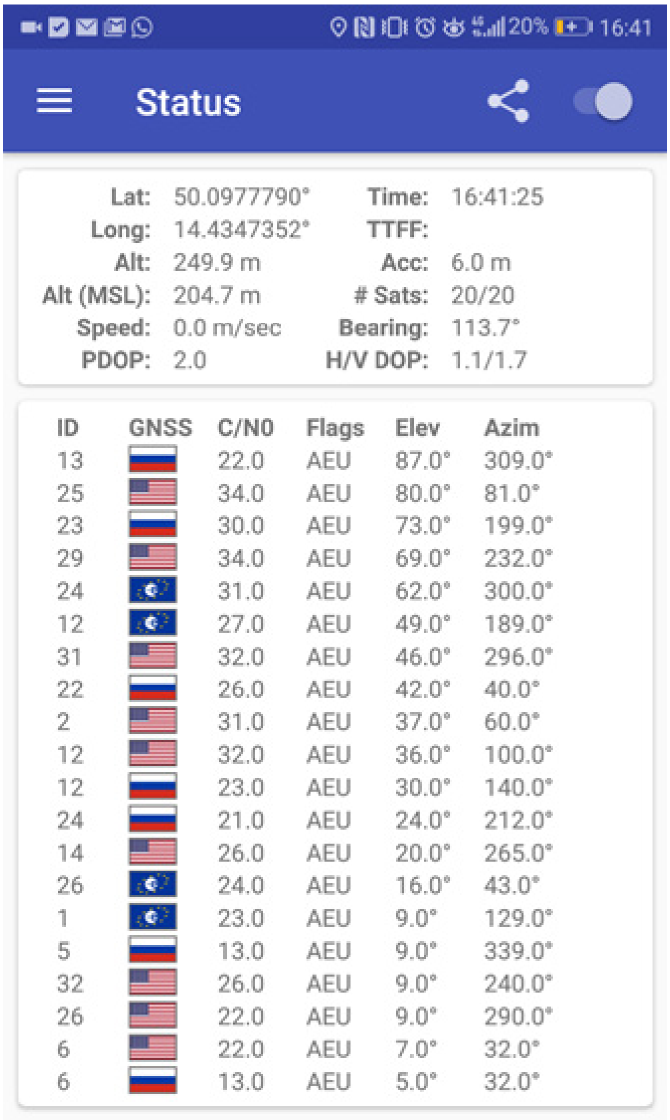

Figure 1 Android device displaying current GNSS status, using GPSTest app

Lat: Indicates the current Latitude of the GNSS receiver, a geographic coordinate that specifies the north–south position of a point on the Earth's surface respect to the equator line.

Long: Indicates the current Longitude of the GNSS receiver, a geographic coordinate that specifies the east-west position of a point on the Earth's surface respect to the prime meridian (Greenwich).

Alt: Indicates the geographical altitude in meters. The GNSS definition of altitude does not refer to the mean sea level, but rather to a gravitational surface called the WGS 84 reference ellipsoid (used to represent the geometric model of the earth). There is a significant difference between this mathematical model and the real object.

Alt (MSL)*: Indicates the altitude with respect to the mean sea level (MSL). As most users expect accurate altitude readings related to MSL, GNSS receivers perform internal calculations based on a combination of formulas, tables, and matrices that use geographic coordinates as inputs to estimate the height with respect to the mean sea level.

 # Sats: Indicates the number of satellites being used in the position solution/ and the total number of satellites in view. Many reasons can lead the receiver to not to consider an in view satellite for the position solution. The most common ones are: bad health (satellite is flagged as bad health in ephemeris or almanac), old ephemeris or no ephemeris available, elevation error (satellite is below the elevation cutoff mask) and low power (satellite has low signal power).

PDOP* : Position Dilution of Precision is a parameter used to describe the strength of the current satellite configuration, or geometry, and its impact on the accuracy of the data collected by a GNSS receiver at the time of use (measure of accuracy in 3-D position). Low PDOP values, in the range of 4.0 or less, indicate good satellite geometry, whereas a PDOP greater than 7.0 indicates that satellite geometry is weak and therefore the user shouldn't rely on the accuracy of that data and should wait until a better PDOP value could be attained by the satellites moving into preferable positioning in the sky.

H/V DOP*: Horizontal Dilution of Precision (HDOP) and Vertical Dilution of Precision (VDOP) are parameters used to describe the strength of the current satellite configuration, or geometry, and it's impact on the accuracy of the data collected by a GNSS receiver at the time of use. HDOP provides a measure of accuracy in 2-D position (e.g. Latitude and Longitude) while VDOP is a measure of accuracy in 1-D position (height). Note that $PDOP^2=HDOP^2+VDOP^2$. HDOP values are typically between 1 and 2. VDOP values are larger than the HDOP indicating that vertical position errors are larger than horizontal errors.

(*) Alt (MSL)", "PDOP", and "H/V DOP" are all derived from NMEA messages from an optional Android API, therefore some Android devices may not supply this data.

Time: Indicates the current local time read from the GNSS. Each satellite has an atomic clock synchronized to UTC time and broadcasts this information – along with the position of the satellite (almanac and ephemeris data) – on the radio signal. The receiver combining this information with its position calculates the local time.

TTFF: The Time To First Fix (TTFF) is a measure of performance of a GNSS receiver and accounts for the time in seconds elapsed from the GNSS receiver switch-on until the output of a position solution (called a fix). In order to compute a navigation solution, the GNSS receiver needs to track the incoming signals of at least four satellites to get ranging information and to decode the navigation message conveyed in the signal. The main drivers for the TTFF performance are the receiver processing capabilities and the signal availability.

Acc: Indicates the user accuracy which refers to how close the device calculated position is from the device's actual position, expressed as a radius in meters. The device's actual position is unknown so this value is an estimate at the 68% confidence level. For example, if Acc is 10 meters, and you draw a circle surrounding the calculated position with a radius of 10 meters, then there is a 68% probability that the actual device position is inside this circle. User accuracy depends on a combination of satellite geometry, signal User Range Error (URE), and local factors such as signal blockage, atmospheric conditions, and receiver design features/quality. GNSS-enabled smartphones are typically accurate to within a 5 m radius under open sky. However, their accuracy worsens near obstacles (e.g. buildings and trees) due to signal attenuation and multipath.

Speed: Indicates the current speed of the GNSS receiver in m/sec. The receiver estimates velocity either by differencing two consecutive positions or by using Doppler measurements related to user satellite motion.

Bearing: The bearing to a point is the angle measured in a clockwise direction from the north line. It is expressed in degrees from 0 to 359. In this application it indicates the horizontal direction of movement of the device.

ID: The satellite ID number identifies a particular satellite within a given constellation. GPS satellite ID numbers range from 1 to 32, Galileo satellites from 1 to 36, GLONASS satellites from 1 to 24 and Beidou satellites from 1 to 37. Satellite-based augmentation system (SBAS) IDs will be in the range of 120-151 or 183-192. On Android 6.0 Marshmallow and below, this column will be displayed as "PRN", which is the pseudorandom noise identifier of each satellite. Because GPS was the only GNSS constellation officially supported on Android 6.0 and below, satellites from other constellations (e.g., GLONASS) may be displayed with a PRN value as well.

GNSS: Indicates the satellite's constellation. Today there are four global constellations: GPS NAVSTAR (American flag), Galileo (EU flag), GLONASS (Russian flag) and Beidou (Chinese flag). Regional satellite-based augmentation systems (SBAS) are also shown in the app, including QZSS (Japanese flag), GAGAN (Indian flag), ANIK F1 (Canadian flag), Galaxy 15 (American flag), Inmarsat 3-F2 and 4-F3 (United Kingdom flag), SES-5 (Luxembourg flag), and Astra 5B (Luxembourg flag)".

CF: The carrier frequency of the signal (e.g., L1, L5). This is the radio frequency on which the information from a satellite is encoded.

C/N0: The carrier-to-noise density is a measure of the signal strength transmitted by the given satellite. It is expressed in decibel-Hertz (dB-Hz) and refers to the ratio of the carrier power and the noise power per unit bandwidth. The greater the signal strength is, the more stable the reception status is. Whereas the reception status would become unstable when the GNSS signal became weaker, due to obstacles or noise sources in the vicinity of the GNSS receiver. Expected C/N0 range is 10 dB-Hz to 45 dB-Hz. On Android 6.0 Marshmallow and below, this column will be displayed as "SNR", which is the signal-to-noise ratio.

Elev: Indicates the satellite's elevation on the sky in degrees, between 0 and 90.

Azim: Indicates the satellite's azimuth on the sky in degrees, between 0 and 359.

Flags: Indicates the different data acquired from the given satellite. "E"-flag: the GNSS engine has the ephemeris data for the satellite, the "A"-flag: the GNSS engine has almanac data for the satellite, and the "U"-flag: the satellite was used by the GNSS engine when calculating the most recent position fix.

H/V Acc: The horizontal and vertical accuracy of the location, both at the 68% confidence. Horizontal accuracy is defined the same as Acc field above. Vertical accuracy is available on Android 8.0 Oreo and higher. Vertical accuracy example- if Alt is 150, and V Acc is 20 then there is a 68% probability of the true altitude being between 130 and 170 meters.

S. Acc: Estimated speed accuracy of this location at 68% confidence, in meters per second. For example, if Speed is 5, and Speed Acc is 1, then there is a 68% probability of the true speed being between 4 and 6 meters per second.

B. Acc: Estimated bearing accuracy of this location at 68% confidence, in degrees. For example, if Bearing is 60, and Bearing Acc is 10, then there is a 68% probability of the true bearing being between 50 and 70 degrees.

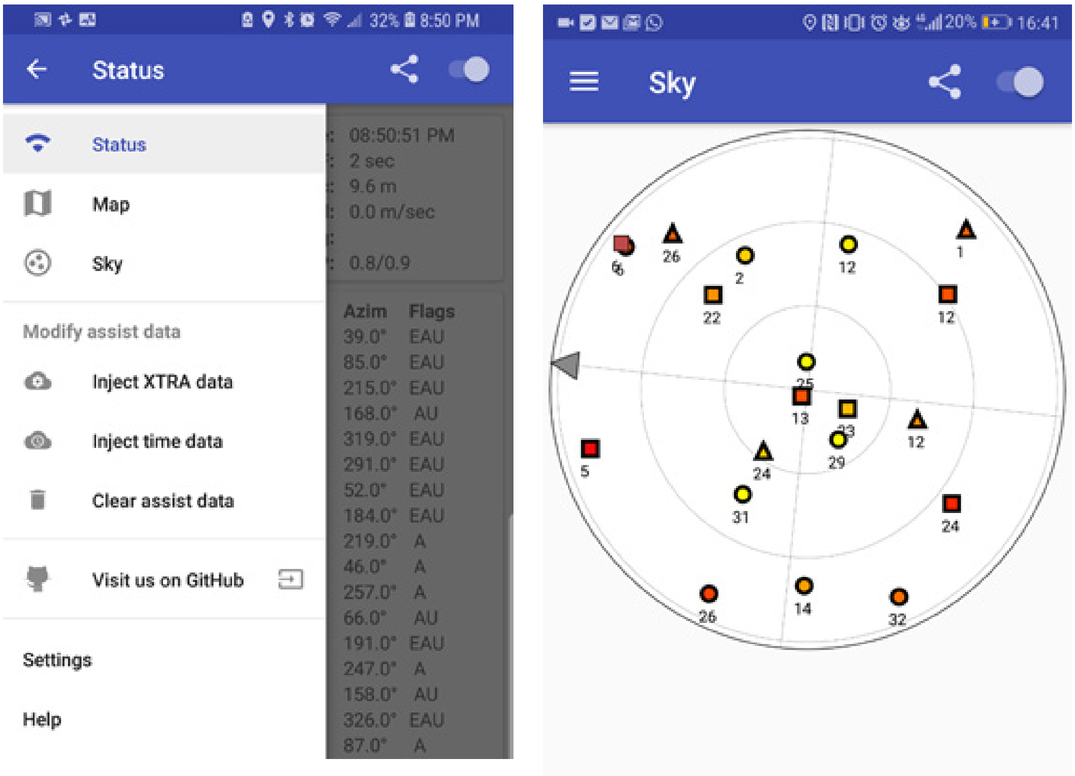

Figure 2 GNSS status, SKY view using GPSTest app

Inject XTRA data: Injects XTRA assistance data for GPS into the receiver, using information from a XTRA server (XTRA files are the current GPS Almanac). A-GPS aquired almanacs provide information about the location of satellites using the cellular network or Wi-Fi so the information does not need to be downloaded by satellite, enabling a faster fix. This command may not be supported on all devices.

Inject time data: Injects time assistance data for GPS into the receiver, using information from a Network Time Protocol (NTP) server. A-GPS aquired time reference can be used to restrict the search range for the relative code phases of the satellite signals enabling a faster fix.

Clear assist data: Clears all assistance data used for GPS, including NTP and XTRA data. This command may not be supported on all devices.

Settings: Change light or dark theme, map tile type, auto-start GPS on startup, minimum time and distance between GPS updates, keep screen on. Settings also includes options for logging NMEA messages, navigation messages, or raw measurement data –

for details please see https://github.com/barbeau/gpstest/blob/master/LOGGING.md.

GALILEO: THE EUROPEAN GLOBAL NAVIGATION SATELLITE SYSTEM (GNSS)

With 18 satellites already operational, and moving closer to full constellation, Galileo the European Global Navigation satellite System (GNSS), is already providing location data for mobile devices, including smartphones.
Galileo in combination with other GNSS offers new opportunities for location based services, providing high reliability and improved accuracy.
Galileo is the state-of-the-art GNSS of the European Union, under civilian control. It provides improved positioning, navigation and timing information everywhere in the world, with significant positive implications for many European services and users.

Its development follows a stepwise approach, in line with the launch of Galileo satellites:

• Initial Services were declared operational in December 2016. Thanks to a constellation of 18 satellites, Galileo enhances the accuracy of the position computed by multi-constellation receivers and supports Search and Rescue operations.

• Full Operational Capability is scheduled for 2020, when the satellite constellation will be complete and the range of services fully provided.

Thanks to its unique features and innovative technology, it aims to assist an extremely broad range of users in different market segments including transport, mass-market and professional services.

GNSS RAW MEASUREMENTS ON ANDROID DEVICES: TOWARDS BETTER LOCATION PERFORMANCE IN MASS MARKET APPLICATIONS

In May 2016, Google announced the availability of GNSS raw measurements from Android 7+. For the first time, developers could access carrier and code measurements and decoded navigation messages from mass-market devices.

There are several advantages to using GNSS raw measurements in smartphones and IoT devices. Use of these measurements can lead to increased GNSS performance, as they open the door to more advanced GNSS processing techniques that, until recently, have been restricted to more professional GNSS receivers.

Several application areas stand to profit from this increased accuracy, such as augmented reality, location-based advertising, mobile health and asset management. The raw measurements also make it possible to optimise multi-GNSS solutions and to select satellites or constellations based on their performances or differentiators.

To learn more download the White Paper Using GNSS Raw Measurements on Android Devices or visit https://www.gsa.europa.eu/gnss-raw-measurements-task-force

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