Location based services with GPS, GLONASS, Galileo and OTDOA

Checking the weather forecast during breakfast or finding your way in rush hour traffic – just two examples of apps that allow smartphone users to benefit from location based services (LBS). How do these useful helpers manage to find the phone's exact position so quickly? This article gives you a behind the scenes look at positioning for location based services. It also outlines the comprehensive range of Rohde&Schwarz test systems which ensure that all components used in positioning work together seamlessly.

Positioning using terrestrial methods: cell ID, enhanced cell ID, OTDOA

There are different methods for determining the position of a mobile phone. The simplest way is to detect the cell ID; however, this method delivers relatively inaccurate information. Better results are achieved with the enhanced cell ID method. In addition, it takes signal parameters into account, for example the reference signal received power and quality (RSRP and RSRQ), which makes it accurate within approximately one hundred meters. In the future, observed time difference of arrival (OTDOA) will provide even more accurate results. This method is used by the LTE wireless communications standard and is based on the delay differences between signals emitted by several LTE base stations.

The conventional satellite-based method: A-GPS

Significantly better results are obtained by using GPS signals, increasing accuracy to within a few meters. However, there is one serious disadvantage to using GPS alone: If a GPS module is not used for a longer period of time, it will typically take up to 50 seconds before the position is displayed. This is due to the GPS signal's low data rate of 50 bit/s that is used to transmit navigation information (satellite paths and correction data). The waiting time can be reduced by using assisted GPS (A-GPS). With this method, the GPS receiver uses additional information delivered by the wireless communications network. This information is referred to as assistance data and includes navigation and other information. The information is delivered quickly, as the location server transmits it through the network in a matter of seconds.

An overview in the labyrinth of protocols

Communications between the mobile phone and the location server can take place in two ways: either via control message (C-plane, similar to SMS) or through IP packets together with other user data (U-plane), see Fig. 1. To date, a new location protocol has been defined for each major wireless communications standard: RRLP, RRC, TIA-801 and LPP. In spite of the variety: All protocols transmit basically similar assistance data. Fig. 2 shows the possible combinations of protocols and wireless communications standards for the C-plane and U-plane. If communications take place via the U-plane, the location protocols are additionally packaged into the secure user plane protocol (SUPL), which takes care of encrypting and authenticating sensitive position data.

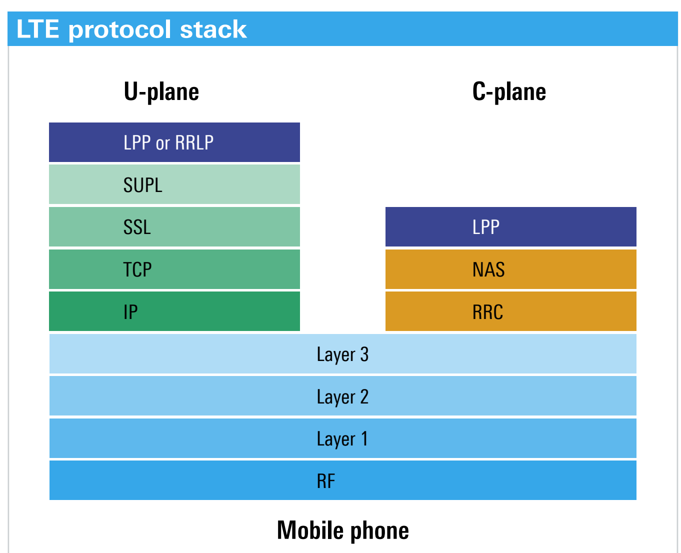


Fig. 1 Communications between mobile phone and location server: LTE protocol stack for U-plane and C-plane.

	GSM	WCDMA	LTE	CDMA2000®
C-plane	RRLP	RRC	LPP	TIA-801
U-plane	RRLP	RRLP	RRLP / LPP	TIA-801

Fig. 2 Possible combinations of wireless communications standards and location protocols. With U-plane transmission, theoretically every location protocol can be sent using every wireless communications standard. The table shows only combinations that are actually used.

System combination for higher accuracy – hybrid positioning

In the meantime, GPS has competition: The Russian GLONASS system is completely functional worldwide since October 2011, and the European Galileo system has four satellites in orbit since October 2012. China has also entered the race with its Beidou system. The assistance data used in the global navigation satellite systems (GNSS) – the generic term for all satellite navigation systems – differ significantly from each other (Fig. 3). This made expansions for all location protocols and for the SUPL protocol necessary.

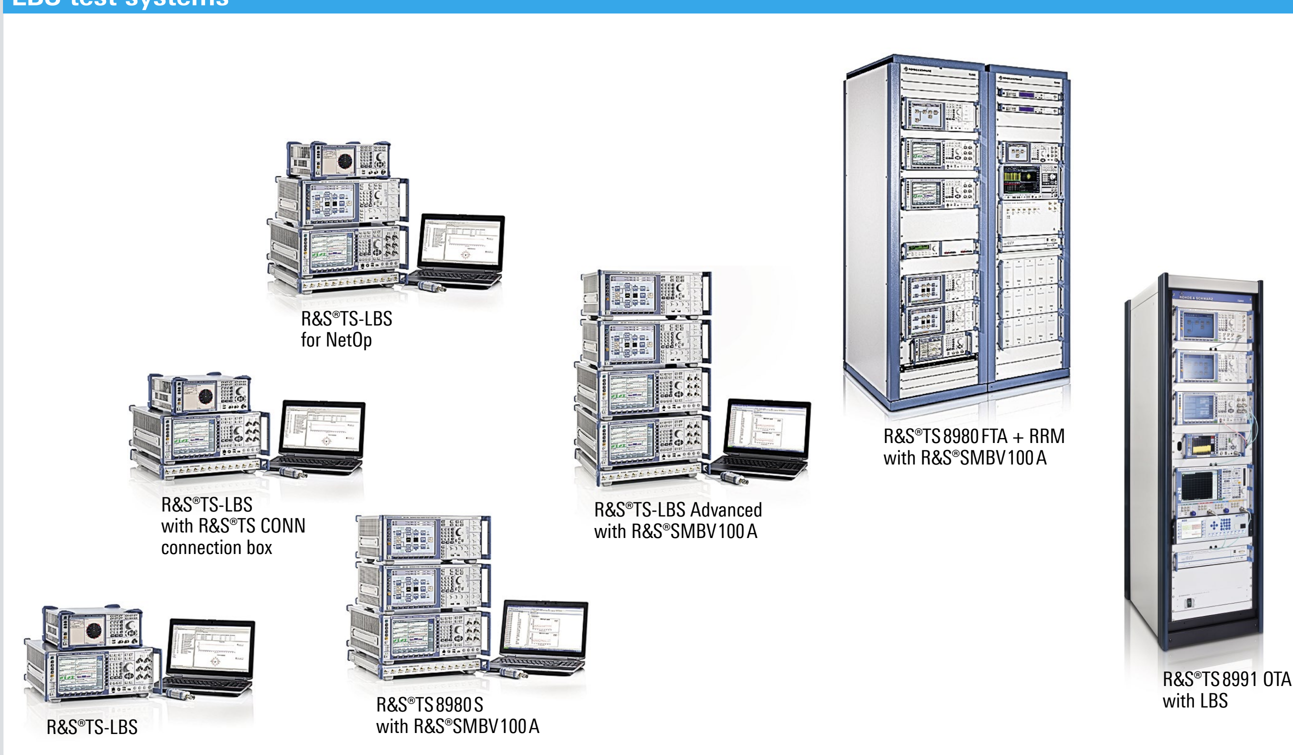
By combining data from different satellite systems and OTDOA it is possible to more accurately calculate a position than with one system alone. Especially in street canyons, where receivers made for only one system have failed,

A comprehensive program: Rohde&Schwarz test systems

Numerous tests examine the performance of terminals with respect to A-GNSS and network based methods (OTDOA / enhanced cell ID), also while simulating extreme conditions. Over-the-air (OTA) measurements verify if a terminal offers adequate sensitivity in any spatial orientation. The minimum performance measurement checks the accuracy and duration of the positioning operation. The complex message flow can be checked using protocol conformance tests. Rohde&Schwarz offers the appropriate test systems for all of these applications. They support C-plane as well as U-plane communications and cover all important wireless communications standards (GSM, WCDMA, LTE and, in the near future, CDMA2000®) with the R&S®CMW500 wideband radio communication tester as a network simulator. All A-GNSS tests can be performed using an R&S®SMBV100A vector signal generator with the appropriate options.

The test hardware can be configured on a modular basis to meet particular requirements: from a compact minimal setup (consisting of an R&S®CMW500, an R&S®SMBV100A and a controller) and OTA performance test systems to the R&S®TS8980FTA test system with integrated radio resource management (RRM) testing and simulation of multiple OTDOA cells as well as fading simulation. The test system can be integrated into the user-friendly R&S®CONTEST software platform to perform automated test sequences.

LBS test systems



Equipment for every type of requirement: test systems for terminals which use A-GNSS and network based methods.

Assistance data: GPS versus GLONASS

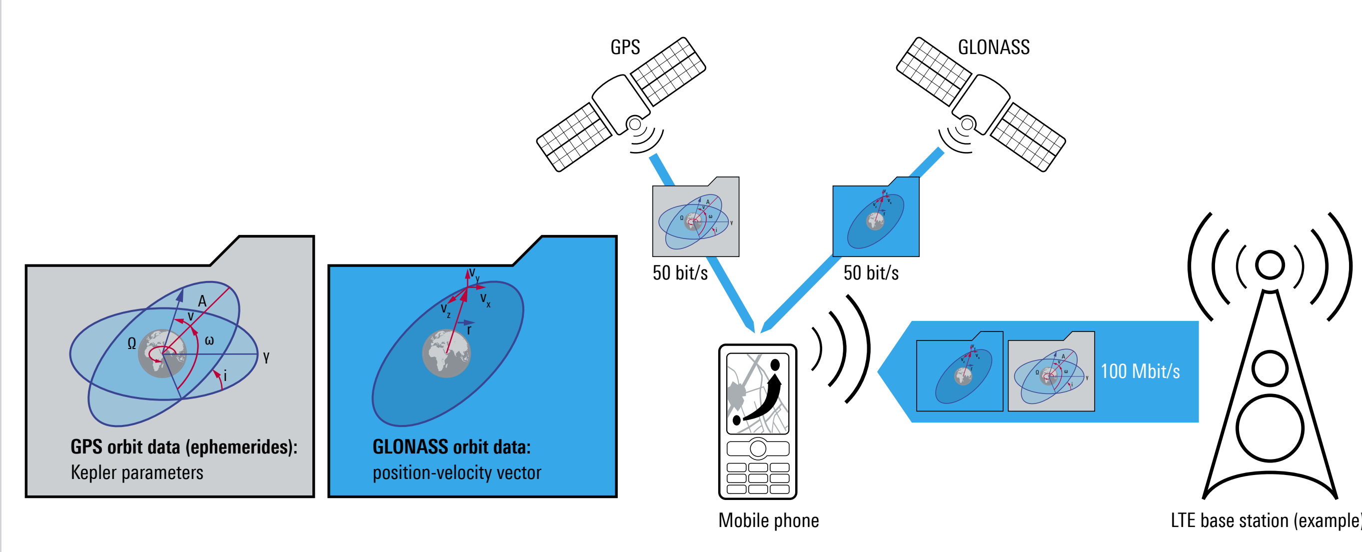


Fig. 3 GPS and GLONASS have very different assistance data. For A-GPS and A-GLONASS, assistance data is transmitted via the wireless communications network within seconds instead of using a slow satellite connection.

it is still possible to determine the position by using several systems. If necessary, the complex hybrid position calculation can be transferred from the mobile phone to the network since the phone is connected to the network provider's location server.

To the rescue: emergency procedures in SUPL 2.0

Not only does the expansion to SUPL 2.0 support the new GNSS as well as LTE; completely new functions for U-plane communications were also added. For example, emergency procedures make it possible to automatically and reliably transmit a caller's position to rescue teams in case of an emergency (Fig. 4). Also, the new geofencing function can transmit a message from the mobile phone to an authorized partner station when someone enters or leaves a defined area (Fig. 5).

Summary

The development and use of location based services is still in its early stage. This field is certain to produce new ideas and applications in the coming years. Rohde&Schwarz can provide the required test and measurement solutions and will continue to be a front-runner as new developments evolve.

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Fig. 4 In case of an emergency, the caller's position is transmitted to rescue teams within seconds.

Fig. 5 The geofencing function informs the user about another person's arrival at a specific train station.

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