# A BETTER LOCATION IN EUROPE

## THE EUROPEAN GEOSTATIONARY NAVIGATION OVERLAY SERVICE (EGNOS) CAN HELP SURVEYORS TO GET EVEN BETTER POSITIONING INFORMATION THAN WITH GPS ALONE. REINHARD BLASI AND SOFIA CILLA PROVIDE AN INTRODUCTION TO THE SERVICE AND ITS BENEFITS

European Geostationary Navigation Overlay Service (EGNOS) is the European satellite-based augmentation system (SBAS) covering Europe. It represents the first concrete European venture into satellite navigation and is essentially 'pre-Galileo' system – Galileo being the European global satellite navigation system (GNSS).

EGNOS uses geostationary satellites and a network of ground stations to receive, analyse and augment GPS. EGNOS is an optimal solution when you need to locate a large amount of points with sub-metre accuracy in real-time, easily, affordably and flexibly. EGNOS can boost data capture, usually the most time-consuming process in the development of a mapping or GIS application. Presently, EGNOS augments GPS using the L1 (1575.42 MHz) coarse/acquisition (C/A) civilian signal function by providing correction data and integrity information for improving positioning, navigation and timing services over Europe. The future version of EGNOS (v3) will augment Galileo and will be double frequency (L1/E1 and L2/E5).

There are two different services for users to access EGNOS corrections for surveying and mapping:

- EGNOS Signal in Space, directly via the geostationary EGNOS satellites (the same L1 frequency as GPS satellites) using a GPS receiver that is EGNOS-enabled, without any additional cost.
- EDAS (EGNOS Data Access Service), which is available over the internet in real-time or in the form of archive data from the EDAS FTP service. In addition to EGNOS corrections, EDAS enables the implementation of advanced positioning techniques.

EGNOS has been designed and developed with the goal to

improve GPS performances in Europe. Its open service is intended to offer these benefits for the users of general-purpose applications without any charge and does not require specific authorisation.

The EGNOS network includes 39 ranging and integrity monitoring stations (RIMS) in more than 20 countries. The RIMS collect measurements from GPS satellites and transmit these raw data to two mission control centres, which compute the information from the RIMS and generate correction messages to improve satellite signal accuracy and information messages with the integrity status of the satellites. EGNOS messages are broadcast through two geostationary satellites.

The corrections transmitted by EGNOS contribute to mitigate the ranging error sources related to satellite clocks, satellite position and ionospheric effects. The other error sources (tropospheric effects, multipath and user receiver contributions) are local effects that cannot be corrected by a global augmentation system.

To receive the satellite EGNOS signal, you need an SBAS receiver – all SBAS receivers are EGNOS-compatible. The difference between an SBAS and a GPS receiver is the special software that enables it to lock onto the EGNOS satellites and applies the EGNOS corrections to the GPS signal. Today, most commercial GPS receivers provide EGNOS capability.

## Mapping

In the particular case of mapping, the positional accuracy is defined mainly for horizontal coordinates, although EGNOS also provides corrected vertical positions. The following parameters are key factors for users:

- The Error Ellipse defines a confidence region for the horizontal coordinates of a point. It is an approximate graphical representation of the standard deviation in two directions (lowest and highest precision directions). The most common confidence level used for error ellipses calculation is 95%.
- The 2DRMS represents twice the Distance Root Mean Square (DRMS). The DRMS is the root mean square of the radial distances from the true position to the observed positions obtained from a number of trials.

Figures 1 and 2 show the results of 2DRMS and 95% error ellipses for one day for 25 EGNOS RIMS. EGNOS Open Service accuracy for surveying is homogenous all around Europe and independent from the distance to the EGNOS reference stations.

## EDAS

EDAS provides free access over the internet to all the data generated and collected by the EGNOS infrastructure for real-time applications and also for post-processing products. Apart from the EGNOS messages,

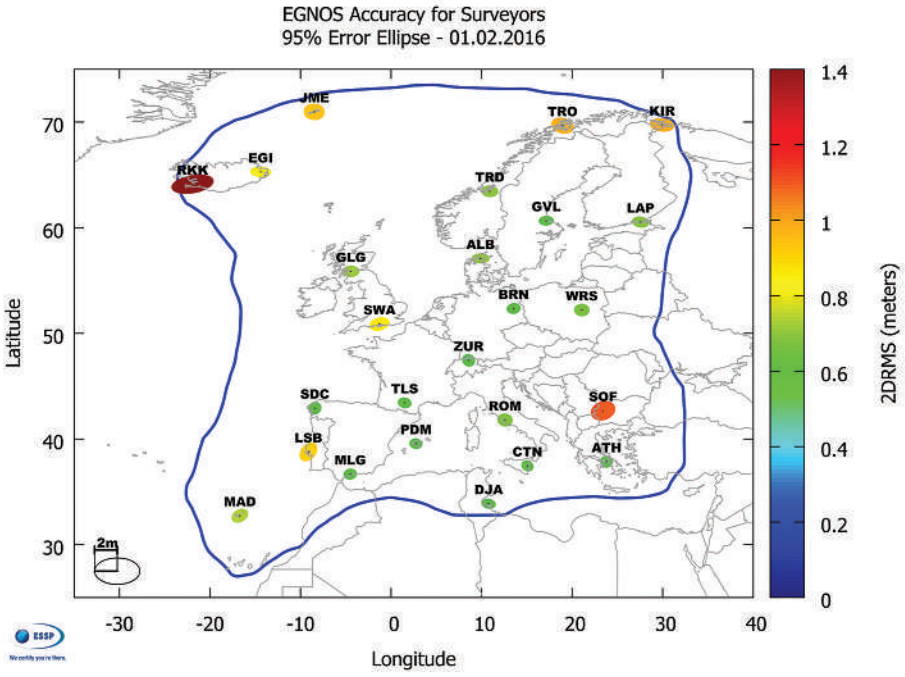


Figure 1. EGNOS 95% error ellipse and 2DRMS in specific locations

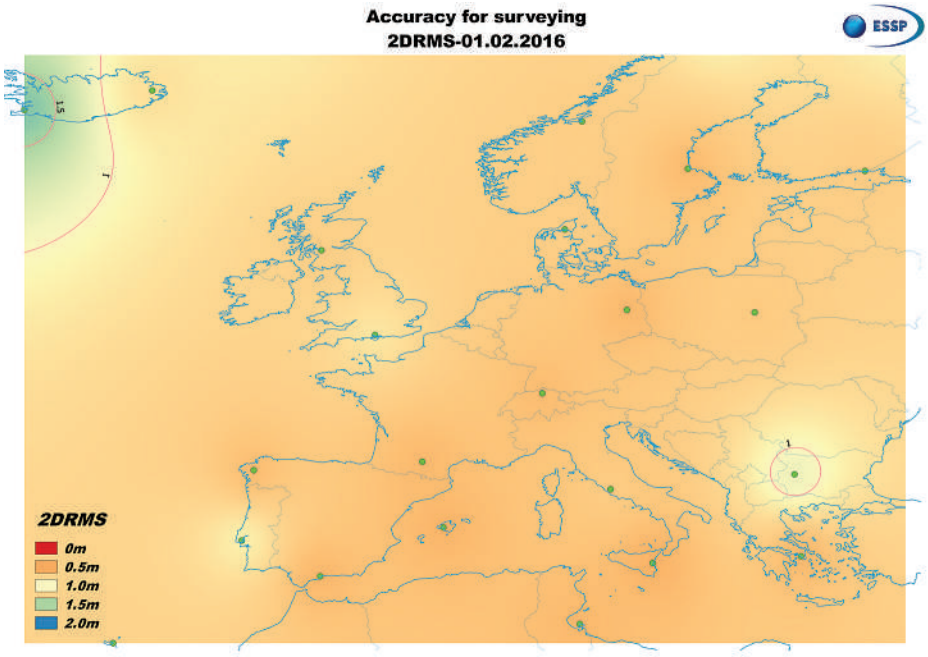


Figure 2. Interpolated EGNOS 2DRMS of the horizontal error over Europe

EDAS also transmits differential GNSS (DGNSS) corrections and real-time kinematic (RTK) messages, to support high-precision positioning when located close to an EGNOS station. Taking into account the proliferation of user applications with stringent accuracy requirements in the surveying domain, the EDAS service can make a difference by enabling the implementation of advanced positioning techniques.

The positioning techniques supported by EDAS are the following, providing higher accuracy (from sub-metre to centimetre accuracy) than GPS alone:

- EGNOS corrections can be applied in real-time using the EDAS SISNET service over the internet. These are especially important in areas when EGNOS geostationary satellites can be obstructed.
- DGNSS technique can be used in real-time through the EDAS NTRIP service, applying DGNSS corrections from a close (within 500km) EGNOS station. Taking into account that the reference stations have a known location, the errors of the satellite (GPS and GLONASS) measurements received can be accurately computed and broadcast to users in the surroundings of the station.
- RTK positioning with centimetre-level accuracy can be computed using the EDAS NTRIP service when located within 40km of the EGNOS station.

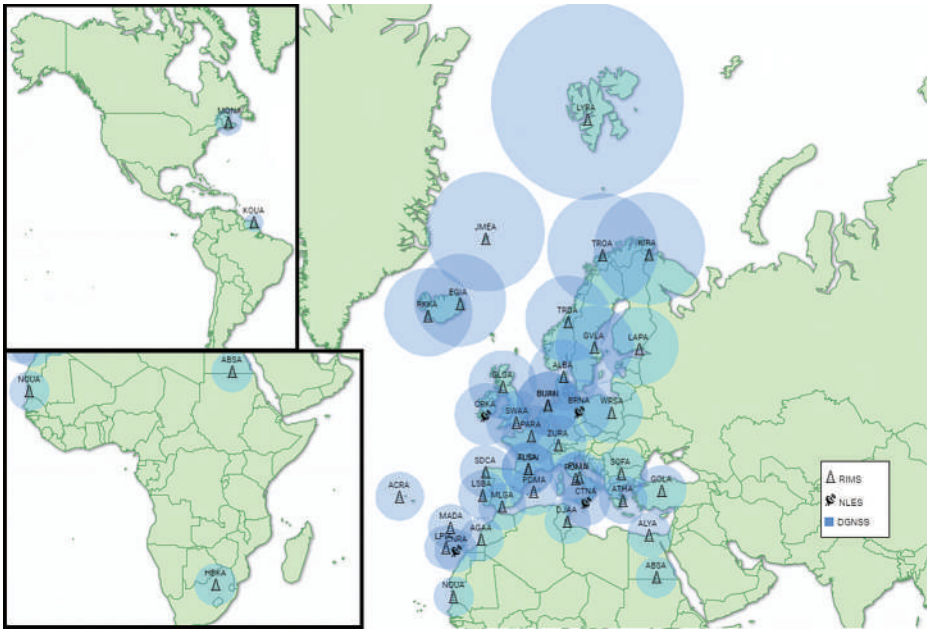


Figure 4. Capability of GNSS receivers – surveying segment. Source: GSA GNSS Market Report 2015

## Optimising surveying

The augmentation technique is chosen depending on the required accuracy of the survey, the available equipment resources, the time required and the environmental characteristics of the surveyed site.

The EGNOS open service provides an attractive option in terms of cost and position accuracy. In addition, restricted to the distance to the reference stations, an increase of the precision can be obtained using positioning techniques supported by EDAS available with affordable receivers.

Figure 3 shows the horizontal error at Berlin RIMS (BRN-A) using GPS by itself as well as GPS augmented by the different options and capabilities of the services offered by EGNOS.

SBAS has made it much simpler to collect real-time data with metre accuracy: before its introduction, one had to either post-process the data or use 300KHz receivers relying on the maritime beaconing system.

Increasingly, manufacturers are introducing optimised EGNOS implementations in their survey and mapping devices. According to the GSA Market Report 2015, EGNOS-enabled devices for surveying are increasing their market share in Europe and EGNOS capability is expected to be available in more than 80% of GNSS receivers (see Figure 4).

## Benefits

European governments and administrative bodies have the opportunity to benefit from using EGNOS in areas such as creating spatial data infrastructures, water delivery and sewer systems and planting trees in green areas. Energy, telecom and utilities companies and owners or managers of extensive infrastructures may rely on EGNOS surveys that allow them to map infrastructure accurately and cost efficiently.

Many national geographic institutes can benefit from using EGNOS for the elaboration, georeferencing and control of their cartography. One example is the SIOSE project (System of Information of Land Occupation in Spain), in which coordinate observation and photograph georeferencing has a maximum permissible error of 5m. For this required level of precision, the use of EGNOS corrections to GPS positioning is a simple and efficient method of observation.

There are many possible applications in the reporting, location and real-time mapping of accidents or incidents, with people in need of medical assistance or rescue in areas of difficult visibility or access taking advantage of EGNOS capabilities.

In geodesy and remote sensing, there is some ongoing research work, such as the introduction of EGNOS into the free, open source software goGPS, which is used for cinematic positioning and was presented at the 2012 seventh Portuguese-Spanish Assembly of Geodesy and Geophysics. The ionospheric and pseudorange corrections provided by EGNOS have been added in a standalone module of the software and the analysis shows significant improvements.

The Community Research and Development Information Service (CORDIS) of the European Commission, in

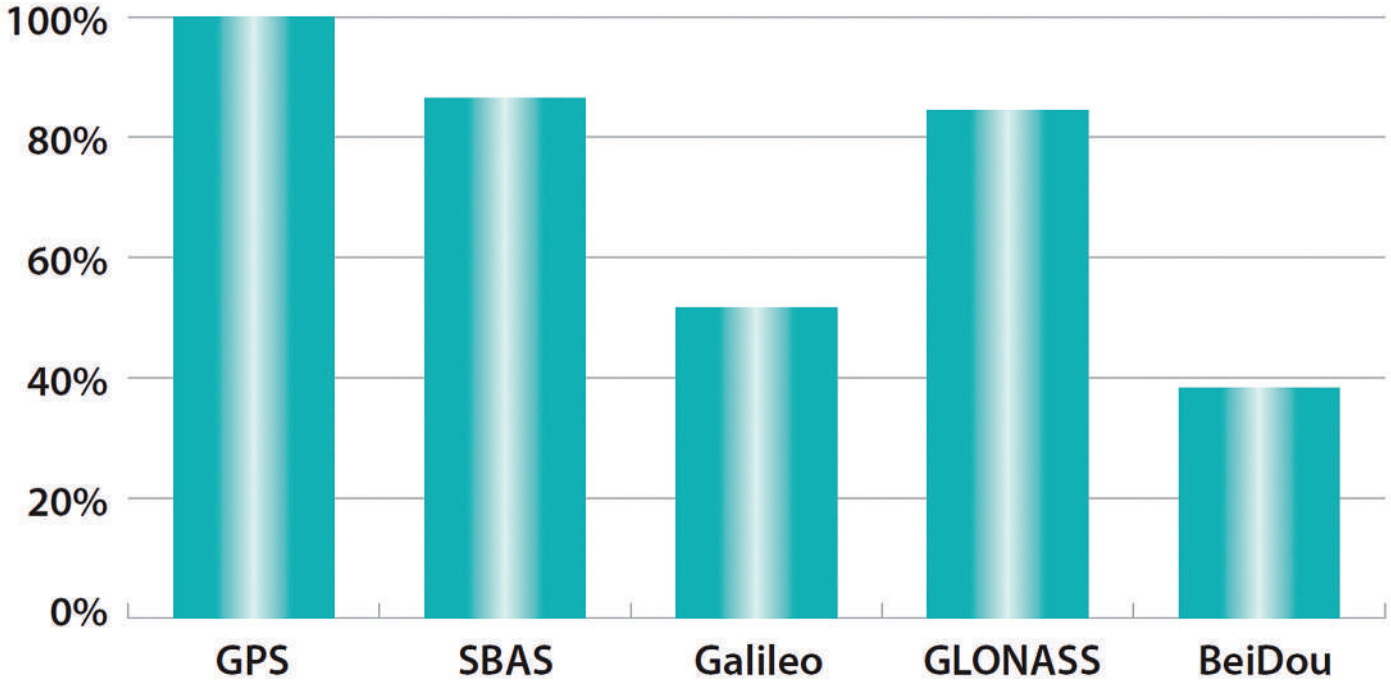


Figure 4. Capability of GNSS receivers – surveying segment. Source: GSA GNSS Market Report 2015

its programme GALILEO-2-2014 – 'Small and Medium Enterprise (SME) based EGNSS applications' is promoting the development of new applications, such as mass-market location-based services products, feasibility studies and market tests, focusing on address emerging user needs and, specifically, taking advantage of the Galileo and EGNOS capabilities and their distinguishing features.

In the future, some receiver manufacturers could potentially develop receivers enhancing the accuracy feature. Galileo and the L5 frequency will help push this process. With dual frequency receivers and probably SBAS supporting both L1 and L5 it will be very easy and inexpensive to achieve 15cm accuracy.

EGNOS IS AN OPTIMAL SOLUTION WHEN YOU NEED TO LOCATE A LARGE AMOUNT OF POINTS WITH SUB-METRE ACCURACY IN REAL-TIME, EASILY, AFFORDABLY AND FLEXIBLY

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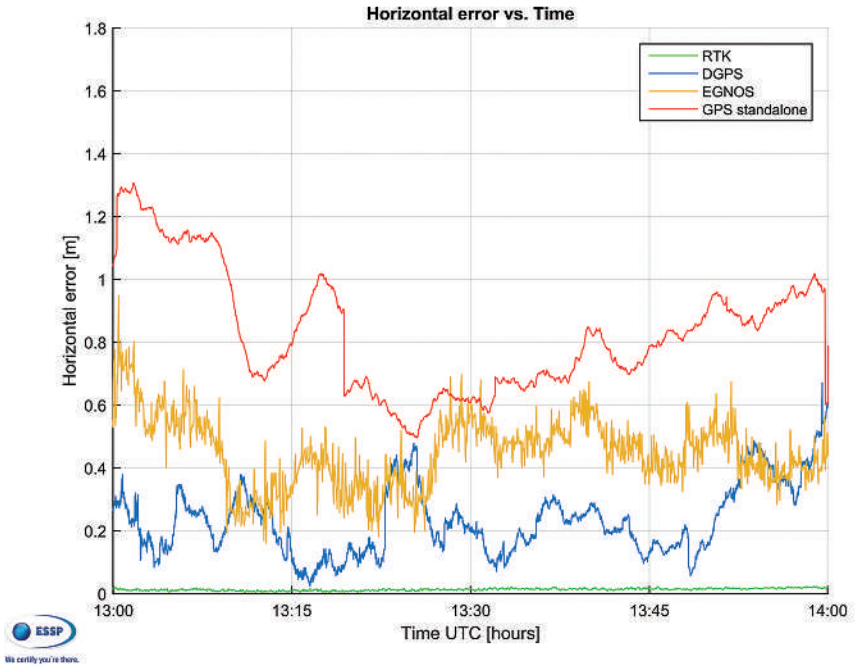


Figure 3. Horizontal error at Berlin RIMS (BRN-A)

## FURTHER INFORMATION

**If you want to know more about EGNOS visit the EGNOS user support website (https://egnos-user-support.essp-sas.eu/new_egnos_ops/index.php) or the GSA website (http://www.gsa.europa.eu/egnos/what-egnos)**

**For any questions, write to egnos-helpdesk@essp-sas.eu and to register for EDAS, visit https://egnos-user-support.essp-sas.eu/new_egnos_ops/?q=content/registration-0**