

European GNSS for Surveying and Mapping

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Key words: EGNOS, Galileo, GNSS, GSA, Surveying, Mapping, High-precision, RTK, PPP, Authentication

SUMMARY

The European GNSS Agency, or GSA, on behalf of the European Commission, manages Europe's GNSS programmes: EGNOS (European Geostationary Navigation Overlay Service) and Galileo. The GSA is connecting the benefits of space technology to European citizens from all walks of life. From aviation to mapping, maritime to rail, European satellite navigation is changing the way we live and do business.

Already today EGNOS is growing the use of GNSS for real time basic mapping solutions by providing free accuracy that is widely available. Applications where meter accuracy is adequate can benefit from EGNOS such as GIS and thematic mapping for small and medium municipalities, forestry and park management as well as surveying of utility infrastructures (e.g. electrical power lines). Most of GNSS receivers used for mapping are now EGNOS ready and the EGNOS signal is free of charge. Besides the professional users, EGNOS also allows more and more non-professionals to access GNSS mapping technologies, thanks to the affordable and simple solutions. The EGNOS signal provides a constant level of position accuracy throughout the EGNOS compliance area which covers Europe and is planned to extend the coverage to Africa and Middle-East.

Getting ready for Galileo to fully take off, the surveying community may benefit from multi-constellations starting by the Initial Services Declaration launched in December 2016. Surveyors will benefit from easier mitigation of multi-path errors, better availability, continuity, reliability and improved geometry, and better results in harsh environment such as urban canyons and under tree canopy. Along the Galileo Open Signal with single or dual frequency (E1, E5) Galileo will offer a Commercial Service (CS) dedicated to high precision applications. CS High Accuracy (CS-HA) will deliver corrections via Galileo E6 across the globe (PPP - precise point positioning) for high accuracy applications for all segments and in a precision comparable to RTK. Moreover, CS-HA will offer triple frequency with faster convergence time for surveying applications, delivering accuracy below one decimetre worldwide. Users can also benefit from authentication service which will be the first-ever Signal in Space based method to assure that the positioning is based on utilising Galileo-signals and not any other source (spoofing detection).

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1. Galileo: Europe's GNSS

Galileo is Europe's own Global Navigation Satellite System (E-GNSS). Galileo provides a highly accurate, reliable global positioning service under civilian control and is interoperable with other GNSS. Offering dual frequencies as standard (E1 and E5), Galileo delivers real-time positioning down to the metre range accuracy. When Galileo is used in addition to existing GNSS constellations, the result is better availability of the satellites and improved operation in harsh environments such as urban canyons.

Galileo offers multiple benefits to the surveying segment. It provides surveyors with a reliable GNSS signal and excellent positioning and timing information that will further improve high-accuracy applications. Galileo signals are designed to better mitigate multipath errors, and they have higher signal-to-noise ratio. In addition, the programme's High Accuracy Commercial Service (CS-HA) is set to offer sub-decimetre level accuracy with global coverage using the PPP (Precise Point Positioning) technique. With Galileo CS-HA, the most noticeable improvement for surveyors will be in areas where other augmentation systems are not accessible. Moreover, Galileo users also benefit from enhanced protection against spoofing attacks.

1.1 Declaration of Galileo Initial Services

Galileo has made significant progress in recent years - 18 Galileo satellites are now orbiting the Earth, with four additional satellites planned to be added this year. Additionally, the supporting ground infrastructure is performing well. As a result, Galileo is now ready to be used. With the Declaration of Galileo Initial Services launched on the 15th of December 2016, Galileo officially moved from a testing phase to the provision of live services. Users will already be able to benefit from a range of Galileo services, including the Open Service, Public Regulated Service (PRS), and Search and Rescue (SAR) service.

1.2 Galileo constellation

The fully deployed Galileo system, which is scheduled for 2020, will consist of 24 operational satellites plus six in-orbit spares. These satellites will be positioned in three circular Medium Earth Orbit (MEO) planes at 23 222 km altitude above the Earth and at an inclination of the orbital planes of 56 degrees to the equator.

Once full operational capacity is achieved, the Galileo navigation signals will provide good coverage even at latitudes up to 75 degrees north, which corresponds to Norway's North Cape – the most northerly tip of Europe – and beyond. The large number of satellites, together with the carefully-optimised constellation design and availability of two active spare satellites per orbital

plane, ensures that a temporary loss of signal from one satellite will not have a discernible effect on the user.

2. Galileo for Surveying

Galileo offers a range of unique services of particular interest to the surveying sector, including:

2.1 Open Service

Galileo's free-of-charge Open Service offers either single (E1) or dual frequency (E1/E5) frequencies. Adding these frequencies to RTK/DGNSS or PPP solutions will further improve augmentation services, enabling increased availability, continuity, reliability and operation in harsh environment such as urban/natural canyons and under tree canopies.

2.2 Commercial Service

By the adoption of the Galileo Commercial Service Implementing Decision¹ in February 2017, the European Commission and the GSA confirm that the first generation of Galileo will provide users with High Accuracy and Authentication services on E6 frequency. A High Accuracy service (CS-HA) is based on the transmission of Precise Point Positioning (PPP) information through its E6-B signal, delivering accuracy below one decimetre worldwide. CS-HA offers surveying applications triple frequency, faster convergence time and comparable accuracy to RTK. In addition, users may also benefit from a Commercial Authentication (CS-Auth.) service allowing for increased robustness of professional applications.

After a test period, the Galileo Commercial Service will become available when Galileo reaches Full Operational Capability (FOC), which is expected by 2020.

2.3 Open Service Navigation Message Authentication (OS-NMA)

The user community will also be able to use the Open Service Navigation Message Authentication (OS NMA) for free. The OS NMA is capable of detecting spoofing attacks by digitally signing the Open Service message in the E1 band.

2.4 E6 for ranging

It is foreseen that one signal component of the Galileo E6 signals remains freely available, allowing user communities to benefit from an open E6 unencrypted ranging signal. This high-quality signal serves as a good choice for the third frequency needed for the linear combination of GNSS observations made on three frequencies (e.g. for faster and more reliable ambiguity resolution in RTK and PPP processing).

2.5 The European GNSS Service Centre – interface with end-users

¹ Commission Implementing Decision (EU) 2017/224 of 8 February 2017 setting out the technical and operational specifications allowing the commercial service offered by the system established under the Galileo programme to fulfil the function referred to in Article 2(4)(c) of Regulation (EU) No 1285/2013 of the European Parliament and of the Council

The European GNSS Service Centre is the single interface between the Galileo system and the users, apart from the SIS (Signal In Space). The aim of the GSC is to provide regular and timely official information to the subscribed users about the status of Galileo system and services. GSC is also performing user support activities and it is hosting a centre of expertise for various OS and CS service aspects. The Galileo users may access all products and services through the GSC web portal (www.gsc-europa.eu), conceived as the one-stop-shop for the Galileo OS users, CS providers and end users. Among the services offered to the users, the most relevant for surveyors are the GSC Helpdesk, where a team of experts, provides technical answers to the users, and the NAGU notification service, that informs users about the constellation status.

3. EGNOS for mapping and GIS

Besides Galileo, the European Geostationary Navigation Overlay Service (EGNOS) is the other European GNSS programme providing benefits to the geospatial community. EGNOS is an augmentation system in service since 2009, improving the accuracy and reliability of GNSS positioning information and providing a crucial integrity message on the continuity and availability of the GNSS signal.

EGNOS offers users an affordable solution for applications where metre accuracy is adequate. Applications such as thematic mapping for small and medium municipalities, forestry and park management, as well as surveying utility infrastructures (e.g. electrical power lines), can all benefit from EGNOS. The EGNOS signal is free of charge, and most of the location devices used for mapping are now EGNOS-ready. Besides its many benefits for professional users, thanks to its affordable and simple solutions, EGNOS also allows more and more non-professionals to access GNSS mapping technologies.

The EGNOS signal provides a constant level of position accuracy throughout the EGNOS compliance area, which covers most of Europe. EGNOS corrections can be received via different means:

- Directly via EGNOS satellites, with a normal GNSS receiver that is EGNOS-enabled, without any communication cost
- Via terrestrial communication means, such as internet or cellular networks, thanks to EDAS, the EGNOS Data Access Service, which is fully operational and available free of charge.

4. The GSA- linking space technology with user needs

By delegation from the European Commission, the European GNSS Agency (GSA) manages Europe's GNSS programmes, connecting the benefits of space technology to European citizens and business. The GSA's mission is to support EU objectives and achieve the highest return on European GNSS investment, in terms of benefits to users and economic growth and competitiveness.

The GSA is responsible for the Galileo service operations and initial services, ensuring that the end user remains at the centre of Galileo. To accomplish this, the GSA is in constant dialogue with user communities, industry and stakeholders via a wide range of activities. For example, the GSA is

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working closely with chipset and receiver manufacturers to ensure all products are Galileo-capable and ready for using it.

The GSA is regularly monitoring GNSS market and technology, presenting an overview, quantification and forecast of the market – including the global surveying GNSS market in terms of shipments, revenues, value chain, technology trends and installed based receivers, with an outlook up to 2023. In addition, GSA released the GNSS User Technology Report in 2016 - the go-to source for comprehensive knowledge and information on the dynamic, global GNSS user technology industry and the latest trends. The publication takes an in-depth look at the latest in state-of-the-art GNSS receiver technology, along with providing expert analysis on the evolutionary trends that are set to redefine the global GNSS landscape.

The GSA also works with the major user communities so they can update their systems and be ready to use Galileo. In addition, GSA-supported R&D funding programmes such as Horizon 2020² and Fundamental Elements³ serve as important mechanisms for reaching the highest level of Galileo-readiness.

BIOGRAPHICAL NOTES

Reinhard Blasi is a market development officer at the European GNSS Agency (GSA) in charge of EGNOS and Galileo in the professional high-precision GNSS markets. He also covers the Galileo Commercial Service definition from a market and user point of view.

Before his engagement with the GSA he has been working as a strategy consultant for various innovation projects.

Reinhard holds a degree in business administration and a master degree in international business studies conducted in the Universities of Paderborn (Germany), Lille (France), and Bologna (Italy).

Alina Hriscu is a market development officer at the European GNSS Agency (GSA) following EGNOS and Galileo in the surveying GNSS market.

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Alina holds a PhD degree and a master degree in physics conducted in the Universities of Delft (The Netherlands), Groningen (The Netherlands), and Bucharest (Romania).

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² <https://www.gsa.europa.eu/r-d/h2020/introduction>

³ <https://www.gsa.europa.eu/r-d/gnss-r-d-programmes/fundamental-elements>

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