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EGNSS downstream standards development

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1. Scope, objectives and purpose

This staff working document intends to take stock of the various activities in the field of European Global Navigation Satellite System (EGNSS) downstream standardisation. The staff working document brings together in one place the decisions of the European Commission (EC) invoking standards in the area of EGNSS applications, which have been spread across multiple documents, and outlines the actions putting those decisions into practice.

The staff working document is structured along three priority areas within the EGNSS applications market. The market segments differ significantly from one another, have various levels of maturity, and consequently - different standardisation needs. This diversity requires specific actions related to standards development per each segment.

The ultimate goal of the staff working document is to present an overview of the downstream standardisation activities of the relevant Commission's services in the field of satellite navigation programmes so as to provide transparency. The staff working document specifies the Commission's services work that is being carried out and intends to bring more understanding as to the future needs and requirements in this area.

2. Policy and legal background

2.1. EGNSS programmes and standards

The European Global Navigation Satellite System encompasses the Global Satellite Navigation System established under the Galileo programme and the European Geostationary Overlay Service (EGNOS).

Galileo has been in operation since December 2016. It provides position, navigation and timing services with worldwide coverage and is interoperable with GPS and other satellite systems. The objective of Galileo is to provide the EU with an independent infrastructure for satellite navigation. By 2020, Galileo will have some unique features that no other satellite navigation system currently offers (such as navigation message authentication to ensure that the navigation data is not counterfeit and that it does not come from any other sources than Galileo satellites).

EGNOS is the European space based augmentation system with regional coverage, improving the performance of GNSS. It has been fully operational since 2011, and its services, such as Safety of Life, are being increasingly used in the transport domains.

The new high-performance satellite navigation services of Galileo and EGNOS provide considerable opportunities for the economy and for society: from environmental protection, sustainable agriculture and climate change to smart mobility and safety (e.g. transport, car navigation, mobile applications), from timing and synchronisation of critical infrastructures (e.g. energy grids, telecommunication and finance) to safety of life services (e.g. in aviation, and possibly in other transport domains).

The satellite navigation market is witnessing continuous growth: the global market today is more than €120bn and it is expected to double in the next five years. The number of devices in use worldwide is currently about 6 billion and by 2020, this number is expected to grow to around 8 billion - there will be more devices than people. A key objective of the EC is to ensure that Galileo and EGNOS are used by the market, and that the EU industry increases its market share in the worldwide downstream market for satellite navigation¹.

EGNSS downstream market refers to the market of applications and services for which Galileo and EGNOS signals, determining users' position, velocity and time, are a significant enabler of functionality. EGNSS downstream standards are related to standards covering the use of Galileo and EGNOS signals in different applications areas/market segments. They play a crucial role in the market uptake of Galileo and EGNOS programmes. They are a powerful tool to support safety related applications in the main transport modes, e.g. in maritime, aviation, rail, road (eCall), smartphones (E112) etc., and are vital to ensure the interoperability of Galileo and EGNOS products and services not only with other navigation systems, but also with other technologies.

EGNSS downstream standardisation is a process that is generally based on the needs of the market; the standards are developed by the industry or European Standardisation Organisations (ESOs). The EC plays an important role in this process by contributing to facilitating and promoting of the inclusion of Galileo and EGNOS in relevant standards.

Alongside the Commission's services, the European GNSS Agency (GSA) plays a significant role in standards development. The GSA is a decentralised agency of the European Union. One of its main tasks is the market development of EGNSS-based applications, including downstream standards². The Agency supports the Commission in carrying out specific actions related to EGNSS downstream standards. The GSA's yearly work programmes contain a planning of the Agency's market development activities, including actions in the downstream standardisation field³.

2.2 EGNSS downstream standardisation priority areas

The European Commission's Space Strategy⁴ adopted on October 2016 outlines that *"In the longer term, the Commission will encourage the uptake of space solutions through standardisation measures and roadmaps and by integrating space into future strategies addressing, for example, autonomous and connected cars, railways, aviation and unmanned aerial vehicles (drones)"*.

¹ Communication from the Commission to the European Parliament, the Council, the European Economic And Social Committee and the Committee of the Regions – Space Strategy for Europe, COM(2016) 705 final.

² Article 14 of Regulation (EU) No 1285/2013 of the European Parliament and of the Council of 11 December 2013 on the implementation and exploitation of European satellite navigation systems and repealing Council Regulation (EC) No 876/2002 and Regulation (EC) No 683/2008 of the European Parliament and of the Council.

³ https://www.gsa.europa.eu/sites/default/files/single_programming_document_2019_-_2021_0.pdf

⁴ Communication from the Commission to the European Parliament, the Council, the European Economic And Social Committee and the Committee of the Regions – Space Strategy for Europe, COM(2016) 705 final.

The analysis commissioned by the Commission's services entitled "*Overview of EGNSS downstream standardisation and assessment of gaps and future needs to facilitate the integration of Galileo and EGNOS into user applications*"⁵ identifies the following three priority areas:

- Intelligent transport and mobility;
- Intelligent interconnectivity;
- Intelligent infrastructures.

Subsequently, those priority areas have been outlined in the European satellite navigation programmes work programme for 2019⁶ and serve as basis for activities of the Commission's services.

2.2. EGNSS downstream standardisation legal framework

Firstly, the EGNSS downstream standardisation activities take place within the wider context of standards development, in accordance with the so-called "Standardisation Regulation"⁷. Activities within the above mentioned priority areas for standardisation are reflected in the Annual Union Work Programme for European Standardisation (AUWP) for 2018⁸ and 2019⁹, as well as in the Rolling Plan for ICT Standardisation for 2019¹⁰.

Secondly, the GNSS Regulation¹¹, provides additional tools to support the development of standards, notably analyses and studies to understand the standardisation needs and the content of standards, or awareness-raising activities about EGNSS and their differentiators vis-a-vis standards developing bodies.

The EU research programmes are also an important tool to support the development of downstream standards. The Horizon 2020 Work Programmes for 2016-2017¹² and 2018-2020¹³ include calls for proposals aiming at fostering the market uptake of EGNSS through the creation of standards and the identification of needs to develop new standards in specific

⁵ Analysis performed for the European Commission by GMV, VVA and LexJus Sinacta, November 2017 http://ec.europa.eu/newsroom/growth/item-detail.cfm?item_id=613695.

⁶ Annex to the Commission Implementing Decision of 8.4.2019 on the financing of the European satellite navigation programmes and the adoption of the work programme for 2019, C(2019) 2527 final.

⁷ Regulation (EU) No 1025/2012 of the European Parliament and of the Council of 25 October 2012 on European standardisation, amending Council Directives 89/686/EEC and 93/15/EEC and Directives 94/9/EC, 94/25/EC, 95/16/EC, 97/23/EC, 98/34/EC, 2004/22/EC, 2007/23/EC, 2009/23/EC and 2009/105/EC of the European Parliament and of the Council and repealing Council Decision 87/95/EEC and Decision No 1673/2006/EC of the European Parliament and of the Council.

⁸ Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions — The Annual Union Work Programme for European standardisation for 2018, COM(2017) 453 final.

⁹ Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions — The Annual Union Work Programme for European standardisation for 2019, COM(2018) 686 final.

¹⁰ <https://ec.europa.eu/docsroom/documents/34788>.

¹¹ Article 12 of Regulation (EU) 1285/2013 of the European Parliament and of the Council of 11 December 2013 on the implementation and exploitation of European satellite navigation systems and repealing Council Regulation (EC) No 876/2002 and Regulation (EC) No 683/2008 of the European Parliament and of the Council.

¹² European Commission Decision C(2017)2468 of 24 April 2017 Horizon 2020 - Work Programme 2016-2017.

¹³ European Commission Decision C(2019)4575 of 2 July 2019 Horizon 2020 - Work Programme 2018-2020.

segments, for example by performing technical analyses or preparing guidelines for future standards.

When referring to standards development, in most of these activities, the standards are understood as international or European standards. Additionally, harmonised standards can be relevant, as it is in the case of equipment placed on the market in the regulatory framework of product legislation. An example is the so-called Radio Equipment Directive (RED)¹⁴, providing for a presumption of conformity for radio equipment which complies with voluntary harmonised standards. Its delegated act¹⁵ introduces a requirement of Galileo compatibility and interoperability for mobile phones during emergency communications. The adoption of this regulation will be followed by a new standardisation request from the EC to ESOs with a goal to develop harmonised standards.

Additionally, the activities for each priority areas are also grounded in various EC documents, which are referred to in the following chapter.

3. Standardisation activities per market segment

This chapter outlines the activities performed by the Commission's services with the support of the GSA in EGNSS downstream standardisation in the market segments covering the priority areas.

(1) Intelligent transport and mobility

1. Manned aviation

Aviation is an important driver of economic growth, jobs and trade, with a major impact on the life and mobility of EU citizens. The next ten years will pave the way for the digital transformation of aviation.

Out of all the market segments, the manned aviation segment is the most mature. It follows well-established working methods. Given the specific nature of the segment, the definition of standards related to Galileo and EGNOS is carried out at the international level: mainly through International Civil Aviation Organization (ICAO), Radio Technical Commission for Aeronautics (RTCA) in the US and its European equivalent – European Organisation for Civil Aviation Equipment (EUROCAE). The definition of standards in aviation takes place on the basis of priorities defined by the aviation community itself. The EC, representing the Union, provides expertise, for example in the form of technical analyses, to the process of the definition of standardisation priorities and the development of standards in aviation.

The Commission's services, with the support of the GSA and other agencies/bodies (European Union Aviation Safety Agency (EASA), Sesar Joint Undertaking), contribute to

¹⁴ Directive 2014/53/EU of the European Parliament and of the Council of 16 April 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC.

¹⁵ Commission Delegated Regulation (EU) 2019/320 of 12 December 2018 supplementing of Directive 2014/53/EU of the European Parliament and of the Council with regard to the application of the essential requirements referred to in Article 3(3)(g) in order to ensure caller location in emergency communications from mobile devices.

promoting the inclusion of Galileo and EGNOS in the aviation Standards And Recommended Practices (SARPs) as well as in the Minimum Operational Performance Standards (MOPS) and Minimum Aviation System Performance Standards (MASPS)¹⁶.

The standardisation activities of the Commission's services within the aviation market segment aim at:

- Ensuring the availability of standards required for aviation to benefit from EGNOS and Galileo and the additional provided performance, e.g. multi-constellation (i.e. combining signals from different GNSS), multi-frequency, ICAO SARPs;
- Facilitating the development of industry standards for avionics which include EGNOS and Galileo, such as the multi-constellation, multi-frequency MOPS;
- Defining the operational concept for remote beacon activation, leveraging the Galileo Search and Rescue return link service (SAR RLS) and associated aircraft distress tracking (MASPS).

The specific activities consist of:

- Contributing to promoting the inclusion of Galileo and EGNOS standards via technical analyses, with a view to obtaining performance-based standards compatible with EGNSS services and their performance for navigation, surveillance and aircraft tracking. In particular:
 - Galileo SARPs by ICAO;
 - Dual-Frequency Multi-Constellation (DFMC) SBAS + GBAS SARPs by ICAO;
 - Dual-Frequency Multi-Constellation (DFMC) SBAS + GBAS MOPS by EUROCAE/RTCA (including ARAIM);
 - MOPS for Aircraft Emergency Locator Transmitter/ELTs/ELT-DT (ED-62B / DO-204B) by EUROCAE/RTCA;
 - MASPS for Galileo return link service (including remote activation) by EUROCAE and updated MOPS;
- Performing technical analyses to solve open points in parallel to the standardisation processes, to introduce Galileo and EGNOS;
- Performing awareness-raising activities, to promote the achievements and outcomes of the standardisation efforts and promote the added value that EGNSS can provide.

2. Unmanned Aircraft

The Unmanned Aircraft¹⁷ (UA) market is growing fast and is expected to grow further in the coming years, from 2.27 million UA devices in 2015 to nearly 70 million devices in 2025.

¹⁶ The work related to standards development within EUROCAE (i.e. MOPS and MASPs) is conducted by the GSA, on the basis of the Commission Implementing Decision entrusting budget implementation tasks to the European GNSS Agency and the European Space Agency linked to the deployment and exploitation of the European GNSS Systems (EGNOS and Galileo), C(2014) 809 final. Additionally, the Commission's services support the development of standards through a grant agreement with EUROCAE, as outlined in the Annex to the Commission Implementing Decision on the financing of the European satellite navigation programmes and the adoption of the work programme for 2019, C(2019) 2527 final.

Standardisation for UAs, and in particular the standardisation of GNSS usage, are at an early stage, which provides a window of opportunity for action. Considering that the main concerns related to drone operations are associated with safety and security, Galileo with its authentication, better performance (accuracy, availability) in a multi-constellation context, as well as providing built-in high accuracy capabilities can bring an important added value. This is particularly important for urban air mobility (UAM), as urban environments are more demanding¹⁸.

The objectives of the Commission's services for the UA market segment entail:

- Contributing to promoting the inclusion of Galileo and EGNOS, as appropriate, in standards developed by European Standardisation Organisations (ESOs) in support to the open category of operations¹⁹;
- Contributing to promoting the inclusion of Galileo and EGNOS in relevant standards developed by EUROCAE in support to the specific and certified categories of operation²⁰, and to the U-Space ;
- Engaging with public and private stakeholders in drone manufacturing and operating industries, and other aviation domains, to promote the benefits of EGNSS.

The specific activities in this market segment consist of:

- Analysing the needs of the market segment and the necessary actions to support standardisation activities of ESOs and EUROCAE with the view to obtaining performance-based standards compatible with appropriate EGNSS services for the different functions that require GNSS data (navigation, remote identification and tracking, geo-fencing, detect and avoid, etc.) identified in the Regulation (EU) 2019/947 and Regulation (EU) 2019/945 or in support to the U-Space, and contribute to the GNSS requirements definition's process led by EASA;
- Performing technical analyses to solve open points in parallel to the standardisation processes, to introduce appropriate Galileo and EGNOS solutions within the different categories of drone operations (certified, specific, open) and the U-space;
- Performing awareness activities to promote the added value and improvements that EGNSS can provide for drones and to the UAs community.

¹⁷ There are three categories of unmanned aircraft operations: certified, specific, open.

¹⁸ Work carried out through Horizon 2020 project EGNSS4RPAS, based on European Commission Decision C(2017)2468 of 24 April 2017 Horizon 2020 - Work Programme 2016-2017. Further projects are expected to be carried out, based on European Commission Decision C(2019)4575 of 2 July 2019 Horizon 2020 - Work Programme 2018-2020.

¹⁹ Work carried out on the basis of Implementing Regulation (EU) 2019/947 of 24 May 2019 on the rules and procedures for the operation of unmanned aircraft and the Delegated Regulation (EU) 2019/945 of 12 March 2019 on unmanned aircraft systems and on third-country operators of unmanned aircraft systems.

²⁰ The work related to standards development within EUROCAE is conducted by the GSA, on the basis of the Commission Implementing Decision entrusting budget implementation tasks to the European GNSS Agency and the European Space Agency linked to the deployment and exploitation of the European GNSS Systems (EGNOS and Galileo), C(2014) 809 final.

3. Road

In the EGNSS downstream market, Road is the most relevant market segment in terms of revenue. In the road sector, EU companies lead the GNSS component and receiver manufacturers market with a 51% share, ahead of Asia Pacific (27%) and North America (22%). European GNSS integrators generate 30% of global turnover, behind Asia (48%).

As from 31 March 2018, the EU regulation concerning eCall²¹ requires mandatory integration of an EGNSS receiver in every new type of car/van produced within the European Union. Similarly, the Commission's implementing regulation regarding smart tachograph²² requires compatibility with Galileo and EGNOS systems as from 15 June 2019.

Overall, the installed base of devices used for other road applications is set to grow substantially in the next years. Galileo and EGNOS are being adopted by the automotive industry to support applications such as advanced driver assistance systems, connected and automated driving and cooperative intelligent transport systems.

Standards could support a more pervasive use of EGNSS, in particular by exploiting differentiators such as authentication, as well as additional capabilities (e.g. use of EGNOS to determine protection levels and/or differentiators such as the high accuracy service), for safety and security.

The main objectives of the Commission's services for the road segment are to:

- Facilitate the development of standards with relation to the creation of an integrity concept in the localisation unit for road applications²³. For applications like connected and automated driving such definition could consist of a characterisation of the residual error budgets (multipath, noise) and a definition of a harmonised methodology to compare performance levels in terms of availability, continuity, accuracy and integrity aspects.
- Promote the update of relevant information exchange standards developed by the industry (information exchange protocols between the different components of the vehicle, and vehicle-to-everything (V2X) data exchange protocols) to include integrity and authentication support for the road domain, in particular with respect to cybersecurity threats in connected and automated driving²⁴.

²¹ Regulation (EU) 2015/758 Regulation (EU) 2015/758 of the European Parliament and of the Council of 29 April 2015 concerning type-approval requirements for the deployment of the eCall in-vehicle system based on the 112 service and amending Directive 2007/46/EC.

²² Commission Implementing Regulation (EU) 2016/799 of 18 March 2016 implementing Regulation (EU) No 165/2014 of the European Parliament and of the Council laying down the requirements for the construction, testing, installation, operation and repair of tachographs and their components.

²³ Work carried out through a project commissioned by the Commission's services, on the basis of Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions — The Annual Union Work Programme for European standardisation for 2018, COM(2017) 453 final.

²⁴ Work carried out on the basis of standardisation mandate M/453 addressed to CEN, Cenelec and ETSI in the field of information and communication technologies to support the interoperability of co-operative systems for intelligent transport in the European Community and M/546 Commission Implementing Decision of 12.2.2016 on a standardisation request to the European standardisation organisations as regards Intelligent Transport Systems (ITS) in urban areas in support of Directive 2010/40/EU of the European Parliament and

- Analysing the questions of integrity and reliability of high definition maps for connected and automated driving with relation to EGNSS²⁵.

The specific activities consist of:

- Providing expertise to the work of CEN/Cenelec, related to the definition of an integrity concept for road applications and safety performance levels specific for the road domain, to provide adequate integrity and protection level specifications.
- Providing expertise to the work of CEN/Cenelec related to a review, at ISO level, of the current in-vehicle communication protocols on Intelligent Transport Systems and the localisation system of automated vehicles in order to expand the message format to add the minimum set of information required to support authentication and integrity. In particular, the revision and/or development of relevant RTCM 134, ISO TC 204 and ISO TC 22 standards.
- Launching a study on integrity and reliability of high definition maps for connected and automated driving, including the potential need to establish standards.
- Supporting the development of ETSI standards related to testing of GNSS authentication for location terminals²⁶.

4. Maritime

GNSS are already widely used by the maritime industry. The installed base of GNSS devices worldwide is expected to increase further, by nearly 60% between 2015 and 2025 (from 250.000 devices to 396.000 devices). Global revenues are expected to grow by 5.2% between 2015 and 2025, achieving total revenues of €1.4bn. The EU holds 43% of the component and receiver manufacturing for the maritime market, just behind the Asia-Pacific (47%), and holds an equal share (35%) of the systems integration market with the North America region.

Standards are particularly important in the area of autonomous vessels, an application still under development. This area is expected to grow in the coming years, similarly to other autonomous transport solutions (aviation, cars, etc.). GNSS is expected to play a key role for positioning and navigation.

Currently, there is no legal framework dealing with the regulatory aspects of operating autonomous vessels, as current maritime conventions assume that vessels operate with crew on board. Consequently, the technical standards for operating autonomous vessels are not yet established. However, there is consensus in the maritime community that aspects concerning safety, security and environment of automated vessels shall be regulated within the Maritime

of the Council of 7 July 2010 on the framework for the deployment of Intelligent Transport Systems in the field of road transport and for interfaces with other modes of transport.

²⁵ Communication from the Commission - On the road to automated mobility: An EU strategy for mobility of the future, COM(2018) 283 final.

²⁶ Work carried out through a project commissioned by the Commission's services, on the basis of the Annex to the Commission Implementing Decision on the adoption of the 2016 Work programme and the financing for the implementation and exploitation of the European satellite navigation programmes, C(2016) 1580 final.

Safety Committee of the International Maritime Organization. Autonomous vessels would need access to accurate and reliable positioning (integrity), therefore there is a clear opportunity for EGNSS, which could provide an added value in terms of:

- authenticated services (Galileo and potentially EGNOS), to mitigate the vulnerability against malicious signals and interference (spoofing and jamming) and other threats; and
- resiliency thanks to integrity (EGNOS) that may be needed in safety-of-life applications.

In this context, the objective for this market segment is to ensure that EGNSS are used and are considered at least on equal terms with other constellations within the framework of the International Maritime Organisation (IMO).

The specific activities consist of:

- Launching a feasibility analysis to assess the performance achievable with EGNSS, and identify how EGNSS could help to ensure safety of unmanned navigation and GNSS-only based navigation. The results of this study could be used to support the definition of positioning requirements for autonomous vessels at international level²⁷.
- Providing expertise to the work of CEN/Cenelec related to standards development in the field of SBAS L1 in Shipborne Rx within IEC²⁸.
- Contributing to the inclusion of Galileo and EGNOS in standards within IMO and IEC to take into account the services delivered and foreseen.

5. Rail

The role of GNSS in rail is expected to dramatically increase in the next decade, by a factor of 11 between 2015 and 2025 (from 8,000 devices to 88,000 devices).

GNSS is perceived as a very promising technology for rail and its usage in more complex, safety relevant applications is considered as a priority for the Union. Satellite based positioning has been identified as one of the five key game changers in the Memorandum of Understanding between the EC, the European Union Agency for Railways and the European rail sector associations concerning the cooperation for the deployment of the European Rail Traffic Management System (ERTMS)²⁹.

²⁷ Work carried out through Horizon 2020 project H2H, on the basis of European Commission Decision C(2017)2468 of 24 April 2017 Horizon 2020 - Work Programme 2016-2017 (see <https://cordis.europa.eu/project/rcn/212899/factsheet/en>).

²⁸ Future project based on the Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions — The Annual Union Work Programme for European standardisation for 2019, COM(2018) 686 final.

²⁹ https://ec.europa.eu/transport/sites/transport/files/mou_for_signatures.pdf.

GNSS are expected to provide an important added value thanks to improved availability and accuracy enabled by Galileo in a multi-constellation context, as well as the Galileo authentication and EGNOS integrity.

The main objective for this market segment is to prepare the inclusion of EGNSS in ERTMS³⁰, as well as in applications such as fleet management, passenger information services or predictive maintenance of trains and infrastructure.

The specific activities consist of:

- Conducting analyses to determine how EGNSS capabilities can be fully exploited for ERTMS, alone or in synergy with a multiplicity of sensors, including the provision of on-board train integrity critical function, in coordination with relevant stakeholders³¹.
- Analysing and assessing the different GNSS augmentation technologies for ERTMS: Space Based Augmentation System (SBAS), Ground Based Augmentation System (GBAS), Advanced RAIM (ARAIM)³².
- Conducting a final and comprehensive cost benefit analysis for the introduction of EGNSS in ERTMS, notably to quantify concrete benefits for the users. This analysis will be based on the technical architecture provided by GSA and Shift2Rail R&D projects³³.

(2) Intelligent interconnectivity

1. Location Based Services

The global installed base of GNSS devices continues to be dominated by smartphones (5.4 billion in 2017). Revenues attributable to GNSS grew from €150m in 2010 to €5bn in 2016 and over 90% of context-aware smartphone applications now rely on GNSS.

GNSS chipsets processing Galileo signals are widely available and there are already more than 1 billion Galileo enabled smartphones in use. Existing industry standards (3rd Generation Partnership Project (3GPP) TS 45.005 and TS 36.171), however, still give priority to GPS for the selection of satellites used to calculate the position, even when satellites from other constellations may have better signal quality. Thus, Galileo satellites are usually not fully utilised for position calculations within smartphones. Using GPS as a primary constellation in the standards could have been reasonable in the past, given the limited availability and low maturity of other GNSS. However, now, with other GNSS available, this preference to GPS hinders adoption of non-GPS systems; ultimately this may also

³⁰ Shift2Rail Joint Undertaking, Decision on the adoption of the Shift2Rail Masterplan No. 4/2015; European Railway Agency

³¹ Work will be carried out through Horizon 2020 call for proposal, on the basis of European Commission Decision C(2019)4575 of 2 July 2019 Horizon 2020 - Work Programme 2018-2020.

³² Work carried out through Horizon 2020 project ERSAT GGC, on the basis of European Commission Decision C(2017)2468 of 24 April 2017 Horizon 2020 - Work Programme 2016-2017 (see <http://www.ersat-ggc.eu/>).

³³ Study managed by the GSA on the basis of the Agency's work programme: https://www.gsa.europa.eu/sites/default/files/single_programming_document_2019_-_2021_0.pdf

compromise the position fix (i.e. the identification of the position), if other non-GPS satellites are able to provide better signal quality in a given situation, but are not being used.

The main objective of the Commission's services for this market segment is to contribute to the promotion of the updates of the technical specifications of those standards, along with the new ones to be drafted for 5G, and to reflect the existence of various GNSS, so that all of them are treated equally without giving a preference to GPS.

The specific activities consist of:

- Contributing to promoting, e.g. through ETSI, CEN/Cenelec, 3GPP, and more specifically Working Group 4 under the Radio Access Network (RAN) Technical Specifications Group (TSG), the adoption of a standardised approach aimed at considering all GNSS equally and on the basis of operational criteria (such as signal-noise ratio, number of satellites in view, etc.).

2. Internet of Things

The network of connected devices, known as Internet of Things (IoT), uses GNSS positioning, velocity and timing information. IoT has been growing fast in the recent years, leading to the development and deployment of location-aware connected applications and services, often before relevant standards have been put in place. This makes the definition of industry-wide standards challenging. GNSS is already considered in IoT solutions, but only at a basic level, i.e. as a sensor. Currently, the low end of the IoT market is extremely price-oriented and focused on minimal power consumption, so the use of GNSS is even more limited. Features that are already mature in other market segments, such as multi-constellation, are not implemented for IoT, despite clear performance gains. There is little room in current standards to leverage the EGNSS differentiators such as integrity (provided by EGNOS), authentication (provided by Galileo), and assistance of GNSS-based positioning. IoT reference architectures support positioning information, but only at a very basic level.

The main objective of the Commission's services for this segment is to promote the updating of current standards to support additional positioning specifications, such as integrity and authentication, which could then be leveraged by more demanding applications.

The specific activities consist of:

- Contributing to promoting the EGNSS expanded functionalities, aiming to include EGNSS in reference architectures designed for IoT applications. This entails working with ETSI and the Alliance for the Internet of Things Innovation (AIOTI) to promote GNSS use within IoT and in particular to support inclusion of authentication and position integrity (EGNSS differentiators) in OneM2M.
- Moreover, the Commission's services intend to establish, through ETSI, similar contacts with ISO/IEC JTC 1/SC 41 (also developing an IoT reference architecture),

as well as the Open Mobile Alliance, 3GPP and the Open Geospatial Consortium.

3. Connecting to the Public Administration

More and more interaction between citizens, enterprises and public administrations in Member States is happening via digital tools and platforms. This sometimes involves the use of positioning, navigation or timing information.

The main objectives for this market segment are to:

- leverage EGNSS technologies in order to develop innovative applications enabling digitalised procedures for commercial entities to interact with public administration, so as to gain operational efficiency;
- monitor and review the results of relevant projects in order to identify potentially promising areas where public administration applications could be enhanced by EGNSS.

The specific activities consist of:

- Contributing to promoting the standardisation of procedures (e.g. by leveraging Galileo for geo-tagged photos to declare parcel boundaries and types of crop cultivated within Land Parcel Identification System (LPIS) and in Integrated Administration and Control System (IACS)) underlying the Common Agriculture Policy (CAP), so as to harmonise solutions and modernise processes^{34,35}.
- Launching a study to identify, in the current clearing procedures involving containers and shipments entering EU customs gates via ship, train, truck or plane, any opportunity to introduce standardised solutions (i.e. hardware/software/applications) that would leverage the distinctive features of EU GNSS technologies (e.g. authentication, high precision encryption) in order to increase efficiency, cut costs, eliminate paperwork & introduce digitisation of flows, increase turnaround time³⁶.

(3) Intelligent infrastructures

GNSS is already used for Timing and Synchronisation (T&S) in many different applications, including in critical infrastructures. However, there are no standards in place for GNSS-based Timing and Synchronisation, although several standards refer to the use of GNSS for timing.

The role of GNSS is expected to become more prominent, because of many factors: in telecommunications, due to more stringent requirements in terms of timing accuracy; in

³⁴ Commission Implementing Regulation (EU) 2018/746 of 18 May 2018 amending Implementing Regulation (EU) No 809/2014 as regards modification of single applications and payment claims and checks.

³⁵ A technical trial will be carried out through a project financed on the basis of Annex to the Commission Implementing Decision on the financing of the European satellite navigation programmes and the adoption of the work programme for 2019, C(2019) 2527 final.

³⁶ Study commissioned by the Commission's services, on the basis of the Annex to the Commission Implementing Decision on the financing of the European satellite navigation programmes and the adoption of the work programme for 2019, C(2019) 2527 final.

finance, due to new regulations³⁷, and in power grids, because there is increasing demand for new power sources and more efficient distribution in the transition from traditional to smart grids.

Moreover, Galileo is important for strategic reasons: critical infrastructure in Europe that uses satellite navigation for timing and synchronisation currently depend largely on GPS. The additional use of Galileo timing and synchronisation services could, thanks to multi-frequency operation and Galileo differentiators, such as authentication, bring improved availability, resilience and redundancy to counter intentional and unintentional disruption of timing and synchronisation operations, and could contribute to making critical infrastructures in Europe gradually more independent from foreign satellite navigation systems.

The main objectives of the Commission's services for this market segments are:

- Facilitating the development of EGNSS timing and synchronisation receiver standards³⁸, through CEN/Cenelec.
- Analysing how those standards could contribute to the development of a conformity assessment scheme³⁹ that would help ensure use of EGNSS for timing and synchronisation by critical EU infrastructure⁴⁰.
- Monitoring and reviewing the results of relevant projects in order to identify potentially promising areas where public administration applications could be enhanced by EGNSS.

The specific activities consist of:

- Contributing to promoting, with CEN/Cenelec members, the awareness of the need for development of EGNSS T&S receiver standards among relevant bodies such as ISO/IEC at global level and ITU-T/ESMA at application level. Additionally, develop (as part of the Galileo research activities) Galileo-based, multi-frequency, timing receivers for critical infrastructure, along with the definition of requirements and architecture to implement and exploit relevant EGNSS features in receivers.
- Carrying out an impact assessment⁴¹ on the possible use of EGNSS for timing and synchronisation in critical infrastructure, and whether a conformity assessment scheme using standards would be needed⁴².

³⁷ e.g. Directive 2014/65/EU of the European Parliament and of the Council of 15 May 2014 on markets in financial instruments.

³⁸ Joint Communication to the European Parliament and the Council - Joint Framework on countering hybrid threats - a European Union response, JOIN (2016)18 final.

³⁹ See e.g. conformity assessment schemes: https://ec.europa.eu/growth/single-market/goods/building-blocks/conformity-assessment_en.

⁴⁰ Study commissioned by the Commission's services, on the basis of the Annex to the Commission Implementing Decision on the adoption of the work programme for 2018 and on the financing of the European satellite navigation programmes, C(2018) 3354 final.

⁴¹ https://ec.europa.eu/info/law/better-regulation/initiatives/ares-2019-554349_en.

- Performing technical analyses to solve open points on the usage of GNSS for timing and synchronisation applications (jamming and spoofing mitigation, T-RAIM (Timing Receiver Autonomous Integrity Monitoring) algorithms, Multi-GNSS timing solutions, feasibility analysis covering EGNSS compliance with timing and synchronisation requirements in critical infrastructures, etc.⁴³.

4. Conclusions

The EGNSS downstream standardisation incorporates various activities, both technical and awareness-raising, focused on promoting of the inclusion of Galileo and EGNOS in standards related to the use of their signals in different application areas and market segments.

The Commission's services will continue their ongoing downstream standardisation activities in each of the market segments, and particularly in the three priority areas, with the objective to further facilitate the integration of Galileo and EGNOS into user applications.

⁴² Study commissioned by the Commission's services, on the basis of the Annex to the Commission Implementing Decision on the financing of the European satellite navigation programmes and the adoption of the work programme for 2019, C(2019) 2527 final.

⁴³ Work carried out through Horizon 2020 project EGALITE, on the basis of Horizon 2020 Work Programme for 2016-2017 (see <https://cordis.europa.eu/project/rcn/101643/factsheet/en>).

LIST OF ACRONYMS

3GPP	Third Generation Partnership Project
ADS-B	Automatic Dependent Surveillance – Broadcast
AIOTI	Alliance for the Internet of Things Innovation
ANSP	Air Navigation Service Provider
ARAIM	Advanced Receiver Autonomous Integrity Monitoring
AUWP	Annual Union Work Programme for European Standardisation
CAA	Civil Aviation Authority
CAP	Common Agriculture Policy
CEN	European Committee for Standardisation
CENELEC	European Committee for Electrotechnical Standardisation
CER	Community of European Railway and Infrastructure Companies
Commission	European Commission
DFMC	Dual-Frequency Multi-Constellation
EASA	European Aviation Safety Agency
EC	European Commission
EGNOS	European Geostationary Navigation Overlay Service
EGNSS	European Global Navigation Satellite System
EIM	European Rail Infrastructure Managers
ELT	Emergency Locator Transmitter
ELT-DT	Emergency Locator Transmitter - Distress Tracking
EPTTOLA	European Passenger Train and Traction Operating Lessors' Association
ERA	European Union Agency for Railways
ERFA	European Rail Freight Association
ERTMS	European Rail Traffic Management System
ESA	European Space Agency
ESMA	European Securities and Markets Authority
ETSI	European Telecommunications Standards Institute
ETSO	European Technical Standard Order
EU	European Union
EUG	ERTMS Users Group
EUROCAE	European Organisation for Civil Aviation Equipment
GBAS	Ground Based Augmentation System
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GSA	European GNSS Agency
GSAP	Galileo Security Accreditation Panel
IACS	Integrated Administration and Control System
ICAO	International Civil Aviation Organisation
ICG	International Committee on GNSS
ICT	Information and Communications Technology
IEC	International Electrotechnical Commission
IMO	International Maritime Organisation
IoT	Internet of Things
ISO	International Organisation for Standardisation
ISO TC	ISO Technical Committee
ITS	Intelligent Transport Systems

ITU-T	International Telecommunication Union – Telecommunication Standardisation Sector
LBS	Location-Based Services
LPIS	Land Parcel Identification System
MASPS	Minimum Aviation System Performance Standards
MOPS	Minimum Operation Performance Standard
MS	Member States
R&D	Research and Development
R&D&I	Research and Development and Innovation
RAN	Radio Access Network
RED	Radio Equipment Directive
RTCA	Radio Technical Commission for Aeronautics
SARPs	Standards and Recommended Practices
SBAS	Satellite Based Augmentation System
SESAR	Single European Sky ATM Research
SoL	Safety of Life
T&S	Timing and Synchronisation
T-RAIM	Timing Receiver Autonomous Integrity Monitoring
TSG	Technical Specifications Group
UAM	Urban Air Mobility
UA	Unmanned Aircraft
UNISIG	Union industry of signalling
V2X	Vehicle-To-Everything
WG	Working Group