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EGNOS

EGNOS Safety of Life assisted service for Maritime users (ESMAS)

Service Definition Document

Issue 1.0

#EUSpace

DOCUMENT CHANGE RECORD

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EGNOS Safety of Life (SoL) assisted service for Maritime Users

Service Definition Document

Issue 1.0

The European Union Agency for the Space Programme
Produced this document under tasks entrusted
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1 Executive Summary

The European Geostationary Navigation Overlay Service (EGNOS) provides an augmentation service to the Global Positioning System (GPS) Standard Positioning Service (SPS). Today, 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. EGNOS will augment both GPS and Galileo in the future, using L1 and L5 (1176.45 MHz) frequencies.

The **E**GNOS **S**afety of Life (SoL) assisted service for **MA**ritime user**S** (**ESMAS**) is provided openly and is freely accessible without any direct charge. This service is tailored to maritime applications, however its performance and future evolution are driven by the priorities and needs of the existing EGNOS Safety of Life (SoL) service for Aviation. The operational use of this service may require specific authorisation by the relevant authorities in the application sectors concerned.

The purpose of this Service Definition Document is to give information on the ESMAS.

The document describes the EGNOS system architecture and Signal-In-Space (SIS) characteristics, the ESMAS service performance, and provides information on the established technical and organisational framework for the provision of this service. It is intended to be of use to Maritime authorities, Maritime Safety Information (MSI) providers, notification bodies, receiver manufacturers, equipment integrators, GNSS application developers and the final users of the ESMAS.

The document also includes complementary high level information on GNSS concepts, the GPS Service, the EGNOS System/Services, the EGNOS Management structure and EGNOS interfaces with users, as well as the minimum performance characteristics of the ESMAS.

This document is not intended to address EGNOS SoL Service for aviation users, Open Service (OS) nor EDAS performance. Information about the EGNOS SoL Service for aviation users is available in a separate document called the "EGNOS Safety of Life Service – Service Definition Document" (EGNOS SoL SDD [RD-06]); information about EGNOS OS is available in a separate document called the "EGNOS Open Service - Service Definition Document" (EGNOS OS SDD - [RD-07]), whilst information regarding EDAS can be found in the "EGNOS Data Access Service (EDAS) – Service Definition Document" (EDAS SDD – [RD-08]).

This document will be updated in the future as required in order to reflect changes and improvements to the ESMAS.

2 Introduction

Satellite navigation systems are designed to provide a positioning, navigation and timing service over a defined area with a certain degree of accuracy. However, a number of events (either internal to the system elements or external, due to environmental conditions) may lead to positioning errors that are in excess of the typically observed navigation errors. For a large variety of users, such errors will not be noticed or may have a limited effect on the intended application. However, for safety critical applications, they may directly impact the safety of operations. Therefore, there is an absolute need to correct such errors, or to warn the user in due time when such errors occur and cannot be corrected. For this reason, Satellite Based Augmentation Systems (SBAS) such as EGNOS have been designed to improve the performance of existing global constellations.

EGNOS (European Geostationary Navigation Overlay Service) currently provides augmentation to the Global Positioning System (GPS) Standard Positioning Service (SPS). EGNOS augments GPS using the L1 (1,575.42 MHz) Coarse/Acquisition (C/A) civilian signal function by broadcasting correction data and integrity information for positioning and navigation applications over Europe. EGNOS will augment both GPS and Galileo constellations in the future, using L1 and L5 (1,176.45 MHz) frequencies.

2.1 Purpose of the document

The purpose of this **Service Definition Document** (SDD) of the "**E**GNOS **S**oL assisted service for **MA**ritime user**S**" (ESMAS) is to present the characteristics of the service offered to users by the EGNOS SoL service for maritime at the time of publication highlighting the committed performance to suitably equipped maritime users using both the IS GPS broadcast signal [RD-04] and the ESMAS augmentation signal.

The document comprises the following sections:

- Section 1: Executive Summary.
- Section 2: Introduction. This section provides the purpose, the scope of the document and the terms and conditions of use of the ESMAS. It also provides a list of applicable and reference documents.
- Section 3: EGNOS system and services overview. This section provides a general description of the EGNOS system and its services.
- Section 4: ESMAS concept. This section defines the EGNOS SoL service for maritime.
- Section 5: ESMAS committed performance.
- Appendix A: this appendix includes ESMAS typical ranging and positioning performance.
- Appendix B: this appendix includes the list of acronyms and abbreviations.

2.2 Scope of the document

ESMAS performance commitments presented in this document shall be understood as minimum performance levels. In many situations, users can usually experience a better performance. The SDD also provides a characterization of typical performance, presented as indicative metrics and provided exclusively for reference. Such figures are expressed in statistical values

under the given assumptions listed in section 2.3.

Therefore, the ESMAS does not commit to the values provided in Appendix A.

This ESMAS SDD applies to the ESMAS as provided at the time of its publication.

The SDD for other EGNOS services are:

- [RD-06] for the EGNOS Safety of Life (SoL),
- [RD-07] for the EGNOS Open Service (OS), and
- [RD-08] for the EGNOS Data Access Service (EDAS).

2.3 Terms and conditions of use of the ESMAS

The ESMAS relies on:

- pseudorange and ionospheric corrections leading to increased accuracy in the position domain with respect to GPS L1 standalone solutions (see sections 4.1 and 4.2),
- the use of specific message types and alerts available in the EGNOS SIS (see section 4.3) and via Maritime Safety Information messages (see section 4.5),
- the use of receivers described in section 4.4,

The evaluation of the ESMAS committed performance contained in this SDD are conditioned upon certain assumptions. These assumptions are described in the following subsections.

2.3.1 End Users responsibilities

The end user is responsible for exercising a level of care appropriate to the use it intends to make of the ESMAS, taking into account the considerations outlined above and with the due respect thereof.

In particular, the users bear the responsibility to ensure that:

- type-approved receivers according to existing GPS standard IEC-61108-1 [RD-15] and the IEC standard for shipborne SBAS L1 maritime receiver IEC 61108-7 [RD-05] are used on their vessels;
- the receivers are compliant to the requirements defined in section 4.4;
- the resulting PVT (position, velocity and timing) data processing follows the recommended principles and functions (i.e. Guidelines for PNT data processing [RD-09], PVT output data stream in line with maritime interface standard [RD-10]);
- they carry the on-board equipment required for the SOLAS ships [RD-12] to be able to receive Maritime Safety Information (MSI) [RD-11] (i.e. Notice to Mariners / Navigational Warnings).

By using the ESMAS, end users acknowledge the information contained in this document and confirm their understanding on how the service shall be used, as well as confirm their familiarity with the performance level and other aspects of the service they can rely on.

Disclaimer of liability

As the owner of EGNOS system, the European Union - including any of its institutions, offices or agencies, such as the EC, EUSPA as EGNOS Programme manager and the ESMAS Service Provider, respectively - do not offer any warranties of any kind (whether expressed or implied) to any party with respect to the service subject of this Definition Document (the ESMAS), including -but not limited to- the warranties regarding availability, accuracy, integrity, reliability and fitness for a particular purpose or meeting the users' requirements, with the sole exception of the commitments (addressed in section 5) with the users using receivers (specified in section 4.4) under the end user responsibilities (specified in section 2.3.1) within the service area specified in section 5.1 and considering the service is broadcast via GEO satellite ONLY. No advice or information, whether oral or written, obtained by a user from the European Union - including any of its institutions, offices or agencies, such as the EC, EUSPA, and other entities acting on the basis of a contract or agreement with the European Union involved in the ESMAS provision - shall offer or commit to offering any such warranty and consequently, be held liable for committing to or offering any such warranty.

By using the ESMAS, the user accepts and agrees that the European Union - including any of its institutions, offices or agencies, such as the EC, EUSPA, and other entities acting on the basis of a contract or agreement with the European Union involved in the ESMAS - shall not be held responsible or liable for any indirect, special or consequential damages resulting from the use of, misuse of, or inability to use the ESMAS, including - but not limited to - damages for interruption of business, loss of profits, goodwill or other intangible losses, other than in accordance with Article 340 of the Treaty on the Functioning of the European Union.

Furthermore, no party shall be entitled to any claim against the European Union and/or the EUSPA if the damage is the result, or the consequence, of any of the following events:

- Use of the ESMAS beyond the conditions and limitations of uses set forth in the ESMAS SDD, or;
- Use of equipment or receivers (as defined in section 4.4) which are either:
  - Not fully compliant with the ESMAS receiver requirements stated in the IEC standard [RD-05], or;
  - Not certified or approved by the relevant competent authority, or;
  - Malfunctioning, or;
- Use of the ESMAS corrections not broadcast via EGNOS GEO satellites, or;
- Use of the ESMAS outside the service area defined in section 5.1, or;
- Use of the ESMAS when a test message is broadcast (a Message Type 0/0 or a Message Type 0/2, or;
- Use of the ESMAS for navigation assuming performance other than the ones detailed in section 5, or;
- Use of the ESMAS for navigation assuming SIS or positioning level performance based on the modelling of locally generated errors and feared events which are the solely responsibility of the maritime users, or;
- In case of a Force Majeure event (i.e. extraordinary event or circumstance beyond control, such as a war, strike, riot, crime, epidemic, or sudden legal change).

2.4 Reference documents

Table 2-1 - Reference Documents.

RD	Document Title
RD-01	ICAO Standards and Recommended Practices (SARPs) Annex10 Volume I (Radio Navigation Aids) Volume I - July 2023 – Amendment #93 https://store.icao.int/en/annex-10-aeronautical-telecommunications-volume-i-radio-navigational-aids
RD-02	Minimum Operational Performance Standards for Global Positioning System/Satellite-Based Augmentation System Airborne Equipment Issue: RTCA DO-229F; Date: 11/06/2020 https://www.rtca.org/
RD-03	GPS Standard Positioning Service Performance Standard – April 2020 5th Edition https://www.gps.gov/technical/ps/2020-SPS-performance-standard.pdf
RD-04	IS GPS 200– NAVSTAR GPS Space Segment / Navigation User Interface – Revision K, 6 May 2019 https://www.gps.gov/technical/icwg/IS-GPS-200K.pdf
RD-05	IEC 61108-7 Maritime navigation and radiocommunication equipment and systems - Global navigation satellite systems (GNSS) - Part 7: Satellite Based Augmentation System (SBAS) L1 – Receiver equipment – Performance standards, methods of testing and required test results. Version in force. https://www.iec.ch/homepage
RD-06	EGNOS Safety of Life (SoL) Service Definition Document Issue 3.5. Date: 23/11/2023 https://egnos.gsc-europa.eu/sites/default/files/documents/egnos_sol_sdd_in_force.pdf
RD-07	EGNOS Open Service (OS) Service Definition Document Issue 2.3. Date: 03/10/2017 https://egnos.gsc-europa.eu/sites/default/files/documents/egnos_os_sdd_in_force.pdf
RD-08	EGNOS Data Access Service (EDAS) Service Definition Document Issue 2.3. Date: 13/09/2022

RD	Document Title
	https://egnos.gsc-europa.eu/sites/default/files/documents/egnos_edas_sdd_in_force.pdf
RD-09	IMO MSC.1/ Circ. 1575. IMO Guidelines for shipborne position, navigation and timing (PNT) data processing. June 2017 wwwcdn.imo.org/localresources/en/OurWork/Safety/Documents/IMO Documents related to/MSC.1-Circ.1575.pdf
RD-10	IEC 61162 Maritime navigation and radiocommunication equipment and systems – Digital interfaces. 2018 https://webstore.iec.ch/publication/63098
RD-11	Joint IMO/IHO/WMO Manual on Maritime Safety Information (MSI) https://iho.int/uploads/user/Inter-Regional%20Coordination/WWNWS/ Relevant%20MSI%20Publications%20and%20Documents/English/MSC_Circ1310.pdf
RD-12	IMO International Convention for the Safety of Life at Sea (SOLAS), 1974 https://www.imo.org/en/About/Conventions/Pages/International-Convention-for-the-Safety-of-Life-at-Sea-(SOLAS),-1974.aspx
RD-13	IMO resolution A.1046 (27) Date: 30 November 2011 https://wwwcdn.imo.org/localresources/en/KnowledgeCentre/IndexofIMOResolutions/ Documents/A%20-%20Assembly/1046(27).pdf
RD-14	Validation of GNSS-derived global ionosphere maps for different solar activity levels: case studies for years 2014 and 2018 Date: 16/05/2021 https://link.springer.com/content/pdf/10.1007/s10291-021-01142-x.pdf
RD-15	IEC 61108-1 Maritime navigation and radiocommunication equipment and systems – Global navigation satellite systems (GNSS) – Part 1: Global positioning system (GPS) – Receiver equipment – Performance standards, methods of testing and required test results Second edition 2003-07 https://webstore.iec.ch/publication/4515
RD-16	13th meeting of the IHO SUB-COMMITTEE ON THE WORLD-WIDE NAVIGATIONAL WARNING SERVICE (WWNWS13) Date: September 2021 https://iho.int/uploads/user/Inter-Regional%20Coordination/WWNWS/WWNWS13/ WWNWS13_2021_7_EN_Full_Final_Report_v2.0.pdf

RD	Document Title
RD-17	IALA Guideline 1005 https://www.iala-aism.org/product/g1005/
RD-18	Marine Equipment Directive 96/98/EC https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:31996L0098
RD-19	Marine Equipment Directive 2014/90/EU https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32014L0090
RD-20	REGULATION (EU) 2021/696 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 28 April 2021 establishing the Union Space Programme and the European Union Agency for the Space Programme and repealing Regulations (EU) No 912/2010, (EU) No 1285/2013 and (EU) No 377/2014 and Decision No 541/2014/EU https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32021R0696

3 Description of the EGNOS system and services overview

3.1 EGNOS: the European SBAS

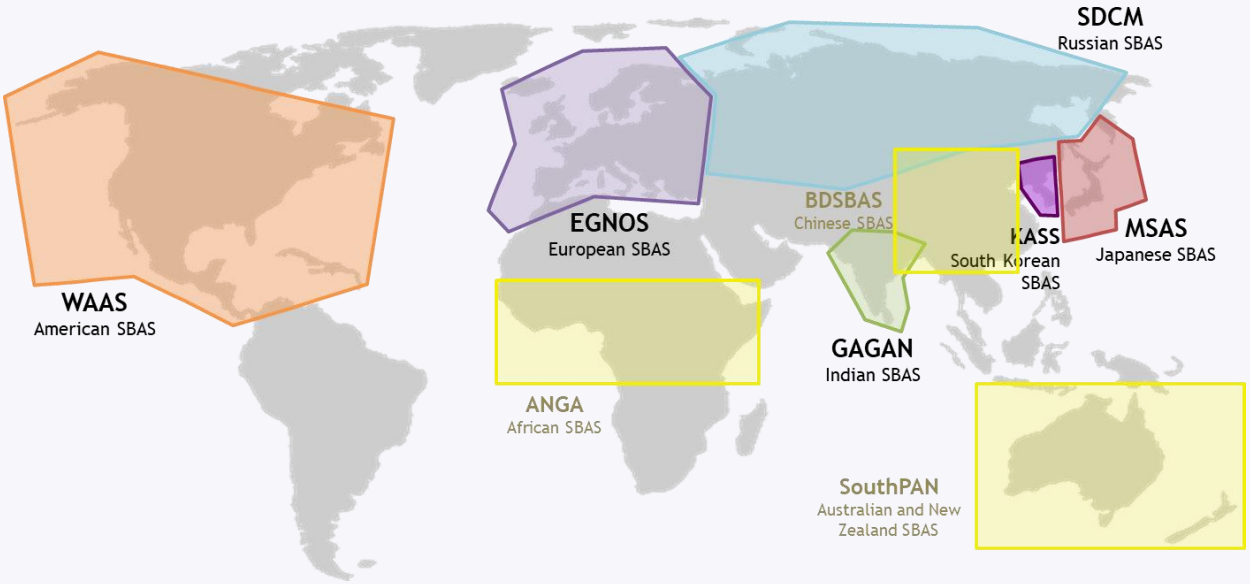
Satellite navigation systems are designed to provide a positioning and timing service over vast geographical areas (typically continental or global coverage) with high accuracy performance. However, a number of events (either internal to the system elements or external, due to environmental conditions) may lead to positioning errors that are in excess of the typically observed navigation errors. For a large variety of users, such errors will not be noticed or may have a limited effect on the intended application. However, for a number of user communities, they may directly impact the quality of operations. Therefore, there is an absolute need to correct such errors, or to warn the user in due time when such errors occur and cannot be corrected. For this reason, augmentation systems have been designed to improve the performance of existing global constellations.

EGNOS is a Satellite Based Augmentation System (SBAS). SBAS systems are designed to augment the navigation system constellations by broadcasting additional signals from geostationary (GEO) satellites. The basic scheme is to use a set of monitoring stations (at very well-known positions) to receive the navigation signals from core GNSS constellations that will be processed in order to obtain some estimations of these errors that are also applicable to the users (e.g. ionospheric errors and satellite position/clock errors). Once these estimations have been computed, they are transmitted in the form of "differential corrections" by means of a GEO satellite. Today, EGNOS augments GPS signals and will augment Galileo signal in the future.

Along with these correction messages which increase accuracy, some integrity data for the satellites that are in view of this network of monitoring stations and for the Ionospheric Grid Points visible from the service area are also broadcast, increasing the confidence that a user can have in the satellite navigation positioning solution.

EGNOS is part of a developing multi-modal inter-regional SBAS service, able to support a wide spectrum of applications in many different user communities, such as maritime, aviation, rail, road, agriculture. Similar SBAS systems, designed according to the same standard (i.e. SARPs [RD-01]), have already been commissioned by the US (Wide Area Augmentation System – WAAS), Japan (MTSAT Satellite based Augmentation System – MSAS) and India (GPS Aided GEO Augmented Navigation – GAGAN). Analogous systems are under commissioning or deployment in other regions of the world (e.g. System of Differential Correction and Monitoring – SDCM - in Russia, Korea Augmentation Satellite System – KASS - in Republic of Korea, BeiDou SBAS – BDSBAS - in China, Southern Positioning Augmentation Network - SouthPAN - in Australia and New Zealand, and African Satellite Augmentation System – ANGA in Africa and Indian Ocean) or under investigation (e.g. Central-Caribbean and South America). EGNOS provides services to European Union Member States (EU-MS). The worldwide existing and planned SBAS systems are shown in Figure 3-1.

Figure 3-1 - Existing and planned SBAS systems



In addition, EGNOS plans to extend their service areas to neighbouring regions, thus paving the way for near global SBAS coverage.

3.2 EGNOS services

EGNOS provides corrections and integrity information to GPS signals over a broad area centred over Europe and it is fully interoperable with other existing SBAS systems.

EGNOS provides three services:

- **Safety of Life (SoL) service**, that provides the most stringent level of signal-in-space performance to all Safety of Life user communities, in particular for the aviation sector; as part of the SoL service, the **SoL assisted service for Maritime users,** which is the service defined in this document, provides characterisation of typical performance at GNSS Signal In Space (SIS) and positioning level;
- **Open Service (OS)**, freely available to any user;
- **EGNOS Data Access Service (EDAS)** for users who require access to specific GNSS data streams for the provision of added-value services, professional applications, commercial products, R&D, etc.

SoL, ESMAS and OS services are transmitted by GEO SIS whereas EDAS is provided by internet access.

All these EGNOS services are available and granted throughout their respective service areas.

3.2.1 EGNOS Safety of Life (SoL) service

The main objective of the EGNOS SoL service is to support civil aviation operations down to Localiser Performance with Vertical Guidance (LPV) minima. In order to provide the SoL Service, the EGNOS system has been designed so that the EGNOS Signal-In-Space (SIS) is compliant to the ICAO SARPs for SBAS [RD-01].

Two EGNOS SoL Service levels (NPA and APV-I) were declared with the first issue of

the EGNOS SoL SDD v1.0 in March 2011 and an additional one (LPV-200) was declared with the EGNOS SoL SDD v3.0 in September 2015 enabling the following SBAS-based operations in compliance with requirements as defined by ICAO in Annex 10 [RD-01]:

- Non-Precision Approach operations and other flight operations supporting PBN navigation specifications other than RNP APCH, not only for approaches but also for other phases of flight.
- Approach operations with Vertical Guidance supporting RNP APCH PBN navigation specification down to LPV minima as low as 250 ft.
- Category I precision approach with a Vertical Alert Limit (VAL) equal to 35m and supporting RNP APCH PBN navigation specification down to LPV minima as low as 200 ft.

The EGNOS SoL Service has been available since March 2nd 2011 and the corresponding SDD is [RD-06], which defines a model for an aviation receiver bounding the local errors for an aircraft in flight. The receiver, based on this model, uses the EGNOS data to compute a high confidence bound on the residual error in the navigation solution (user level integrity) and compares it to a pre-established tolerance to determine whether the service can be used operationally or not within a limited geographical area, called the service area. This high confidence bound together with the capacity to warn the user within a specific time (time to alert) is what has been defined as SBAS integrity (i.e., a measure of the trust that can be placed in the correctness of the information supplied by SBAS, including its ability to provide timely and valid warnings to the user (alerts)).

3.2.1.1 ESMAS

In an operational environment a vessel travels close to various obstacles for the GNSS signals: buildings, port infrastructure, other vessels or even bridges, that create multipath, interference or blockages of satellite signals. As such, the SBAS integrity model mentioned above is not valid for maritime applications. Current PVT user solutions usually rely on GNSS complemented by a variety of sensors and/or sensor fusion techniques to offer accuracy and a certain level of confidence in the position for safety purposes.

The ESMAS offers a service tailored to maritime users to enable marine navigation in harbour entrances, harbour approaches and coastal waters of the European Union Member States and EGNOS contributing countries (Iceland, Norway and Switzerland) in line with IMO Resolution A.1046 [RD-13].

This service targets a large variety of users. It provides certain performance that the corrections being broadcast shall or shall not be used and up to which extent. Therefore, it increases the confidence that a user can have in the satellite SIS information. The receiver manufacturer will be responsible to combine this information with other sensor(s) to compute the navigation position and the associated confidence levels.

More information about the ESMAS concept can be found in section 4.

3.2.2 EGNOS Open Service (OS)

The main objective of the EGNOS OS is to improve the achievable positioning accuracy by correcting several error sources affecting the GPS signals. 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 wide area augmentation system. Finally, EGNOS can also detect distortions affecting the signals transmitted by GPS and prevent

users from tracking unhealthy or misleading signals.

The EGNOS OS is accessible in Europe to any user equipped with an appropriate GPS/SBAS compatible receiver for which no specific receiver certification is required.

The EGNOS OS has been available since 1st October 2009 and the corresponding SDD is [RD-07].

3.2.3 EGNOS Data Access Service (EDAS)

EDAS is the EGNOS terrestrial data service which offers ground-based access to EGNOS data in real time and also in a historical FTP archive to authorised users (e.g. added-value application providers). EDAS is the single point of access for the data collected and generated by the EGNOS ground infrastructure (RIMS and NLES) mainly distributed over Europe and North Africa.

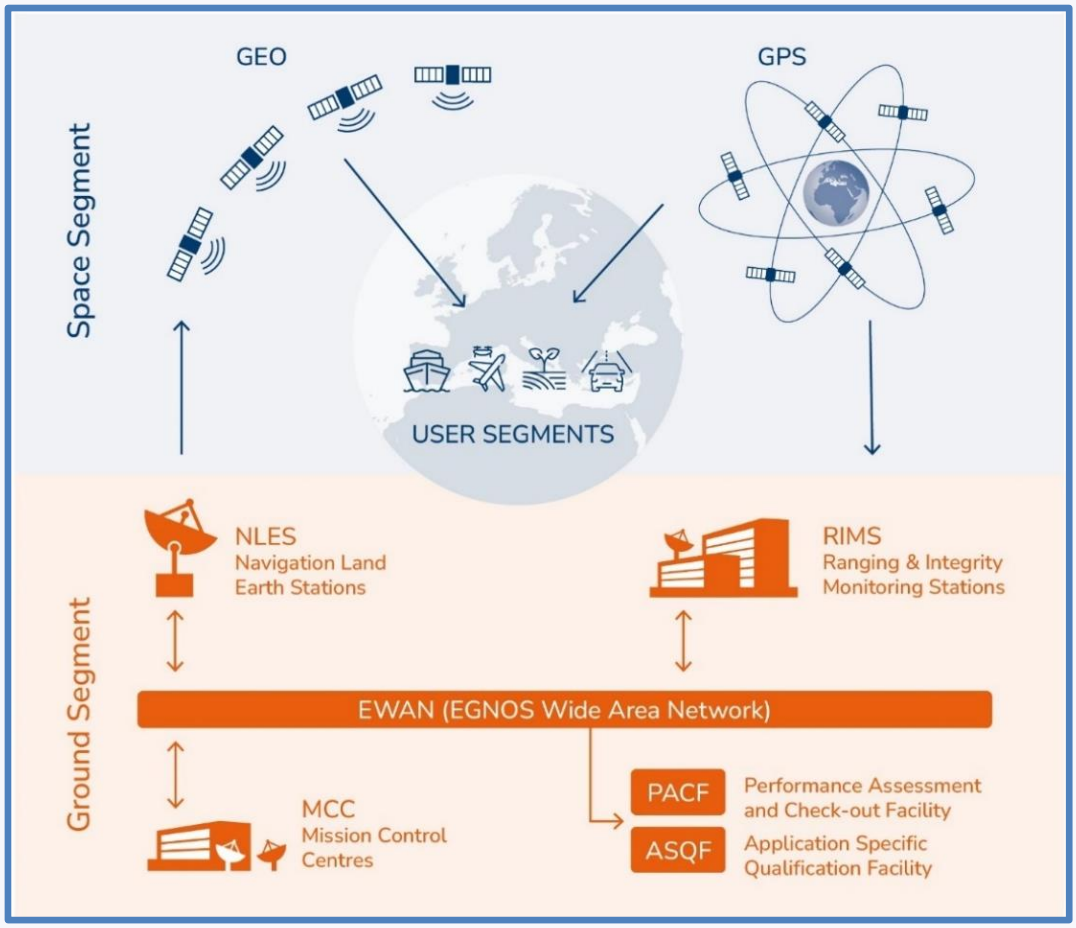
EDAS users and/or application Providers will be able to connect to EDAS, and directly exploit the EGNOS products or offer added-value services based on EDAS data.

The EDAS service is available since July 26th 2012 and the corresponding SDD is [RD-08].

3.3 EGNOS architecture

In order to provide its services to users equipped with appropriate receivers, the EGNOS system comprises three main segments: the Space Segment, the Ground Segment and the User Segment. EGNOS functional architecture is shown in Figure 3-2.

Figure 3-2 - EGNOS architecture.



3.3.1 EGNOS space segment

The EGNOS space segment comprises at least 3 geostationary (GEO) satellites broadcasting corrections and integrity information for GPS satellites in the L1 frequency band (1575.42 MHz). The configuration of the GEOs in operation does not change frequently but possible updates are nevertheless reported to users by the EGNOS Service Provider. At the date of publication, the 3 GEOs used by EGNOS are the following ones.

Table 3-1 - GEOs used by EGNOS.

GEO Name	PRN Number	Orbital Slot
ASTRA-5B	PRN 123	**23.5 E**
ASTRA SES-5	PRN 136	**5 E**
EUTELSAT 5West B[1]	**PRN 121**	**5 W**

This space segment configuration provides a high level of redundancy over the whole service area in case of a geostationary satellite link failure. The EGNOS operations are handled in such a way that, at any point in time, at least two of the GEOs broadcast an operational signal and the other one broadcasts a test signal. This secures a switching capability in case of interruption and ensures a high level of continuity of service.

The detailed configuration of operational and test satellites is reported in the EGNOS User Support webpage[2].

The EGNOS space segment is constantly replenished over time in order to maintain the required level of redundancy. The exact orbital location of future satellites may vary, though this will not impact the service offered to users. Similarly, different PRN code numbers may be assigned to future GEOs.

It is important to remark that these changes in the EGNOS GEO space segment are performed in a seamless manner without any interruption from an EGNOS user point of view and without compromising at any moment the EGNOS performances. For this purpose, and whenever there could be any relevant information complementing the SDD, an EGNOS Service Notice is published[3] and distributed.

3.3.2 EGNOS ground segment

The EGNOS Ground Segment comprises a network of Ranging Integrity Monitoring Stations (RIMS), two Mission Control Centres (MCC), two Navigation Land Earth Stations (NLES) per GEO, and the EGNOS Wide Area Network (EWAN) which provides the

[1] At the time of publication of this document, EUTELSAT 5 West B is used for testing purposes and broadcasts Message Type 0 indicating it cannot be used for SoL applications by the certified receivers.

[2] https://egnos.gsc-europa.eu/

[3] https://egnos.gsc-europa.eu/documents/field_gc_document_type/service-notices-87

communication network for all the components of the ground segment.

Two additional facilities are also deployed as part of the ground segment to support system operations and service provision, namely the Performance Assessment and Checkout Facility (PACF) and the Application Specific Qualification Facility (ASQF), which are operated by the EGNOS Service Provider.

3.3.2.1 Ranging Integrity Monitoring Stations (RIMS)

The main function of the RIMS is to collect measurements from GPS satellites and to transmit these raw data every second to the Central Processing Facilities (CPF) of each MCC. The current RIMS network comprises 38 RIMS sites located over a wide geographical area described in Figure 3-3.

Figure 3-3 - EGNOS RIMS sites

3.3.2.2 Central Processing Facility (CPF)

The Central Processing Facility (CPF) is a module of the MCC that uses the data received from the network of RIMS stations to:

1) Elaborate clock corrections for each GPS satellite in view of the network of RIMS stations. These corrections are valid throughout the geostationary broadcast area (i.e. wherever the EGNOS signal is received).
2) Elaborate ephemeris corrections to improve the accuracy of spacecraft orbital positions. In principle, these corrections are also valid throughout the geostationary broadcast area. However, due to the geographical distribution of the EGNOS ground monitoring network, the accuracy of these corrections will degrade when moving away from the core of the EGNOS service area.
3) Elaborate a model for ionospheric errors over the EGNOS service area in order to compensate for ionospheric perturbations to the navigation signals.

These three sets of corrections are then broadcast to users to improve positioning accuracy.

In addition, the CPF estimates the residual errors that can be expected by the users once they have applied the set of corrections broadcast by EGNOS. These residual errors are characterised by two parameters:

- User Differential Range Error (UDRE): this is an estimate of the residual range error after the application of clock and ephemeris error correction for a given GPS satellite.
- Grid Ionospheric Vertical Error (GIVE): this is an estimate of the vertical residual error after application of the ionospheric corrections for a given geographical grid point.

These two parameters can be used to determine an aggregate error bounded by the horizontal and vertical position errors. Such information is of special interest for Safety of Life users but may also be beneficial to other communities needing to know the uncertainty in the position determined by the user receiver.

Finally, the CPF includes a large number of monitoring functions designed to detect any anomaly in GPS and in the EGNOS system itself and is able to warn users within a very short timeframe (less than Time To Alert (TTA)) in case of an error exceeding a certain threshold. These monitoring functions are tailored to the Safety of Life functions and will not be further detailed in this document.

3.3.2.3 Navigation Land Earth Stations (NLES)

The messages elaborated by the CPF are transmitted to the NLESs. The NLESs (two for each GEO for redundancy purposes) transmit the EGNOS message received by the CPF to the GEO satellites for broadcast to users and to ensure the synchronisation with the GPS signal.

The NLES are grouped by pairs, pointing to a Geostationary satellite. For each GEO, one NLES is active (broadcasts) and the other in Back-up mode.

The main functions of the NLES include:

- the selection of the CPF that broadcasts the SBAS message,
- the modulation of the message provided by the CPF,
- the synchronization of the uplink signal with GPS time,
- the transmission of the data to the GEO satellites,

- monitoring that the received signal from the GEO satellites is the one transmitted and within certain power levels.

3.3.2.4 Central Control Facility (CCF)

The EGNOS system is controlled through a Central Control Facility (CCF) located in each of the Mission Control Centres. These facilities are manned on a 24/7 basis in order to ensure permanent service monitoring and control.

3.3.3 EGNOS user segment

The user segment consists of the user equipment that processes the received signals from the GNSS satellites (EGNOS and GPS) and uses them to derive and apply position, time and integrity information. The equipment ranges from smartphones and handheld receivers, to sophisticated, specialized receivers used for high-end safety critical applications.

The particular user equipment for the EGNOS Safety of Life assisted service for maritime users is detailed in section 4.4.

3.4 EGNOS Signal In Space (SIS)

The EGNOS Signal In Space format is compliant with the ICAO SARPs for SBAS [RD-01].

3.5 EGNOS Organisational Framework

3.5.1 Bodies involved in the EGNOS programme and service delivery

The European Union (EU) is the owner of the EGNOS system.

The European Union Agency for the Space Programme (EUSPA) is the ESMAS Service Provider.

As per the EU Space Regulation [RD-20]:

- The European Commission has the overall responsibility for the implementation of the EGNOS Programme, including for security and determines the priorities and long-term evolutions.
- The European Union Agency for the Space Programme (EUSPA) is in charge of the EGNOS exploitation and - according to the Financial Framework Partnership Agreement between the European Commission representing the European Union, EUSPA and ESA- acts as System Prime for the System in Operations for EGNOS, i.e. is responsible for maintenance changes and mid-term improvement of the System in operations.
- ESA is in charge of the System evolution and - according to the Financial Framework Partnership Agreement between the European Commission representing the European Union, EUSPA and ESA- acts as Design Authority, i.e. holds the technical responsibility of the system baseline, design integrity and consistency including for the System in Operations.

3.5.2 How to get information on EGNOS and EGNOS applications

Detailed information about the EGNOS programme, EGNOS system status, and EGNOS services performance can be found by accessing the sources listed in Table 3-2.

Table 3-2 - Where to find information about EGNOS.

Topic and Organisation Responsible	Description and Web/contact details
EGNOS Programme **EC**	EC institutional information about the EGNOS Programme http://ec.europa.eu/growth/sectors/space/egnos/
What is EGNOS? **EUSPA**	General information related to EGNOS Programme. https://www.euspa.europa.eu/european-space/egnos/what-egnos
EGNOS Safety of Life assisted service for maritime users and EDAS User Support Website and Helpdesk **EUSPA**	ESMAS User support Website is the main source of information for ESMAS and EDAS status and performance, system description, historical and real time services performance, forecasts, applicable documentation, FAQs, etc. The helpdesk is accessible on-line through the website and also by e-mail and by phone. It is the direct point of contact for any question related with ESMAS service, including performance and applications. https://edas-maritime.gsc-europa.eu helpdesk@edas-maritime.gsc-europa.eu Helpdesk line : +34 911 236 555
EGNOS User Support and Helpdesk **ESSP**	EGNOS user support website is the main source of information for EGNOS OS and EGNOS SoL aviation users: EGNOS OS and EGNOS SoL aviation status and performance, system description, historical and real time services performance, forecasts, EGNOS OS and EGNOS SoL aviation applicable documentation, FAQs, etc. The helpdesk is accessible on-line through the website and also by e-mail and by phone. It is the direct point of contact for any question related with the EGNOS OS and EGNOS SoL aviation services, including performance and applications. https://egnos.gsc-europa.eu helpdesk@egnos.gsc-europa.eu Helpdesk line: +34 911 236 555
EGNOS app **ESSP**	Direct point of contact for any question related with the EGNOS system, its performance and applications. https://itunes.apple.com/app/egnos/id1346540596?ls=1&mt=8 https://play.google.com/store/apps/details?id=com.essp.egnosapp

4 ESMAS overview

The ESMAS (EGNOS Safety of Life (SoL) assisted service for Maritime Users) is an application of the EGNOS SoL service to type approved equipped shipborne receivers (certified according to IEC 61108-7 standard [RD-05] for SBAS L1 receiver equipment) taking advantage of both the GPS Standard Positioning Service (SPS) broadcast signal and EGNOS messages to compute an enhanced positioning and navigation solution with navigational status indications to support a safe navigation.

The EGNOS Safety-of-Life (SoL) service was designed considering the environmental conditions of an aircraft in flight; as such, EGNOS corrections are used in the aviation domain to obtain a positioning and navigation service at user level with a level of trust (i.e. integrity on the user position).

However, in other sectors such as maritime, due to their specific environmental conditions, masking of satellites and multipath at user-level, the EGNOS SoL integrity concept cannot ensure the trust in the navigation solution like it does for aviation. Therefore, the receiver manufacturers usually combine GNSS data with other on-board sensors when computing their position, to meet the required operational requirements. For this reason, ESMAS provides performance commitments related to the EGNOS contribution to the integrated solution.

The final positioning-level performance based on the modelling of locally generated errors and feared events, such as multipath, non-line-of-sight signals, etc. with proper overbounding, shall be the solely responsibility of the maritime user. This document provides only indicative performance based on reference user models for information.

This section provides a high-level description of the ESMAS, including definitions and minimum service usage assumptions:

- Subsection 4.1 provides background information about pseudorange and ionosphere concepts.
- Subsection 4.2 provides the exact definition of SIS Ranging Error. Note that the service is aimed at this stage at providing typical performance on the accuracy of the SIS residual errors.
- Subsection 4.3 provides a high-level overview of the ESMAS SIS interface, including alerts.
- Subsection 4.4 describes the end users' receivers and usage assumptions for the ESMAS.
- Subsection 4.5 provides a high-level overview of the ESMAS Maritime Safety Information proposal notification service.

4.1 Pseudorange and ionosphere concepts

According to [RD-01], the pseudorange is defined as the difference between the time of transmission by a satellite and the time of reception by a GNSS receiver multiplied by the speed of light in a vacuum, including bias due to the difference of time reference between a GNSS receiver and the satellite clocks. Therefore, it is an approximation of the distance between a satellite and a GNSS receiver.

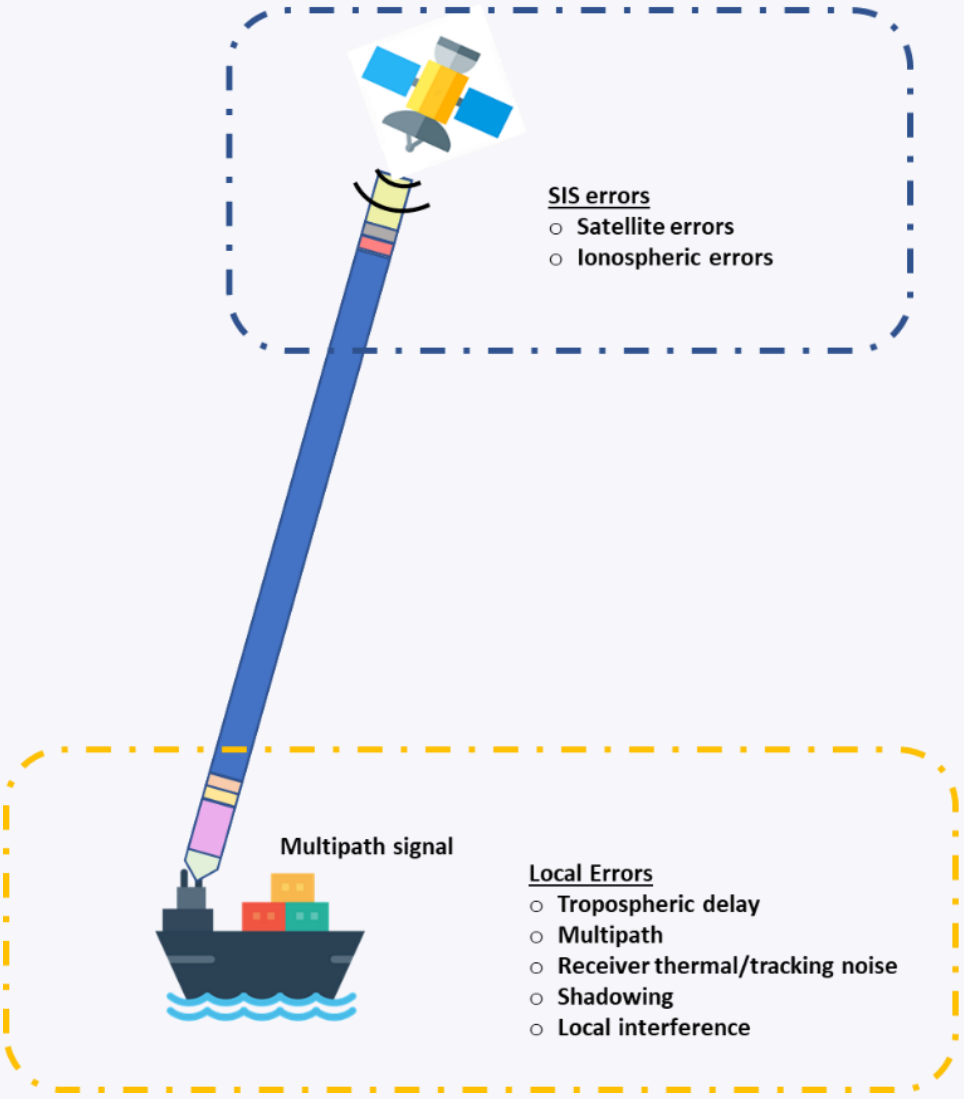
The resulting distances are not only related to the distance between the receiver antenna and the satellites, i.e. the range, but also to an imperfect alignment of the receiver's time scale to the Galileo and GPS time scales, they are therefore called pseudoranges.

A GNSS receiver processes the individual satellite pseudorange measurements and combines them to compute an estimate of the user position (latitude, longitude, altitude and user clock bias). The process by which this combination shall be performed by a shipborne receiver can be found in the IEC61108-7 standard [RD-05].

The ionosphere is an ionized layer of the atmosphere located a few hundred kilometres above the surface of the Earth. When the satellite navigation signals go through the ionosphere, they are perturbed in such way that disturbance is directly translated in range measurement errors at the receiver level. The size of the error will depend on the level of solar activity (peaks in the solar activity occur on approximately an 11-year cycle) and on the satellite elevation above the horizon. For a low elevation satellite (5° above the horizon or below), the error affecting the measurement is about 3 times larger than the error affecting a satellite seen at the zenith.

The estimation of the satellite-to-user range is based on the measurement of the propagation time of the signal (which is depicted in Figure 4-1).

Figure 4-1 - GNSS signal pseudorange measurements content and potential sources of error



When combining the range measurements from the different satellites in view to compute the user position, the variance of the estimated error for non-failed satellites are modelled as the sum of the squares of residuals of the different components, [RD-05]:

$$\sigma_i^2 = \sigma_{i,flt}^2 + \sigma_{i,UIRE}^2 + \sigma_{i,ship}^2 + \sigma_{i,tropo}^2$$

Where

- i is the ith satellite,
- $\sigma_{i,flt}^2$ is the fast and long-term correction residual variance,
- $\sigma_{i,UIRE}^2$ is the ionospheric delay estimation error,
- $\sigma_{i,ship}^2$ is the shipborne receiver errors variance estimation,
- $\sigma_{i,tropo}^2$ is the tropospheric delay estimation errors.

Residual errors related to clock, orbit and ionosphere are recommended to be derived from sigmas ($\sigma_{i,flt}^2$ and $\sigma_{i,UIRE}^2$) provided by the SBAS messages, whereas the estimate of remaining residuals ($\sigma_{i,ship}$ and $\sigma_{i,tropo}$) are the responsibility of the receiver manufacturer.

4.2 SIS Ranging Error

GNSS SIS data validity and reliability are key for maritime receiver manufacturers and users in maritime applications that intend to combine GNSS measurements or corrections with other sensors at range level.

The accuracy performance at range level is characterised by two parameters, the User Differential Range Error (UDRE) and the Grid Ionospheric Vertical Error (GIVE):

- UDRE is an estimate of the residual range error after the application of clock and ephemeris error corrections for a given GPS satellite and excluding atmospheric effects and receiver errors. In this case the User Differential Range Error Indicator (UDREI) provided by EGNOS is used to compute the standard deviation of a normal distribution associated with the satellite residual error (σ_{UDRE}) after fast and long-term corrections have been applied.
- GIVE is an estimate of the vertical residual error after application of the ionospheric corrections for a given geographical grid point. The Grid Ionospheric Vertical Error Indicator (GIVEI) is used to compute the standard deviation of a normal distribution associated with the residual ionospheric vertical error (σ_{GIVE}) at an Ionospheric Grid Point (IGP) for an L1 signal.

The ESMAS provides typical performance in the range domain in Appendix A.

4.3 Signal In Space

This section provides an overview of the EGNOS SIS interface characteristics, related to carrier and modulation radio frequency and structure.

4.3.1 EGNOS SIS RF characteristics

The EGNOS GEO satellites transmit right-hand circularly polarised (RHCP) signals in the L band at 1575.42 MHz (L1). The broadcast signal is a combination of a 1023-bit PRN navigation code of the GPS family and a 250 bits per second navigation data message carrying the corrections and integrity data elaborated by the EGNOS ground segment.

The EGNOS SIS is such that, at all unobstructed locations near ground level from which the satellite is observed at an elevation angle of 5 degrees or higher, the level of the received RF signal at the output of a 3dBi linearly polarised antenna is within

the range of –161dBW to –153dBW for all antenna orientations orthogonal to the direction of propagation.

The ESMAS radio frequency characteristics listed above are compliant to IEC-61108-7 standard [RD-05] and ICAO SARPs [RD-01].

4.3.2 EGNOS SIS messages

The EGNOS SIS navigation data is composed of a number of different Message Types (MT). The format and detailed information on the content of the listed MTs and their use at SBAS maritime receiver level are indicated in the IEC standard [RD-05].

It is important to remark that:

The accuracy of corrections for each satellite is defined through the UDRE (User Differential Range Error) and broadcast through the UDREI (UDRE Indicator) field in the Fast Correction Messages (MT 2 to 6) and MT 24 (which includes fast and long-term corrections) as follows:

- **Use**: the ESMAS user shall consider UDREI values < 12 as usable. UDREI 11 represents an associated value of σ^2_{UDRE} equal to 20.7870 m^2.
- **Don't use for maritime applications**: the ESMAS user shall not consider UDREI values ≥ 12 as usable in the solution.

The ionospheric corrections are defined by the Grid Ionospheric Vertical Delay (GIVE) and the GIVEi (GIVE indicator) and broadcast through Message Type 26. The status of the IGP is defined as follows:

- **Use:** the ESMAS shall consider GIVEI values < 15 for an IGP as usable.
- **Don't use for maritime applications:** the ESMAS user shall not consider GIVEI=15 or a vertical delay equal to 63.875m value in the solution.

4.3.3 Alerts

The **ESMAS** provides:

- **System Alerts**: If the EGNOS GEO broadcasts a Message Type 0, it indicates that the ESMAS information broadcast by that GEO is not adequate for safety applications driven by aviation requirements and that maritime users cannot take benefit from. The reception of a Message Type 0 will result in the cessation of the use of that SBAS GEO for all maritime applications.
- **Satellite Alerts:** The status of each satellite in the UDRE broadcast through the Fast Correction Messages (MT 2 to 6) and MT 24 (which includes fast and long-term corrections) defines an alarm when the UDREI=15. It indicates that an inconsistency has been found for this satellite (alarm situation) or the estimated fast correction is out of the following range of values [-256.000m – +255.875m]. It represents an alarm situation for the satellite and shall not be used.
- **Ionosphere Alerts:** The IGP Vertical Delay Estimate for each IGP is broadcast through Message Type 26. When the vertical delay equals to 63.875m for a specific IGP, it represents an alarm situation for the related IGP and shall not be used.

In case of satellite alerts (UDREI=15) and/or ionospheric alerts (IGP Vertical Delay Estimate = 63.875 m), the system is designed to inform the user no later than 5.2 seconds after the moment of the alarm condition is triggered. The alert is repeated 3 times broadcasting in total 4 consecutive alarm messages (users with a loss of 4 or more consecutive messages, shall not continue using ESMAS).

4.4 User receivers

The target users for the ESMAS are maritime Single Frequency (SF) users within the service area defined in section 5.1, that:

- receive the GPS Standard Positioning Service (SPS) broadcast signal (see [RD-04]), and
- use a specific set of EGNOS messages (see section 4.3.2) and alerts (see section 4.3.3), and
- use a type-approved shipborne GPS and SBAS receiver developed according to the IEC-61108-1 [RD-15] and IEC 61108-7 [RD-05] standards.
- carry the on-board equipment required for SOLAS ships [RD-12] to be able to receive EGNOS related Maritime Safety Information (MSI).

The IEC 61108-7 standard [RD-05] includes the tests description to be performed by the receiver manufacturers to get the type-approved certificate.

SBAS receivers shall be compliant to the design and functional requirements included in IEC 61108-7 standard [RD-05] and to the requirements defined below, so that when applying the EGNOS corrections, the users can benefit from the ESMAS alarms and performance.

The impact of signal distortions on the receivers depends on receiver-dependent parameters (e.g. antenna and RF front-end equivalent filter, the tracking technique, smoothing filter). Therefore, to ensure that the EGNOS alarms and commitments are meaningful for the maritime users, the maritime receiver shall:

- use a smoothing filter to smooth pseudoranges with carrier phase measurements with time constant of 100 seconds. In the presence of a code-carrier divergence rate of up to 0.018 m/s, the smoothing filter output shall achieve an error less than 0.25 m within 200 seconds after initialisation.

  Note that the integrity is only valid for the satellites whose measurements are already in a converged-state in the smoothing filter.
- detect a pseudorange step greater than 700 meters on any satellite used in the position solution, including steps that cause loss of lock for less than 10 seconds. The equipment shall exclude from the position solution any satellite for which the step detection function has declared a step error;
- not use satellites (GPS or SBAS) with elevation angles below 5 degrees in the position estimation;
- compute three-dimensional position using a linearized, weighted least-squares solution.

As per IEC 61108-7 standard [RD-05], for high-speed crafts, the equipment shall output to a display the position solution at least once every 0.5 seconds. Moreover, the computed position shall be dynamically independent. Therefore, the position shall be computed every second and displayed at the same second and 0.5 seconds after.

In addition, note that when using corrections, the user's solution shall be computed with respect to the SBAS Network Time (which is negligibly different from GPS system time), and not with respect to GPS system time.

If corrections are not applied, then the solution shall be computed with respect to GPS Time, and the resulting accuracy will be affected by the difference between the two. SBAS Network Time is within 50 nanoseconds of GPS system time.

If data from multiple SBAS satellites are used, then the equipment shall account for differences in the time reference used to generate corrections (e.g., SBAS network time as achieved by each satellite).

4.5 ESMAS - Maritime Safety Information proposal notification service

IMO SOLAS Convention [RD-11] Chapter IV defines Maritime Safety Information (MSI) as "*navigational and meteorological warnings, meteorological forecasts and other urgent safety related messages broadcast to ships*". The mission of the ESMAS Maritime Safety Information is to provide information on ESMAS outages to mariners who want to use EGNOS for navigating in ocean waters, harbour entrances, harbour approaches and coastal waters, [RD-16].

ESMAS MSI proposals of EGNOS outages are generated based on predicted unavailability periods at specific locations. The ESMAS service provider will send ESMAS MSI proposals via email (according to the appropriate format, [RD-11]) to the relevant MSI Provider, who is ultimately responsible for issuing and formatting the final navigational warnings. In fact, the MSI Provider is in charge of assessing whether the ESMAS MSI proposal received impacts the area under their responsibility and of issuing the corresponding warning or notice if relevant for the safety of navigation.

5 ESMAS – committed performance

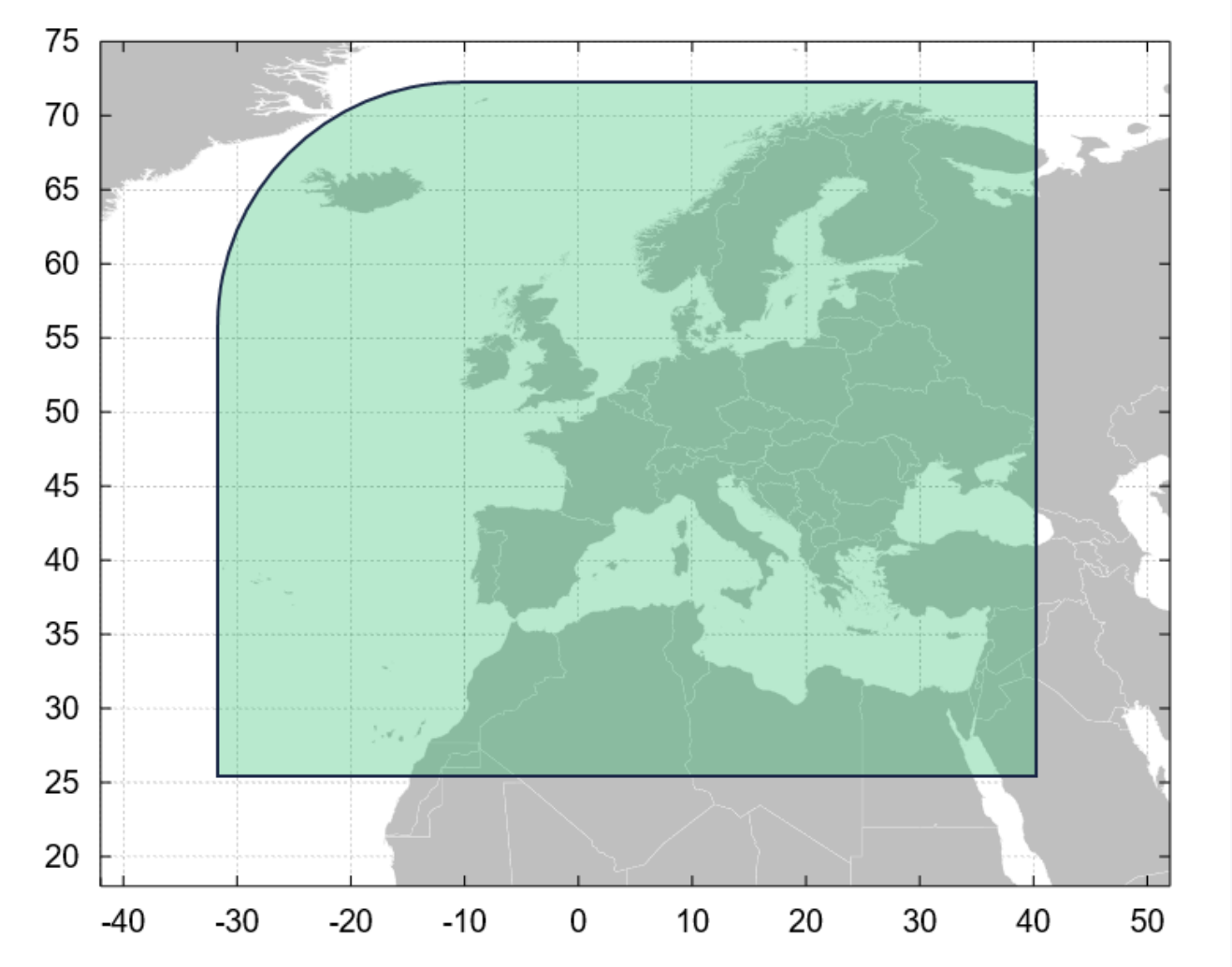
This section addresses the ESMAS committed performance contributing to maritime navigation in line with IMO Resolution A.1046 [RD-13].

5.1 Service area

The ESMAS service area is defined as the geographical area within the waters of the European Union Member States and EGNOS participant states (Iceland, Norway and Switzerland) in which the ESMAS users can expect the fulfilment of the minimum performance levels specified in this section, namely, for signal availability, time to alert and MSI proposal notifications.

The ESMAS service area is defined in the following figure as the area in green.

Figure 5-1 – ESMAS service area



5.2 Signal Availability

A signal is considered available when it is provided according to its specification within the defined area of service.

The signal availability is the percentage of time the EGNOS SIS (compliant to [RD-01]) is provided by the EGNOS GEOs through messages that can be processed by an EGNOS receiver aligned with the receiver standards [RD-05].

5.3 Time to Alert

EGNOS broadcasts alerts as defined in section 4.3.3.

5.4 Maritime Safety Information (MSI) proposal notification

The ESMAS MSI proposal service delivers notifications to MSI providers[4] within the ESMAS service area in case of planned or unplanned events [RD-16].

Planned events consist of scheduled temporary unavailability (e.g. due to maintenance activities) of GPS satellites, GEO satellites, RIMS stations, etc. which may lead to unavailability of the ESMAS service.

Unplanned system events consist of rare events leading to unscheduled temporary unavailability of GPS satellites, GEO satellites, RIMS stations, etc. which may lead to unavailability of the ESMAS service.

Table 5-1 – ESMAS Signal Availability commitment.

ESMAS Signal Availability commitment	Conditions and constraints
99.8%	• Calculated over a period of 30 days • Received from at least one EGNOS operational GEO • At any point over the service area • With a receiver aligned with receiver standards [RD-05] [RD-15]

Table 5-2 – ESMAS Time to Alert commitment.

ESMAS Time to Alert commitment	Conditions and constraints
≤5.2s	• Between the onset of the alarm condition and the time that the last bit of the alert message reaches the antenna of the user receiver • Received from at least one EGNOS operational GEO • At any point over the service area • With a receiver aligned with receiver standards [RD-05] [RD-15]

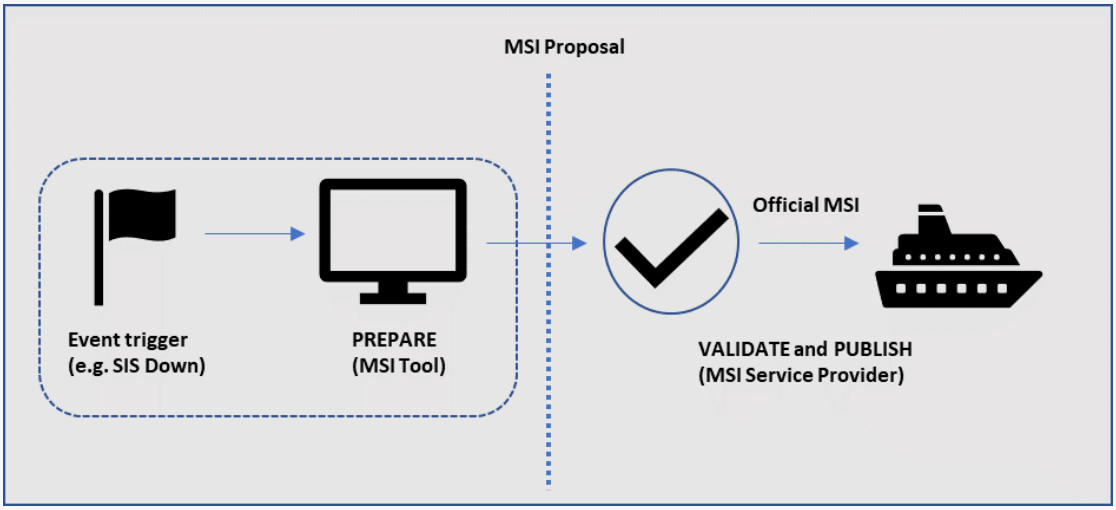
[4] The MSI Provider (NAVAREA Coordinator / National Coordinator / Local Authority) is the authority entitled to issue a warning or notice (ESMAS MSI) to the mariners through the established communication channels (as described in section 4.5).

Note that the performance commitments described in Table 5-3 concern only the delivery of the navigational warning proposal to the MSI providers, while the MSI providers themselves are responsible for issuing and formatting the final navigational warnings to maritime users. In fact, the MSI providers are in charge of assessing whether the ESMAS MSI proposal received impacts the area under their responsibility and of issuing the corresponding warning or notice to maritime users if relevant for the safety of navigation.

Table 5-3 – ESMAS MSI proposal notification service.

ESMAS MSI proposal notification commitment	Conditions and constraints
Planned events affecting the service • ≥ 72 hours before the service is affected	• Events affecting the service area • MSI proposal notification limited to NAVAREAs[5] I, Ib, II, III and XIX coordinators covering the waters of the European Union Member States and EGNOS participant states (Iceland, Norway and Switzerland) • Only considers unavailabilities longer than 15 minutes
Unplanned events affecting the service • ≤ 2 hours after the event affecting the service is detected	

Figure 5-2 – MSI proposal dissemination logic.



[5] For NAVAREAs maps, please refer to https://iho.int/en/navigation-warnings-on-the-web

Appendix A ESMAS typical performance

The typical performances in this section are expected values provided exclusively for reference. Therefore, the EGNOS SoL assisted service for Maritime does not commit to the values provided in this section.

A.1 SIS Ranging Accuracy

A.1.1 Satellite Residual Error (SRE)

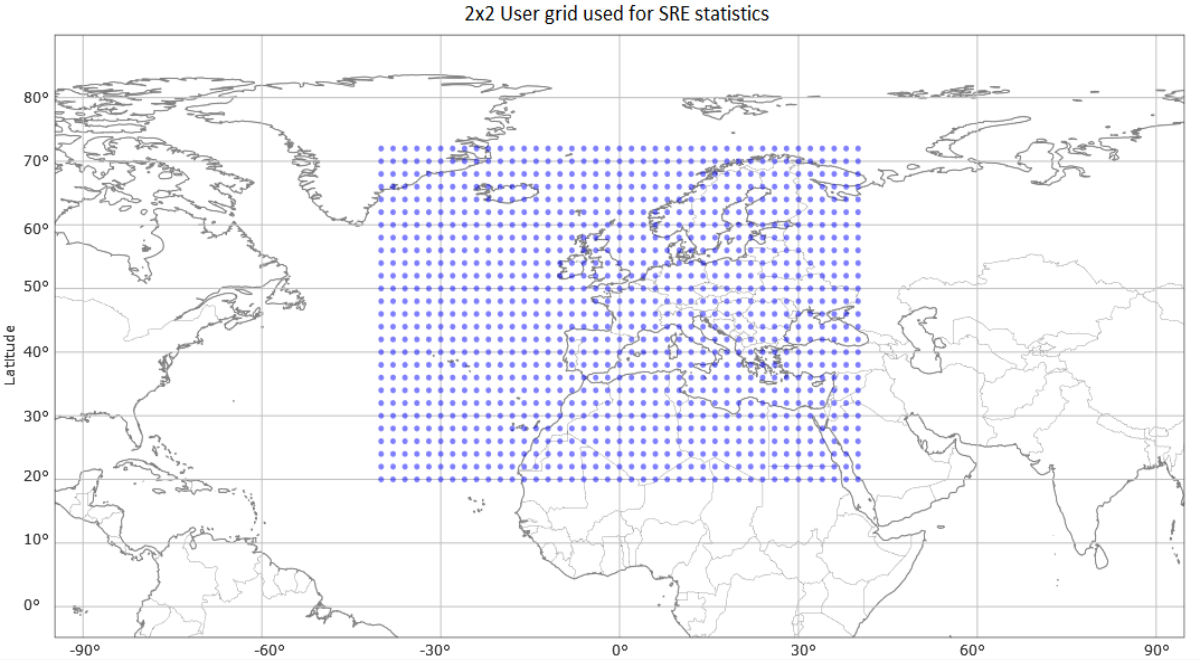
The Satellite Residual Error (SRE) is the difference between the reconstructed orbit and clock after applying SBAS orbit and clock corrections to the GNSS navigation messages, and real SV orbit and clock projected in the direction of the user line of sight. More information on SIS ranging errors is available in section 4.2.

In order to calculate the SRE statistics, a user grid has been defined within longitudes from 40E to 40W and within latitudes from 20N to 72N and a distance step of 2° for each axis.

Table A-1 – ESMAS SRE typical performance.

ESMAS SRE typical performance	Conditions and constraints
At Average User Location (AUL) • ≤ 0.68m (95%) • ≤ 0.77m (99%) • ≤ 0.93m (99.9%) • ≤ 1.47m (99.999%)	• Calculated over a period of 30 days. • Percentiles calculated over the overall constellation dataset. • Average (RMS), over a 2x2 grid as per Figure A-1.
At Worst User Location (WUL) • ≤ 1.96m (95%) • ≤ 2.36m (99%) • ≤ 2.98m (99.9%) • ≤ 4.73m (99.999%)	• Calculated over a period of 30 days. • Percentiles calculated over the overall constellation dataset. • Maximum, over a 2x2 grid as per Figure A-1.

Figure A-1 – Grid map used for SIS ranging characterisation.



A.1.2 Vertical Ionospheric Residual Error (VIRE)

Vertical Ionospheric Residual Error (VIRE) at Ionospheric Grid Points (IGPs) is defined as the difference between the estimated (reconstructed) vertical ionospheric delay and the real vertical ionospheric delay at IGP. More information is available in section 4.2. The VIRE statistics are calculated using EGNOS IGP grid, as per Figure A-2.

Figure A-2 - IGP grid used in EGNOS.

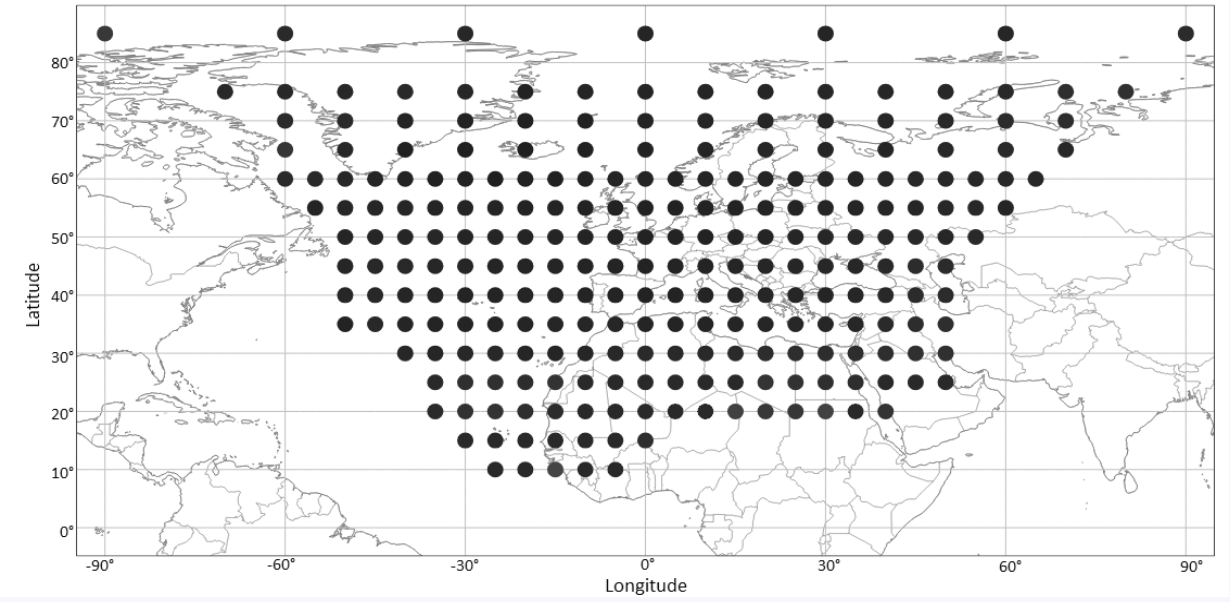


Table A-2 – ESMAS VIRE typical performance.

ESMAS VIRE typical performance	Conditions and constraints
At Average IGP: • ≤ 1.18m (95%) • ≤ 1.36m (99%) • ≤ 1.53m (99.9%) • ≤ 1.81m (99.999%)	• Calculated over a period of 30 days. • Percentiles calculated over the overall constellation dataset. • Average (RMS), over the IGP grid as per Figure A-2.
At Worst IGP: • ≤ 5.58m (95%) • ≤ 7.77m (99%) • ≤ 10.26m (99.9%) • ≤ 13.43m (99.999%)	• Calculated over a period of 30 days. • Percentiles calculated over the overall constellation dataset. • Maximum, over the IGP grid as per Figure A-2.

A.2 SIS Ranging Availability

The characterisation of ESMAS in terms of SIS Ranging Availability is an on-going activity. This section will be developed in future issues of the document.

A.3 SIS Ranging Continuity

The characterisation of ESMAS in terms of SIS Ranging Continuity is an on-going activity. This section will be developed in future issues of the document.

A.4 Typical availability of Horizontal Accuracy

The typical availability of the Horizontal Accuracy at a given location is the percentage of time when the Horizontal position error is below of equal to 10 m ([RD-05]).

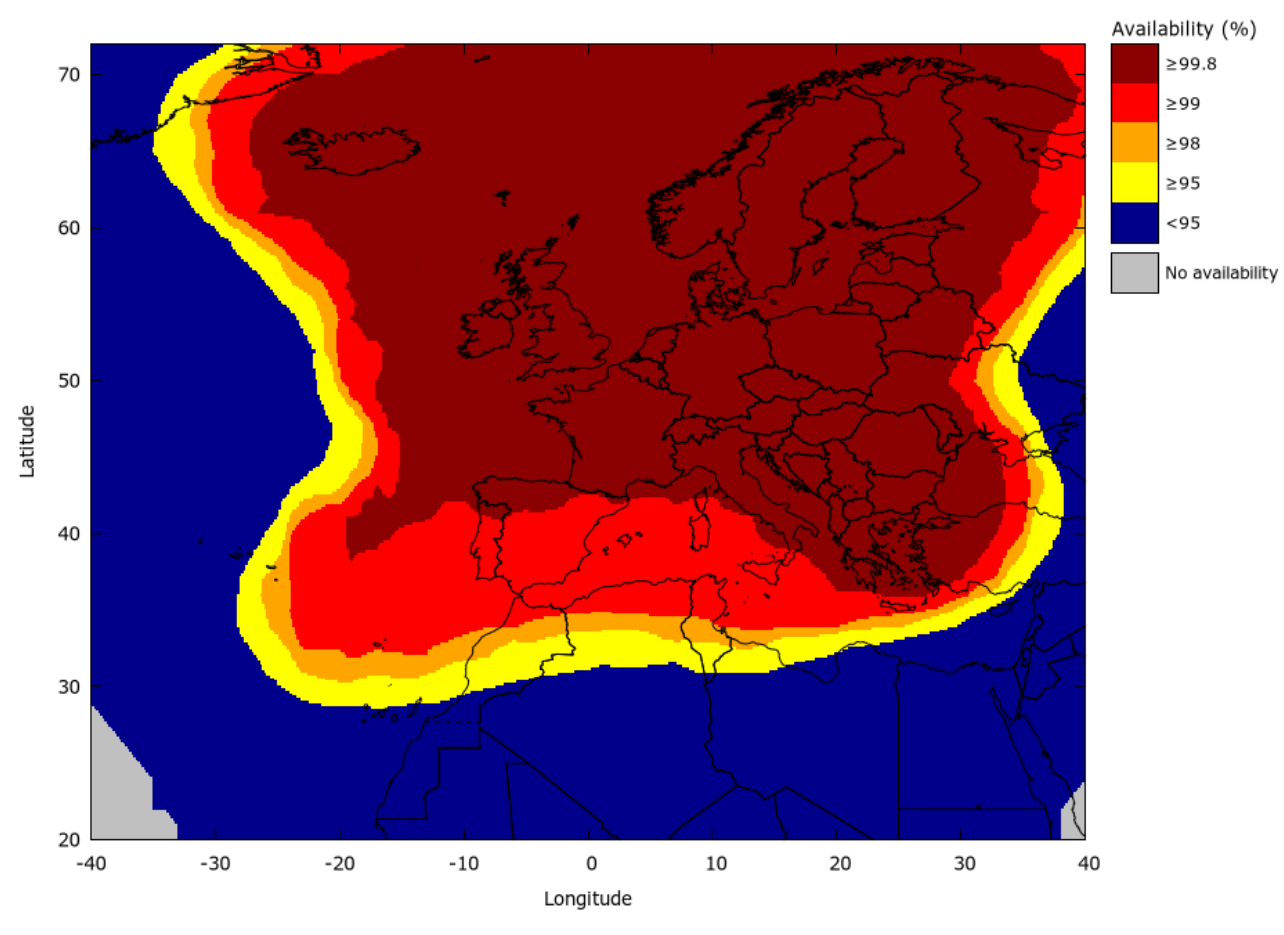
A.5 Service Continuity

The characterization of ESMAS in terms of service continuity is an on-going activity. This section will be developed in future issues of the document.

Table A-3 – ESMAS typical availability of horizontal accuracy

ESMAS typical availability of horizontal accuracy	Conditions and constraints
As per Figure A-3	• Percentage of time when the horizontal position error is equal or lower than 10 meters. • Considering healthy signals above 5deg elevation. • Calculated over a period of 30 days. • Calculated at virtual grid nodes using a fixed 1°x1° user grid in the ESMAS service area.

Figure A-3 - ESMAS monthly typical Availability of Horizontal Accuracy of 10m [6]



[6] The ESMAS typical performance presented has been computed using a multipath model compliant with SBAS MOPS DO229 specifications [RD-02].

Appendix B List of acronyms

The following table provides the definition of the acronyms used in this document.

Table B-1- List of acronyms

ACRONYM	DEFINITION		
ANGA	Augmented Navigation for Africa	EU	European Union
APV	Approach with Vertical guidance	EU-MS	European Union Member States
ASQF	Application Specific Qualification Facility	EUSPA	European Union Agency for the Space Programme
AUL	Average User Location	EWAN	EGNOS Wide Area Network
BDSBAS	BeiDou SBAS	FTP	File Transfer Protocol
CCF	Central Control Facility	GAGAN	GPS Aided GEO Augmented Navigation
CPF	Central Processing Facility	GEO	Geostationary Earth Orbit
CTI	Continuity Time Interval	GIVE	Grid Ionospheric Vertical Error
DFMC	Dual Frequency Multi-Constellation	GIVEI	GIVE Indicator
EC	European Commission	GLONASS	GLObalnaya NAvigatsionnaya Sputnikovaya Sistema
EDAS	EGNOS Data Access System	GNSS	Global Navigation Satellite System
EGNOS	European Geostationary Navigation Overlay Service	GPS	Global Positioning System
EGNOS participant States	EU-MS plus Iceland, Norway, and Switzerland	ICAO	International Civil Aviation Organization
ESA	European Space Agency	IEC	International Electrotechnical Commission
ESMAS	EGNOS SoL assisted service for MAritime userS	IGP	Ionospheric Grid Point
ESSP	European Satellite Services Provider	IHO	International Hydrographic Organization
IMO	International Maritime Organization	RTCA	Radio Technical Commission for Aeronautics
KASS	Korea Augmentation Satellite System	SBAS	Satellite Based Augmentation System
LPV	Localizer Performance with Vertical guidance	SDCM	System of Differential Correction and Monitoring
MCC	Mission Control Centre	SDD	Service Definition Document

ACRONYM	DEFINITION		
MSAS	MTSAT Satellite-based Augmentation System	**SIS**	Signal In Space
MSI	Maritime Safety Information	**SOL**	Safety Of Life
MTSAT	Multi-functional Transport Satellite	**SOLAS**	Safety Of Life At the Sea
NLES	Navigation Land Earth Station	**SPS**	Standard Positioning Service
NPA	Non-Precision Approach	**SRE**	Satellite Residual Error
PACF	Performance and Check-out Facility	**TTA**	Time To Alert
PBN	Performance Based Navigation	**UDRE**	User Differential Range Error
PDF	Portable Data File	**UDREI**	UDRE Indicator
PNT	Position Navigation and Timing	**UTC**	Universal Time Coordinated
PRN	Pseudo-Random Noise	**VAL**	Vertical Alert Limit
PVT	Position Velocity and Timing	**VIRE**	Vertical Ionospheric Residual Error
RHCP	Right-Hand Circularly Polarised	**WAAS**	Wide Area Augmentation System
RIMS	Ranging and Integrity Monitoring Stations	**WUL**	Worst User Location
RMS	Root Mean Square		
RNP	Required Navigation Performance		

Notes

More information on the European Union is available on the Internet (http://europa.eu).

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