



European  
Global Navigation  
Satellite Systems  
Agency



## **Appendix 1: EGNOS Service Provision Schemes for Maritime and IWW**



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# 1 INTRODUCTION

## 1.1 Purpose and Scope of the Document

The purpose of this document is to define the **appropriate schemes for the EGNOS v2 service provision** in the maritime domain.

This document is one of the appendices generated in the frame of the EMRF Service Provision Working Group, as depicted in the figure below, gathering the information shared and addressed by the group members for the definition of the EGNOS Service Provision aspects:

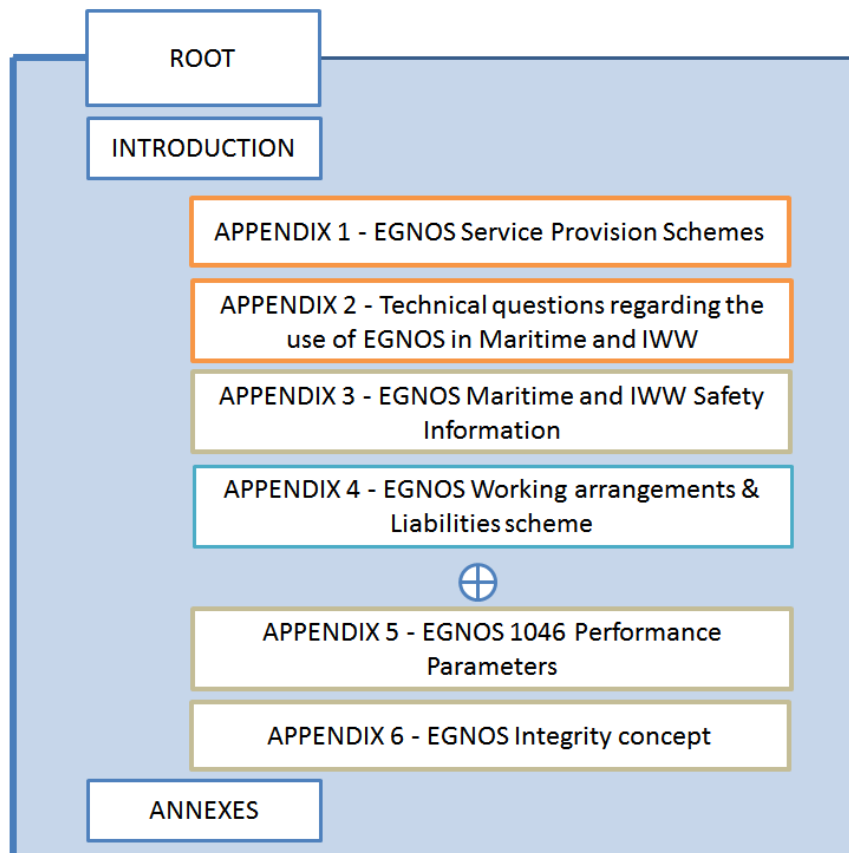


Figure 1: SPWG Technical document new structure

## 1.2 Reference Documents

RD	Document Title
[RD-1]	EMRF-SPWG-Root_v1.0, March 2018
[RD-2]	EMRF-SPWG-APPENDIX 2 - Technical questions regarding the use of EGNOS in Maritime and IWW
[RD-3]	EMRF-SPWG-APPENDIX 3 - EGNOS Maritime and IWW Safety Information



[RD-4]	EMRF-SPWG-APPENDIX 4 - EGNOS Working Arrangements & Liabilities Scheme
[RD-5]	EMRF-SPWG-APPENDIX 5 - EGNOS 1046 performance parameters_v7
[RD-6]	EMRF-SPWG-APPENDIX 6 - EGNOS V2 Integrity for maritime operations_v1.3
[RD-7]	2017 joint EMRF-NMSP Workshop on the Maritime Use of EGNOS Report – Athens 5th and 6th October
[RD-8]	IMO International Convention for the Safety of Life at Sea (SOLAS), 1974
[RD-9]	IALA Guideline No. 1005 on Contracting Out Aids to Navigation Services, December 2005
[RD-10]	IALA Guideline G1129 – The Retransmission of SBAS Corrections Using MF RB and AIS. – December 2017
[RD-11]	IMO MSC.1/Circ.1575 “Guidelines for shipborne Position, Navigation and Timing (PNT) data processing” – June 2017
[RD-12]	IMO Resolution A.1046(27) on Worldwide Radionavigation Systems - 30 November 2011
[RD-13]	IALA Recommendation R-121 on the Performance and Monitoring of DGNSS Services in the Frequency Band 283.5 – 325 kHz - Edition 2.0 - May 2015
[RD-14]	IALA Recommendation R-135 On The Future of DGNSS - Edition 2 - December 2008
[RD-15]	IALA Guideline No. 1112 On Performance and Monitoring of DGNSS Services in the Frequency Band 283.5 – 325 kHz - Edition 1 - May 2015
[RD-16]	IALA Guideline No. 1053 on The Submission of a DGNSS Service for Recognition as a Component of the IMO WWRNS - December 2006
[RD-17]	IALA Guideline No. 1060 on Recapitalisation of DGNSS - Edition 2, June 2011
[RD-18]	IMO MSC.112(73) Revised performance standards for shipborne global positioning (GPS) receiver equipment - 1 December 2000
[RD-19]	IMO MSC.113(73) Revised performance standards for shipborne GLONASS receiver equipment - 1 December 2000
[RD-20]	IMO MSC.114(73) Revised performance standards for shipborne DGPS and DGLONASS maritime radio beacon receiver equipment, 1 December 2000
[RD-21]	IMO MSC.115(73) Revised performance standards for shipborne combined GPS/GLONASS receiver equipment, 1 December 2000
[RD-22]	IMO MSC.233(82) Adoption of the performance standards for shipborne GALILEO receiver equipment, 5 December 2006
[RD-23]	IMO MSC.401(95) Performance Standard for Multi-System Shipborne Receivers – Edition 1 – June 2015
[RD-24]	2018 EMRF and EGNOS Service Provision Working Group Report – Madrid, 30 <sup>th</sup> and 31 <sup>st</sup> October

Table 1: Reference documents

### 1.3 Acronyms

The list of acronyms is provided is included hereafter.

Acronym	Definition
EFCA	European Fisheries Control Agency
EMRF	European Maritime RadioNavigation Forum
EMSA	European Maritime Safety Agency
EPFS	Electronic Position Fixing Systems
ESA	European Space Agency
ESSP	European Satellite Services Provider
GSA	European GNSS Agency
IALA	International Association of Marine Aids to Navigation and Lighthouse Authorities
IEC	International Electrotechnical Commission
IGO	Intergovernmental Organization
IMO	International Maritime Organization
ITU	International Telecommunications Union
MF	Medium Frequency
MSI	Maritime Safety Information
NGO	Non-governmental international organization
NMSP	National Maritime Service Providers
NtM	Notice to Mariners
NtS	Notice to Skippers
PSC	Port State Control
RB	Radiobeacon
RIS	River Information Services
SBAS	Satellite-Based Augmentation System
SDD	Service Definition Document
SLA	Service Level Arrangement
SPWG	EGNOS Service Provision Working Group
WWRNP	World-Wide Radionavigation Plan
WWRNS	World-Wide Radionavigation System

Table 2: Acronyms



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## 2 POTENTIAL GNSS APPLICATION RELATED APPROVAL PROCESSES

The intention of this section is to analyse the need and approach to be followed by the EGNOS System and EGNOS Service Provider to be in the position of providing EGNOS services for maritime according to the requirements established by the different National Maritime Authorities.

Different Maritime authorities may follow different processes to validate new technology before operational deployment. The aim of this section is to identify the minimum set of activities that would be required in any Member State, highlighting the differences between applicable legal frameworks that would cause variations in approval process.

### 2.1 System Approval Process

For the formal approval for the use of EGNOS for maritime applications, a traditional approach was preferred by several National Maritime Administrations, which believe that any other path may require more time and would be more complex.

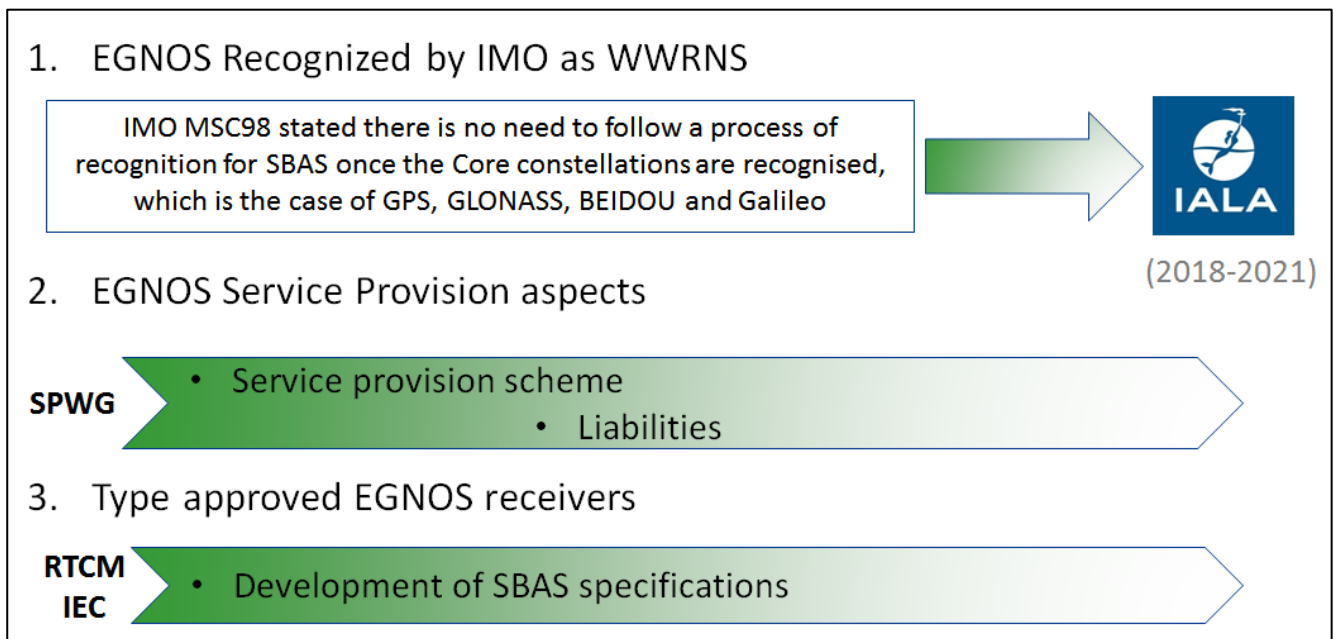


Figure 2: Traditional approval process

The proposed approach comprises the following three steps:

#### 1. EGNOS recognition as part of the WWRNS requested at IMO & IALA Guidelines for Augmentation services, including SBAS.

Although IMO recognition is not a compulsory/critical step it was perceived that it would facilitate and accelerate the process of standardisation and adoption of EGNOS in maritime, giving guarantees about the system, its duration, its conditions of use and so on, to the different Maritime Authorities and users.

As agreed, EGNOS Recognition as IMO WWRNS Process was initiated (15/3/2017) with the support of all EU (28) Council member states.

In the IMO MSC 98th session (13/6/2017) it was concluded that there is no need to follow a process of recognition for SBAS/EGNOS once the Core constellations are recognized. IMO stated that the recognition of augmentation services was not required and that the WWRNS Resolution, A.1046 (27) was intended for standalone systems, not augmentations.

Resolution A.1046 (27) does not actually exclude augmentation systems as it states ‘The recognition by IMO of a radio navigation system would mean that the Organization recognizes that the system is capable of providing adequate position information within its coverage area’. However, as the recognition of augmentation systems is not required (according to MSC98), there is no formal process for the status and characteristics of such systems to be reported to mariners and this will apply not only to EGNOS but also to IALA DGNSS too. So, the IALA ENAV WG5 decided during the last ENAV 21<sup>st</sup> meeting, that IALA could take over this role and agreed to provide guidance to its members on the status and performance of GNSS augmentation systems. It was agreed to add this item to the IALA 2018-2022 work plan.

## **2. EGNOS Service Provision Aspects (declaration of EGNOS as an AtoN at National level)**

Once the recognition of EGNOS as WWRNS is no longer needed (according to IMO MSC98 statement), the next step in this process would be the complete definition of the SP aspects including the information (technical documentation and evidences) to be provided by the ESP to the authorities to have the EGNOS System approved to be used in their waters.

This phase comprises two activities:

### **Activity 1: Definition of the Service Provision Schemes**

Different scenarios are identified taking into account the EGNOS transmission means and the way the EGNOS corrections are sent to the mariners/skippers (the detailed description of these Service Provision Schemes is included in Section 2 below).

**These schemes have been endorsed by the maritime and IWW authorities attending the 2017 EMRF-NMSP workshop held in Athens (5-6 October) [RD-7]. Additionally the attendees of the EMRF SPWG in Madrid (30-31 October 2018) [RD-24] confirmed the Service Provision Scheme for the EGNOS L1 Maritime Service (Scenario 2 - Figure 5).**

### **Activity 2: Definition of the liabilities particular arrangements to be put in place**

Once the Service Provision Scenarios have been identified, it is necessary to define the particular liabilities and arrangements to be established between the ESP and the corresponding Authority or AtoN provider so as to have the EGNOS Service formally approved for its use in their waters, considering that no additional liabilities will be allocated to the Competent Authorities beyond the current ones [RD-24].

For example, the service provider may be required to publically state the usable coverage region, performance characteristics (in terms of availability, continuity, accuracy and integrity), along with other factors such as an undertaking to provide the service for a set amount of time and the amount of notification provide before any significant change to the service offered. This information may be required/offered as part of the approval process.

So as to facilitate the analysis, all these points are addressed within the SPWG and gathered in a separate document (Appendix 4) with the liability schemes and working arrangements [RD-4].

The need for EGNOS being declared an AtoN at National level within this step is still unclear and should be further analysed within the appropriate fora (EMRF, IALA,...). As this declaration deals with national legislation, it would most likely need to be made case-by-case for each national authority. Moreover, this declaration could bring several liability points that would be significant for the states/maritime authorities and that should be properly addressed (within the working arrangements with the EGNOS Service provider).

In the case of the retransmission of EGNOS corrections over existing infrastructure, as AIS and DGPS are already national AtoN, the question is whether EGNOS would also need to be declared as a national AtoN as well. According to the opinion of the Maritime Authorities within the SPWG, in this case there is no need to declare EGNOS as national AtoN, but an agreement needs to be established between EGNOS Service Provider and national AtoN service providers. However, the particular conditions/requirements of different countries would need to be addressed in a case by case basis.

### 3. Type approval of EGNOS receivers

The third step in this process, the type approval of EGNOS receivers, is necessary for the provision of a new EGNOS service in maritime. As noted in Annex 1.2.2.3, SOLAS regulation requires EPFS to be type approved, i.e. they meet a performance standard and have an associated IEC test specification. This work is on-going through the development of the SBAS receiver documentation (see roadmap in SPWG Root document [RD-1] for details on the status of these activities).

## 2.2 Navigation Service Provider Recognition/Approval

The intention in this section is twofold:

- On one hand, to clarify whether any Maritime Authority asks for specific requirements for the companies/organisations providing services (e.g. quality control certificates acquired by the company/organisation or specific safety management procedures implemented,...)
- On the other hand, identify if there is a specific authority in charge of overseeing all the safety and quality of the services provided (e.g. with specific audits, reporting requirements,...).

In maritime domain it seems that there is not a regulation establishing a liability scheme at international level (as there is in other domains as aviation).

Additionally, it seems that there is not an **international** regulation establishing the requirements to be fulfilled and the standard processes to be followed by a Service Provider to be allowed to provide maritime services (no international certification or regulation of the service provider, as in the aviation domain).

According to the SPWG inputs, it seems that at **national level** the Maritime Service Providers are regulated by each government. For example, the GLA service is regulated by the government, who delegates responsibility of AtoN provision to the GLA. The UK Government signs up to the SOLAS convention, and then the GLA operate under that convention as part of national legislation. The GLA is the one that decides the level of service provided, based on the level of risk required and also considering the consultation with a wider maritime community that helps them to understand the impact of the different levels of service.

In some cases (UK) the Port Authorities are responsible for the provision of the AtoN Service within their port boundaries, and the Lighthouse Authorities oversees this provision and provides AtoNs outside port boundaries.

In the UK, the SOLAS convention requirements are captured in the Merchant Shipping Act, with the definition of AtoNs listed as a lower level piece of legislation.

If an AtoN provider as the GLA was to work with the EGNOS Service provider, it is still not clear what would be required for the EGNOS Service Provider to comply with (this would be a new process to assess, as the involvement of a third party is an unknown situation).

These two different levels, at international and national level, are analysed below:

- International approval

IMO has no dedicated international process for approval of Navigation Service Providers. Governments sign up to the SOLAS convention and inform the IMO once this is complete. From that point on they have a duty to operate under that convention as part of national legislation.

However, the second bullet ("continued provision of service is assured") in the list of requirements given in resolution A.1046 can be seen as a criterion for the international approval of the Navigation Service Provider.

The organization responsible for the provision of EGNOS should prove it is able to maintain the system in the same or better performance level for a stated amount of years ahead. It should also present a quality system by which it will meet the stated performance level.

- National approval

It is important to differentiate between these two types of service provision:

- Type 1: The EGNOS SiS received directly by vessels.
- Type 2: EGNOS information retransmitted by the national Administration's Marine Radio beacons or AIS stations.

Regarding the responsibilities currently in place in case of an accident:

- if ships use the GPS signal (off-air) without the Administration involvement, they do it under their own responsibility and there is no liability on the Administration.
- if the Maritime Administration is responsible for the radiation of the signal used by the ships (such as the IALA Beacon DGPS transmissions), then there is the a potential that the Administration would need to show that the information provided was not causing the accident.

By analogy with the current GPS off-air situation, if vessels use the EGNOS SiS directly, there should be no liability on the national Administration and no need for national approval of the EGNOS service provider.

However, if EGNOS were to be used as part of beacon DGPS, it would be the responsibility of the National Maritime Authority (NMA) to assure the quality of service/information that is being used from EGNOS in beacon transmissions, in a similar way to the current assurance of the quality of the locally measured beacon information. A crucial issue is where responsibility and liability falls and a Service Level Agreement (SLA) would be needed to be put in place between ESSP and the NMA that guarantees a minimum quality of service and information,

passing liability to ESSP if this is not met. National approval of the EGNOS Service Provider **may** be necessary in this case that the EGNOS service would replace some of the local national Aids to Navigation Services including local terrestrial GNSS augmentation service. Meanwhile Guidance material on this topic is not published by IALA, NMAs may need to consider the same kind of aspects that IMO would address in case of international recognition of a service. In addition there would be need to agree on the liability issues and to sign an agreement or MoU between the service provider and the country in question.

Regarding a third party responsible for the oversight of the Service Provider, this role is not currently in place in the maritime scenario and the attendees of the 2018 EMRF and EGNOS SPWG [RD-24], confirmed that there is no need of an oversight entity for the EGNOS L1 Maritime Service

### 3 EGNOS SERVICE PROVISION SCHEMES FOR MARITIME/IWW NAVIGATION

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The intention of this section is to define the high-level EGNOS Service Provision scheme in Open Sea, coastal waters, harbour approaches and entrances and Inland Waters including roles, responsibilities, and requirements for generic and specific interfaces.

#### 3.1 EGNOS transmission options

EGNOS currently offers three services, the Open Service (OS), the Safety of Life Service (SoL) and the EGNOS Data Access Service (EDAS). This section considers EGNOS V2 where the SoL was designed for use by aviation and should not be considered for use in the maritime sector unless qualified as appropriate (this is to show that what is an aviation centric system, with aviation definition of service area availability, integrity etc, can be made applicable to maritime requirements in a suitable and clear manner). It is important to highlight that 90% of shipborne receiver manufacturers have implemented SBAS in their receivers, while different maritime authorities are exploring the possibility to use EDAS as a source of differential corrections for AIS and IALA beacons (IALA Guideline G1129 [RD-10]). Therefore, today OS is in use by the maritime community, EDAS use is starting within some pilot projects, while SoL is only used for R&D purposes. For this reason, Aviation SoL service is not considered further in this section.

However, if mariners were to use EGNOS, it must be considered that it could and would be used in a safety-of-life context. Moreover, since IMO MSC.401(95) states that the multi-system shipborne radionavigation receiver should be designed to provide a means of integrity monitoring for each PVT source employed, then the use of the integrity data provided by EGNOS could be considered as an input. For this purpose, a dedicated Maritime EGNOS Service (EGNOS L1 Maritime Service) is under definition and consolidation, compliant with requirements in IMO Resolution A.1046 and therefore including integrity at system level.

EGNOS data may be received by the mariner through various communication methods, as well as the different services, with each method resulting in a different level of standardization, legislation and number of organizations involved. The following options are considered in this section, and shown in Figure 3, although this is not necessarily a complete list:



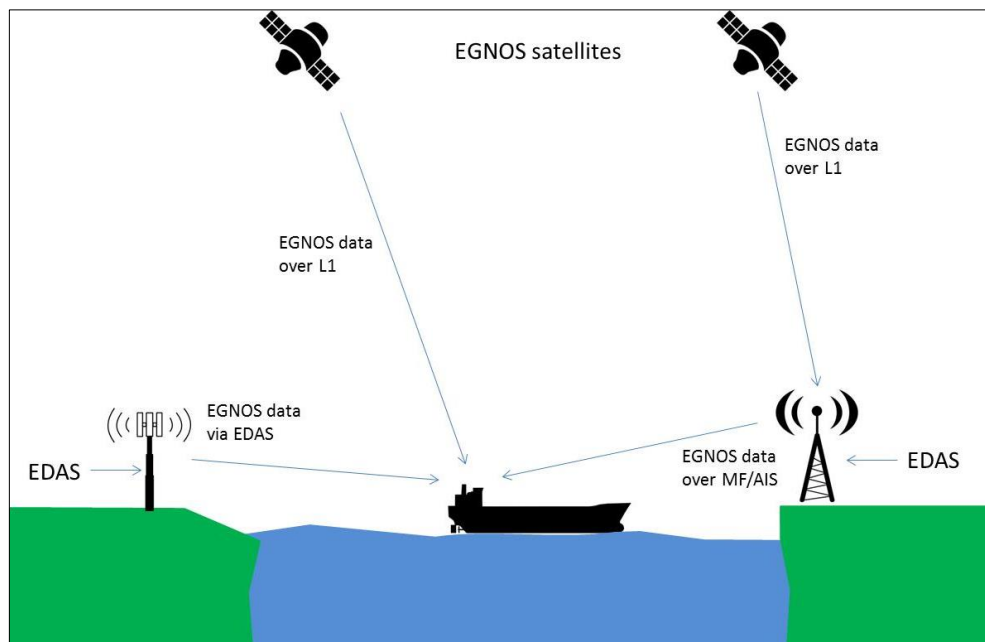


Figure 3: Generic view of the three considered options for EGNOS transmission/reception in the maritime sector. See IALA Guidelines G-1129 [RD-10].

- **EGNOS Data used Off Air (SiS)**

This is expected to be a most employed approach with EGNOS data received directly from the satellites over the L1 frequency.

- **EGNOS Data used via EDAS**

In this approach, the mariner opts to use data from the EGNOS Data Access Service (EDAS) received directly by the vessel (e.g. via a shore-to-ship or satellite broadband link).

- **EGNOS Data used via Maritime Service providers' AtoNs[RD-10]**

In this approach, EGNOS data is provided to the mariner over an existing marine radio service currently used for a recognized Aid to Navigation, such as marine beacon 300kHz and VHF frequencies used for AIS. In this case, two options are considered for the access to the EGNOS data: SiS and EDAS.

1. SiS: the source for the generation of the DGPS corrections (RTCM 2.x) to be broadcast by the (IALA beacon or AIS) transmitter is the EGNOS Signal in Space.
2. EDAS: the source for the generation of the DGPS corrections (RTCM 2.x) to be broadcast by the (IALA beacon or AIS) transmitter is the EGNOS message received from EDAS.

### 3.2 Service provision scheme in open sea, coastal waters and harbour entrances and approaches

The service provision scheme in open sea, coastal water and harbour entrances and approaches may change under the following possible scenarios, which consider the different the different ways in which EGNOS data may be received by the mariner:

1. EGNOS SiS (off-air) used directly by the vessels with **no responsibility on the EGNOS Service Provider (Open Service)**
2. EGNOS SiS (off-air) used directly by the vessels with **responsibility on the EGNOS Service Provider (Maritime Service)**
3. EGNOS information (SiS or EDAS) provided to an AtoN provider, which then retransmits the information/signal with partial responsibility on the EGNOS Service Provider (IALA Guidelines G-1129 [RD-10]).
4. EDAS used directly by the vessels

**The scenarios included in this section, endorsed by maritime authorities attending the 2017 joint EMRF/NMSP Workshop held in Athens [RD-7], present the high-level schemes for the provision of EGNOS Service in Maritime, identifying the main actors involved together with their main interfaces/responsibilities. Additionally the attendees of the EMRF SPWG in Madrid (30-31 October 2018) [RD-24] confirmed the Service Provision Scheme for the EGNOS L1 Maritime Service (Scenario 2 - Figure 5). and the operational roles and responsibilities apportionment described in the proposed operational scheme (3.2.2), considering that there is no need of an oversight entity for the EGNOS L1 Maritime Service.**

**The intention of this section is to identify and present all the agreed potential high level scenarios and the associated service provision schemes. The low-level details of the presented Service Provision Schemes may evolve in future versions of this document based on the current developments [RD-2].**

The specific characteristics of each of these scenarios in terms of service provision are presented in the sections below.

It should be noted that the low-level details in terms of roles, responsibilities and the liability scheme approach for these scenarios are being addressed through a dedicated analysis (gathered in a separate document [RD-4]).



### 3.2.1 Scenario1: EGNOS SiS (off-air) used directly by the vessels with no responsibility on the EGNOS Service Provider (Open Service)

This first scenario considers the use of EGNOS Open Service (OS) with either type approved receivers on-board or legacy receivers, which are already using the existing EGNOS (v2) OS SiS. This scenario has two sub-categories, Scenarios 1A and 1B. Scenario 1A covers the existing situation of EGNOS use by mariners of legacy receivers that are not type approved. It captures the status quo which is a highly unsatisfactory situation. In this respect, Scenario 1A is the baseline from which to consider the transition to a more satisfactory scenario and its merits.

Scenario 1B covers a possible future situation where EGNOS type approved receivers are used by some mariners but with no responsibility or liability acknowledged by the EGNOS service provider. The content of this section covers both Scenarios 1A and 1B unless explicitly stated otherwise.

The high-level description of the service provision scheme for this first option is presented in the figure below:

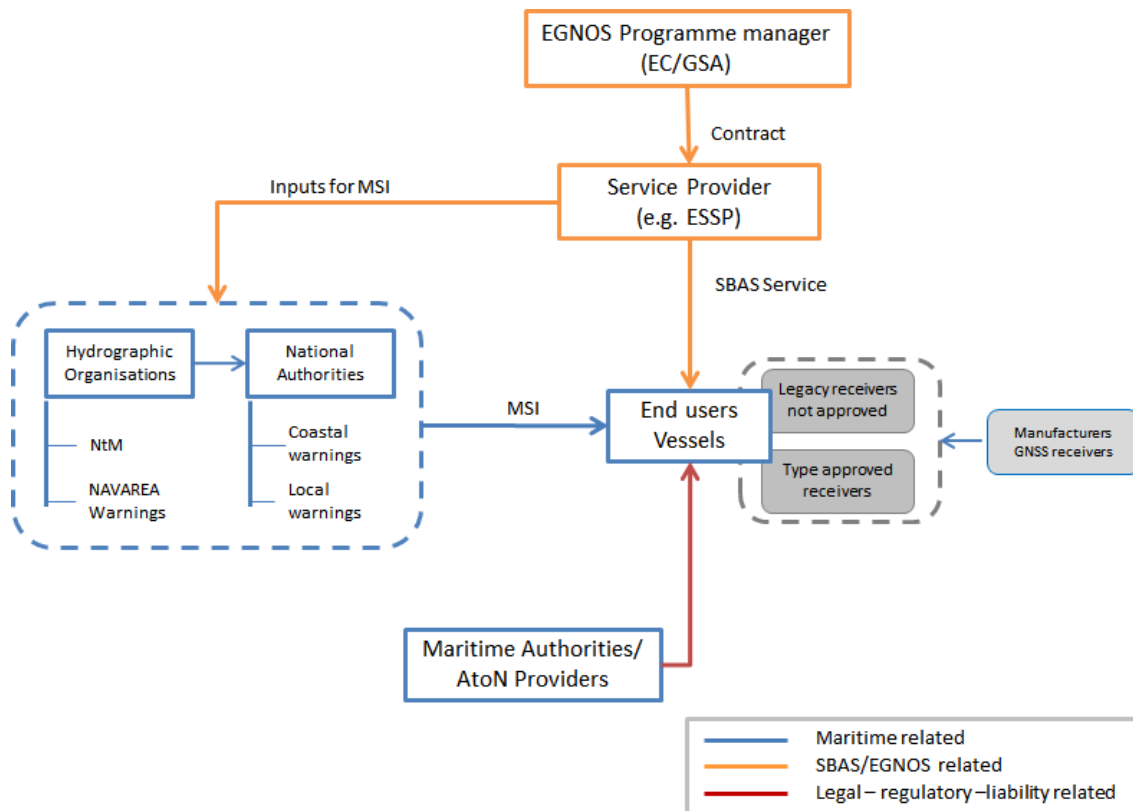


Figure 4: Example – Service Provision Scheme – Scenario #1

As commented before, regarding the SBAS/EGNOS receivers, the figure reflects that there will be:

- SBAS/EGNOS enabled receivers which are type approved (corresponding IEC test specifications)
- SBAS/EGNOS receivers not type approved, those currently available in the market (more than 80% of receiver available in the market are EGNOS enabled for both SOLAS and non-SOLAS vessels.).

For the use of the EGNOS Open Service signal, only the receivers on-board (type approved or not) would be needed and the final responsible party in case of an accident would be the vessel captain.

It is remarked for Scenario 1B should be able to use the information in the existing EGNOS SiS to provide integrity at system level to the vessels. Compliance of EGNOS v2 to A.1046 requirements is only relevant to Scenario 1B as it can only be made useable by type approved receivers which should be able to use integrity information and provide this indication to the mariner.

This scenario also considers the involvement of the EGNOS Service Provider in the generation/provision of Maritime Safety Information regarding unavailabilities of the EGNOS OS. The need and particular terms and conditions of this role still need to be properly assessed.

However, in terms of liabilities, if the EGNOS Service Provider does not play a responsibility role, it assumes that the mariners are using the OS (even if the receivers are able to provide integrity at system level, complying with A.1046 requirements), and no complaints could be made in terms of integrity failures or other performances failures to the EGNOS Service Provider. The final responsible party would be the captain of the vessel using the SBAS receiver at his own risk. For this reason, Scenario 1B is not a desirable option. The preferred way forward would be to try to avoid Scenario 1B if possible, or to minimise the time for which Scenario 1B pertains. The preferred option is Scenario 2 (§3.2.2), with type approved receivers and a commitment by the ESP, rather than scenario 1B.

#### 3.2.1.1 *Involved organizations and their roles and responsibilities*

This approach would require the following organizations, with their roles and responsibilities outlined:

- **EGNOS service provider**

The EGNOS service provider is responsible for the transmission of the EGNOS data.

Under Scenario 1 where the EGNOS service provider has no responsibility other than to transmit the EGNOS data and support Maritime Safety Information, no EGNOS system formal approval is required.

There will be an onus on the service provider to inform the mariner if their service is due to go off air for maintenance, is degraded in any way, or is subjected to unplanned outages. The method of this notice should be suitable for all mariners using the service; as such the notification should be “pushed” to the user, rather than left for them to “pull” the data. An existing methodology for Maritime Safety Information (MSI) exists and therefore the service provider is encouraged to consider the format and approach used.<sup>1</sup>

- **Equipment manufacturer**

For Scenario 1B, manufacturers will need to develop appropriate maritime user equipment that conforms to the required IMO Performance Standard for SOLAS vessels, taking into account the IEC Test Specifications, once developed.

In the future, there will be two distinct sets of maritime user equipment, both of which will be capable of using SBAS data, however only one will be fully approved for use on SOLAS vessels (those designed to meet the IMO Multi-system Performance Standards). Manufacturers

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<sup>1</sup> Guidance on the IMO/IHO World-Wide Navigational Warning Service adopted by the IMO by resolution A.706(17)

are encouraged to make it clear which receiver performance standard applies to which user equipment to ensure the correct equipment is used.

- **End users: Mariners and other users**

Users have the responsibility to ensure the correct maritime user equipment is used on their vessel and that the resulting data is used in the appropriate manner. This is likely to be controlled by the equipment manufacturer, although they are not directly involved in the day to day use.

As commented before, the mariners using either approved SBAS receivers or legacy receivers will be the final responsible party in case of an accident.

- **National Maritime Service Providers / Other regional body**

This scenario does not consider the declaration of EGNOS as a national AtoN. If it is not declared an AtoN, then any use by the mariner (via data direct from the satellite) may be outside the National Maritime Service providers remit, although they may wish to monitor the performance of EGNOS; however they would have no obligation or formal role to play. It would therefore be up to the EGNOS service provider to inform the mariner of any outages or safety related information and, as explained before, no other liability of use would be established as it is understood that the mariners would use the EGNOS OS at their own risk.

- **Hydrographic Organisations**

The Hydrographic Organisations are involved in the provision of Notices to Mariners and NAVAREA warnings (as part of MSI) and therefore they are included in the scheme above. Depending on the content of the Maritime Safety Information, different bodies are responsible for their creation. It is important to make sure all stakeholders are involved. An unscheduled outage or degradation of the EGNOS service should be communicated to the users as soon as possible. It would be necessary to establish a communication link for this type of information.

#### 3.2.1.2 *Required interfaces/working arrangements*

The following interfaces and working arrangements are required:

For Scenario 1B, EGNOS Service provider, maritime equipment manufacturers and user representatives should all be involved in the SBAS standardization/type approval process inter alia through IEC. This involvement is important to ensure the applicable standards and guidelines are developed and applied correctly and up to date with EGNOS developments, (first with respect to SBAS L1 SiS and in the future with respect to the new SBAS L5 SiS).

In service, the EGNOS Service provider and user groups are involved. The EGNOS Service Provider may provide details on the service provided (EGNOS OS). The EGNOS Service Provider will need to provide information to users on service warnings, downtime, and long term evolution of the service (including notification of service changes).

As the use of EGNOS OS is considered in this scenario, the establishment of a full EGNOS Working agreement outlining aspects on service boundaries, liabilities, performance expectations and collaborative decision making via bi-directional communications is not needed and the Service Definition Document issued by the European GNSS Agency is enough. However, a limited Working Agreement may be necessary to define the process for EGNOS information in Maritime Safety Information.

### 3.2.1.3 Potential concerns, questions and unknowns

This section outlines the different questions raised at this point.

- *What is the best method of promulgating MSI to mariners over a wide area, ensuring the right information is provided to the right mariners in a timely manner?*

The generation and provision of MSI is addressed in [RD-3]

### 3.2.2 Scenario2: EGNOS SiS (off-air) used directly by the vessels with responsibility on the EGNOS Service Provider

This second scenario considers the reception of the of the EGNOS L1 SiS directly on-board the vessels equipped with type-approved receivers (SBAS Rx), thus allowing the end users (mariners vessels) to benefit from EGNOS L1 Maritime Service enhanced performance.

The next figure presents high level service provision scheme for this second scenario:

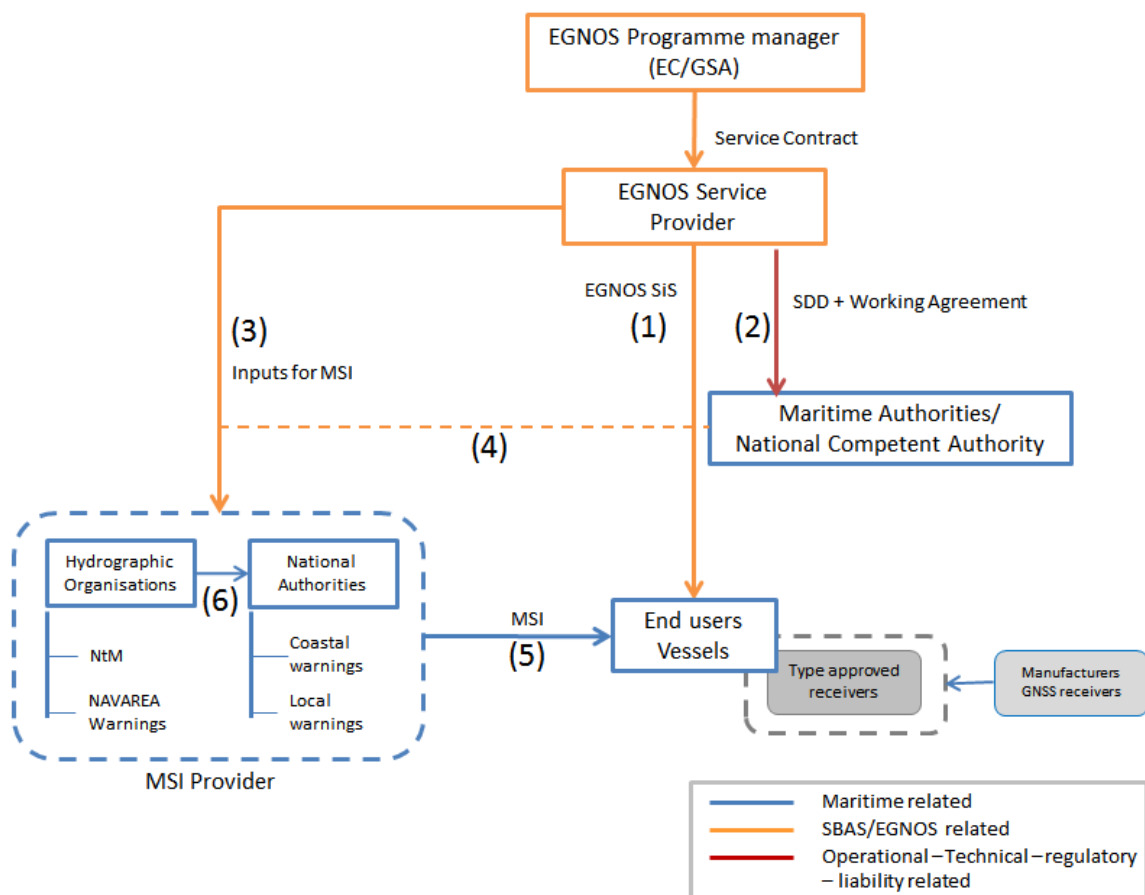


Figure 5: Example – Service Provision Scheme – Scenario #2

In terms of liabilities, in contrast to scenario#1, the EGNOS Service Provider does play a responsibility role guaranteeing the EGNOS performance, including integrity at system level according to IMO Resolution A.1046 requirements. If there is a liability scheme in place (further details on the proposed liability scheme are included in Appendix4 [RD-4]), the agreed performances are guaranteed and complaints could be made to the EGNOS Service Provider in case of a deviation from the committed performances.

It should be noted that, in case of problems/complaints due to EGNOS performances degradations (in the frame of this scenario), the final responsible party would be the EGNOS Service provider (the Maritime Authority is expected to be the link with the EGNOS Service provider). No additional liabilities will be allocated to the Maritime Authorities/Competent Authorities beyond their current ones [RD-24].

### 3.2.2.1 *Involved organizations and their roles and responsibilities*

This approach would require the following organizations, with their roles and responsibilities outlined:

- **EGNOS service provider (ESP)**

The EGNOS Service Provider will be the entity which provides the EGNOS L1 Maritime Service (see (1) in Figure 5) as per SDD. The EGNOS service provider is responsible for the transmission of the EGNOS data, along with the integrity of that data ensuring that it is fit for purpose.

The ESP will also be responsible for establishing and supporting all required operational interfaces, as per the corresponding maritime operational chain, including the generation the EGNOS MSI proposals (see (3) in figure 5) to be distributed by the Hydrographic organisation to the end users of the service.

The EGNOS service provider is responsible for meeting the conditions established in the EGNOS agreement framework (defined in Appendix 4 [RD-4]). Liability for accidents by vessels with SBAS type approved receivers caused by a breach of these conditions lies with the EGNOS service provider.

According to the SPWG discussions, ESP may be required or opt to, publically state the usable coverage region, performance characteristics (in terms of availability, continuity, accuracy and integrity), along with other factors such as an undertaking to provide the service for a set amount of time and the amount of notification provide before any significant change to the service offered; consistent with IALA Recommendation R-121 and IALA Guideline No.1112 on marine beacon service provision.

There will also be an onus on the service provider to inform the mariner if their service is due to go off air for maintenance, is degraded in any way, or is subjected to unplanned outages. The method of this notice should be suitable for all mariners using the service; as such the notification should be “pushed” to the user, rather than left for them to “pull” the data. An existing methodology for Maritime Safety information (MSI) exists and therefore the service provider is encouraged to consider the format and approach used.

Based on the inputs above provided by SPWG members and considering the analysis of the applicable requirements and best practices already in place (see Appendix4 [RD-4]), the low-level ESP responsibilities may be structured in four main blocks, as follows:

1. **Operation and Maintenance:** The EGNOS service provider should continuously monitor the service to detect and manage service disruptions and degradations and inform users. The information on the EGNOS service degradations and unavailability's is to be delivered to the MSI provider. An unscheduled outage or degradation of the EGNOS service should be communicated to the users as soon as practicable to the MSI provider.  
The EGNOS MSI Service will follow the already existing processes and the ESP will be the originator of the appropriate EGNOS related MSI.
  2. **Performance Verification:** The EGNOS service provider should verify that the service is performing according to specifications committed.
  3. **Publication of information:** The EGNOS service provider should provide a description of the service (service characteristics, performances, coverage area, etc.) via the SDD , provide information of scheduled maintenance activities & planned unavailability, and service performance reporting and support to the users (e.g. EGNOS helpdesk)
  4. **SDD + Working agreements:** With reference to the Service Definition Document (SDD) and in line with the liabilities, operational aspects and best practices already in place in the maritime domain, the working agreements between the ESP and National Authorities should contain at least:
    - Liability scheme
    - Commitment about the long term operation of the EGNOS service
    - Service offered as per SDD
    - Reliability/continuity/quality of the service
    - EGNOS MSI proposals
    - Costs of the service – (i.e. free of charge)
    - Legal data recording
- **Equipment manufacturer**  
Manufacturers will need to develop appropriate maritime user equipment that conforms to the required IMO Performance Standard for SOLAS vessels, taking into account the IEC SBAS Test Specifications, once developed.  
In the future, there will be two distinct sets of maritime user equipment, both of which will be capable of using SBAS data, however only one will be fully approved for use on SOLAS vessels and able to provide integrity at system level, as required by IMO resolution A.1046. Manufacturers are encouraged to make it clear which receiver performance standard applies to which user equipment to ensure the correct equipment is used. Consequently, in order to allow the maritime community to benefit from EGNOS L1 SiS Integrity (at system level) the type-approved receivers should be used (note that SOLAS vessels are expected to use these type-approved receivers; non-SOLAS vessels may use type-approved receivers as well. However, non-SOLAS vessels may have a choice in respect of lesser capability possibly at lower cost. In this case the service and guarantees offered to a non-SOLAS vessel using not type approved



receivers is not clear and needs further investigation. EGNOS/SBAS Labels might be an option).

Standardisation activities involving the different equipment manufacturers are needed for the development of these type approved receivers (SBAS Rx). At RTCM level (SC-104) a dedicated subgroup for the development of a standard for maritime SBAS receivers was created to provide the inputs for the development of the test specifications at IEC level (for more details on the current status of these activities the updated roadmap included in the Root document [RD-1] can be consulted). The objective is the development of a standard for SBAS Rx (similar to MOPS in aviation), considering the transmission of EGNOS/SBAS messages in RTCA format (with no additional data conversions).

- **End users: Mariners and other users**

Users have the responsibility to ensure the correct maritime user equipment is used on their vessel and that the resulting data is used in the appropriate manner. This is likely to be controlled by the equipment manufacturer, although they are not directly involved in the day to day use.

As commented before, in this case the end users will benefit from EGNOS integrity at system level when using type-approved receivers (SBAS Rx).

In terms of liabilities, the agreed performances are guaranteed and complaints could be made to the EGNOS Service Provider in terms of integrity failures or other performances degradations. In case of problems/complaints due to EGNOS performance degradations (in the frame of this scenario), the final responsible party would be the EGNOS Service provider. For more details on the proposed liability scheme the Appendix 4 can be consulted [RD-4].

- **National Maritime Service Providers / Competent Authority**

ESP will engage with National Competent Authorities (see (2) in Figure above). The body designed as Competent Authority may vary for each individual State (for example: Coast Guard, Aids to Navigation Authority, etc.). For the different matters related to the EGNOS Maritime Service the National Competent Authority role and relationship will be one of mutual cooperation and support and will not entail any additional responsibility or liability for the Authority involved, beyond the existing ones.

On the basis of the SDD, this relationship may be formalized through a Working Agreement or MoU with the ESP, including the operational and technical modalities (see Appendix 4 [RD-4] for more details on the proposed liability scheme).

The Maritime Competent Authority is not responsible for any problem/accident imputed to EGNOS. According to the group inputs, to this moment, they do not identify wider responsibilities on the Competent Authority apart from their involvement in the promulgation of Maritime Safety Information, according to common existing practices. **Further responsibilities to be established within the EGNOS Working Arrangement framework, may depend on whether EGNOS is declared an AtoN by the national/competent authority and would need further analysis (gathered in Appendix4 [RD-4]).**

National Maritime Service Providers may monitor SBAS performance to ensure it does not interfere or degrade use of marine beacon correction information.

It should be noted that EGNOS performances are continuously been monitored by the EGNOS Service Provider. In case of outage, maintenance, performance degradations, etc (with respect to the Service levels established), the agreement counterpart is informed through a specific agreed procedure (e.g. contingency procedure). However, depending on how data is provided, the maritime Competent Authority may wish to record data for integrity monitoring and alerting, post processing for performance monitoring, and/or to ensure they are content that the EGNOS working agreement conditions are met.

For MSI, existing internationally agreed procedures will be followed (see (3) and (4) in Figure above). As schematically shown in Figure 5 (see (4)) the Maritime Authorities may be involved in the MSI process, according to the common existing practices.

- **Hydrographic Organisations**

The Hydrographic Organisations are involved in the provision of Notices to Mariners and NAVAREA Warnings as part of MSI and therefore they are included in the scheme above. Depending on the content of the MSI, different bodies are responsible for their creation. It is important to make sure all stakeholders are involved. An unscheduled outage or degradation of the EGNOS service should be communicated to the users as soon as possible. It would be necessary to establish a communication link for this type of information.

#### 3.2.2.2 *Required interfaces/working arrangements*

The following interfaces and working arrangements are required:

EGNOS Service provider, maritime equipment manufacturers and user representatives should all be involved in the standardization/approval process inter alia through IEC (see §2 for more details on the approval process). This involvement is important to ensure the applicable standards are developed correctly and up to date with EGNOS developments, first with respect to SBAS L1 SiS and in the future with respect to the new SBAS L5 SiS.

In service, the EGNOS Service provider and user groups are involved. The EGNOS Service Provider should provide details on the services provided the usable coverage and expected service performance requirements in terms of equipment and coverage (mapped against the IMO Performance requirements). The EGNOS Service Provider should provide means of reporting the historical performance of EGNOS on a previous day, or period (this may require all data to be recorded). The EGNOS Service Provider will need to provide information to users on service warnings, downtime, and long term evolution of the service (including notification of service changes). Legal recording may require such data to be captured in the vessel's Data Recorder, although the exact data and need has yet to be established.

Appendix 4 [RD-4] describes the proposed liability scheme (Working arrangements + SDD), outlining aspects on service boundaries, liabilities, performance expectations and collaborative decision making via bi-directional communications. Data will need to be recorded to ensure the committed level of service is met.

To date, any co-ordination with mariners with regards to AtoN provision has been with the National Maritime Service provider and national mariner bodies and users representatives. The ideal of trying



to scope such discussions on a multi-national level, to take into account a regional service, would make it difficult and probably unworkable due to the large number of people involved (considering representatives at regional and national levels). A suitable approach will need to be developed to ensure the appropriate level of communication and representation of all stakeholders is achieved.

### 3.2.2.3 *Potential concerns, questions and unknowns*

This section outlines the different questions raised at this point.

- *Should EGNOS provision be classified as a marine AtoN? (If it were to be declared a marine AtoN, it could bring superintendence and management responsibilities on to the National Maritime Service Provider without the ability of the provider to control what would be a pan-European service.)*

The formal recognition/approval of EGNOS by national competent authorities is being addressed in [RD-4].

- *What is the best method of promulgating MSI information to mariners over a wide area, ensuring the right information is provided to the right mariners in a timely manner?*

The generation and provision of MSI is addressed in [RD-3].

- *How should a SLA with National Maritime Service Provider (if an AtoN), mariners and other user representatives be established (provide service level performance guarantees and liability limits etc)? (IALA may consider a guideline on the approach to an SLA)*

The agreements with National Authorities are addressed in [RD-4].

- *It would need to be confirmed by each maritime authority that this proposed role (involving an agreement to be established between the EGNOS Service Provider and the maritime authorities) is within its remit and that its legal framework enables the authority to participate in such an agreement.*

The intention is to propose an approach homogeneous to different European Authorities. This approach is been developed within [RD-4].

- *It would be impractical for a Working Arrangement to be put in place with every individual port, so as part of the supervisory role of the maritime authority an EGNOS Working Arrangement (EWA) with the maritime authority should explore the inclusion of regions within port boundaries if possible.*

The competent authority signing the maritime EWA is addressed in [RD-4].

### 3.2.3 Scenario 3: EGNOS information (SiS or EDAS) provided to an AtoN provider, which then retransmits the information/signal with partial responsibility on the EGNOS Service Provider (IALA Guidelines G-1129 [RD-10]).

This third scenario considers the transmission of EGNOS information to an AtoN provider, which then retransmits it over AIS or DGPS stations. The vessels would use the existing AIS and/or DGNSS receivers onboard<sup>2</sup>. Thus, this scenario has two sub-categories:

- Scenario 3A: transmission of EGNOS corrections over DGPS stations

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<sup>2</sup> Use of the existing DGNSS receivers onboard means that there is no modification needed to the ship's equipment.

- Scenario 3B: transmission of EGNOS corrections over AIS stations

Additionally, an EGNOS Working Arrangement should be put in place between the EGNOS Service Provider and the Maritime Authority/AtoN Provider.

The tentative service provision scheme for this third scenario is presented below:

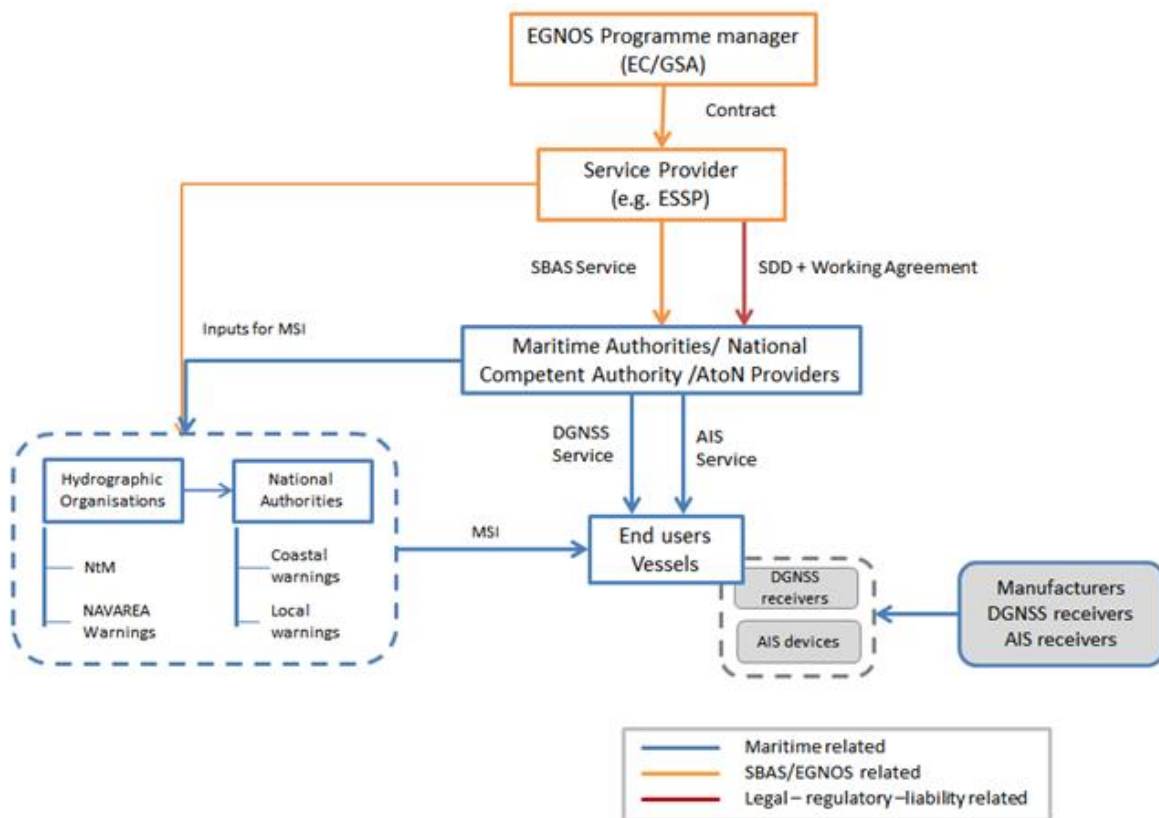


Figure 6: Example – Service Provision Scheme – Scenario #3

Regarding the benefits of this scheme, it should be noted that **Scenario 3A** requires no changes in the equipment onboard the vessels – it takes advantage of the added value provided by EGNOS without additional cost for the vessels.

- The DGNS receivers could be used without changes (for Scenario 3A)

In respect of **Scenario 3B**, changes to ships' equipment may be necessary if the EGNOS information transmitted over AIS is to be used by the ship's principal navigation systems (e.g. ECDIS) and not just by the ship's AIS itself.

- For AIS receivers, the AIS standard includes the (optional) capability of providing DGPS messages through the AIS channel.

IEC 61993-2 Maritime Navigation and Radiocommunication Equipment and Systems – Automatic Identification systems (AIS) contains the minimum operational and performance requirements, as well as the methods of testing for AIS Class A shipborne equipment. In terms of requirements, it is important to highlight the following requirements and recommendations affecting the distribution of DGNSS corrections through the AIS Message 17:

- The AIS shall comprise a means of processing data from an electronic position-fixing system.
- Since UTC is required for synchronisation purposes, an internal GNSS receiver shall be used to determine the UTC.
- When the external position is unavailable, the internal GNSS receiver may be used as a source for AIS position reporting.
- The internal GNSS receiver **shall be capable of being differential corrected, at least by evaluation of message 17.**

Furthermore, the IEC defines the priority of the position sources that shall be used by AIS. It is noted that by default, the external DGNSS corrections shall be used, but in case the external source is not available, the AIS shall automatically switch (after 5 seconds) to the internal DGNSS corrections provided in the AIS message 17.

However, it is not clear whether all stations/devices present this capability. It would be necessary to identify which manufactures/stations/onboard equipment already include this capability – in those cases the equipment could be reused without changes and extra cost (for Scenario 3B). However, in Scenario 3B, further changes to the ship's equipment may be required to convey the AIS message 17 data (from EGNOS) to other ship's systems external to the AIS (RTMC connection). Without such changes, the principal navigation systems of the ship may not benefit from the EGNOS-derived information. This could also lead to a situation where the ship's position reported by AIS was not consistent with the ship's position within its own primary systems.

The particular benefits of this scenario (costs, operational, redundancy, safety improvement, back-up implementation, etc) would need to be addressed on a case-by-case basis, as each nation/Service provider presents different needs and different options for amended beacon system architecture configurations.

Regarding a third party responsible for the oversight of the Service Provider, this role is not currently in place in the maritime scenario and according to the discussion addressed during the 2018 EMRF and EGNOS SPWG [RD-24] there is no need for a third party oversight entity. As commented before, if the Maritime Authority is to provide oversight to the EGNOS Service Provider, then the legislation may be subject to modification and needs to be assessed.

**It should be mentioned that there are still technical assumptions and open points which need to be further investigated in order to confirm the feasibility of the transmission options within this scenario [RD-2].**

#### 3.2.3.1 *Involved organizations and their roles and responsibilities*

This approach would require the following organizations, with their roles and responsibilities outlined:

- **EGNOS service provider**

The EGNOS service provider is responsible for the generation of the EGNOS data, along with the integrity of that data ensuring that it is fit for purpose at the point it is passed to the National Maritime Service provider for transmission.

The EGNOS service provider is responsible for meeting the conditions of the EGNOS service level agreement contained in the Working Arrangements. Liability for accidents by vessels with existing type approved (beacon DGPS) receivers caused by a breach of these conditions lies with the EGNOS service provider. The liability when EGNOS data retransmission is via AIS requires further clarification.

This scenario considers the establishment of an EGNOS Working Arrangement between the EGNOS Service Provider and the Maritime Authority/AtoN Provider, that clearly outlines who is responsible for which part of the service, how data is provided and how outages are managed, both in terms of notification and return to service. It is assumed under this approach that the National Maritime Service Provider is the body that interfaces directly with the end user.

It is unclear at present whether standardization will be required or not. Depending on the approach/architecture used, it may not require any change as the only change would be the source of correction information (EGNOS data extracted and converted to the form of maritime beacon correction information (RTCM format data)). There will be an onus on all stakeholders to ensure the system is fully tested to ensure correct performance, as this is a novel approach. While it may not be formally required, there would be benefits for the standardization/international recommendation of the method to ensure all safety aspects have been considered.

It is likely that even without the need for formal standardization, there will be a recommendation that all stakeholders liaise and capture in some form, guidance and information on how receiver equipment and mariners should respond when provided with DGNSS correction information from different sources at the same time.

Depending on which organization takes responsibility for the service, (EGNOS Service Provider or National Maritime Service Provider) a clear statement on the performance, approach and implication may be required, along with any other requirement as set out in IMO SOLAS Chapter V, Regulations 13.3.

- **Equipment manufacturer**

The approaches considered include the conversion of EGNOS data into RTCM, providing differential correction information in the existing RTCM format and no hardware/firmware change would be needed. This conversion from RTCA to RTCM format is considered in Scenario 3 so as to be able to use technologies in place which already use RTCM format.

Any use of the EGNOS SiS is expected to use the messages in RTCA format with no additional conversions<sup>3</sup>. The reception of EGNOS data in RTCA format is envisaged for EGNOS/SBAS SiS receivers within Scenarios #1 and #2. In particular, for Scenario 2 they would be type approved receivers (SBAS Rx).

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<sup>3</sup> Note that the Guidelines for the SBAS Rx (presented in RTCM) and introduced in this document is to be the baseline/initial step for the development of a standard for SBAS Rx (similar to MOPS in aviation); so, this would only apply to Scenario 2 → SiS + approved receivers, and considers the use of RTCA format without additional conversions.

- **End users: Mariners and other users**

Users have the responsibility to ensure the correct maritime user equipment is used on their vessel and that the resulting data is used in the appropriate manner. This is likely to be controlled by the equipment manufacturer, although they are not directly involved in the day to day use.

In the context of EGNOS data provided via marine beacon or AIS, the mariner has a responsibility to ensure the receiver is set to the correct configuration and that they are sufficiently aware of the system being used and any limitations that may, or may not, be associated with it.

- **National Maritime Service Providers / Other regional body**

The provision of EGNOS data via an existing maritime AtoN will certainly place an element of liability on the National Maritime Service Provider to ensure the data provided is correct and safe to use.

A similar liability is already laid on the NMSP for the beacon DGPS or AIS transmissions. The provision of EGNOS data via an existing AtoN will not discharge the NMSP from its liability but it will require the sharing of liability between the NMSP and the EGNOS service provider in a way that needs to be explored further.

Liability may be shared with the EGNOS Service Provider depending on the contents of the SLA (EGNOS Working Arrangement will need to explain how this liability is shared). As a consequence, the National Maritime Service Provider is expected to record data provided to them as well as the data issued to the mariner, along with any changes to the service provision.

The National Maritime Service provider would be responsible for providing Safety Information and ensuring the mariner is aware of any safety information or changes. The National Maritime service provider will already have responsibility to ensure the correct AtoNs are provided depending on the degree of risk, of which EGNOS would form part of the mix in this sense.

Any significant change to the performance of the marine beacon or AIS services will need to be promulgated with sufficient notice to ensure all marines are aware.

As AIS and DGPS are already national AtoN, the question is whether EGNOS would need to be declared formally as an AtoN if its information is transmitted over existing AtoN. In this case, the considerations regarding the declaration of EGNOS as an AtoN (steps, implications, roles) would need further assessment.

- **Hydrographic Organisations**

The Hydrographic Organisations are involved in the provision of Maritime Safety Information and therefore they are included in the scheme above. Depending on the content of the MSI, different bodies are responsible for their creation. It is important to make sure all stakeholders are involved. An unscheduled outage or degradation of the EGNOS service should be communicated to the users as soon as possible. It would be necessary to establish a communication link for this type of information.

- **Communications provider**

This scenario considers EDAS as one of the sources for the EGNOS information, and EDAS is provided over any communications link that permits internet access. Additionally, particular centralised technical architectures (see the technical considerations in [RD-2]) rely on communication links for the provision of EGNOS corrections to the mariners/end users.



Consequently, the communications provider (role and responsibilities) should also be considered in the frame of scenario #3.

It should be mentioned that establishing a robust communications link/provision for many remote DGPS stations may be challenging. However, based on particular architectures and needs, each Provider may choose to implement this option only in certain locations (as mentioned before, the benefits of these options, including the communications availability, need to be assessed on a case by case basis).

Additionally, it would be necessary to consider that the communication provider may change and there may be more than one provider in any given location or for any given passage.

The communications provider has the responsibility to ensure the communications link remains available and that the data conveyed along it remains intact and unaltered. There is likely to be some kind of SLA between the user and the communications provider, but it may be relatively generic, therefore EGNOS data over this connection may have a lower availability and may be subject to security concerns. Then, the establishment of a dedicated SLA between the communications provider and maritime service provider/AtoN provider should be considered in order to guarantee the minimum level of performances.

There may also be a latency issue to consider with this type of transmission, which may be an issue depending on the communications system employed – latency may affect the accuracy of the calculated position and the provision of integrity information.

There will be an onus on the communications provider to make their users aware of any expected downtime and to minimize the impact.

#### 3.2.3.2 *Required interfaces/working arrangements*

The following interfaces and working arrangements are required:

EGNOS Service provider, National Maritime Service Provider, maritime equipment manufacturers and user representatives should all be involved in the standardization process. This involvement is important to ensure the standards are developed correctly and up to date with current developments, first with respect to SBAS L1 SiS, later with respect to the new SBAS L5 SiS and the provision of data via existing AtoN transmission medium to the maritime receiver equipment.

In service, the EGNOS Service provider, National Maritime Service Provider and user groups are involved. The EGNOS Service Provider should provide details on the services provided, the National Maritime Service Provider is responsible for providing details of the usable coverage and expected service performance requirements (mapped against the IMO Performance requirements).

Both the EGNOS Service Provider and National Maritime Service Provider should provide means of reporting the historical performance of EGNOS and the transmission on a previous day, or period (this may require all data to be recorded). The National Maritime Service Provider will need to provide information to users on service warnings, downtime, and long term evolution of the service (including notification of service changes). Legal recording may require such data to be captured in the vessel's Data Recorder, although the exact data and need has yet to be established.

EGNOS Service providers, National Maritime Service providers and users, may all need to be involved in a service level agreement outlining aspects on service boundaries, liabilities, performance expectations and collaborative decision making via bi-directional communications. Data will need to be recorded to ensure the SLA is met.

To date, any co-ordination with mariners with regards to AtoN provision has been with the National Maritime Service provider and national mariner bodies and users representatives. The ideal of trying to scope such discussions on a regional level, to take into account a regional service, would make it difficult and probably unworkable due to the large number of people involved. A suitable approach will need to be developed to ensure the appropriate level of communication and representation of all stakeholders is achieved.

National Maritime Service Providers will also wish to liaise internationally with other maritime service providers and look to develop IALA documentation relevant to the promulgation of data in this manner. The development of such documentation will require the input of all stakeholders to ensure it is conducted correctly.

### 3.2.3.3 *Potential concerns, questions and unknowns*

*One important concern regarding Scenario 3B is that it should be checked whether the existing ships' AIS equipment actually uses the integrity information from Message 17.*

This question is to be addressed in the appropriate technical projects, and to do so it has been included in [RD-2].

Additionally, there are a number of legal questions to this approach, including:

- *SOLAS use of SBAS data - Given that SBAS use is not currently approved for maritime use, there remains a legal question on whether its use via a different broadcast medium affects this. Is EGNOS data use via MF/AIS any different to its use directly from the satellite or via EDAS in the IMO context? This question may not yet have been considered or addressed.*

No IMO recognition is needed for SBAS (see §2 for more details). Thus, the formal approval of EGNOS will be done at national level, trying to define an harmonized approach that suits the needs for the different European authorities. This is further developed in [RD-4].

- *Liabilities of service – who would be liable for incorrect data, or data integrity issues? (potentially captured in the SLA or other such document).*

This question is being addressed in [RD-4]

### 3.2.4 Scenario 4: EGNOS EDAS information used directly by the vessel

EDAS provides data to the user either in real time, or delayed, via an internet connection, and provides several different data services, depending on the application. In general, available data includes raw GPS measurements observed at the EGNOS Ranging and Integrity Monitoring Stations (RIMS) and the same data as provided from the EGNOS Geostationary Satellites. The latter is provided by the EGNOS SISNet protocol and is expected to be the service of interest in this scenario as it conveys the same information as that received directly from the satellite.

This scenario considers that the mariner uses data from the EGNOS Data Access Service (EDAS) received directly by the vessel (e.g. via a shore-to-ship or satellite broadband link).

It is likely that such a service will be used when it is not possible to receive data directly from the satellites, either due to obscuration or other issues with the receiving antenna.

EGNOS data is likely to be used in this manner if the mariner is unable to retrieve data directly from the satellites, either due to obscuration, high latitude, or an antenna issue. If we consider a vessel sitting in port alongside tall port-side infrastructure, the view from the antenna to the satellites may be

obscured. In this case, the crew may opt to select EGNOS data via EDAS, perhaps using a local port Wi-Fi link to save cost. As they leave port, they will either return to using data directly from the satellite or, if not possible, continue to use the EDAS service. With the latter, the ship will need to switch to a different communications method as they leave port, possibly using a GSM or satellite broadband connection, either of which may drop out from time to time as the vessel moves. Satellite broadband can also suffer from obscuration when the vessel is on a certain heading, depending on equipment fit on that vessel. Therefore there is a need to consider the handover between different communication links, periods of communications outages and the handover between EGNOS data via EDAS and direct from the satellite.

This approach does require good communications and ship broadband is considered in this example.

The development of the Maritime Cloud, as part of the IMO e-Navigation concept should help this approach and it is recognized that SBAS data transmission as part of the VHF Data Exchange Service (VDES) is being considered.

The main differences between the use of EDAS in Scenario 3 (§3.2.3) and in Scenario 4 are listed below (these differences depict why scenario 4 is considered to be more complex in terms of service provision and also from a technical point of view):

- Scenario 3 considers both SiS and EDAS as potential sources for the EGNOS information. EDAS could be used as the primary source, as a backup of the SiS or not used at all. Scenario 4 considers the use of EDAS as the main source of information directly onboard the vessel through an internet connection.
- In Scenario 3, depending on the architecture and on each nation/Service Provider needs, it could be decided to use EDAS only in particular AIS stations/IALA beacons (perhaps in not very remote sites where the availability of communications can be guaranteed). In those cases it would be necessary to rely on the communications link (SLA with communications provider). In Scenario 4 the availability of the communications link onboard the vessels needs to be guaranteed all the time at any location. It would be necessary to analyse the SLA to establish with a Satellite Internet/communications Provider (bandwidth, availability,...).
- In Scenario 3 (potentially) does not require changes in the equipment onboard. In Scenario 4 changes onboard would be necessary: new receiver equipment, EDAS client, link with the bridge equipment,...

**It should be noted that, even if EDAS is accessible globally onboard de vessels, the EGNOS information should not be used for navigation outside the EGNOS coverage area.**

#### 3.2.4.1 *Involved organizations and their roles and responsibilities*

This approach would require the following organizations, with their roles and responsibilities outlined:

- **EGNOS service provider**

The EGNOS service provider is responsible for the provision of EDAS. The EGNOS service provider is responsible for meeting the conditions of the EGNOS system approval and the service level agreement contained in the Working Arrangements.



The liability for accidents by vessels using EDAS onboard through Internet needs to be further investigated (open point: liability to be shared between the EGNOS Service Provider, the Maritime Authorities, the Communications provider?)

Depending on the route taken for the EGNOS system approval (see §2), the service provider may opt to publically state the usable coverage region, performance characteristics (in terms of availability, continuity, accuracy and integrity), along with other factors such as an undertaking to provide the service for a set amount of time and the amount of notification provide before any significant change to the service offered. This information may be required/offered as part of the approval process, however if not, the service provider is encouraged to provide this information to help encourage uptake – the service provider should consider providing this information as part of the information provided in EGNOS Service Provision Layer; consistent with IALA Recommendation R-121 on marine beacon service provision.

There will also be an onus on the service provider to inform the mariner if their service is due to go off air for maintenance, is degraded in any way, or is subjected to unplanned outages. The method of this notice should be suitable for all mariners using the service; as such the notification should be “pushed” to the user, rather than left for them to “pull” the data. An existing methodology for “notices-to-mariners” (NtM) exists and therefore the service provider is encouraged to consider the format and approach used.

- **Communications provider**

As EDAS can be provided over any communications link that permits internet access, the provider may change and there may be more than one provider in any given location or for any given passage.

The communications provider has the responsibility to ensure the communications link remains available and that the data conveyed along it remains intact and unaltered. There is likely to be some kind of SLA between the user and the communications provider, but it may be relatively generic, therefore EGNOS data over this connection may have a lower availability and may be subject to security concerns. There may also be a latency issue to consider with this type of transmission, which may be an issue depending on the communications system employed – latency may affect the accuracy of the calculated position and the provision of integrity information.

There will be an onus on the communications provider to make their users aware of any expected downtime and to minimize the impact. The development of the Maritime Cloud concept may mitigate this issue, although there is no set time for its implementation. The Maritime Cloud should see the implementation of multiple means of communication being used together to ensure the safe, reliable and resilient communications required to support the IMO e-Navigation concept.

- **Equipment manufacturer**

Manufacturers will need to develop appropriate maritime user equipment that conforms to the required IMO Performance Standard for SOLAS vessels, taking into account the IEC Test Specifications, once developed.

In the future, there will be two distinct sets of maritime user equipment, both of which will be capable of using SBAS data, however only one will be fully approved for use on SOLAS vessels (those designed to meet the IMO Multi-system Performance Standards). Manufacturers are encouraged to make it clear which receiver performance standard applies to which user equipment to ensure the correct equipment is used. Consequently, in order to allow the

maritime community to benefit from EGNOS SiS Integrity (at system level) the type-approved receivers should be used.

With EGNOS data being provided over the EDAS SISNet, the data is the same information as that received directly from the satellites and in the same format. As such, the receiver should be designed to expect SBAS data in RTCA format on the LAN or serial port for this approach to work, without the need for a 3<sup>rd</sup> party data converter. Current marine user equipment is not configured in this manner and expects data on the LAN and serial port to be in RTCM format. This is a significant requirement and should be included in the IEC test specification development.

User equipment may have SBAS information from off-air and via EDAS. It should be clear how the receiver should deal with data when it is presented via both means, especially if latency issues have resulted in different data being presented.

User equipment may have SBAS and marine beacon data present at the same time, with different correction information in different formats. Equipment manufacturers will need to have a clear understanding on how to manage this data and which correction information to apply at the same time.

- **End users: Mariners and other users**

Users have the responsibility to ensure the correct maritime user equipment is used on their vessel and that the resulting data is used in the appropriate manner. This is likely to be controlled by the equipment manufacturer, although they are not directly involved in the day to day use.

In the context of EGNOS data provided via EDAS, the mariner has a responsibility to ensure the receiver is set to the correct configuration and that the communications system used is configured appropriately.

- **National Maritime Service Providers / Other regional body**

The establishment of an EGNOS working agreement between the EGNOS Service Provider and the maritime authorities (regardless of whether the EGNOS System is declared an AtoN or not), which guarantees the EGNOS performance, including integrity at system level needs to be further investigated for this Scenario 4.

Regarding the declaration of a National AtoN, as in previous scenarios, it is unclear at present whether any use of EGNOS will be declared an Aid-to-Navigation (AtoN). There are benefits for such declaration in that it formalizes the use of EGNOS within some service areas, however it may require legislation to enact, for each nations waters.

The involvement of National Service providers may or may not relate to whether EGNOS is declared an AtoN or not. If it is not declared an AtoN, then any use by the mariner (via data direct from the satellite) is outside the National Maritime Service providers remit, although they may wish to monitor the performance of EGNOS, both off-air and via EDAS but this would depend on their legal framework; however they would have no obligation or formal role to play. It would therefore be up to the EGNOS service provider to inform the mariner of any outages or safety related information and any liability of use would be between them and the mariner.

An exception to this would be if the National Maritime Service provider is involved in the promulgation of Maritime Safety Information (MSI), which is normally the case. However as the approach for promulgating EGNOS operational status data has yet to be defined, this is

unknown. It will be necessary to implement a method of informing the mariner, and other users, of periods when the service will not be available, or is affected by unplanned events.

Each country may consider whether EGNOS should be declared an AtoN. If it is, EGNOS provision will become subject to SOLAS Chapter 5, Regulation 13 on the establishment and operation of Aids to Navigation. As such, the National Maritime Service provider in each country opting to declare EGNOS an AtoN may wish to have a Service Level Agreement or other instruction, and may have a greater oversight in the operation, maintenance and performance of EGNOS under existing national legislation.

- **Hydrographic Organisations**

The Hydrographic Organisations are involved in the provision of Notices to Mariners and navigational warnings as part of MSI.

#### 3.2.4.2 *Required interfaces/working arrangements*

The following interfaces and working arrangements are required:

EGNOS Service provider, communication service representatives/providers, maritime equipment manufacturers and user representatives should all be involved in the standardization process. This involvement is important to ensure the standards are developed correctly and up to date with current developments, particularly in relation to EGNOS Version 3 and the provision of data via the internet and its presentation to, and use within, maritime receiver equipment.

In service, the EGNOS Service provider, communication service representatives and user groups are involved. The EGNOS Service Provider should provide details on the services provided, the usable coverage and expected service performance requirements (mapped against the IMO Performance requirements). The EGNOS Service Provider should provide means of reporting the historical performance of EGNOS on a previous day, or period (this may require all data to be recorded). The EGNOS Service Provider will need to provide information to users on service warnings, downtime, and long term evolution of the service (including notification of service changes). Legal recording may require such data to be captured in the vessel's Data Recorder, although the exact data and need has yet to be established.

EGNOS Service providers, Communications provider, National Maritime Service providers and users, may all need to be involved in a service level arrangement outlining aspects on service boundaries, liabilities, performance expectations and collaborative decision making via bi-directional communications. Data will need to be recorded to ensure the SLA is met.

To date, any co-ordination with mariners with regards to AtoN provision has been with the National Maritime Service provider and national mariner bodies and users representatives. The ideal of trying to scope such discussions on a national & regional level, to take into account a regional service, would make it difficult and probably unworkable due to the large number of people involved. A suitable approach will need to be developed to ensure the appropriate level of communication and representation of all stakeholders is achieved.

#### 3.2.4.3 *Potential concerns, questions and unknowns*

This section outlines the different questions raised at this point.

- *Should EGNOS provision be classified as an AtoN? Unless it is, some National Maritime Service providers will have no authority in respect of the service. Making it an AtoN will introduce other requirements and may require changes to national legislation.*  
To be addressed under the umbrella of the EGNOS Working Agreements in [RD-4].
- *What is best method of promulgating MSI information to mariners over a wide area, ensuring the right information is provided to the right mariners in a timely manner?*  
The provision of EGNOS Safety Information is addressed in [RD-3].
- *Should service providers, National service providers and users monitor the performance of EDAS SISNet?*  
To be addressed under the umbrella of the EGNOS Working Agreements in [RD-4].
- *Should MSI information include communications outages?*  
The provision of EGNOS Safety Information is addressed in [RD-3].
- *How should a SLA with mariners and other user representatives be established and who will enforce it?*  
To be addressed in [RD-4].
- *Will VDES be declared an AtoN, or the content an AtoN? Will VDES be able to carry EGNOS data?*  
According to the information in IALA Guideline G1129[RD-10], VDES will be carrying SBAS data,

### 3.2.5 Conclusions

It is considered that the use of SBAS data off-air will be the primary scenario employed, however the use of SBAS in the provision of maritime differential corrections may also need to be considered by National Maritime Service providers.

It is considered that while the primary means of using SBAS data will be direct from the satellites, the other approaches could be used to mitigate any outage or obstruction. Therefore, there is a need for further investigation into the effect of latency and what should be done when EGNOS data is available on multiple ports concurrently, particularly if such data relates to different epochs etc.

From a regulatory perspective, the direct use of SBAS SiS or EDAS data on a SOLAS vessel is restricted until the development of new receiver equipment, as discussed previously. The use of data via marine beacon broadcast (where EGNOS data is used as the source of the corrections) may be affected by the precise details of national legislation that governs the beacon as a national AtoN. This legislation is potentially different in each country however, in the UK the legislation does not detail how corrections are calculated and therefore SBAS derived information seems permissible. This may not be the case in all nations. This would be a new approach and therefore, while this may be permitted (both by national legislation and SOLAS wording), a full and open development of the approach is recommended with recommendations formally captured where applicable to ensure the safe use of this new approach.

It should also be noted that for some AtoN architectures using EGNOS within marine beacon transmissions, the use of EGNOS data would replace the legacy local correction data, meaning that there is no redundancy and no benefit is realized from having both available. Prior to any implementation, it is recommended that the study referenced earlier into where marine beacon and SBAS provide complementary services and where they are beneficial as back up to each other is completed.

### 3.2.6 Maritime Community User requirements

The activities/services provided within the EGNOS Service Provision layer need to be tailored to the specific maritime community needs.

The sections below describe the particular needs /user requirements coming from the maritime community (regulatory driven or added value /technical feasibility driven), under two categories:

- Needs in terms of EGNOS information to be publicly available to all maritime users/stakeholders
- Needs regarding the tailored information/services to be offered in the frame of an EGNOS Working Arrangement for the ESP counterpart.

#### 3.2.6.1 Public Information needs

The sections below describe the maritime community EGNOS information needs. The points described deal with **public/generic** services to be put in place by the EGNOS Service Provider, taking into account the needs coming from the maritime users/community.

##### - Helpdesk

There are not specific requirements in maritime regulation for the provision of ad-hoc support to mariners including user helpdesk. However, some organizations such as the US Coast Guard offer helpdesk services where to submit doubts or enquiries.

A 24/7 helpdesk is already available for EGNOS users in all applications domains including maritime.

According to the WG feedback, it is unlikely that the mariners will call the EGNOS helpdesk, but any National service provider may use the helpdesk when/if they have any questions or queries. Therefore, it seems that the helpdesk service would be useful, at least for National Service Providers.

As there are no specific requirements, the existing 24/7 helpdesk could be maintained in the same way as it is operated now. Future interaction with maritime users/service providers might come up with changes or new requirements to be considered and changed in the helpdesk service.

It should be noted that, in principle the helpdesk aim is to answer generic questions related with EGNOS: performances, appropriate/certified receivers, etc. If the queries are related to the conditions of a specific EWA, then other communication means should be used (the EWA establishes official/dedicated communication channels between the signing counterparts).

##### - User support website

The EGNOS User Support website (<http://egnos-user-support.essp-sas.eu>) provides real-time information on EGNOS performances by means of maps, tables and diagrams.

Mariners use websites and depending on the equipment fit, may do so either in port or with an appropriate communications link onboard (e.g. Notice to Mariners are accessed through websites).



Although the maritime engineering personnel may find historic data included in the website very useful, it is still not clear whether the mariners or other users would use the EGNOS User Support website.

These aspects are difficult to resolve until the larger picture and understanding of how the service will be provided is clear. Thus, the way the User support website could be adapted to fit maritime user needs will need to be assessed in the future, taking into account actual feedback of the web users within the maritime community.

#### - **Performance Reports and Statistics**

According to IALA Guideline No. 1112, the service provider should continuously monitor the DGNSS transmissions to detect service disruptions and anomalies.

The EGNOS Service Provider regularly provides periodic performance reports for the different EGNOS services on a monthly and yearly basis. If required by the maritime community, such reports should be adapted to the specific needs of maritime users.

The particular needs coming from the maritime community regarding the information and reports will become clearer in time, and will need to be considered to better adapt this service to their particular needs.

As performed for other EGNOS services, EGNOS parameters to be monitored and included in the monthly and yearly analysis and reports will be the parameters that characterize the service tailored for maritime navigation and included in the associated SDD (these parameters, how they are understood and measured, are described in [RD-5]).

#### - **Performance forecasts**

For MSI requirements refer to [RD-3].

##### 3.2.6.2 *Working arrangements needs*

The sections below describe the maritime community needs in the frame of the working arrangement to be established with the EGNOS Service Provider.

The points described are commitments, data and services to be offered by the EGNOS Service Provider (only) to those bodies/entities who have previously established a working arrangement with the EGNOS Service Provider.

#### - **Performance commitment**

The commitment of the EGNOS Service Provider will be included in the EGNOS Service Definition Document (see Working Arrangements definition in [RD-4] for more details). Temporary amendments will be published through Service Notices.

#### - **Contingencies management**

The process/procedure to communicate and manage contingencies still needs to be defined. No particular requirements have been identified.

#### - **Data recording / ad-hoc analyses**

IMO SOLAS Regulation establishes that *vessels under SOLAS must carry voyage data recorders (VDRs) to assist in accident investigations.*

Regarding data recording, it should be mentioned that the EGNOS Service Provider continuously record all GNSS data received, processed and delivered by EGNOS. These data can be provided to solicitants under request.

According to the WG feedback, this service could be useful for the maritime community: the ability to review historic data will be necessary and useful, should there be incidents of outage etc. Data should be kept for a reasonable period of time (still to be defined: possibly in the region of 6-12 months).

Additionally it could be further analysed if ad-hoc data analyses using the available recorded data is necessary/useful for the maritime community.

### 3.3 Service Provision Scheme in Inland Waterways

The service provision scheme in Inland Waterways may change under the following possible scenarios, which consider the different ways in which EGNOS data may be received by the mariner:

1. EGNOS used directly by the vessels
2. EGNOS information provided to an Inland Authority, which then retransmits the information

**The scenarios included in this section, endorsed by inland authorities attending the 2017 joint EMRF/NMSP Workshop held in Athens [RD-7], present the high-level schemes for the provision of EGNOS Service in IWW, identifying the main actors involved together with their main interfaces/responsibilities. The detailed roles and responsibilities together with the very scope of their required interfaces should be subject to a specific assessment to be further developed.**

**The intention of this section is to identify all the potential scenarios and the associated service provision schemes. However, there are certain assumptions, questions and open points that still need to be addressed and that, when solved, may change the low-level details of the presented Service Provision Schemes.**

#### 3.3.1 Scenario IL1: EGNOS SiS used directly by the vessels

This first scenario considers the use of EGNOS SiS with either type approved receivers on-board or legacy receivers. This scenario has two sub-categories:

- Scenario IL1A: EGNOS OS SiS used directly by the vessels with no responsibility on the EGNOS Service Provider.

For the use of the EGNOS Open Service signal in inland waterways, only the receivers on-board (type approved or not) would be needed and the final responsible party in case of an accident would be the vessel's Captain. Inland ECDIS in "information mode" could be used in this case and no type approval is required.

- Scenario IL1B: EGNOS v2 1046 Service SiS (including integrity at system level) used directly by the vessels with responsibility on the EGNOS Service Provider.

This scenario considers the establishment of an EGNOS agreement between the EGNOS Service Provider and the Inland Authorities, which guarantees the EGNOS performance, including integrity at system level according to IMO Resolution A.1046 requirements (if provided within a dedicated EGNOS Maritime Service /Service level for maritime, which is currently under definition). In this case the skippers would benefit from EGNOS SiS Integrity (at system level) using type-approved receivers (SBAS Rx or Multisystem Rx). The requirements for Inland ECDIS in Navigation modus could be considered in the definition of these receivers type approval.

It should be noted that the establishment of EGNOS Agreements with the Inland Authorities seems to be a new process that could present some difficulties, (at least in Germany). It should be taken into account that at present there is no firm requirement for DGNSS service provision and that GPS is used without any service agreement. DGNSS is recommended to use and the responsibility is still at the navigator site. The use of EGNOS with responsibility on the EGNOS Service provider side is a new approach that should be further analysed.

This scenario also considers the broadcast of Notices to Skippers (NtS) to vessels informing of outages of the EGNOS service.

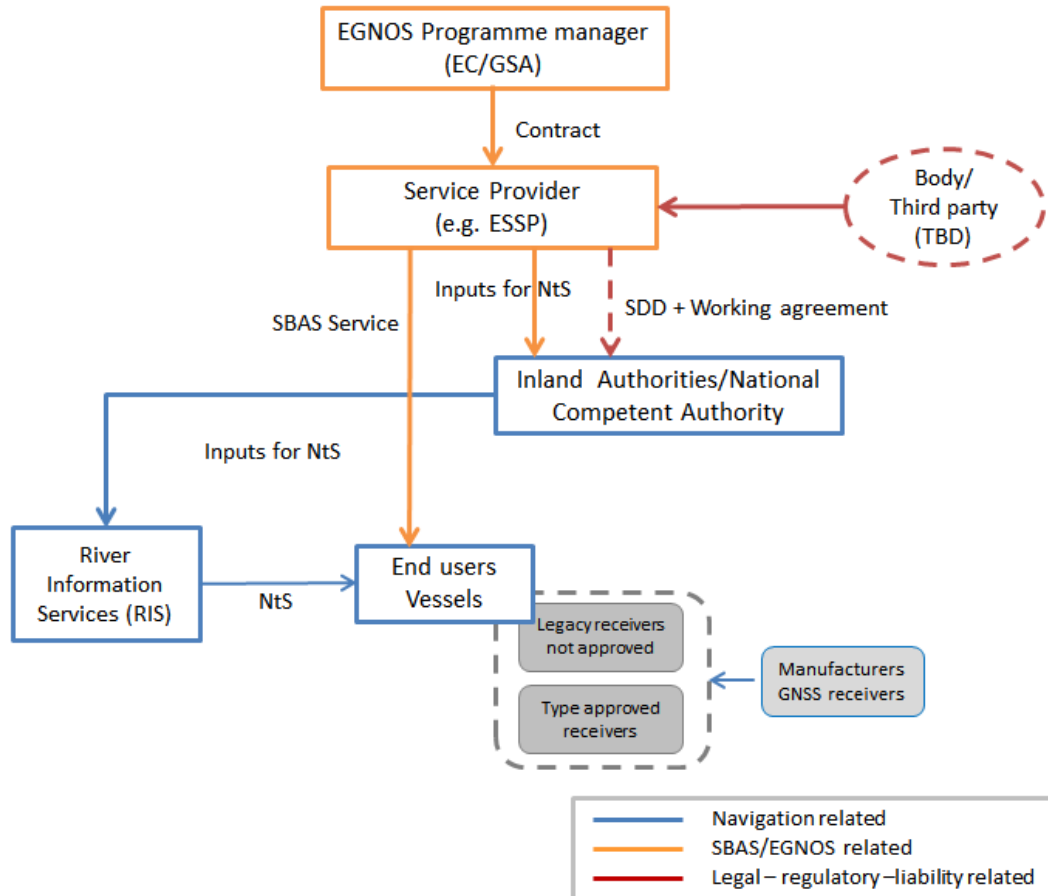




Figure 7: Example – Inland Waterways Service Provision Scheme – Scenario IL1

The following table includes the different actors involved, their roles and responsibilities and the potential agreements to be established between them:

Organization/Actor	Roles and Responsibilities
EGNOS Service Provider	<p><b>Scenario IL1A:</b> To provide EGNOS Open Service, as described in the EGNOS OS Service definition Document. In principle there is no need for specific agreement (except for the provision of Notices to Skippers).</p> <p>No liabilities – skipper/vessel captain will be the final responsible</p> <p><b>Scenario IL1B:</b> The provision of EGNOS 1046 Service including integrity at system level.</p> <p>It would be the EGNOS Service Provider responsibility to ensure the EGNOS information meets the performance requirements described in associated EGNOS SDD.</p> <p>To monitor the service using integrity parameters to detect service disruptions and anomalies;</p> <p>To inform Inland Waterways Authority regarding service disruptions or scheduled interruptions;</p> <p>To manage any service disruptions;</p> <p>To manage maintenance work or changes to the service in such a way that service disruption is minimized and the users are provided with advance warning.</p> <p>The service offered (EGNOS 1046 service) will comply with IMO Resolution A.1046 requirements, which are (for Inland Waterways):</p> <ul style="list-style-type: none"> <li>- Horizontal Accuracy <math>\leq 10</math> m.</li> <li>- Time to Alarm 10 s.</li> <li>- Signal Availability (2 years) <math>\geq 99.8\%</math>.</li> <li>- Service Continuity (over 15 min) 99.97%.</li> </ul> <p>The EGNOS Service Provider responsibility would be to provide the service according to the conditions specified in the associated SDD.</p> <p>The EGNOS Service Provider would be involved in the generation of Notice to Skippers, providing input information to the Inland Authorities to generate the associated Notices to Skippers on the EGNOS Service Provision.</p> <p>A Working Agreement (including liability scheme) would need to be established with Inland Authorities. The EGNOS service provider is responsible for meeting the conditions of the EGNOS system approval and the service level agreement contained in the Working Arrangements. Moreover, the agreement to be established with the RIS provider for the provision of</p>

Organization/Actor	Roles and Responsibilities
	<p>Notices to Skippers should also be considered.</p> <p>It should be noted that the establishment of EGNOS Agreements with the Inland Authorities seems to be a new approach that should be further analysed.</p>
Inland Authorities	<p>There are no specific regulations for inland waterways requiring the installation and use of GNSS and EGNOS integrated receivers,</p> <p><b>Scenario IL1A:</b> There is no interface between the service provider and the inland waterways authorities, as this scenario considers the use of the EGNOS OS directly by the vessels.</p> <p>The establishment of an agreement between the inland authority and the EGNOS Service Provider for the provision of NtS in this case should be further analysed.</p> <p><b>Scenario IL1B:</b> To authorize the use of the EGNOS 1046 service, and then to monitor alerts issued by ESSP about EGNOS Service degradation, relaying information to Skippers.</p> <p>The Inland Authorities would be responsible for broadcasting Notice to Skippers warning alerts when a degradation of Navigation Satellite Systems performances is reported by the ESSP.</p> <p>A Working Agreement (including liability scheme) to be established between the EGNOS Service Provider and the Inland Authorities. Moreover, the agreement to be established with the RIS provider for the provision of Notices to Skippers should also be considered.</p>
Receiver manufacturers	<p>Manufacturers will need to develop appropriate maritime user equipment that conforms to the required IMO Performance Standard for SOLAS vessels, taking into account the IEC Test Specifications, once developed.</p>
Skippers	<p><b>Scenario IL1A:</b> The skipper would be the EGNOS OS final user and the final responsible in case of an accident.</p> <p><b>Scenario IL1B:</b> The skipper would be the EGNOS 1046 Service final user.</p> <p>The skipper would need:</p> <p>To make a proper use of the Navigation System (in order to benefit from the integrity provided by EGNOS – at system level according to A.1046 requirements – and from the guarantees offered by the EGNOS service Provider)</p> <p>To check the navigation system is working properly.</p> <p>To have a good knowledge on the navigation system installed on board</p> <p>To navigate in accordance with the rules issued by the waterway authority</p>

Organization/Actor	Roles and Responsibilities
RIS Provider (if different from the Inland Authority)  (for instance in In Germany there is no difference between Inland Authority and RIS operator)	Generation of Notice to Skippers.  An agreement would need to be established with the EGNOS Service Provider to manage the generation of Notice to Skippers with information on the EGNOS Services degradations.

Table 3: Inland Waterways Scenario IL1 -Actors, roles and responsibilities

### 3.3.2 Scenario IL2: EGNOS information provided to an Inland Authority, which then retransmits the information

This scenario considers the transmission of EGNOS information to an Inland Authority/RIS provider, which then retransmits it over Inland AIS or DGPS stations. The vessels would use the existing Inland AIS devices and/or DGNSS receivers onboard. Thus, this scenario has two sub-categories:

- Scenario IL2A: transmission of EGNOS corrections over Inland AIS base stations.  
Note that due to current AIS VDL channel overload, this first scenario could be the future solution when VDES with more channel bandwidth is available.
- Scenario IL2B: transmission of EGNOS corrections over DGPS stations/IALA DGNSS Beacons.  
In Inland Waterways the GNSS corrections can be distributed via Inland AIS Base Station. If the vessels are equipped with inland AIS (most of the cases), they do not need a DGNSS receiver.

Scenario IL2 considers the transmission of EGNOS information to the AIS Base Station or DGNSS station, which could be located at the Vessel traffic Services of the River Information Service or not, which then retransmits it to the vessels. The vessels would use the existing Inland AIS or DGNSS devices onboard.

In this case an EGNOS Working Arrangement should be put in place between the EGNOS Service Provider and the Inland Authority or national authorities responsible for the RIS. Additionally the service provider should coordinate with the RIS authorities in order to broadcast Notices to Skippers related to EGNOS Service status.



The following table includes the different actors involved, their roles and responsibilities and the potential agreements to be established between them (for Scenario IL2A):

Organization/actor	Roles and Responsibilities
EGNOS Service Provider	<p>To provide EGNOS 10146 Service to the Inland Authorities (that will retransmit the information to the VTS Centers).</p> <p>To ensure DGNSS information meets the performance requirements described in the appropriate Service Definition Document (to be defined):</p> <p>To monitor the service using integrity parameters to detect service disruptions and anomalies;</p> <p>To inform Inland Waterways Authorities regarding service disruptions or</p>

Organization/actor	Roles and Responsibilities
	<p>scheduled interruptions;</p> <p>To manage any service disruptions;</p> <p>To manage maintenance work or changes to the service in such a way that service disruption is minimized and the users are provided with advance warning.</p> <p>The service offered (EGNOS 1046 service) will comply with IMO Resolution A.1046 requirements, which are (for Inland Waterways):</p> <ul style="list-style-type: none"> <li>- Horizontal Accuracy <math>\leq 10</math> m.</li> <li>- Time to Alarm 10 s.</li> <li>- Signal Availability (2 years) <math>\geq 99.8\%</math>.</li> <li>- Service Continuity (over 15 min) 99.97%.</li> </ul> <p>The EGNOS Service Provider responsibility would be to provide the service according to the conditions specified in the associated SDD. It should be further analysed if the EGNOS 1046 SDD will fit also this scenario or a separate service/SDD would need to be defined for this case.</p> <p>In the case EGNOS information is provided through an EDAS station or a VRS architecture is used, the ESP should ensure that the established performances are fulfilled. Dedicated communication lines with high availabilities should be considered in this case.</p> <p>The ESP would also be involved in the generation of Notice to Skippers.</p> <p>A Working Arrangement (including liability scheme) needs to be established with Inland Authorities/RIS Provider. The EGNOS service provider is responsible for meeting the conditions of the EGNOS system approval and the service level agreement contained in this Working Arrangements. Moreover, the agreement to be established with the RIS provider for the provision of Notices to Skippers should also be considered.</p> <p>It should be noted that the establishment of EGNOS Agreements with the Inland Authorities seems to be a new approach that should be further analysed.</p>
Inland Authorities	<p>To ensure all RIS services are properly provided in accordance with the relevant regulations.</p> <p>To broadcast Notice to Skippers warning alerts when a degradation of Navigation Satellite Systems performances is reported by the ESP.</p> <p>To program alternative ways of DGNSS corrections provision if EGNOS fails.</p> <p>In the case EGNOS information is provided through an EDAS station, should ensure continuous provision by using dedicated internet lines.</p> <p>A Working Agreement (including liability scheme) needs to be established between the EGNOS Service Provider and the Inland</p>

Organization/actor	Roles and Responsibilities
	<p>Authorities.</p> <p>In case of RIS shared by two different countries, a coordination agreement, or a Memorandum of understanding has to be made by both National Authorities.</p>
Receiver manufacturers	<p>No changes in the existing equipment would be needed. The potential added value of this scenario is the use of the existing Inland AIS receivers.</p> <p>However, changes to ships' equipment may be necessary if the EGNOS information transmitted over Inland AIS is to be used by the ship's principal navigation systems (e.g. ECDIS) and the communication between the AIS device and the bridge is not enabled.</p>
Skippers	<p>The skippers are the Inland AIS final user.</p> <p>Make a proper use of the Navigation System (in order to benefit from the integrity provided by EGNOS – at system level according to A.1046 requirements – and from the guarantees offered by the EGNOS service Provider).</p> <p>To check the navigation system is working properly.</p>
RIS provider (if different from the Inland Authority)	<p>To receive EGNOS information and manage appropriate EGNOS integrated receivers.</p> <p>To convert EGNOS messages into AIS/DGNSS format.</p> <p>To broadcast the corrections to the vessels in the area.</p> <p>To ensure EGNOS information transformed to RTCM format is broadcasted with a minimum delay.</p> <p>To check the DGNSS corrections accuracy and integrity, by using them in a DGNSS receiver, testing if the position solution is into the acceptable limits. To reject the information if not meets the standard accuracy.</p> <p>To monitor integrity information issued by the EGNOS messages.</p> <p>To deliver warning alerts to the National Inland Waterways Authority to be broadcasted as Notice to Skippers, when a degradation of Navigation Satellite Systems performances is reported by the ESP.</p> <p>To program an alternative way to produce DGNSS corrections if EGNOS fails.</p>
Communication Provider	<p>In the case EGNOS information is provided through EDAS or a VRS architecture is used, dedicated communication lines with high availabilities should be considered.</p> <p>A Working Agreement would need to be established with the</p>



Organization/actor	Roles and Responsibilities
	Communications provider.

Table 4: Inland Waterways Scenario IL2 -Actors, roles and responsibilities

### 3.3.3 Inland Waterways Community User requirements

The activities/services provided within the EGNOS Service Provision layer need to be tailored to the specific needs coming from the Inland waterways community.

The sections below describe the particular needs /user requirements under two categories:

- Needs in terms of EGNOS information to be publicly available to all maritime users/stakeholders
- Needs regarding the tailored information/services to be offered in the frame of an EGNOS Working Arrangement for the ESP counterpart.

#### 3.3.3.1 Public Information needs

The sections below describe the maritime community EGNOS information needs. The points described deal with **public/generic** services to be put in place by the EGNOS Service Provider, taking into account the needs coming from the inland waterways users/community.

Inland Navigation Authorities need to be informed of any issue related with the service provision:

- Warning on any satellite that is not working properly, especially if detected by EGNOS but there has not been prior information the responsible of the corresponding GNSS agency:
- Anomalous variation in the ionospheric propagation delay.
- EGNOS internal conditions affecting the transmitted information
- GNSS conditions external to EGNOS
  - o GPS constellation status.
  - o Degraded GPS Core Constellation

The most of this information will not be known by the skippers. However the Inland Navigation Authority should be kept informed. It would be useful in case of calamity, and for further investigation of incidents. For these cases there should be also important to keep records of transmitted information.

#### - Helpdesk

No specific requirements have been identified on the provision of ad-hoc support through a helpdesk service. A 24/7 helpdesk is already available for EGNOS users in all applications domains including maritime. As there are no specific requirements, the existing 24/7 helpdesk could be maintained in the same way as it is operated now. Future interaction with skippers and inland waterways experts might come up with changes or new requirements to be considered and changed in the helpdesk service.

#### - User support website

The EGNOS User Support website (<http://egnos-user-support.essp-sas.eu>) provides real-time information on EGNOS performances by means of maps, tables and diagrams. The users are already

familiarized with web-services (note that Notices to Skippers are provided according to the standard in XML-format downloadable in the Internet) and this user support service might be useful.

The way the User support website could be adapted to fit skippers needs should to be assessed in the future, taking into account actual feedback of the web users within the inland waterways community.

#### - **Performance Reports and Statistics**

The particular needs coming from the inland waterways community regarding the information and reports will become clearer in time, and will need to be considered to better adapt this service to their particular needs.

As performed for other EGNOS services, EGNOS parameters to be monitored and included in the monthly and yearly analysis and reports will be the parameters that characterize the service tailored for maritime navigation and included in the associated SDD.

#### - **Performance forecasts**

For MSI requirements refer to [RD-3].

##### 3.3.3.2 *Working arrangements needs*

This section describes the inland waterways' community needs in the frame of the working arrangement to be established with the EGNOS Service Provider.

The points described are commitments, data and services to be offered by the EGNOS Service Provider (only) to those bodies/entities who have previously established a working arrangement with the EGNOS Service Provider.

#### - **Performance commitment**

The commitment of the EGNOS Service Provider will be included in the EGNOS Service Definition Document (see [RD-4] for more details). Temporary amendments will be published through Service Notices.

#### - **Contingencies management**

The process/procedure to communicate and manage contingencies still needs to be defined. No particular requirements have been identified.

#### - **Data recording / ad-hoc analyses**

IMO SOLAS Regulation establishes that *vessels under SOLAS must carry voyage data recorders (VDRs) to assist in accident investigations.*

The EGNOS Service Provider continuously record all GNSS data received, processed and delivered by EGNOS. These data can be provided to solicitants under request. This service could be useful for the inland waterways community. Additionally it could be further analysed if ad-hoc data analyses using the available recorded data is necessary/useful for the maritime community.

## ANNEX 1. REGULATORY FRAMEWORK AND KEY STAKEHOLDERS

### Annex 1.1. Main stakeholders

This section aims to provide an overview about the main actors involved in the Maritime Navigation including its main roles, responsibilities, links and interfaces.

The most important regulatory actor related to maritime Navigation is the **International Maritime Organization (IMO)**.

Member States of IMO agree through *Safety of Life At Sea (SOLAS) convention* on the mandatory carriage requirements for vessels (Chapter 5, Regulation 19). These **carriage requirements** form the minimum level of navigational equipment that certain type of vessel is expected to have onboard. In addition there can be some regional (e.g. EU) or national carriage requirements that exceed the basic SOLAS requirements. The IMO SOLAS convention also gives Coastal States the general regulations for the establishment and operation of aids to navigation (Chapter 5, Regulation 13).

A high level summary of maritime **navigation related user requirements** is published in IMO's *resolution A.1046(27)* on World Wide Radio Navigation System (WWRNS). The resolution gives requirements which have to be met that a system can be recognized as part of IMO's WWRNS. WWRNS can be seen as a mixture of different positioning systems and their supporting augmentation systems [RD-12]. The grey shadowed Systems in the Figure 9 are already identified by IMO as part of a WWRNS.

The need for resilient PNT information has been further stressed during IMO's ongoing work on e-Navigation.

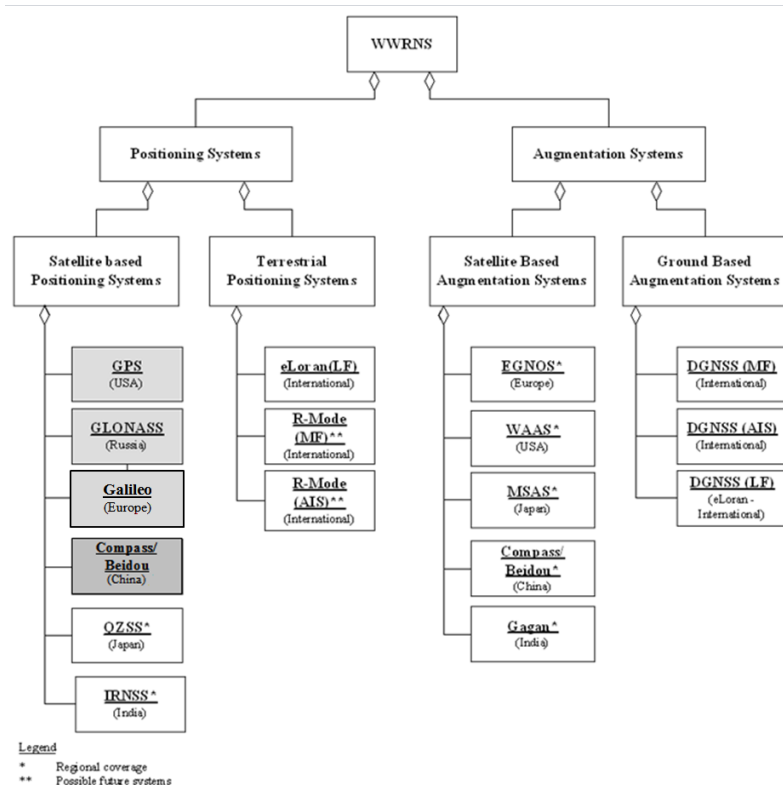


Figure 9: World Wide RadioNavigation Systems. Source: IALA World Wide RadioNavigation Plan

Having in mind the core role of IMO, as explained above, **subsection Annex 1.1.1** lists more actors and bodies having some regulatory, recommendatory or standard making role related to maritime Radio Navigation Systems.

Regarding user requirements, as with carriage requirements, some particular user requirements might exceed the ones stated in IMO resolution A.1046(27). A list of user organizations giving specific requirements for Maritime Radio Navigation Systems is given in **subsection Annex 1.1.2**.

Additionally, all onboard navigation equipment, used for primary navigation must be manufactured to meet the appropriate IMO performance standards. This is assured by testing the equipment against common test standard developed in co-operation with industry. It must be noted that without a relevant IMO performance standard no test standard can be develop and thus no equipment type approved. **Subsection Annex 1.1.3** lists organizations related to drafting of equipment standards and test standards.

Regarding SBAS/EGNOS receivers, it should be further noted that in the future there will be:

- EGNOS enabled receivers which are approved (those covered by IMO MSC Resolution 401(95), Recommendation on the Performance Standards for Multi-System Shipborne Radionavigation Receivers, approved in June 2015, and subsequent IEC test specifications currently under development based on the work currently under development in the frame of RTCM SC-104) and
- those EGNOS receivers which are currently available, which will not be approved as the SBAS element was not developed to meet any maritime specification by the time they were developed.

Finally a list of organizations involved in harmonizing Radio Navigation Service provision is given in **subsection Annex 1.1.4**.

#### **Annex 1.1.1 Maritime Authorities / Rulemaking bodies / Relevant institutions / bodies involved in Regulatory and Standardization activities**

The purpose of this subsection is to detail the different actors and bodies which have some regulatory, recommendatory or standard making role related to maritime Radio Navigation Systems.

The next figure summarises the most relevant actors involved in Regulatory and Standardisation activities related to maritime Radio Navigation, and their link with IMO and its activities. It is very important to highlight the relevant role of the IMO for establishing an adequate regulatory and standardisation framework that allows coordinating the efforts from different agencies with different disciplines.

Looking at the figure, three main groups are identified:

- Non-governmental international organizations (NGOs) that have the capability to make a substantial contribution to the work of IMO may be granted consultative status by the IMO Council with the approval of the Assembly.
- Intergovernmental Organizations (IGOSs) which have concluded agreements of cooperation with IMO. IMO may enter into agreements of co-operation with other intergovernmental organizations on matters of common interest with a view to ensuring maximum co-ordination in respect of such matters. To date there are 64 intergovernmental organizations which have signed agreements of co-operation with IMO.

- Independent: other relevant agencies working on regulatory and standardisation issues but not coordinated with IMO.

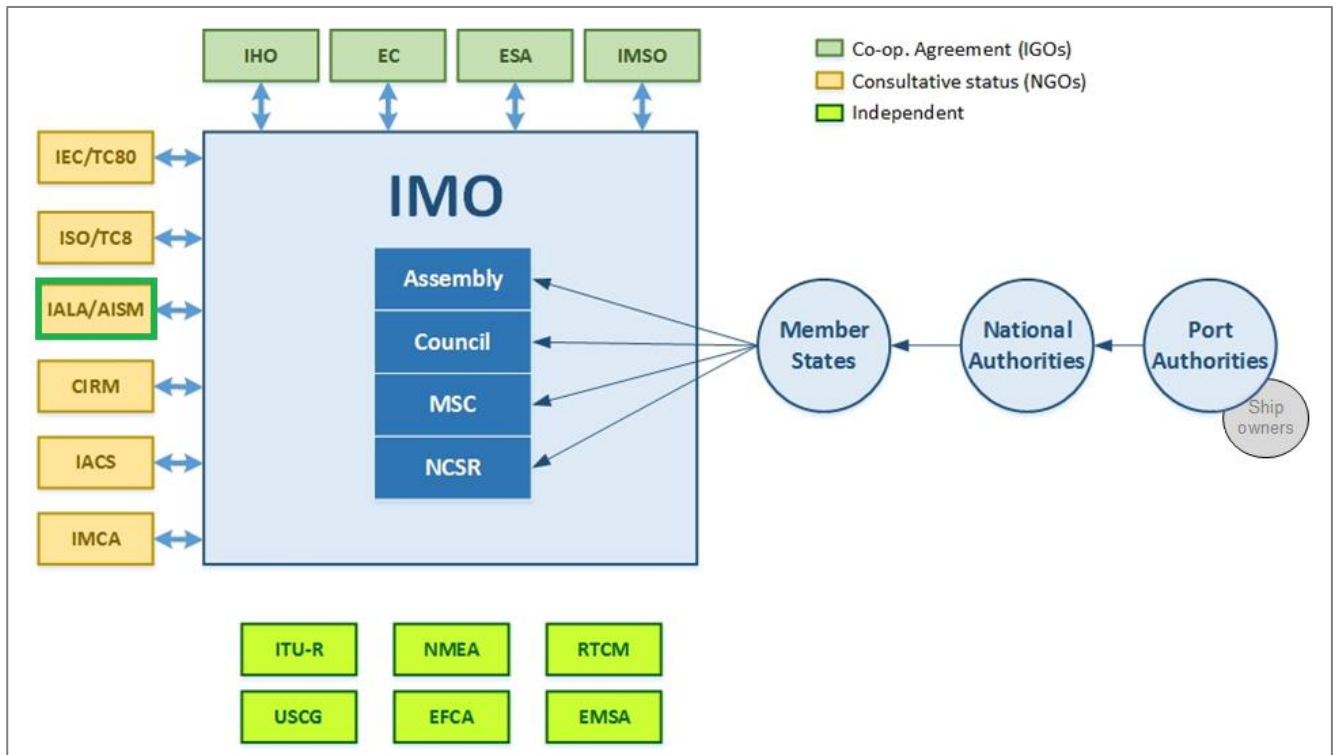


Figure 10: Maritime Authorities and Relevant bodies involved in Regulatory and Standardization activities

The next table summarises the main roles and responsibilities of the above mentioned bodies:

Stakeholder	Main roles and Responsibilities	Links and interfaces
IMO	<b>International Maritime Organisation</b> is a specialized agency of the United Nations. IMO is the global standard-setting authority for the safety, security and environmental performance of international shipping. Its main role is to create a regulatory framework for the shipping industry that is fair and effective, universally adopted and universally implemented.	<a href="http://www.imo.org/">www.imo.org/</a>
<b>IGO (IMO)</b>		
EC	The <b>European Commission</b> has received the mandate from the European Union (EU) to become involved in maritime and radionavigation issues through a number of articles in the Treaty of Union and the Common Transport Policy.  In this line a number of resolutions and initiatives have been outlined regarding maritime transport. EC also takes part in regular talks of international organizations, especially	<a href="http://www.ec.europa.eu">www.ec.europa.eu</a>



Stakeholder	Main roles and Responsibilities	Links and interfaces
	<p>relating to issues such as safety, the protection of the marine environment or labor standards. It coordinates with Member States the EU positions when negotiating forums such as the IMO.</p> <p>It should be mentioned that EC, as the final responsible for the EGNOS and Galileo satellite systems, is the organization in charge of the submission of the formal proposal to IMO for the recognition of these systems in the WWRNS.</p>	
ESA	The <b>European Space Agency</b> is an international organisation with 22 Member States. Its mission is to shape the development of Europe's space capability. ESA has established a cooperation agreement with IMO for providing advice in aspects related to application of space-based systems into the maritime domain.	<a href="http://www.esa.int/">http://www.esa.int/</a>
IHO	A principal aim of the <b>International Hydrographic Organization</b> is to ensure that all the world's seas, oceans and navigable waters are surveyed and charted. The Mission of the IHO is to create a global environment in which States provide adequate and timely hydrographic data, products and services and ensure their widest possible use. The Vision of the IHO is to be the authoritative worldwide hydrographic body which actively engages all coastal and interested States to advance maritime safety and efficiency and which supports the protection and sustainable use of the marine environment.	<a href="http://www.iho.int/">www.iho.int/</a>
IMSO	The <b>International Mobile Satellite Organization (IMSO)</b> is the inter-governmental organization whose Primary Purpose is the oversight of certain public satellite safety and security communication services provided by mobile satellite communication systems. IMSO also acts as the International LRIT Coordinator, appointed by IMO to ensure the operation of the international system for the Long Range Identification and Tracking of Ships (LRIT) worldwide by auditing and reviewing the performance of the system	<a href="http://www.imso.org">www.imso.org</a>
<b>NGO (IMO)</b>		
IALA	<p><b>International Association of Lighthouse Authorities</b> is a non-profit, international technical association. Established in 1957. IALA encourages its members to work together in a common effort to harmonise aids to navigation worldwide and to ensure that the movements of vessels are safe, expeditious and cost effective while protecting the environment.</p> <p>It should be noted that IALA has started a process for the implementation of an International Agreement that would change the status of IALA from that of a non-governmental organisation (NGO) to that of an international</p>	<a href="http://www.iala-aism.org/">www.iala-aism.org/</a>



Stakeholder	Main roles and Responsibilities	Links and interfaces
	intergovernmental organisation (IGO).	
CIRM	The <b>Committee International Radio-Maritime</b> is promoting marine electronics for efficient shipping and the safety of life at sea. CIRM represent the industry in developing international regulations and standards, and providing technical and industrial advice to the Organisations	<a href="http://www.cirm.org/">www.cirm.org/</a>
ISO	<b>International Organization for Standardization Technical Committee 8</b> also develops test standards based on IMO performance standards. For historical reasons, test standards for ship's heading sensors (magnetic and gyro compass) has been the responsibility of ISO.	<a href="http://www.iso.org/">www.iso.org/</a>
IEC	<b>International Electrotechnical Commission</b> is the international standards and conformity assessment body for all fields of electro technology. <b>IEC TC80</b> develops test standards based on IMO performance standards for maritime equipment required on board SOLAS ships.	<a href="http://www.iec.ch/">http://www.iec.ch/</a>
IACS	It is the <b>International Association of Classification Societies</b> . Dedicated to safe ships and clean seas, IACS makes a unique contribution to maritime safety and regulation through technical support, compliance verification and research and development. More than 90% of the world's cargo carrying tonnage is covered by the classification design, construction and through-life compliance Rules and standards set by the twelve Member Societies of IACS.	<a href="http://www.iacs.org.uk/">www.iacs.org.uk/</a>
IMCA	The <b>International Marine Contractors Association</b> is the international trade association representing offshore, marine and underwater engineering companies. IMCA publishes good practice guidance, technical reviews; safety promotion materials and other documentation related to navigation requirements for offshore operations	<a href="http://www.inca-int.com/">www.inca-int.com/</a>
<b>IMO Independent organisations</b>		
EMSA	<b>European Maritime Safety Agency</b> provides technical assistance and support to the European Commission and Member States in the development and implementation of EU legislation on maritime safety, pollution by ships and maritime security. It has also been given operational tasks in the field of oil pollution response, vessel monitoring and in long range identification and tracking of vessels.	<a href="http://www.emsa.europa.eu/">www.emsa.europa.eu/</a>
ITU	<b>International Telecommunication Union</b> is the UN organism specialized in the Information Technology and Telecommunications. In particular ITU-R and WRC regulates allocation and protection of maritime radio bands and GNSS frequencies as well as recommendations on their use.	<a href="http://www.itu.int">http://www.itu.int</a>

Stakeholder	Main roles and Responsibilities	Links and interfaces
EFCA	The <b>European Fisheries Control Agency</b> (EFCA) is a European Union body established in 2005 to organise operational coordination of fisheries control and inspection activities by the Member States and to assist them to cooperate so as to comply with the rules of the Common EU Fisheries Policy in order to ensure its effective and uniform application.	<a href="http://efca.europa.eu/">http://efca.europa.eu/</a>
NMEA	<b>National Marine Electronics Association</b> is also an independent US organisation. The NMEA 0183 and NMEA 2000 are de-facto standards for interfacing marine electronic devices, and also adopted by IEC (61162-series).	<a href="http://www.nmea.org/">www.nmea.org/</a>
RTCM	<b>Radio Technical Commission for Maritime services</b> is an independent US organisation. The RTCM-SC 104 standards for Differential GNSS is a de-facto standard for transmission of differential corrections to GNSS, and is adopted by ITU-R (M.823-3). In addition, it is also important to mention RTCM-SC 131 standards for multi-system performance standard, which is going to include SBAS systems.	<a href="http://www.rtcn.org/">www.rtcn.org/</a>
United States Coast Guard (USCG)	The Coast Guard is the principal Federal agency responsible for maritime safety, security, and environmental stewardship in U.S. ports and waterways. The Coast Guard is a law enforcement and regulatory agency with broad legal authorities associated with maritime transportation, hazardous materials shipping, bridge administration, oil spill response, pilotage, and vessel construction and operation.	<a href="https://www.uscg.mil/">https://www.uscg.mil/</a>
<b>IMO – Member States</b>		
Port Authority	Roles and responsibilities depending on the way Ports are regulated for each country around the world: landlord, private, public... Most of the cases Port Authorities are focused on commercial issues ensuring the highest degree of safety and environment.	
Ship owners	Linked to the Port Authorities ( e.g. Protecting their economic interests). Note that shipowners are included in subsection below as a relevant users' organisation	
National/regional Maritime Administration	Aids to Navigation Support to Vessel traffic regulation Perform of PSC (Port State Control) regulation	

Table 5: Maritime Authorities and Relevant bodies involved in Regulatory and Standardization activities

## Annex 1.1.2 User Organizations

For the purpose of this chapter next table summarizes a view of different user groups and organizations involved in the Maritime Navigation. These actors might have some specific requirements towards Radio Navigation Systems exceeding the ones stated in IMO Resolution A.1046 (27).

User organization	Role	Objectives	Interfaces
<b>LOGISTICS</b>			
Shipowners	Note owner of vessel is not always the shipping line when speaking about logistics.  Owner of the ship it is managed by himself or hired.	Perform most economic advantages as possible of vessel management.	Shipping line / operator
Shipping line	Fleet management of vessels actively and daily.	Perform most economic advantages as possible of vessel management.	Master, Terminal
Masters	Final responsible of any decision taken on board	Ensure safety and minimize trip and port turnaround.	Shipping line / operator
Ports/Terminal	Make profit with the movement of cargo in their facilities	Ensure safety and maximize profit	Pilots, Shipping line
Pilots	Port service provided to shipping lines	Ensure safety movements of vessels inside port waters.	Master, Port
Tugs	Port service provided to shipping lines	Ensure safety movements of vessels inside port waters.	Master, Port
Bunkering	Port service provided to shipping lines	Provide water, goods, food and fuel to vessels inside Port waters.	Shipping line, Master, Port
Dredge operations	Performance dredge operations when asked by the port	Ensure safety movements of vessels inside port waters	Port
Surveys	Performance survey operations when asked by the port	Ensure safety movements of vessels inside port waters	Port
<b>FISHING</b>			
Fishing Vessel owners	Owner of the ship it is managed by himself or hired.  Fish operations	Perform most economic advantages as possible.	Port
Fisheries control agencies (EFCA, EC, MSs,...)	Perform fishing inspections	Detect as much as possible illegal and unreported fishing activities	Fishing vessels
<b>OFFSHORE</b>			
Ship owners	Note owner of vessel is not always the shipping line when speaking about logistics.  Owner of the ship it is managed	Perform most economic advantages as possible of vessel management.	Shipping line / operator

User organization	Role	Objectives	Interfaces
	by himself or hired.		
Masters	Final responsible of any decision taken on board	Ensure safety and minimize trip and port turnaround.	Shipping line / operator
<b>OTHERS</b>			
Search & Rescue Agencies	General duty to provide maritime SAR services.	Maritime Search and Rescue (SAR) services exist to assist people in distress or danger at sea.	Member States
EMSA	In terms of maritime navigation, EMSA performs directly oil spill recovery operations.	Ensure safety and reduce environmental impact of vessel maritime navigation	Member States
Security Agencies	Perform security operations related with detection of illegal drugs maritime transport, illegal migration, others.	Ensure security	Member States
Pipeline deployment companies	Note owner of vessel is not always the shipping line when speaking about logistics.  Owner of the ship it is managed by himself or hired.	Perform most economic advantages as possible of vessel management.	Contractor
PIANC (Fairway planning)	Guidance on Channel Design	Optimize the Safe Navigation in fairways and the construction costs	Members
AtoN providers (IALA)	Positioning of AtoNs, fairway maintenance	Ensure safety	Members
<b>LEISURE</b>			
Leisure craft	Enjoyment of the waterway. Many remain close to shore, although some venture further	Enjoyment of the sea	

Table 6: User Organisations

### Annex 1.1.3 Industrial / Manufacturers related organizations

In addition of the **IEC** and the **CIRM** which have been already mentioned above in section Annex 1.1.1 as regulatory and standardization bodies, the following industrial and manufacturers related organizations should be presented:

**ETSI, the European Telecommunications Standards Institute**, produces globally-applicable standards for Information and Communications Technologies (ICT), including fixed, mobile, radio, converged, broadcast and internet technologies. This Institute recognized by the European Union as a

European Standards Organization is a not-for-profit organization with more than 700 members drawn from 62 countries world-wide.

**Galileo Services** is a non-profit-making organization founded in 2002 as a major partner for the Galileo programme. The organization's mission is both to support and assist the Programme implementation and to stimulate downstream technology and business development (terminals, applications and services). Galileo Services comprises European members ranging from SMEs to large enterprises and international members from both North America and Asia. The members mainly come from down-stream industry.

The **ORganization of European GNSS INdustry** of equipment and service (OREGIN) was founded in 1999 to support the development of the GNSS downstream industry with a specific emphasis on Galileo (today more than 160 members from 20 European countries). OREGIN provides programme information, contributes to partnership up to the smallest and less visible innovative industries, advertises EU industry competencies all over the world, supports on-need EU institutions and expresses industry views.

#### Annex 1.1.4 Maritime Services Providers related Organizations

In addition of **IMO**, **IALA** and the **RTCM** which have been already mentioned above in section Annex 1.1.1, **EMRF** should be presented:

The **European Maritime Radionavigation Forum** (EMRF) gathers together different bodies from maritime administrations to shipowners' organisations to focus on the co-ordination of European maritime interests in the field of radionavigation systems for development within Europe. One of its main aims is to promote the maritime requirements for the safety assessment and certification of future satellite systems, their augmentation systems and back-up, and to develop material to achieve recognition and operational approval of those systems as part of the IMO World-Wide Radionavigation System.

#### Annex 1.1.5 Main stakeholders for Inland Waterways

This subsection aims to identify the particular stakeholders and roles and responsibilities for Inland Waterways. Apart from the maritime stakeholders listed above, for Inland Waterways there are additional actors, as the River Commissions, (or additional roles) that are detailed below.

Stakeholder	Main roles and Responsibilities	Links and interfaces
UNECE (United Nations Economic Commission for Europe) Inland transport Committee	<ul style="list-style-type: none"> <li>- Develop efficient, harmonized and integrated, safe and sustainable transport in inland waterways.</li> <li>- Perform Agreements and resolutions</li> <li>- Establish a comprehensive normative framework for the key aspects of inland navigation,</li> <li>- Trying to promote rapid establishment of harmonized</li> </ul>	<a href="http://www.unece.org">www.unece.org</a>

	river information services.	
EU (European Union)	<p>In particular, DG-MOV prepares directives and regulations.</p> <p>Its main roles and responsibilities are:</p> <ul style="list-style-type: none"> <li>- Establishing a policy framework to support and optimize the functioning of IWT.</li> <li>- Reducing administrative and regulatory barriers.</li> <li>- Developing and implementing safety and environmental requirements and technical regulations</li> <li>- Implementing, River Information Services (RIS)</li> <li>- Managing the NAIADES action Programme, the action programme in support of inland waterway transport.</li> <li>- Defining and appropriate institutional governance framework and clarifying relations with River Commission.</li> </ul>	<a href="http://www.ec.europa.eu">www.ec.europa.eu</a>
CCNR (Central Commission of the Rhine)	<p>The CCNR promotes the development of close cooperation with the other international organization working in the field of European transport. It promotes the development of inland navigation, primarily on the Rhine but also on all waterways in Europe and ensuring the freedom and safety of navigation.</p> <p>The CCNR is involved in the International Standards for Notices to Skippers. Its Member States are: Germany, France, The Netherlands, Belgium and Switzerland.</p> <p>Main roles and responsibilities:</p> <ul style="list-style-type: none"> <li>- Promoting a unified system of regulation for Rhine Navigation and equal treatment.</li> <li>- Ensuring an appropriate economic framework.</li> <li>- Competitiveness of the waterway</li> <li>- Integration of Rhine navigation in the European river transport system</li> </ul>	<a href="http://www.ccr-zkr.org">http://www.ccr-zkr.org</a>
DC (Danube Commission)	<p>The main objective of the Danube Commission is to provide and develop free navigation on the Danube for commercial vessels.</p> <p>Member states of the DC are: Austria, Bulgaria, Hungary, Germany, Moldova, Russia, Romania, Serbia, Slovakia, Ukraine and Croatia</p> <p>Main roles and responsibilities:</p> <ul style="list-style-type: none"> <li>- Improve conditions and safety navigation on the Danube River.</li> <li>- Unifying and providing mutual recognition on the basic regulatory navigation documents.</li> </ul>	<a href="http://www.danubecommission.org/">http://www.danubecommission.org/</a>
MC (Moselle Commission)	<p>The MC promotes the interests of shipping on the Moselle River and ensures that shipping continues to operate as profitable as possible.</p>	<a href="http://www.commission-de-la-moselle.org/">www.commission-de-la-moselle.org/</a>



	Member States are: France, Luxembourg and Germany.	
ISRBC (International Sava River Commission)	The International Sava River Basin Commission (ISRBC) member states are Bosnia-Herzegovina, Serbia, Slovenia and Croatia. Through the Framework Agreement on the Sava River Basin (FASRB), ISRBC has as main goals to establish an international regime of navigation on the Sava River and its navigable tributaries; carrying on a sustainable water management and undertaking of measures to prevent or limit hazards and to reduce or eliminate related adverse consequences	<a href="http://www.savacommission.org/">www.savacommission.org/</a>
VTT EG	The Vessel Tracking and Tracing Expert Group (VTT EG) is responsible to maintain and develop the technical specifications for vessel tracking and tracing systems regulated by the EC	<a href="http://www.ris.eu">www.ris.eu</a>

Table 7: Maritime Authorities and Relevant bodies for Inland Waterways

## Annex 1.2. Main related regulatory framework (Maritime Navigation and GNSS Specific)

This section aims to provide an overview of the main maritime regulations, standards and/or technical references to be considered for GNSS-SBAS Service provision aspects including the on-board ones.

### Annex 1.2.1 Regulations/standards/technical references related to the Provision of Maritime Services.

As earlier mentioned in Chapter Annex 1.1 IMO's SOLAS convention contains some regulations related to provision of shore side systems supporting the maritime navigation.

**SOLAS Chapter V, Regulation 13** [RD-8] gives only very high level requirements on how to establish and operate aids to navigation but directs Contracting Governments to follow other relevant international recommendations and guidelines (e.g. published by IALA) when establishing the aids. Chapter V, Regulation 13 of the SOLAS Convention (as amended by Resolution MSC.99 (73) adopted on 5 December 2000) states:

*" Regulation 13 Establishment and operation of aids to navigation*

- 1. Each Contracting Government undertakes to provide, as it deems practical and necessary either individually or in co-operation with other Contracting Governments, such aids to navigation as the volume of traffic justifies and the degree of risk requires.*
- 2. In order to obtain the greatest possible uniformity in aids to navigation, Contracting Governments undertake to take into account the international recommendations and guidelines when establishing such aids.*
- 3. Contracting Governments undertake to arrange for information relating to aids to navigation to be made available to all concerned. Changes in the transmissions of position-fixing systems which could adversely affect the performance of receivers fitted in ships shall be avoided as far as possible and only be effected after timely and adequate notice has been promulgated."*

It should be highlighted that this IMO SOLAS Chapter V, Regulations 13.3 states that any change in the service affecting the performance of receivers fitted in ships shall only be effected after an adequate notice has been promulgated.

#### Annex 1.2.1.1. IMO Resolution A.1046 (27) on Worldwide Radionavigation Systems

**IMO's Resolution A.1046 (27) [RD-12]** establishes the requirements that a certain radionavigation system shall fulfil to be recognized by IMO as a component of the WWRNS. The recognition by IMO of a radionavigation system means that the system is recognized to be able of providing adequate position information within its coverage area and that the carriage of receiving equipment for use with the system satisfies the relevant requirements of the 1974 SOLAS Convention.

The following points need to be demonstrated prior to the recognition of a system, and should be considered for the purpose of this document on the provision of EGNOS service for maritime navigation:

- *The government or organization providing and operating the system has stated formally that the system is operational and available for use by merchant shipping.*
- *The continued provision of the service is assured.*
- *The system is able to provide position information within the declared coverage area with a performance not less than that established in the present resolution.*
- *Adequate arrangements have been made for publication of the characteristics and parameters of the system and of its status.*
- *Adequate arrangements have been made to protect the safety of navigation should it be necessary to introduce changes in the characteristics or parameters of the system that could adversely affect the performance of shipborne receiving equipment.*

Thus, the governments or organizations (see the different actors and their roles in section 3.2) willing to have EGNOS as a recognized radionavigation system should formally notify IMO that the system is operational and available for use by merchant shipping. In addition, they should declare the coverage area of the system and provide as much other information as practicable to assist IMO in its consideration (information to be included in an SDD). It is important to highlight that changes to operational characteristics need to be communicated adequately to prevent any risk to the safety of navigation.

In addition, a set of requirements are dictated by this Resolution A.1046 for the shipborne receiver equipment, as follows:

- *Avoid the necessity of carrying more than one set of receiving equipment on a ship.*
- *Conform to the relevant performance standards not inferior to those adopted by IMO.*
- *Automatically select appropriate stations for determining ship's position.*
- *Adequate interfaces to exchange positioning data with other equipment.*

The resolution also establishes the operational requirements that a system shall fulfil to be recognized by IMO as a component of the WWRNS. The summary of requirements can be found in the appendix "Operational Requirements" of the resolution. The requirements are summarized below:

- **Ocean waters:** the system should provide positional information with an error not greater than 100 m with a probability of 95%. Signal availability should exceed 99.8%. An integrity

warning of system malfunction, non-availability or discontinuity should be provided to users as soon as practicable by Maritime Safety Information (MSI) systems.

- **Navigation in harbour entrances, harbour approaches and coastal waters:** positional information with an error not greater than 10 m with a probability of 95%. Signal availability should exceed 99.8%. When the system is available, the service continuity should be  $\geq 99.97\%$  over a period of 15 minutes. An integrity warning of system malfunction, non-availability or discontinuity should be provided to users within 10s.

Therefore, this IMO resolution is particularly important as it states the minimum operational requirements that the maritime community requires from any navigation system in order to be accepted and used for maritime navigation.

#### Annex 1.2.1.2. IALA Recommendations and Guidelines

IALA develops and publishes recommendations and guidelines related to the establishment and operation of aids to navigation (as mentioned in IMO's SOLAS convention). The following IALA publications are relevant for Radio Navigation Systems:

- **Recommendation R-121** (applicable to maritime radio beacon DGNSS services) [RD-13].

The new Edition of this document provides a new structure with removal of the Annex to a new IALA Guideline (No.1112), with updated content, options for DGNSS reengineering, service based architecture and improved explanation of requirements.

According to this Recommendation the provision of differential GNSS (DGNSS) services should be operated in accordance with certain minimum standards that take into account relevant ITU-R Recommendations and IMO Resolutions. These minimum standards should include the signal format, reference datum, availability, continuity, integrity, accuracy, signal monitoring, range and coverage, status reporting, validation, and the publication of information about the system,

This IALA document recommends to Members and other Authorities providing DGNSS services in the MF band to adopt the following principles:

- Provide the service in accordance with ITU-R Recommendation M.823-3;
- Provide integrity information for GNSS;
- Provide the service with a level of redundancy to achieve performance requirements IMO A.1046 (27);
- Provide means of verifying the performance of the service;
- Provide mariners with information about the service, for example
  - description of the service
  - achieved service performance
  - service disruptions
  - geographical service area

- Adopt the design and implementation principles set out in the relevant IALA Guideline(s)

- **Recommendation R-135** – Future of DGNSS, Edition 2, 2008 [RD-14]

This recommendation outlines an updated strategy for the recapitalisation of DGNSS. It sets out the requirements and available options, and identifies areas that need to be further studied. According to the IALA document, *this strategy should be viewed in the context of the development by IALA of proposals for a World Wide Radio Navigation Plan (WWRNP) in support of e-Navigation*. The document adds that *one key concept in this Plan is the possibility of separating the generation of correction data from the means of transmission, to facilitate broadcasting by a variety of methods*.

The following table, extracted from the recommendation, shows a comparative of proposed alternatives to the IALA beacon system for the distribution of safety related differential services:

The following table, extracted from the recommendation, lists available PNS systems: shows a comparative of potential alternatives to the IALA beacon system for the distribution of safety related differential services:

System	Accuracy	Coverage	Integrity/ Continuity	Provider Cost	User Cost	Marine Standard
DGNSS	1-3m	local/regional	yes/high	moderate	low	yes
SBAS	1-3m	regional/global	yes/high	very high	low	no
AIS	1-3m	local	yes/moderate	low	low	yes
Pseudolites	sub-meter	local	yes/moderate	high	moderate	no
eLoran	1-3m	regional	yes/high	low	moderate	no
RTK	sub-meter	local	no/low	moderate	high	no

Table 8: Comparative of potential alternatives to the IALA beacon

It should be noted that some of the data included in the table might lead to confusion for uninformed users, since the provider cost for EGNOS is stated as very high. On the one hand, EGNOS is provided for free to users and costs are hence not borne by AtoN providers. On the other hand, EGNOS is a multimodal system, so this should be taken into account when assessing the potential costs of the system.

Additionally, other figures in the table should be modified to match more realistic values, as:

- eLoran accuracy is over 8m (not “1-3m”).
- “sub-dm” describes better the RTK accuracy, than “sub-meter”.
- the high user cost for RTK solutions could also be changed to moderate.

The baseline requirements and principles for the re-capitalisation of the IALA DGNSS service are stated as follows:

- Maintenance of legacy signals (backward compatibility).
- Flexibility to support future service requirements e.g. multiple GNSS, ranging and communications functions.
- Internationally applicable solution.
- Life-time of at least 10 years.

A set of four strategies for re-capitalisation of DGNSS are briefly described in the document: Hardware Reference Stations and Integrity Monitors (RSIM), Software RSIM, Virtual Reference Stations (VRS) and SBAS integration.

It is worth remarking that EGNOS is in a position to fulfil the former requirements and principles stated by IALA. The Recommendation states that *“integration with an existing SBAS, such as WAAS or EGNOS could offer a low-cost solution to service providers. This could be achieved in a variety of ways ranging from the use of SBAS receivers on each site to direct data links with the SBAS control centre”*. However, as commented in points within this document, further technical studies would be needed to clearly demonstrate the feasibility of the use of SBAS/EGNOS for maritime navigation. Additionally, the recommendation highlights the necessity of setting service level agreements between the service providers and the AtoN provider for establishing requirements and contractual obligations: *“The service would then be dependent on the SBAS provider so that a Service Level Agreement would be needed”*.

- **Guideline No.1112** – Performance and monitoring of DGNSS services in the MF band [RD-15]

This Guideline provides the design and implementation principles of IALA Recommendation R-121 on Performance and Monitoring of DGNSS Services in the MF Band.

Regarding the service provision, according to this document, *the operation of the service is considered as the set of tasks performed by the DGNSS service provider in the following domains:*

- ***Operation and Maintenance:*** *The DGNSS service provider should continuously monitor the DGNSS transmissions to detect service disruptions and anomalies.*

To monitor the quality of the service, the Service provider should provide means to:

- to monitor the service using local or remote integrity monitors to detect service disruptions and anomalies;
- inform users using navigational warnings regarding service disruptions or scheduled interruptions;
- manage any service disruptions;

- manage maintenance work or changes to the service in such a way that service disruption is minimized and the users are provided with advance warning.
- **Performance Verification:** *The DGNSS service provider should verify that the service is performing according to specifications.*

The DGNSS service provider should verify that accuracy and integrity requirements are achieved (measured with appropriate monitoring facilities).

- **Publication of information:** *The DGPS service provider should provide a description of the DGNSS service and provide up to date information of scheduled maintenance activities.*

The service provider should publish sufficient information about the service to enable users to use the service safely at all times. This IALA Guideline proposes to employ the existing information channels, appropriate to the intended users and to the nature of the information (e.g. Notices-to-Mariners, broadcasting of maritime safety information (MSI) in the GMDSS).

The relevant information to be published should include:

- description of the service [for example which GNSS is supported], and its intended purpose, identification of the service provider, identification of where information relating to the service can be found and references to the relevant standards and specifications the service comply to.
- advice for safe use of the service and cautionary notes taking into account user receiving equipment;
- technical parameters for each DGNSS beacon;
- achieved service performance;
- the geographical service area where the performance criteria apply;
- contact information for the service provider;
- navigational warnings regarding service disruptions or scheduled interruptions.
- Guideline No.1005 – Contracting out Aids to Navigation Services [RD-9]

The majority of AtoN services are provided by national authorities that are governmental bodies. However in some cases AtoN services may be contracted out to external companies. This IALA guideline identifies the characteristics, proposed steps and types of contracting out AtoN.

According to the guidance information provided in this reference document, some of the factors to be considered when contracting Aids to Navigation Services are:

- Quality of the service:
- Service offered to mariners



- Reliability and continuity of the service
- Response to outages
- Aids in place at the right time
- Physical proximity of service providers to clients
- Flexibility and innovation from the service provider
- Implementation of new technologies
- Risk Management
- Costs of the service:
  - Reduction of costs
  - Cost-effectiveness
  - Financial risk
  - Availability of cost recovery exercise

Other considerations included in this guideline are included below:

- The responsibility towards the international community always remains with the contracting Government as signatory of the SOLAS Convention. Any contract between the AtoN Authority and the private sector for doing tasks on aids to navigation remains under the responsibility of the authority.
- National Authorities should pay particular attention to the legislation within their countries. Being the owner of the aids to navigation service or the official organization responsible to provide an aid to navigation service under legislations, the National Authorities could be held liable to any third party injured as a result of negligence attributable to the service provider in the execution of the maintenance contract. Most often, the liability and the responsibility attributed to the National Authorities cannot be passed to the service provider, even using a very detailed and solid contract.
- National Authority should define the appropriate insurance coverage to be maintained by the service provider. The National Authority could be held liable to any third party injured as a result of negligence attributable to the service provider in the execution of the contract. The subject is very much dependent on local geographical conditions, applicable laws and regulations and general political strategy.
- National Authorities should implement action items for the inspection, monitoring and the auditing of the delivery of the service by the service provider.
- The contract should specify in details the performance of the aids to navigation service to be delivered to the mariners under the responsibility of the service provider.
- The contract should specify that the service provider must use this process to inform mariners of any outages of the aids to navigation under its contractual agreement.

It needs to be highlighted that this guideline is applicable to the provision of DGNSS when such services are subcontracted by the national authorities to external companies.

- **Guideline No.1053** – Submission of a DGNSS Service for Recognition as a component of the IMO WWRNS [RD-16]

This guideline contains a template (offered by the United States as an example) for the submission to IMO of a proposal for the recognition of the DGNSS service as a component of the WWRNS. This document provides a good example of an assessment on the compliance of the requirements stated in IMO A.1046 that could be taken as a reference for the submission of a proposal for the IMO recognition of EGNOS as part of the WWRNS.

- **Guideline No.1060** – Recapitalisation of DGNSS [RD-17]

This guideline recommends that AtoN providers should consider modernization of the DGNSS service in order to ensure that levels of service can be maintained and even enhanced. This recommendation is made in the context of the development of the IALA WWRNP in support of e-Navigation. The recapitalization of DGNSS should consider and take into account the following key concepts:

- Separation of the generation of correction data from the means of transmission
- Integration of terrestrial systems (DGNSS beacons, eLoran, AIS) to provide shared data channels and common correction contributing to a redundant position-fixing solution, complementary to, but independent of GNSS.

In addition, IALA members are encouraged to carry out investigations and studies for future enhancements of DGNSS and to share their results with other different members.

- **Guideline G1129** – The Retransmission of SBAS corrections using MF RB and AIS [RD-10]

This IALA Guideline has been developed in the frame of the IALA ENAV Committee and was approved by the IALA Council in December 2017.

The objective of this IALA Guideline is to set out guidance for marine Aids to Navigation (AtoN) service providers wishing to understand where SBAS information could be used to support the mariner and how to employ such data. The main purpose of the document is to describe the SBAS use within augmentation services via marine radio beacon and AIS transmissions.

The document provides an overview of SBAS structure, use and general coverage areas. Then, recognising that the generation of differential corrections can be split from the means of transmission, a number of different example SBAS based architectures are provided. It should be noted that these proposed architectures are examples, recognising that the infrastructure deployed and operational architecture will vary between service providers.

Finally, the document recommends following the same recommendations related to operational aspects included at IALA guideline 1112 [RD-15], to be considered in case of the SBAS use via AtoN, notably those addressing at least:

- Operation and maintenance
- Performance verification
- Publication of information

This guideline recommends AtoN providers considering utilization of SBAS to consult the SBAS service provider and establish appropriate working arrangements, including at least:

- Provision of Information related to the SBAS service degradation and maintenance activities
- Provision of Information related to the Service characteristics (Performances, coverage area, etc.)
- Establishment of a Liability scheme
- Provision of alarms/alerts procedure in relation with service degradations
- Commitment about the long term operation of the service

It should be noted that IALA continues developing additional Guidelines and Recommendations regarding the provision of PNT relevant services and augmentation systems, which will be analysed (when ready) to check if they include additional requirements for the provision of EGNOS Service for maritime.

#### Annex 1.2.2 Regulations/standards/technical references related to onboard “Navigation systems/devices” (generic or GNSS specific)

The **IMO Safety Of Life At Sea (SOLAS)** Convention [RD-8] stipulates the mandatory carriage requirements for vessels.

The following paragraphs describe applicable requirements that can be found in;

- Chapter V, Regulation 19 of the IMO SOLAS convention
- Chapter V, Regulation 18 of the IMO SOLAS convention

The **Chapter V, Regulation 19 of the IMO SOLAS convention** describes the “Carriage requirements for shipborne navigational systems and equipment”, which is applicable for the purpose of this paper. Section 2.1.6 states:

*“All ships, irrespective of size, must have... a receiver for a global navigation satellite system or a terrestrial radionavigation system, or other means, suitable for use at all times throughout the intended voyage to establish and update the ship's position by automatic means.”*

The Convention also sets out that such navigation equipment, used for primary navigation, should be manufactured to meet the appropriate IMO Performance Standard. In addition Regulation 1 of Chapter 5 permits local administrations to determine whether the mandatory carriage requirements outlined in Regulation 19 are applicable to:

- ships below 150 gross tonnage engaged on any voyage;
- ships below 500 gross tonnage not engaged on international voyages; and
- fishing vessels.

It is important to note therefore, that different vessels may be exempt in different locations, although largely all vessels will be covered as safety of navigation is paramount.

Therefore, vessels covered by Regulation 19, Chapter 5 of the SOLAS convention are unable to use EGNOS for primary navigation until the development and installation of a receiver that meets the IMO Multi-system receiver performance standards (IMO MSC 401(95)). Such approved receivers are expected post-2019 and it should be noted that receivers currently available are not developed to meet these standards and are therefore not approved, although are capable of using SBAS data. It is important to note that this only covers equipment used for primary navigation and as long as other, approved, equipment is used for the navigation of the vessel, an EGNOS receiver can be installed, although not used for navigation.

The **Chapter V, Regulation 18 of the IMO SOLAS convention** describes the “Approval, surveys and performance standards of navigational systems and equipment and voyage data recorder” According to the regulation 18 section 2, *Systems and equipment installed on or after 1 July 2002 to perform the functional requirement of regulation 19 shall conform to appropriate performance standards not inferior to those adopted by the Organization.*

#### Annex 1.2.2.1. IMO Performance standards

The **performance standards adopted by the IMO** for onboard GNSS receiver equipments are recalled in the following table. The Performance Standard for Multi-System Shipborne Radionavigation Receiver will in the future enable also EGNOS enabled receivers to be type approved:

MSC.112(73)	Recommendation on Performance Standards for Shipborne Global Positioning System Receiver Equipment
MSC.113(73)	Recommendation on Performance Standards for Shipborne GLONASS Receiver Equipment
MSC.114(73)	Recommendation on Performance Standards for DGPS and DGLONASS Maritime Radio Beacon Receiver Equipment
MSC.115(73)	Recommendation on Performance Standards for Combined GPS/GLONASS Receiver Equipment
MSC.233(82)	Recommendation on the Performance Standards for Shipborne GALILEO Receiver Equipment
MSC.401(95)	Recommendation on the Performance Standards for Multi-System Shipborne Radionavigation Receivers

Table 9: Performance standards for onboard GNSS receiver equipment

#### - Resolution MSC.112 (73)

This IMO Resolution establishes the minimum performance standards that a GPS receiver has to fulfil under SOLAS regulation for its use in maritime applications. Among the different required features and performances, GPS receivers must have the facilities to process differential GPS (DGPS) data fed to it in accordance with the standards of Recommendation ITU-R M.823 and the appropriate RTCM standard. Besides, when a GPS receiver is equipped with a differential receiver, performance standards

for static and dynamic accuracies should be 10 m (95%). In addition, a list of failure warnings and status indications will need to be provided:

- The receipt of DGPS signals
- Whether DGPS corrections are being applied to the indicated ship's position
- DGPS integrity status and alarm
- DGPS text message display

This IMO resolution highlights the importance given to GNSS augmentation, as GPS receivers are required to process differential (DGPS) corrections in accordance to relevant standards. However, according to this resolution, GPS receivers are not strictly required to integrate a differential receiver in the same device.

- Resolution MSC.115 (73)

This resolution establishes the minimum performance standards that a combined GPS/GLONASS has to fulfil under SOLAS regulation for its use in maritime applications.

- Resolution MSC.113 (73)

This resolution lays down the minimum performance standards for GLONASS Receiver Equipment in the frame of the SOLAS regulation.

- Resolution MSC.114 (73)

This resolution establishes the minimum performance standards that a DGPS or DGLONASS receiver has to fulfil under SOLAS regulation for its use in maritime applications. It describes the different facilities required for DGNSS receivers and lists a series of functional requirements. There are no specific requirements to highlight (some of them could be very similar to the ones potentially required for EGNOS/SBAS receivers).

- MSC.233(82)

This resolution lays down the IMO established performance standards for Galileo equipment.

- MSC.401(95)

This Performance Standard for Multi-System Shipborne Receivers was approved by IMO MSC in mid-2015 at MSC95. This document includes the requirements regarding the use of terrestrial signals in combination with GNSS augmentation, fostering the use of systems as eLoran and SBAS in the maritime sector.

#### Annex 1.2.2.2. IEC International Standards

The following **IEC International Standards** describe the Performance Requirements, the Methods of Testing and the Required Test Results for maritime GNSS receiver equipment.

IEC 61108-1	GPS receivers
IEC 61108-2	GLONASS receivers
IEC 61108-3	GALILEO receivers

IEC 61108-4	DGPS and DGLONASS maritime radio beacon receiver equipment
IEC (expected 2021)	Multi-system receivers

Table 10: IEC International Standards

Regarding the Performance Standard for Multi-System Shipborne Receivers approved by IMO (MSC.401(95)), the RTCM Special Committee 131 is due to develop the first draft of the related Test Specification. Then IEC will start developing the final Test Standard which is expected to be available for manufacturers by 2021 (more details on the status of these standardisation activities can be found in Annex 3).

Linked to the activities above, IMO has developed the Guidelines for shipborne Position, Navigation and Timing (PNT) data processing (Resolution MSC.1/Circ.1575 [RD-11]) which aim to describe the harmonized provision of PNT data and integrity information with multi-system shipborne radionavigation receivers. Although the Guidelines are directly associated with the performance standards for multi-system ship-borne radio-navigation receivers (resolution MSC.401(95)), the scope of application covers all shipborne navigation equipment and systems applying or providing PNT data and associated integrity and status data.

#### Annex 1.2.2.3. Additional regulations for onboard equipment.

The next table lists additional regulations for onboard equipment.

Regulations/standards/technical references	Description	Navigation Systems/devices
SOLAS 1978 (chapter IV) Amendment	GT $\geq$ 1600 -> one radar GT $\geq$ 10000 -> two radars	Safetynet (Inmarsat), Navtex receiver
SOLAS 1988 Amendment (Chapter V)	Includes GMDSS system full revision EPFS requirements Navigation equipment requirements AtoN provision requirements	Safetynet (Inmarsat), Navtex receiver. Radio-communication equipment and systems are internationally regulated in terms of safety. Although are used for other objectives as commercial, social,..
SOLAS 2002 Amendment	AIS and VDR on board is mandatory	AIS VDR
SOLAS 2008 Amendment	LRIT on board is mandatory	LRIT
Radio Equipment Directive (RED) 2014/53/EU	New products placed on the market must be compliant with the Radio Equipment Directive after June 2016	Applicable to non-SOLAS vessels



Regulations/standards/technical references	Description	Navigation Systems/devices
Marine Equipment Directive (MED) 2014/93/EU	The Marine Equipment Directive aims to ensure that marine equipment meets the requirements of international conventions and additionally common standards of safety and performance.	Covers equipment on board vessels subject to carriage requirements and operating under the flag of an EU nation, Norway, Iceland or Liechtenstein. Starting January 1 2001, all newly installed devices listed in Annex A.1 of the directive must be labelled with the wheelmark label.

Table 11: Other regulations for onboard equipment

### Annex 1.2.3 Regulatory framework for Inland Waterways

This subsection aims to identify the main regulatory framework applicable to navigation in Inland Waterways.

International bodies have established the regulatory framework: agreements and resolutions of the UNECE, together with the relevant EU directives and regulations are the main sources of laws and rules adopted by the riparian states, in particular the members of the EU.

However, for the regulations of inland waterways, the organisms involved in the EU, i.e. European Commission, European Parliament and the Council, take into account the expertise of the commissions for navigation of rivers, in particular the Central Commission for the Navigation of the Rhine, as recognized by the Administrative Arrangement Concerning a Framework for Cooperation between the Secretariat of the Central Commission for the Navigation of the Rhine and the Directorate-General for Mobility and Transport of the European Commission signed by the DG-MOVE and CCNR, signed in May 2013.

Other specific bodies related with different aspects of the navigation in Inland Waterways issued standards and rules, usually adopting a compatible scheme with the corresponding item on maritime navigation.

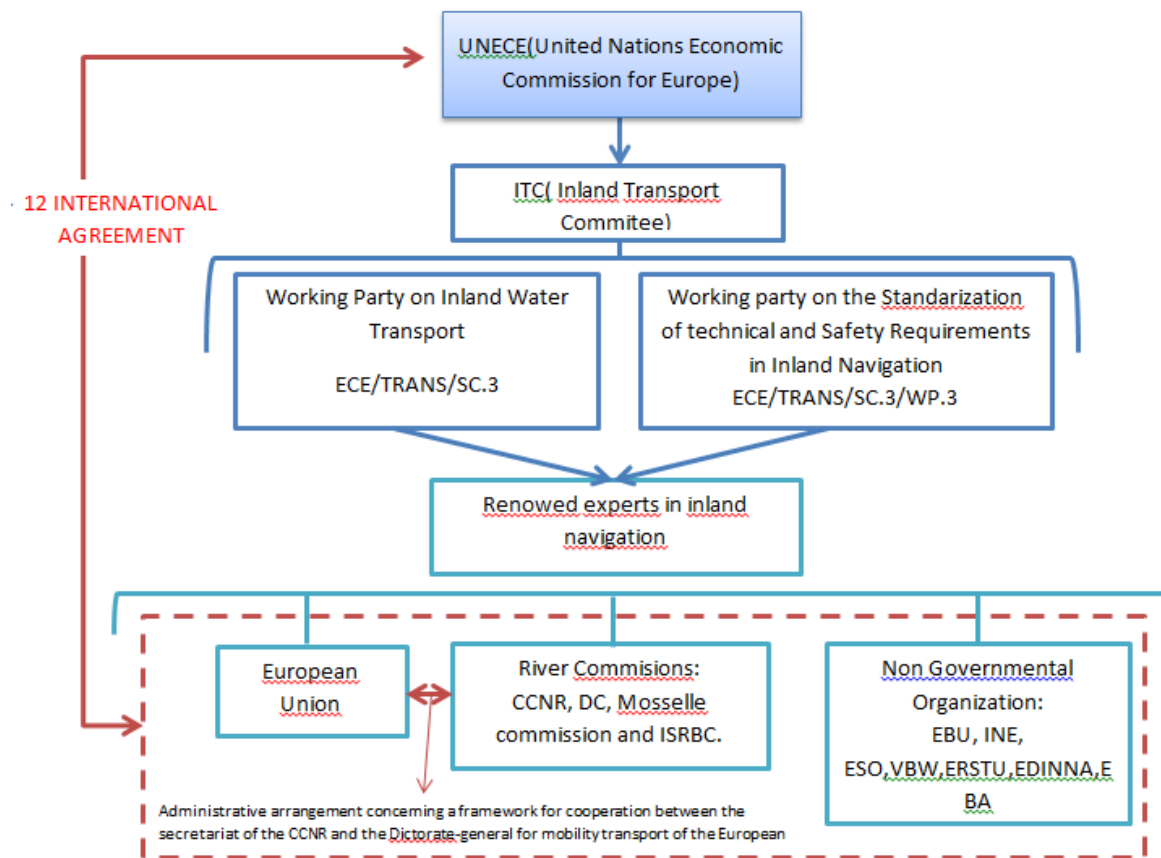


Figure 11: Inland Waterways regulatory framework overview

#### Annex 1.2.3.1. Regulations/standards/technical references related to “PNT Service Provision” or generic Services Provision aspects

Recommendation or Standard	Observations
<b>IALA</b> <b>RECOMMENDATION R-121</b> - PERFORMANCE AND MONITORING OF DGNSS SERVICES IN THE FREQUENCY BAND 283.5 – 325 KHZ.	See description of the Recommendation in section Annex 1.2.1.2
<b>IALA</b> <b>GUIDELINE NO.1112</b> - PERFORMANCE AND MONITORING OF DGNSS SERVICES IN THE	See description of the Guideline in section Annex 1.2.1.2

FREQUENCY BAND 283.5 – 325 KHZ·	
<b>IMO</b> <b>RESOLUTION A.1046 (27) -</b> WORLDWIDE RADIONAVIGATION SYSTEMS	See description of this Resolution in section Annex 1.2.1.1
<b>IALA</b> <b>RECOMMENDATION A-124</b> <b>APPENDIX 16</b> DGNSS BROADCASTS FROM AN AIS SERVICE	<ul style="list-style-type: none"> <li>DGNSS corrections are always provided by an External Service to an AIS Base station, and are not generated by the AIS service. <ul style="list-style-type: none"> <li>In order to provide the correction data to the AIS base station, a DGNSS Reference Station and Integrity Monitor (RSIM) is required.</li> </ul> </li> </ul>
<b>ITU</b> RECOMMENDATION M.823-3	DGNSS corrections transmission technical characteristic as <ul style="list-style-type: none"> <li>Carrier frequency and separation</li> <li>General DGNSS Message format</li> <li>Different DGNSS message types</li> </ul>
<b>RTCM 10401.2</b>	Standard for Differential GNSS Reference Stations and Integrity Monitors (RSIM)
<b>RTCM 10402.3</b>	RTCM Recommended Standards for Differential GNSS Service
<b>NMEA 0183</b>	Protocol to send information from GPS receivers

Table 12: Regulations/standards/technical references related to “PNT Service Provision” or generic Maritime Services Provision aspects

#### Annex 1.2.3.2. Regulations/standards/technical references related to onboard “Navigation systems/devices” (generic or GNSS specific)

Regulation or Standard	Observations
<b>EU</b> <b>DIRECTIVE 2006/87/EC</b> LAYING DOWN TECHNICAL REQUIREMENTS FOR INLAND WATERWAY VESSELS	<p>There is not mandatory to install a GNSS device on board: Generically, article 8 makes reference to possible DGNSS sensor:</p> <p><i>The position sensor (e.g. DGPS antenna) must be installed in such a way as to ensure that it operates with the greatest possible degree of accuracy and is not adversely affected by superstructures and transmitting equipment on board ship.</i></p> <p>There was no reference to AIS on board</p>
<b>CCNR</b> PROTOCOL 2006-I-21. VESSEL	Chapter 1 describes the functional specifications related to vessel tracking and tracing in inland navigation.

TRACKING AND TRACING STANDARD FOR INLAND NAVIGATION.	Chapter 2 describes the inland AIS standard including the standard inland tracking and tracing messages
<b>CCNR</b> PROTOCOL 2014-I-12, ANNEX 2.	Minimum requirements for Inland ECDIS devices and comparable chart display devices for using Inland AIS data on board. Inland AIS will be the DGNSS source to navigate in Inland waterways
<b>CCNR</b> RHINE VESSEL INSPECTION REGULATIONS, ANNEX N, PART I.	Inland AIS devices may only be installed by a specialized firm approved by the competent authority.
<b>CESNI</b> EUROPEAN STANDARD LAYING DOWN TECHNICAL REQUIREMENTS FOR INLAND NAVIGATION VESSELS (ES-TRIN) EDITION 2015/1.	Article 7.06. Navigation and information equipment:  2. Inland ECDIS equipment which can be operated in navigation mode shall be regarded as navigational radar installation. The requirements described in Annex 5 of the current Inland ECDIS Standard shall be met.  3. Inland AIS equipment shall meet the requirements of the current “Vessel Tracking and Tracing Standard for Inland Navigation”. The CCNR adopted the Vessel Tracking and Tracing Standard for Inland Navigation with Resolution 2006-I-21
<b>MSC.114 (73)</b> REVISED PERFORMANCE STANDARDS FOR SHIPBORNE DGPS AND DGLONASS MARITIME RADIO BEACON RECEIVER EQUIPMENT.	Standards which should be met by the AIS Base station receiving DGNSS corrections to be broadcasted later.
<b>ITU</b> ITU-R M.1371-4(04/2010) TECHNICAL CHARACTERISTICS FOR AN AIS USING TIME-DIVISION MULTIPLE ACCESS IN THE VHF MARITIME MOBILE BAND	For the use of the automatic identification systems (AIS), the regional arrangement concerning the radiotelephone service on inland waterways concluded in Basel on 6 April 2000 in the framework of the radio regulations of the International Telecommunication Union (ITU) shall apply.
<b>ETSI</b> EUROPEAN STANDARD (TELECOMMUNICATIONS SERIES) EN 300 698-1 V1.4.1 (2009-12).	Electromagnetic compatibility and Radio spectrum Matters (ERM); Radio telephone transmitters and receivers for the maritime mobile service operating in the VHF bands used on inland waterways.

Table 13: Regulations/standards/technical references related to onboard “Navigation systems/devices” (generic or GNSS specific)



European  
Global Navigation  
Satellite Systems  
Agency





European  
**G**lobal Navigation  
**S**atellite Systems  
**A**gency



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