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| IALA Guideline |

GXXXX

SBAS MARITIME SERVICE

Edition x.x

Document date

Revisions to this IALA document are to be noted in the table prior to the issue of a revised document.

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# Introduction

GNSS have become the primary means of obtaining Position, Navigation and Timing (PNT) information at sea. Most ships (including recreational craft) are equipped with GNSS receivers (SOLAS carriage requirement [1]).

Traditionally maritime users have relied on the DGPS augmentation service, provided by maritime administrations, to improve accuracy and provide integrity for GPS. For those administrations evaluating the possibility to rationalize their DGPS services, Satellite Based Augmentation Systems (SBAS) can be used as a backup or as a complementary means to provide augmentation. New navigation receivers installed on ships also generally utilize SBAS, however type approval processes for navigation receivers currently do not ensure specific performance requirements for SBAS are met.

Administrations can take advantage of the use of the SBAS, which provide enhanced performance over the capabilities of the GNSS and RNSS constellations. SBAS improves the accuracy and reliability of GNSS information by correcting signal measurement errors and by providing information about the accuracy, integrity, continuity and availability of its signals.

Thus clear guidance of how and when to use SBAS in maritime is required, so as to make the most of the SBAS services for the benefit of safety of coastal and harbour navigation.

## Scope of the document

The scope of this guideline is to identify aspects that maritime or coastal administrations may consider in connection with recognition of the use of SBAS on ships in their waters. The guideline provides the description of all the elements of SBAS system relevant to the maritime sector (direct reception of SBAS Signal in Space (SiS) onboard the vessels). This includes service provision, reference requirements, description of the service and the operational chain and equipment. (footnote: note that IALA G1129 covers the retransmission of SBAS corrections using MF-radiobecon and AIS)

## Structure of the document

To include the structure of the document.

[ An appendix to be made to summarize the considerations the administration is recommended to perform when considering SBAS, perhaps modelled om IALA A1084]

# Reference Requirements

The reference requirements for the implementation of SBAS Service for maritime navigation are gathered hereafter.

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

IMO Resolution A.1046(27) on Worldwide Radionavigation Systems [1] establishes the requirements that a radionavigation system needs to fulfil to be recognized by IMO as a component of the WWRNS. This 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. IMO recognize GNSS as part of WWRNS only for oceans areas where required performance levels can be reached without use of augmentation systems. In order to reach the levels of performance stated in 1046 for coastal areas augmentation of the GNSS is required. However IMO (reference here) does not require that augmentation systems are recognized as part of the WWRNS.

The resolution establishes the operational requirements that a system shall fulfil, which are summarised in the table below:

Table 2‑1: IMO Resolution A.1046 operational Requirements

|  | **Ocean waters** | **Harbour entrance, harbour approach and coastal waters** |
| --- | --- | --- |
| Accuracy  (95% Horizontal Navigation System Error (HNSE)) | 100 m | 10 m |
| System Integrity\* | As soon as practicable by Maritime Safety Information | Within 10s |
| Signal Availability | 99.8% | 99.8% |
| Continuity | N/A | 99.97% (over 15 min) |

\*Integrity warning of system malfunction, non-availability or discontinuity should be provided to users within 10s.

* For 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 ≥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.

It should be noted that, according to existing documentation [ [3] IALA Guideline No. 1112, Performance and Monitoring of DGNSS Services in the Frequency Band 283.5 –325 kHz] the signal availability and continuity requirements could be relaxed to 99.5% and 99.95% respectively when the augmentation system is used in combination with other back-up system (for areas of overlapping coverage).

Note that 1046 considers the integrity at “system level”, this means that in case a failure is detected in the system, the user is warned to not use it.

Moreover, the 1046 require that governments or organizations owning and operating the recognized radionavigation systems should comply with the following points:

* 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.

The administration may consider if the above requirements should be fulfilled by the SBAS provider. This may possibly be achieved by use of the method recommended in [IALA recommendation in progress task 3.4.3 in the IALA task register]

## Other reference DOCUMENTATION

To complete with other reference documentation.

# SBAS Architecture

The main elements of a basic SBAS architecture are:

* **Space segment**: Includes the satellites with payloads aimed to transmit the corrections to the GNSS core constellations and integrity information.
* **Ground segment**: Includes all the ground elements in charge of the provision of the SBAS navigation message.
* Monitoring Station Network.
* Processing Facility Centre.
* Satellite Control Centre.
* Communication Layer.
* **User segment**: Includes the user equipment needed to receive and use the SBAS information.

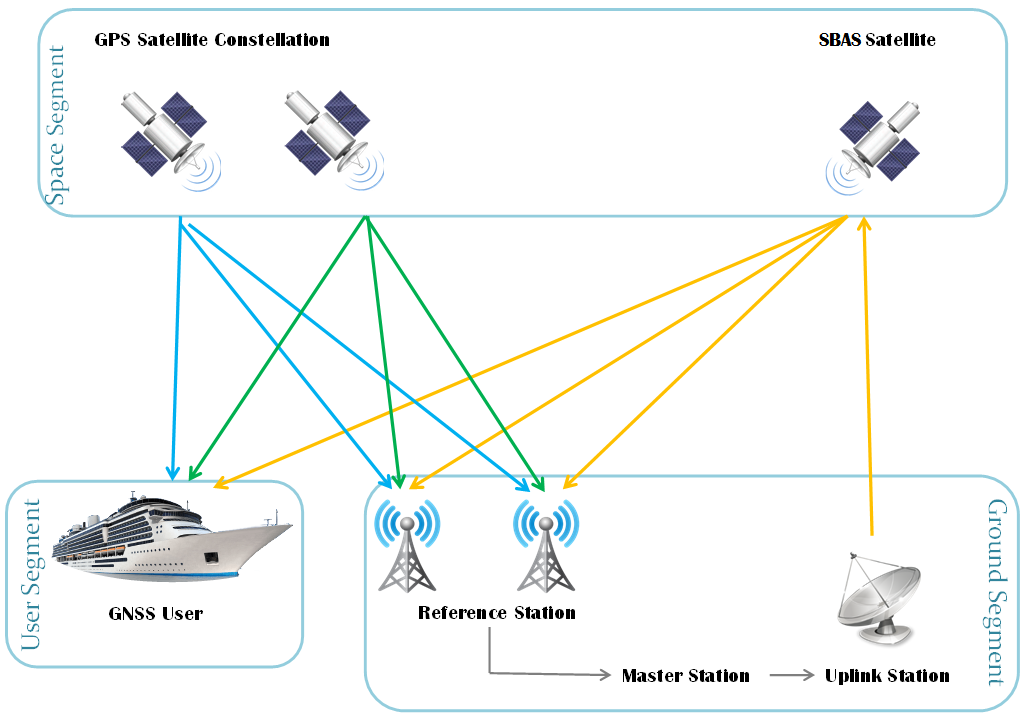


Figure 3‑1: Basic SBAS architecture

## Existing SBAS

Several countries have implemented their own Satellite-based Augmentation System. There are several others in various stages of development (see diagram below)

* **Europe**: European Geostationary Navigation Overlay Service (EGNOS)
* **USA**: Wide Area Augmentation System (WAAS)
* **Japan**: Multi-functional Satellite Augmentation System (MSAS)
* **India**: GPS and GEO Augmented Navigation (GAGAN)
* **China**: Satellite Navigation Augmentation System (SNAS) (in development)
* **South Korea:** Korea Augmentation Satellite System (KASS). (in development)
* **Russia**: System for Differential Corrections and Monitoring (SDCM) (in development)
* **Australia**: Still to be named system in development for Australia region

[The above list to be changed to a table including, identification of organisation in charge of that SBAS, which GNSS is augmented, whether the SBAS is in operation or under development, include the Australian system].

SBAS is originally designed for aviation users, however several of the SBAS service providers have posted information on the Internet stating that their service support also other users than aviation users.

All these systems comply with or will comply with a common global standard [insert ref to specific standard]and are therefore:

* **Compatible:** in the sense thatthey do not interfere with each other;
* **Interoperable:** in the sense that a user with a standard receiver can benefit from the same level of service and performance, regardless of their location

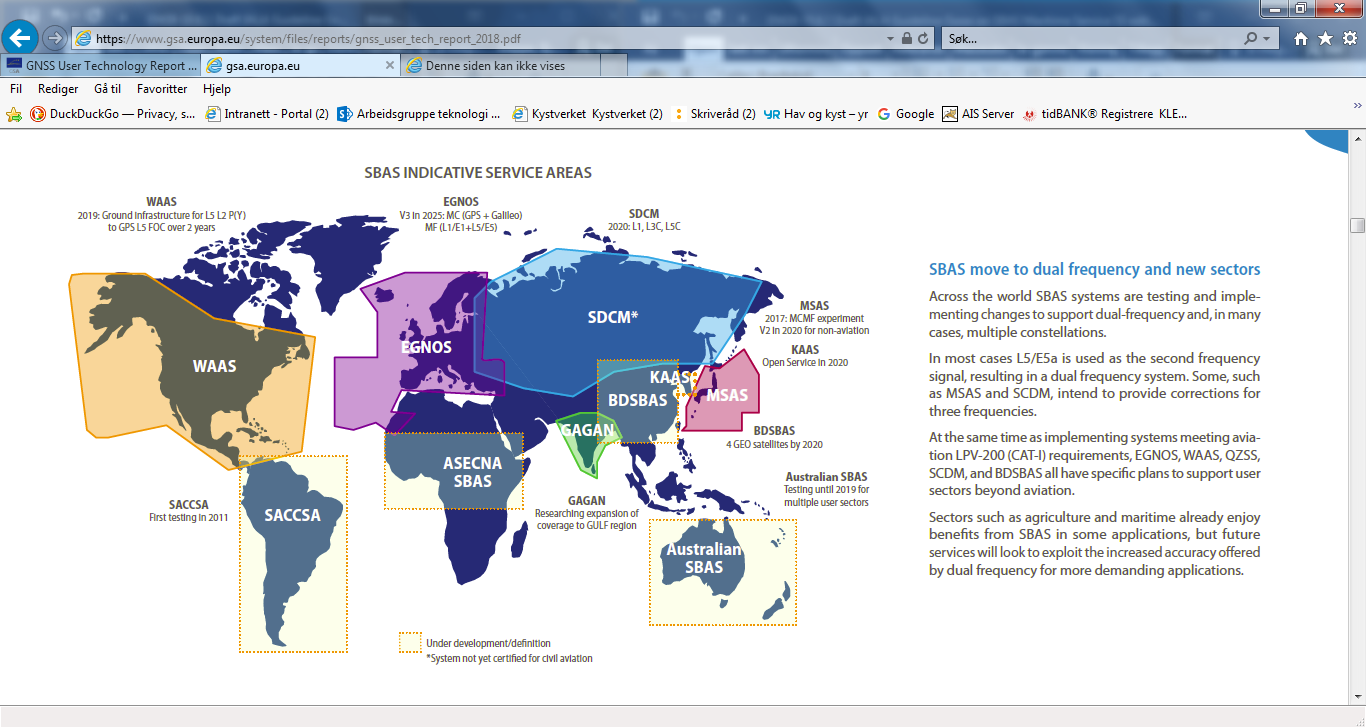


Figure 3‑2: Existing SBAS (in operation and under development) Service areas for aviation users indicated.

# SBAS Service Performance Parameters

This section proposes a list of service parameters to characterize SBAS for maritime use which are different for “ocean waters” and for “harbour entrances, harbour approaches and coastal waters”.

The list of service parameter required for a complete characterization of an SBAS Maritime Service are derived from the list in IMO Resolution A.1046(27), together with the parameters defined in IALA G1112, as shown in table 4-1.

Table 4‑1: SBAS Performance parameters

|  |  |
| --- | --- |
| **Ocean Waters** | **Harbour entrances, harbour approaches and coastal waters** |
| **Signal Availability**  **Service Availability**  **Horizontal Accuracy 95%**  **Position update rate**  **Service Coverage** | **Signal Availability**  **Service Availability**  **Service Continuity**  **Horizontal Accuracy 95%**  **Position update rate**  **Time To Alarm**  **Service Coverage** |

The paragraphs below detail how these parameters can be understood and measured.

* **Signal Availability**

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

For maritime SBAS Signal Availability would be the percentage of time the SBAS SiS is provided by the GEOs according to messages that can be processed by an SBAS receiver aligned with the IEC Test specifications throughout all points within the specified maritime coverage area.

Therefore the signal availability is calculated as the combined signal availability of the operational SBAS GEOs. SBAS receivers are expected to be capable of instantaneous GEO switching without impacting the user.

* **Service Availability**

Service Availability is the probability that a user is able to determine its position with the specified accuracy and to monitor the integrity of its determined position at the initiation of an operation at any location within the coverage area.

* **Service Continuity**

It is defined as the probability that a user will be able to determine its position with the specified accuracy and is able to monitor the integrity of the determined position over the time interval applicable for a particular operation within the coverage area.

Every transition from a service available to unavailable is a service continuity event. SBAS Maritime Service Continuity is calculated as follows:

Service Continuity=1-CTI/MTBF

Where: CTI is 15 min, MTBF is the “Mean Time Between Failures” over the corresponding period, e.g. for period of two years, computed (over a period P) as: MTBF= P/n, where “P” is the 24 months period (in minutes), and “n” is the number of discontinuity events in P.

* **Horizontal Accuracy 95%**

In the present context, accuracy is a statistical value and is defined as the degree of conformance between the measured position and the true position of the user at a given level of confidence at any given instant in time and at any location in the coverage area. Accuracy is specified as the position error at 95% confidence level.

The Horizontal position accuracy is the 2D radial error of the instantaneous measured position in respect to the true instantaneous position.

* **Time To Alarm**

The Time to Alarm (TTA) is defined as the maximum acceptable time starting when an alarm condition occurs to the time that the alarm is displayed at the user interface. The time to detect the alarm condition is included as a component of this requirement.

* **Position update rate**

SBAS receivers must be designed to meet the 2s update rate required by IMO Resolution A.1046(27). The compliance to this parameter shall be demonstrated by the receiver/equipment manufacturers.

* **Service Coverage Area**

The maritime service coverage area is a designated geographical area where, taking into account the radio frequency environment, SBAS is adequate to provide required maritime performance throughout a phase of navigation.

# User Segment Approach [consider to reference this paragraph from introduction]

This section describes the SBAS Service compatible equipment, including requirements for standardization of user equipment and needed equipment upgrades.

## SBAS Type approved receivers

To benefit from the SBAS Maritime Service enhanced performance, including integrity at system level, the vessels must be equipped with SBAS type-approved receivers compliant with IEC-XXXXX (SBAS Receivers Test Specifications).

[Make refernce to IMO navigation receiver performance specifications: MSC 401, MSC.1/Circ.1575 and receivers for all GNSS

IEC type approval test specifications for navigation receivers IEC61108 series ]

Type approval standards including tests of SBAS signal do not excist today. The administration should consider whether the regulatory status of use of SBAS, preclude recognition or which regulations or standards are needed to achieve recognition.

In the future such type approval standards may be created, approved navigation receiver offered and installed on ships. The completion of this process may affect the administrations future considerations.

Upgrade to future versions of SBAS systems

# SBAS Service Provision Scheme

## SBAS Maritime Service Provision Scheme

This section aims at describing the high-level SBAS Maritime Service Provision scheme, with the different stakeholders involved, including the interfaces and the provision of SBAS related Maritime Safety Information (MSI) to the end users.

The picture below presents schematically this High level Service provision model:

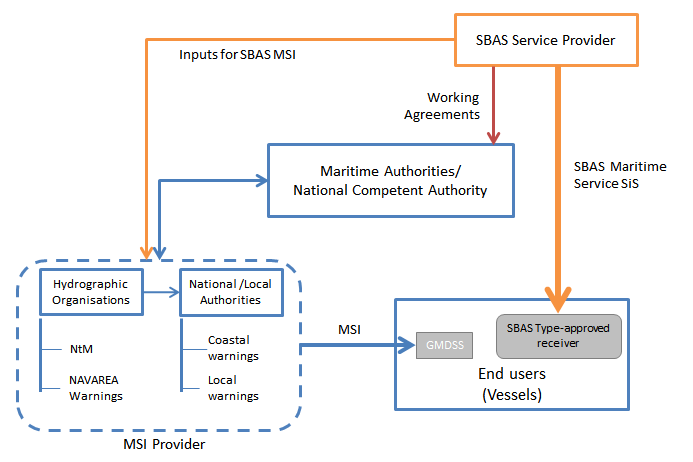


Figure 6‑1: SBAS Maritime Service Provision Scheme

This model considers the reception of the of the SBAS SiS directly on-board the vessels equipped with type approved receivers, thus allowing the end users (mariners vessels) to benefit from SBAS Maritime Service.

The actors involved in this high level service provision model, including their expected roles and responsibilities are described below:

* **The SBAS Service Provider**

The SBAS Service Provider will be the entity which provides the SBAS Maritime Service. The SBAS Service Provider will also be responsible for establishing and supporting all required operational interfaces, as per the corresponding maritime operational chain, including the generation the SBAS MSI proposals to be distributed by the Hydrographic organisation (MSI providers) to the end users of the service.

The SBAS Service Provider responsibilities may be structured in four main blocks, as follows:

1. **Operation and Maintenance:**

The SBAS Service Provider should continuously monitor the service to detect and manage service disruptions and degradations and inform users. The information on planned and unintended SBAS service degradations and unavailabilities is to be delivered to the MSI provider.

1. **Performance Verification:**

The SBAS service provider should verify that the service is performing according to specifications committed.

1. **Publication of information:**

The SBAS service provider should provide a description of the service such as service characteristics, acheived performances, maritime service coverage area, and provide information of scheduled maintenance activities & planned unavailability, and acheived service performance reporting and support to the users.

1. **Working agreements:**

The formalisation of SBAS Service Provider commitment to provide the service and the engagement with National Competent Authorities could be done by establishing working agreements, including:

* + - Roles and responsibilities and Liability[[1]](#footnote-1) scheme
    - Assurance of the long term operation of the SBAS service
    - Service offered and its characteristics
    - Service performance in compliance to the A.1046 and maritime service coverage area
    - SBAS MSI proposals (generation and distribution procedure)
    - Costs of the service – (i.e. free of charge)
    - Legal data recording needs
* **Maritime Authorities**

The administration is responsible to ensure Maritime Safety Information (MSI), relevant to the SBAS maritime service in its area of responsibility is properly received from the SBAS provider and forwarded to end users and to ensure the co-operation of other relevant maritime authorities such as hydrographic services and coast guard, regarding this.

The administration should consider to propagate information about the SBAS maritime service in its publications to end users and on the Internet, and to encourage the use of the SBAS maritime service in their waters.

For MSI existing internationally agreed procedures should be followed.

* **End Users**

The end users are the mariners/vessels using the SBAS Maritime Service SiS with a type approved receiver. The end users are also the recipient of the MSI related to SBAS.

The end users have the responsibility to ensure the correct maritime user equipment is used on their vessel, in this case type approved receivers, and that the resulting data is used in the appropriate manner. The end user is also responsible for the reception of the SBAS related safety information and to use these advises/warnings in the appropriate manner.

* **MSI provider**

The MSI provider (in particular de NAVAREA coordinators) are the bodies responsible for the transmission of MSI to the final users. The MSI provider is responsible for promulgating to the final users, using the established communication channels, the MSI related to SBAS Service status and degradations.

The way to provide this information takes as reference the existing procedures for the generation and distribution of Maritime Safety Information. The SBAS Service Provider is expected to send the SBAS MSI proposals (e.g. service performance degradations) to the MSI provider. These inputs will be provided in a format agreed between these parties. The MSI provider will use the procedures and channels already in place for the transmission of MSI to the vessels. Depending on the specific characteristics of the SBAS MSI, the MSI provider will distribute the information as NAVAREA warning[[2]](#footnote-2) or Notices to Mariners (NtM)[[3]](#footnote-3), or will forward it to the National Authorities to be distributed as coastal or local warnings[[4]](#footnote-4) by the established mechanism.

(Possibly include some text re SBAS as an AtoN following discussions in IALA LAP in april 2019)

# Acronyms

SBAS 🡪 Satellite Based Augmentation Systems

MSI 🡪 Maritime Safety Information

AtoN 🡪 Aids to Navigation

SiS 🡪 Signal in Space

# References

1. IMO International Convention for the Safety of Life at Sea (SOLAS), Chapter V (Safety of navigation), 1974 (as amended).
2. IMO Resolution A.1046 (27) on the World Wide Radio Navigation System (WWRNS), November 2011.
3. IALA Guideline No. 1112, Performance and Monitoring of DGNSS Services in the Frequency Band 283.5 –325 kHz, Edition 1, May 2015
4. Preliminary Performance Analysis

To include performance analysis results (available for EGNOS).

1. Including technical, operational and legal aspects [↑](#footnote-ref-1)
2. NAVAREA warning is the MSI of temporary nature applicable to one of the 21 navigational areas in the world. [↑](#footnote-ref-2)
3. Notices to Mariners (NtM) is the MSI permanent information published by the National Hydrographic Office. [↑](#footnote-ref-3)
4. Coastal or local warnings are the MSI of temporary nature applicable to a coastal or local area. [↑](#footnote-ref-4)