**Input paper: [[1]](#footnote-1)** ENG14-3.1.3.1

**Input paper for the following Committee(s):** **Purpose of paper:**

(Select as appropriate)

ARM  ENG  PAP  Input

ENAV VTS  Information

**Agenda item** [[2]](#footnote-2) n.n

**Technical domain/ Task number** 2 WG3

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Proposal for update of IALA Guidelines 1129 - Retransmission of SBAS corrections using MF radio beacon and AIS

# Summary

This input paper proposes to update of IALA Guidelines 1129 published on December 2017 with the objective to include the main conclusions derived from Pilot Project SC24 funded by the European Union Agency for the Space Programme (former European GNSS Agency).

https://www.iala-aism.org/technical/e-nav-testbeds/pilot-project-transmission-sbas-corrections.

In the draft update, the operational benefits and recommendations identified in the SC24 pilot project have been included. The main objective of this project was to demonstrate the operational performance of the transmission of EGNOS corrections converted to Differential GPS corrections over the existing transmission infrastructure (AIS base stations/IALA beacons) in the Maritime and Inland Waterways domains, while providing a detailed cost benefit analysis of the solutions proposed.

This update will be useful for those authorities willing to update their MF radio beacon and/or AIS/VDES infrastructure to retransmit SBAS corrections.

## Purpose of the document

The purpose of this document is to propose an update of IALA Guidelines 1129 [1] based on the outcomes of the pilot projects implementing the retransmission of SBAS corrections.

## Related documents

* [1] - IALA G1129 THE RETRANSMISSION OF SBAS CORRECTIONS USING MF-RADIO BEACON AND AIS

# Discussion

## Pilot Project Performance

During Pilot project duration, the **availability** of the EGNOS-based corrections was enough to meet the 99.8% availability requirement defined by IMO in the A.1046 resolutions.

The most demanding performance parameter was the **service continuity**. Missing monitoring raw data to perform the Pre-Broadcast Monitoring (PBM) check can cause that 99.97% requirement is not met. The missing raw data causes short continuity events that have an impact on the parameter calculation. In most of the cases, these raw data gaps/delays are due to the fact that pilot projects use conventional communication lines (i.e. not dedicated) to transmit data from the monitoring receiver to the central facility.

Regarding the **accuracy** results, it is to be noted that the position accuracy highly depends on the quality of the antenna and the GPS receiver. Performance levels obtained with an EGNOS-based solution reached an horizontal position error of 1 meter at the 95 percentile in line with the independent performance monitoring reports (between 0.5-1.3m 95%) [3].

The **integrity** monitoring modules showed that no single satellite correction was discarded due to high PRC, RRC and that only a few were discarded due to high corresponding residual values (affecting satellites at low elevations). This provides a quantitative measurement of the quality of the corrections. If the corrections are accurate, the differences between the geometric and the corrected pseudorange will be low and therefore good position accuracies will be obtained. At the position domain, only few events with errors exceeding the horizontal position threshold were detected and only in one of the pilots in northern latitudes.

In summary, the pilots showed that the retransmission of SBAS corrections are technically feasible because of:

* the high availability of the EGNOS SiS (100% in the period of analysis when using combined SiS), and EDAS (only minor outages detected), and
* the high quality of the corrections generated.

## Cost Benefit Analysis

In close cooperation with the participating authorities, the cost-benefit analysis done showed the savings brought by EGNOS introduction in all the scenarios and allowed to assess the optimal deployment strategy for maximising benefits of this transition. Positive savings were reached with SBAS option against the reference scenario in all cases, from a minimum of 5% to a maximum of 52%, depending on the previous infrastructure.

The reason for this cost reduction is that the infrastructure in centralised EGNOS-based solutions is lighter (i.e. it requires fewer components) when compared to a classical DGNSS approach.

## Operational Benefits for IALA SBAS Guidelines Update

The following operational benefits for the provision of EGNOS-based DGPS corrections have been identified in the project

* **Reduction of spares and maintenance effort**: The rationalization of the infrastructure in a centralised solution permits to rely on a more agile and lighter architecture, consisting on a smaller number of devices and tools, also for maintenance purposes. In return, this derives on a reduced number of man-days effort required to perform the maintenance activities.
* **Increased infrastructure robustness against RF interferences (jamming/spoofing):** In an EGNOS-based centralized architecture Reference Stations (RS) are virtualised and therefore, cannot be jammed or spoofed. Only Integrity Monitoring Stations (IMS) can suffer this attack, which can be minimized by adding redundant IMS. In traditional DGNSS systems, however, since normally both RS and IMS are co-located, they can be equally jammed/spoofed.
* **Increased infrastructure robustness against failures:** When EGNOS is used in combination with traditional DGNSS (hybrid solution), EGNOS introduces redundancy on the source of the corrections. Furthermore, EGNOS corrections can be obtained via a double source: SiS or EDAS. This implies that, when a source of corrections fails, the system can automatically switch to a different source to avoid service interruption. Thus, the system is more robust to potential malfunctions coming either from HW failures or SW failures.
* **Synergies between IALA and AIS systems:** A centralised EGNOS solution could increase synergies between IALA and AIS systems, since the central server could generate corrections for both systems in an efficient way thanks to the VRS concept. These synergies could in return decrease the costs of generating corrections to be broadcasted by both systems.
* **Enhanced integrity at system level:** EGNOS corrections contain integrity alerts either in the Integrity Information Message (MT6) or the Fast Corrections Messages (MT2 to MT5 and MT24). The application SW will map these integrity alerts into DGNSS RTCM format for transmission by either setting the DGNSS MT1/9 PRC field to binary 1000 0000 0000 0000 (which means this satellite cannot be used for the navigation solution) or even, when the alert condition affects all satellites, by setting the Station Health field to “not working”. On top of the EGNOS integrity check, the DGNSS system will continue providing alerts also at integrity monitoring level, as they currently do.

## Project Recommendations

This section contains the recommendations that have been derived from the project. Table 1 details the recommendations to be considered by National Competent Authorities when implementing an Aid to Navigation service based on EGNOS (centralised or hybrid architecture):

Table . Project Recommendations for NCA consideration

| ***ID*** | ***System***  ***(AIS/IALA)*** | ***Recommendation*** |
| --- | --- | --- |
| *#1* | *Any* | *Ensure good communications between monitoring stations to server and between server to transmission sites (by setting up a) SLA with communications provider, b) redundancy of monitoring stations, or c) redundancy of communication lines* |
| *#2* | *Any* | *Use infrastructure equipment of geodetic quality* |
| *#3* | *Any* | *Ensure good locations for installed antennas (free of multipath effects)* |
| *#4* | *Any* | *Ensure that old corrections are not buffered when a communications outage occurs* |
| *#5* | *AIS* | *Verify that owned AIS Base Stations really support Message Type 17* |
| *#6* | *AIS* | *Ensure correct definition of configuration parameters related to Message Type 17 broadcast.* |

On the other hand, and based on the issues faced during the pilot projects setup and the performance campaign, the following table contains a set of recommendations/topics to be considered for discussion at IALA level.

Details about these recommendations are provided in ANNEX A.

# References

1. IALA GUIDELINE G1129 THE RETRANSMISSION OF SBAS CORRECTIONS USING MF-RADIO BEACON AND AIS
2. Specific Contract GSA/OP/07/13/SC24 ‘Support to Maritime Service Providers for the transmission of EGNOS corrections via IALA beacons and AIS/VDES stations’
3. EGNOS Monthly Performance Reports. https://egnos-user-support.essp-sas.eu/new\_egnos\_ops/documents/field\_gc\_document\_type/monthly-performance-report-84

# Action requested of the Committee

The Committee is requested to:

1. Note the information provided in this paper and the proposed modification of IALA Guidelines G1129.
2. Assess the convenience to publish an update of the IALA Guidelines G1129 [1].
3. – Project Recommendations
   1. Project recommendations

This section details the list of recommendations derived from the project.

* + 1. Recommendations to Competent National Authorities

In general terms, authorities should consider the following technical recommendations when implementing an Aid to Navigation service based on EGNOS (centralised or hybrid architecture):

* Ensure good **communications** lines both to transmit the corrections generated at the server as to get **raw data from the monitoring stations for PBM** (Id #1)
* Equipment (receiver and antenna) used for PBM and FFM should be of high quality (geodetic receiver and antenna). It is of special relevance that the antenna has multipath reduction capability (Id #2).
* **Location of the installed antenna for PBM** (away from possible local interference effects) is crucial to achieve a good system performance (Id #3).

Notwithstanding, particular recommendations for IALA, AIS and communications have been derived from the execution of the pilot projects and are presented below.

**Particular recommendations for IALA beacons**

When broadcasting **corrections through IALA beacons**, authorities should take into account the following recommendation:

* In case a communication outage between the central server and the transmitter site occurs, the system should be designed to avoid buffering and retransmitting the old corrections once the communication is resumed (Id #4).

Even though this issue has been identified when using a DGNSS radio-beacon, it can also be made extensible to AIS architectures.

**Particular recommendations for AIS Base stations**

When broadcasting **corrections through AIS**, authorities should take into account:

* Verification that the AIS Base Station can actually **broadcast Message 17.** When planning to use an AIS Base Station as a **FFM**, verification that it can actually **use Message 17 to compute its position** (Id #5).
* **Ensure the following parameters are properly defined** (Id #6)**:**
* Number of slots per message
* Msg17 slot interval
* Separation between Msg17 start slots on AIS channels A and B

IALA Recommendation A-124 Appendix 16 provides general recommendations on AIS Message 17 slot settings. However, the actual implementation depends on local circumstances (e.g. location, traffic density, GNSS systems supported, whether AIS base station models in use support single slot reservation to meet 10 seconds TTA or not, etc.). Hence, these parameters should be defined on a case by case basis.

* In order to minimise impact of transmission of Message Type 17 on other types of information, the following approach should be followed (Id #6):
* As long as there is not an integrity event, other messages can use message 17 slots. However, a minimum update rate of the corrections shall be respected in order to ensure that corrections are provided for all visible satellites and in this way preserve positioning accuracy.
* A requirement shall be set to guarantee the capability of transmitting a message within the next 3 1/3 seconds upon an event as already stated in IALA Recommendation A-124 Appendix 16. Alternatively, other ways to meet the 10-second TTA requirement should be identified. This question should be revisited within IALA.

**Communication issues**

In EGNOS-based centralised solutions, reliable communication lines are required to ensure that no data gaps or network outages occur, compromising the availability and continuity figures. This problem is common with other architectures that have similar communications requirements, such as:

1. DGNSS beacons following the network approach
2. AIS base stations that receive corrections via the Internet generated by a DGNSS reference station.

These communication problems can be solved by setting Service Level Agreements (SLA) with the communication providers (Id #1).

However, for those cases where this is not possible (e.g. remote locations located in rural areas) or even when this is possible but to ensure enough redundancy, there are two alternative solutions (Id #1):

1. **Redundancy of monitoring stations**

With this solution a network of IM stations is distributed in the service area, which will be responsible of:

* Providing raw data to perform the Pre-Broadcast Integrity checks at the Central Server.
* Act as Far-Field monitors assessing also the quality of the correction data radio link.
* Inform service operators in case of problems detected with reference stations.

Furthermore, to ensure stations redundancy, it is possible to use public GNSS networks for this purpose (EUREF Permanent Network, SAPOS network in Germany, etc.) perhaps with a combination of authority-owned sensor stations. This should reduce the deployment and maintenance costs.

1. **Redundancy of data links**

Diversification of data links is also beneficial to ensure that if a data link fails, another link can be available.

Both solutions can be implemented separately or a fair combination of both can also be adopted.

1. Input document number, to be assigned by the Committee Secretary [↑](#footnote-ref-1)
2. Leave open if uncertain [↑](#footnote-ref-2)