Document Revisions (Title style)

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**IALA Guideline No. ####**

**on**

**Techniques used for on-board PNT Data Processing**

**Edition 1**

**[Date issued]**

**[Previous Edition; Date issued]**

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

|  |  |  |
| --- | --- | --- |
| **Date** | **Page / Section Revised** | **Requirement for Revision** |
| 22.04.2015 | 9 | Draft of document structure |
| 30.09.2015 | 12 | Draft of chapter 1.1 and 1.2 to explain purpose, scope and aimed content of guideline. |
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# Introduction

## Purpose and scope of document

*FYI - service vs system corresponding ENAV16-9.15:*

*“For the shore-based technical system under consideration (‘own system’), i.e. the ‘common shore-based technical system harmonized for e-Navigation’ in the overarching architecture (Figure 2), three categories of points of service delivery should be recognized, namely*

* *the technical service(s) provided from ashore to shipping as embedded in the MSPs;*
* *the technical service(s) that provide(s) the HMI directly to the shore-based user, e.g. at a VTS centre; and*
* *the technical service(s) that provide(s) data to other shore-based systems via M2M interfaces.”*

Worldwide Radio Navigation Systems (WWRNS) provide services used for shipside determination of Position, Navigation, and Time (PNT) data. They can basically be divided into services for PNT data determination and services enabling the improvement of PNT data by provision of correction data and integrity information. For example, Global Navigation Satellite Systems (GNSS) provide radionavigation signals which can be used worldwide by GNSS receivers for positioning and timing. The use of terrestrial radionavigation services (e.g. eLoran, R-Mode) is considered as additional source for onboard PNT data provision. Augmentation systems such as Differential GNSS (DGNSS) are used to improve the quality of onboard PNT data Their services provide real-time corrections and/or integrity information. A representative example is the IALA Beacon DGNSS which is the present standard in the maritime field. Satellite Based Augmentation Systems (SBAS) are used to improve accuracy and integrity of GNSS based positioning and timing by the aviation community. But even in the maritime segment the alternatively as well as complementary use of augmentation services provided by SBAS is appropriate to improve the onboard provision of PNT data. Furthermore the usefulness of PNT relevant information services should be taken into account. Such a service could provide additional information about the status of all radionavigation services to indicate their usability.

The purpose of the guideline is the harmonization between service provision and the shipborne utilisation.. Therefore the guideline contains general rules which can be applied for onboard PNT data provision if one or more PNT-relevant services are available. In this context special attention is laid on the harmonization of safety-relevant information (e.g. status, data and system integrity). The document summarizes recommendations of service providers, such as when and how the provided service data should be used by onboard equipment. This forces the clarification of responsibilities and dependencies between shore-side and ship-side parts of the maritime PNT system under consideration of the diversity on performance requirements.

This document use references to existing and future recommendations and guidelines from IALA dealing with the development, deployment and operation of PNT-relevant services including technical specification of communication interfaces between services and users.

## Structure of document

Section 1.3 gives an overview about PNT-relevant services with relevance for the ship-side PNT data provision. Services will be classified in relation to functions, aimed data output and performance.

In Chapter 2 references are given, where the applicable communication means are described in relation to communication channels and signals up to data protocols, messages, and formats.

Chapter 3 informs about recommendations and guidelines of service providers on how to use the service data during onboard PNT data processing. Furthermore the chapter provides rules for the integrated use of various services. In addition various coverage aspects are considered.

Chapter 4 deals with new and innovative approaches for enhanced service provision and its impact for improved onboard PNT data processing.

The following annexes are included:

* Annex A: Abbreviations
* Annex B: Definitions
* Annex C: References

## Overview of PNT-relevant Services

[Short Specification of Service, Link to other IALA guidelines and recommendations dealing with service provision and operation]

In the scope of this document PNT-relevant services are considered as AtoN or described by IALA recommendations and guidelines.

>> reference to IMO’s list of MSP (reference PNT); reference to need on resilient PNT and the need on PNT-relevant services

>> we propose to summarize all services in a common table containing the name of service, a short description, and the reference documents

## GNSS Augmentation Service

## Ground-based

## Satellite-based

## Terrestrial Radionavigation Service

## eLoran

## R-Mode

## Tbd

## Provision of PNT-relevant Safety Information

EXPLAIN OPTIONS

# Interfaces to ensure Service utilization

[Possibilities to access on service signals; data protocols, messages, and format; Crosscheck of interface specification in service guideline and aimed onboard utilization; unambiguous specification of data content and meaning]

>> provide information of main specification ITU, RTCM, applied for service provision

>> technical details only on message level

## GNSS Augmentation Service

## Ground-based

1. DGNSS Service in MW
   1. Signal specification ITU-R .823/3
   2. Data content specification: GNSS correction specified in RTCM SC104 (Version 2.3);
   3. GPS-relevant Message 1, 3, 6, 7(27), 9, and 16; GLONASS-relevant Messages
   4. Reference to standards of shipborne equipment MSC-DGPS and MSC-dGLONASS ensuring the access on service (IEC 61108-4)
2. DGNSS Service via AIS
   1. Signal specification…
   2. Data content specification RTCM SC104 (Version 2.3)
   3. Message …

## Satellite-based

## Terrestrial Radionavigation Service

## eLoran

## R-Mode

## Tbd

## Provision of PNT-relevant Safety Information

# Principles of Service utilization (ONBOARD Data processing)

[principles per services; principles for integrated use of services including consideration of integrity aspects: e.g. selection, assessment of error budget, exclusion]

## GNSS Augmentation Service

## Ground-based

DGNSS (MW+AIS)

* Range and range rate corrections (reference how it should be used)
* Health status (healthy, unhealthy, unmonitored) (reference how it should be used)
* Satellite based integrity monitoring (for used signals): used, do not use, no corrections (reference how it should be used)

## Satellite-based

## Terrestrial Radionavigation Service

## eLoran

## R-Mode

## Tbd

## Provision of PNT-relevant Safety Information

NOT APPLICABLE IN TIME

## Rules for integrated use of various services

Rules should be provided to achieve standardized output data

## Service selection (alternatives, based on service integrity information)

## Service assessment (in case of redundancy)

## Service exclusion (identifiers and logic)

## Coverage aspects

[incomplete service provision; overlapping service provision; use of other communication means]

DGNSS.

* Flow chart to pick up the best DGNSS
* DGNSS via MW used by onboard equipment and for AIS position reports; AIS message 17 is intended to use only by AIS/ equipment for positioning; Conflict: different position results; use of AIS-DGNSS by onboard equipment has no guidance; future standardization should solve it;

# Proposals for enhanced services and management

This chapter describes new and innovative approaches for enhanced service provision and its impact for improved onboard PNT data processing. This includes:

* Harmonized generation and utilization of integrity information (integrity management)
* Intelligent access on independent services
* Access on extended integrity information (e.g. coming/provided by/from crosschecks of different services in a common coverage area) supporting the decision finding regarding their use

This proposed improvements may have impact to existing standardisation.

## GNSS Augmentation Service

## Ground-based

DGNSS

* Harmonization of monitoring concepts e.g. FFIM to ensure that integrity information considers the current integrity of services in the coverage area (e.g. by extended health indicator)
* to inform about the current coverage services site
* provision of UDRE by standardized methods to enable the future use to condition the onboard processing
* crossover from single station concept to enable the use of virtual reference stations (VRS) in the coverage area

## Satellite-based

## Terrestrial Radionavigation Service

## eLoran

## R-Mode

## Tbd

## Provision of PNT-relevant Safety Information

## Requirements for integrated use of various services

## ANNEX A Abbreviations

|  |  |  |
| --- | --- | --- |
| BEIDOU | - | Global Navigation Satellite System (China) |
| DGALILEO | - | Differential GALILEO |
| DGLONASS | - | Differential GLONASS |
| DGNSS | - | Differential GNSS |
| DGPS | - | Differential GPS |
| DOP | - | Dilution of Precision |
| EGNOS | - | European Geostationary System |
| eLoran | - | Enhanced LORAN |
| GAGAN | - | GPS Aided Geo Augmented Navigation |
| GALILEO | - | European GNSS |
| GLONASS | - | Глоба́льная навигацио́нная спу́тниковая систе́ма,  Global Navigation Satellite System (Russia) |
| GNSS | - | Global Navigation Satellite System |
| GPS | - | Global Positioning System |
|  |  |  |
| HF | - | High Frequency (3 – 30 MHz) |
| IALA | - | International Association of Marine Aids to Navigation and Lighthouse Authorities |
| IEC | - | International Electrical Commission |
| IMO | - | International Maritime Organisation |
| IMS | - | Integrity Monitoring Station |
| INS | - | Integrated Navigation System |
| ITU | - | International Telecommunication Union |
| LORAN | - | Long Range Navigation |
| MF | - | Medium Frequency (0.3 – 3 MHz) |
| MRR | - | Multi-system Radionavigation Receiver |
| MSC | - | Maritime Safety Committee |
| MSI | - | Maritime Safety Information |
| NMEA | - | [National Marine Electronics Association](https://de.wikipedia.org/wiki/National_Marine_Electronics_Association),  Maritime Communication Standard |
| PNT | - | Position, Navigation, and Timing |
| PVT | - | Position, Velocity, and Timing |
| RAIM | - | Receiver Autonomous Integrity Monitoring |
| RS | - | Reference Station |
| RTCM | - | Radio Technical Commission for Maritime Services |
| SDMC | - | System for Differential Corrections and Monitoring |
| SHF | - | Super High Frequency (1- 2 GHz) |
| WAAS | - | Wide Area Augmentation System |
| VRS | - | Virtual Reference Station |

## ANNEX B Definitions

|  |  |
| --- | --- |
| Accuracy |  |
|  | |
| Availability |  |
|  | |
| Integrity |  |
|  | |
| Reliability |  |
|  | |
| Resilience |  |
|  | |

## ANNEX C References