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| IALA Guideline |

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GNSS satellite-based Precise Point Positioning(PPP) 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

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

Precise Point Positioning (PPP) is a method for global absolute positioning that typically combines multi-frequency GNSS phase measurements with provided precise satellite orbits and clock corrections. PPP data products are generated based on the measurements of a global or regional network of GNSS monitoring stations. Local effects have to be compensated at the user side when the PPP service provider does not offer data for regional or local corrections. If single frequency phase measurements are used, additional precise ionosphere models have to be considered. Once the PPP corrections are calculated, they are delivered to the end users via satellite, Internet or any other dissemination means. These corrections are used by the receivers, resulting in decimetre-level or centimetre-level positioning without the need for communication with close range GNSS reference stations .

PPP can achieve high accurate positioning, but it strongly depends on accurate and uninterrupted satellite orbit and clock error estimations, the number of tracked satellites and the time of continuous phase measurements. The main error sources for PPP are mitigated by Dual-Frequency Operation, External Error Correction Data, Modelling or PPP Filter Algorithms. A typical PPP solution requires a period of time to converge to dm or cm accuracy in order to resolve any local biases such as the atmospheric conditions, multipath environment and satellite geometry. The actual accuracy achieved and the convergence time required is dependent on the quality of the corrections and how they are applied in the receiver.

Currently, there are two types of consolidated PPP implementations. One is to obtain post-processed solutions and the other is to have real-time solutions. Post-processed PPP solutions have been in use for many years and generally achieve better results than real-time solutions. The main difference between the two implementations is that, post-processed solutions apply correction after measuring using the corrections provided by the service provider, while real-time solutions require precise orbit information and clock corrections to be sent in real-time to the GNSS receiver location.

A communication channel is continuously needed to broadcast correction parameters. Satellite-based Precision Point Positioning (PPP) services broadcast PPP navigation messages on the public service signals of GNSS satellites It is an important technology for satellite navigation systems to achieve wide-area high-precision positioning through satellite navigation signals due to its wide signal coverage, uniform accuracy distribution, and small number of ground reference monitoring stations. Especially in the use cases of PPP fields, such as autonomous unmanned ship automatic berthing, channel mapping, dredging, cargo loading and unloading, etc., decametre or centimetre level positioning accuracy is very necessary.

## Scope of the document

The guideline provides the description of all the elements of GNSS satellite-based PPP service relevant to the maritime administrations (direct reception of GNSS satellite-based PPP service Signal in Space (SiS) onboard the vessels[[1]](#footnote-1)). This includes XXX.

## Structure of the document

Section 1 is the introduction to this Guideline, including the scope of the document.

Section 2 establishes the IMO Resolution A.1046(27) and A.915(22) operational requirements as the reference for the implementation of GNSS satellite-based PPP Maritime Service.

Section 3 describes the main elements of a basic GNSS satellite-based PPP service architecture and the existing systems

Section 4 proposes a list of service parameters to characterize GNSS satellite-based PPP service for maritime use, including their definition.

Section 5 describes the GNSS satellite-based PPP service compatible equipment and maritime application scheme.

And Section 6 describes scenarios of the GNSS satellite-based PPP service in Maritime Service.

# IMO Resolution A 1046(27) and a.915(22) Reference Requirements

The IMO Resolution A.915(22) operational requirements are considered to be the appropriate reference requirements for the implementation of GNSS satellite-based PPP service for maritime navigation.

The administration may consider if the above requirements should be fulfilled and documented by the GNSS satellite-based PPP service provider. This may possibly be achieved by using the appropriate IALA recommended methods.

# GNSS satellite-based PPP service

The main elements of a basic GNSS satellite-based PPP service architecture is usually as following:

* **Space segment**: Includes the satellites with payloads aimed to transmit the corrections to the GNSS core constellations
* **Ground segment**: Includes all the ground elements which provide the PPP navigation messages.
* master control station (MCS)
* uplink stations (ULS)
* monitoring stations (MS)
* **User segment**: Includes the user equipment needed to receive and use the GNSS high accuracy PPP service information.

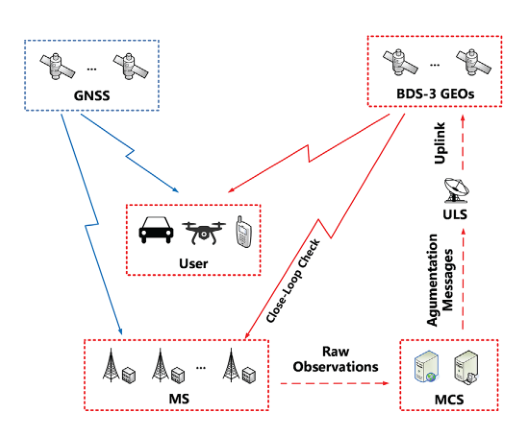


Figure 3‑1: Basic GNSS satellite-based PPP service architecture(to be modified)

## Existing and planned GNSS satellite-based PPP systems

At the time of writing this document the existing GNSS satellite-based PPP service and their status are shown in Table 3‑1 below:

Table 3‑1: The existing and planned GNSS satellite-based PPP systems

| **Country/Region** | **GNSS**  **satellite-based PPP system** | **Organisation in charge** | **Coverage area** | **Status** | **GNSS Augmented** |
| --- | --- | --- | --- | --- | --- |
| China | BDS PPP B2b | China Satellite Navigation Office |  | Operational | GPS  BDS |
| Europe | Galileo HAS | EUSPA |  | Operational | GPS  Galileo |
| Japan | QZSS | Japanese Ministry of Land, Infrastructure and Transport |  | Operational | GPS |
| Australia and New Zealand | southPAN | Australian and New Zealand governments |  | In development | GPS |

# GNSS satellite-based PPP service Performance Parameters

This section proposes a list of service parameters to characterize GNSS satellite-based PPP service for maritime use.

The list of service parameters required for a complete characterization of a GNSS satellite-based PPP service are derived from the list in IMO Resolution A.915(22) and IALA Guideline 1127.

Table 4‑1: GNSS Satellite-based PPP Service 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**
* **Service Availability**
* **Service Continuity**
* **Horizontal Accuracy 95%**
* **Time to Alarm**
* **Position Update Rate**
* **Service Coverage Area**

# GNSS satellite-based PPP MARITIME Service Provision Scheme

A scheme for providing the users with the appropriate GNSS Satellite-based PPP Maritime Service should be established, including the provision of maritime safety related information to the end users.

This section describes an example of this scheme, with relevant stakeholders involved, including the interfaces between them and the provision of GNSS satellite-based PPP service related Maritime Safety Information (MSI) to the end users. The picture below presents schematically this High level Service provision model:



Figure 6‑1: GNSS Satellite-based PPP Maritime Service Provision Scheme

# User Segment Approach

[Including specific scenarios for maritime usage]

MASS

dredging

automatic docking

cargo handling

construction works

hydrography

# Acronyms

IMO International Maritime Organization (Acronym style)

# References

1. [↑](#footnote-ref-1)