e-NAV12 Input

Agenda item 8.2

Task Number 6

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Discussion paper for the development of IALA Guidelines on GNSS augmentation services for port and docking.

# Summary

The e-Navigation Gap Analysis identified a lack of PNT relevant services for port operations and automatic docking. A potential solution for this is to develop IALA Guidelines for GNSS augmentation services to support port approach, port manoeuvres and docking. These could then assist service providers when looking to implement such systems.

There are a number of items to be considered during the development of such a guideline however, such as identifying the user requirements, system requirements and how such services could be implemented; both with consideration to port side infrastructure and the necessary ship borne equipment.

## Purpose of the document

The aim of this document is to identify some of the potential user requirements and to capture relevant points which can become topics for further discussion, in preparation for the development of such guidelines.

## Related documents

The following related documents should be considered:

* IMO Resolution A.915(22), “Revised Maritime Policy And Requirements For A Future Global Navigation Satellite System (GNSS)”, 2001.
* IMO Resolution A.1046(27), “Worldwide Radionavigation System”, 2011
* IMO e-Navigation Working Group Report (Gap Analysis) - NAV 58/WP.6

# Background

Following a review of the e-Navigation Gap Analysis e-NAV11, it was identified that there is a lack of PNT relevant services for port operation and automatic docking. Service providers may be encouraged to develop such services if guidance is provided by IALA.

# Discussion

It is known that GNSS alone cannot meet the performance requirements to support some port applications, particularly those requiring 1m accuracy or better. Therefore augmentation, through some means, is required to provide the required accuracy and integrity to perform these operations.

The first stage is to review the user requirements to ensure these are correctly captured, before then investigating typical augmentation services that can support such applications. Therefore, this paper is split into two sections; the first will consider the current performance requirements as gathered from the different reference documents listed above; and the second section gives consideration to the different augmentation and support systems currently available.

## Review of requirements

### PNT Requirements.

Port approach, Port and automatic docking requirements are outlined in IMO A.915 and IMO A.1046.

Table 1 provides the minimum maritime user requirements as set out in IMO A.915, which considers future requirements without determining how they are met.



Table 1: Table of minimum maritime user requirements for general navigation, from A.915 (22).

The same reference document also establishes the performance requirements for automatic docking, as shown in Table 2.



Table 2: The minimum maritime user requirements for positioning, from IMO A.915 (22).

Since Resolution A.915 was published, in 2001, the continuity time interval of 3 hours has been amended to 15 minutes through publication of Resolution A.1046. This resolution details the operational requirements for Worldwide Radionavigation Systems (WWRNS) and reflects requirements to be met today.

A.1046 also details requirements for navigation in Harbour Entrances, Harbour Approaches and Coastal Waters, as:

* Positional information with an error not greater than 10m (95% probability)
* The coverage area should be adequate to cover the entire phase of navigation
* The system should permit an update rate of not less than once every 2 seconds (applying to computed and displayed position data, with correction information remaining valid for 30s or more).
* 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.
* The system shall be considered available when it provides the required integrity for the given accuracy level.

By consolidating these requirements together (Table 3), it is possible to see that there is a large level of agreement between these two resolutions. The first stage in the development of any guideline will be to clearly establish user requirements.

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| --- | --- | --- | --- | --- | --- | --- | --- |
|  | Horizontal accuracy | Time to alarm | availability | continuity | coverage | Update interval (seconds) | Resolution |
| Coastal waters | 10 | 10 | 99.8% (over 30 days) | N/A | Global | 1 | A.915 |
| Port approach and restricted waters | 10 | 10 | 99.8% (over 30 days) | 99.97% (over 3hr period) | Regional | 1 | A.915 |
| Port | 1 | 10 | 99.8% (over 30 days) | 99.97% (over 3hr period) | Local | 1 | A.915 |
| Automatic docking | 0.1 | 10 | 99.8% (over 30 days) | 99.97% (over 3hr period) | Local | 1 | A.915 |
| Harbour entrances, harbour approaches and coastal waters | 10 | 10 | 99.8% | 99.97% (over 15 min period) | Adequate for application | 2 | A.1046 |

Table 3: Comparison of navigation requirements for similar phases of navigation from A.915 & A.1046.

### Other requirements and considerations

The Gap Analysis also captured a number of items that should be considered when gathering user requirements and when considering how future services could be offered. These are listed below, split into operational, technical, regulatory and training aspects.

Operational

* Accurate ship dimensions will be required.
* Accurate environmental information will be required.
* The system will need to be simple to use.
* There is a need to develop automatic procedures for docking.

Technical

* Augmentation services such as GBAS, Pseudolites, phase based corrections with Integrity should be considered.
* Commonality in design between port services is needed to ensure single bridge equipment can be used for berth to berth navigation.
* Any solution will need to be developed in combination with accurate chart data (better accuracy than the measurements)
* The solution will need a full failure mode effect analysis.
* The system may use relative measurements between the vessel and the berth.
* The solution will need to raise warnings to advise on hazardous conditions (e.g. high speed, wrong heading, drifting)

Regulatory

* There is a need for specification of requirements on all PNT (horizontal, vertical, attitude etc) and chart data.
* There is a need to identify responsible authorities for the provision of all necessary data and services.
* There is a need for type approval of equipment.
* The system should be considered as part of the IHO S-100 Registry
* Consideration should be given to the definition of common interface for control of vessel systems.
* A full failure mode effects analysis and risk assessment should be conducted.

Training

* Training will need to be designed for the new equipment and procedures.
* Training of operating procedures under different environmental conditions should be conducted.
* The use of simulators should be considered.
* Training should include what to do if it goes wrong mid procedure.

## Review of available systems

It is known that GNSS alone can provide accuracies in the order of 5-10m (95%) which is insufficient to meet the tightest requirement in Table 3, of automatic docking (0.1m, 95%). Conventional code augmentation services would struggle to meet this level of accuracy and approaches such as real-time kinematic, or precise point positioning would need to be considered to achieve such accuracies.

There are a number of alternative systems currently being marketed as docking assistance systems and some of these are noted below. These, and other systems, could be reviewed as potential solutions, if they meet the agreed user requirements.

Laser docking assistance systems

* http://www.trelleborg.com/en/Marine-Systems/Products-And-Solutions/Docking-and-Mooring/Docking-Aids/
* <http://www.atlantasmarine.com/htm/product/details/marimatech_laser_docking_system>

Radar assistance systems

* <http://www.furunousa.com/products/productdetail.aspx?product=DS60&category=Products+%3A+Sonars+%3A+Doppler+Speed+Logs>
* <http://www.google.com/patents/US20030137445>
* Xenex Navigation Inc. Precise Radar Positioning System

RTK systems and similar

* Rotterdam port
* Trimble CentrePoint system
* Fugro Marinestar GNSS
* pseudolites

# Action requested of the Committee

The Committee is requested to review, and develop, user requirements for such port approach and docking services. Secondly, the committee is invited to discuss the various augmentation methods which could be used to meet such requirements with the aim of capturing them in their most generic form within the discussion document.

The outcome could then be used to develop suitable guidelines on the provision of such services.