|  |  |
| --- | --- |
| SUBCOMMITTEE ON  SAFETY OF NAVIGATION  58th Session  Agenda Item … | NAV58/INF/……  Draft 1 Jan 2012  Original: English |

**DEVELOPMENT OF AN E-NAVIGATION STRATEGY IMPLEMENTATION PLAN**

Modular and open concept of Integrated PNT System

Submitted by IALA

|  |  |
| --- | --- |
| **SUMMARY** | |
| *Executive summary:* | This document describes a modular and open concept of Integrated PNT System, which can meet e-navigation user needs such as improvement and indication of reliability. This concept takes into account the enhancement of radio navigation equipment and meets the modular structure of INS. |
| *Strategic Direction:* | 5.2 |
| *High-level Action:* | 5.2.6 |
| *Planned output:* | 5.2.6.1 |
| *Action to be taken:* |  |
| *Related documents:* | MSC 85/26 (Annex 20 and 21); Res. A.915(22); Res. MSC.112(73); Res. MSC.113(73); Res. MSC.114(73);Res. MSC.115(73); Res. MSC.233(83); Res. MSC.252(83); Res. A.817(19); Res. A.1046(27); SN.1/Circ.274; NAV 56/WP.5 |

# Introduction

1. “E-navigation is the harmonized collection, integration, exchange, presentation and analysis of marine information on board and ashore by electronic means to enhance berth to berth navigation and related services for safety and security at sea and protection of the marine environment.” (MSC 85/26 Annex 20). Position fixing is one of the 8 identified key elements of e-navigation.
2. Primary aim of position fixing is to provide position, velocity, and time data (PVT) for navigators and navigational functions (ECDIS, Track Control Systems, AIS, INS and safety-related functions). In Resolution A.915(22), Global Navigation Satellite Systems (GNSS) are recommended for PVT determination.
3. A more significant objective is the resilient provision of position, navigation, and timing data (PNT) taking into account that in the future an improvement and indication of reliability (e.g. accuracy and integrity) should be achieved for all navigation relevant data. In this context PNT data encompasses PVT data and ship’s parameters describing ship’s current movement and attitude (e.g. heading, rate of turn) (NAV 56/WP.5, see indication of reliability).
4. Resilience is the ability of the PNT system to detect and compensate external and internal sources of disturbances, malfunction and breakdowns in parts of the system. This shall be achieved without loss of PNT data provision and preferably without degradation of their performance. The high-level user need “data and system integrity” reflects the need on resilient e-navigation systems (MSC/85/26 Annex 20).
5. Provision of resilient PNT data relies on the exploitation of existing, modernized and future radio navigation systems, sensors and services. High-level user needs such as “improvement and indication of reliability” should be measurable. Some relevant information is given in Res. A.915(22) for example the requirements on future GNSS for horizontal position. However unambiguous specified performance quantities (e.g. accuracy, integrity, continuity, availability) are needed for all required PNT data.
6. To achieve the different requirements associated with operational needs relating to each phase of navigation (e.g. ocean, coast, port, docking), a concept of scalability of requirements is introduced. This can enable an objective decision finding regarding e-navigation implementations. Different performance classes may require different shore-side services (PNT relevant Maritime Service Portfolio).
7. A suitable framework is necessary to compensate gaps (e.g. technical, administrative, regulatory, training, etc.) towards the stepwise fulfillment of identified user needs (improvement of reliability, indication of integrity, automatic assessment of all navigation relevant data, automatic reporting….). A part of this framework is the integrated PNT concept (NAV 56/WP.5).
8. The proposed PNT concept supports the exploitation of modernization processes in radio navigation systems (space-based and terrestrial), ship-side sensors and shore-side services. The PNT concept is an open framework supporting the usage of any sensors, services and data sources improving the accuracy or assessing the integrity of provided PNT data and applied components. The concept should be timely, considered in maritime standardization and is prepared by the modular concept of performance standards (SN.1/Circ.274).
9. The PNT concept takes into account existing technology and enhancements of PNT sensors and techniques as well as processing facilities:

* The development of a multi-system navigation receiver (MSR) will facilitate access to new radio navigation signals. The MSR is a ship-side receiving equipment capable of using signals from one or more systems such as GNSS and shore-side services, which provide augmentations, as well as terrestrial radio navigation signals for PVT data provision.
* Resilient PNT data provision requires integrated PNT data processing, which enables the exploitation of multi-sensor based redundancy and fusion to achieve assessment of PNT data reliability (e.g. accuracy, integrity). This may need a future performance standard covering this functionality.

# Concept of maritime Integrated PNT System

1. The “Integrated PNT System” is the required overlay of GNSS as part of WWRNS, shore-side PNT services (PNT relevant MSP), ship-side components (PNT Module), and communication links, whose integrated use ensures the accurate and reliable provision of ships’ PNT data to applications during all phases of vessel navigation in a timely, complete and unambiguous manner (Figure 1).

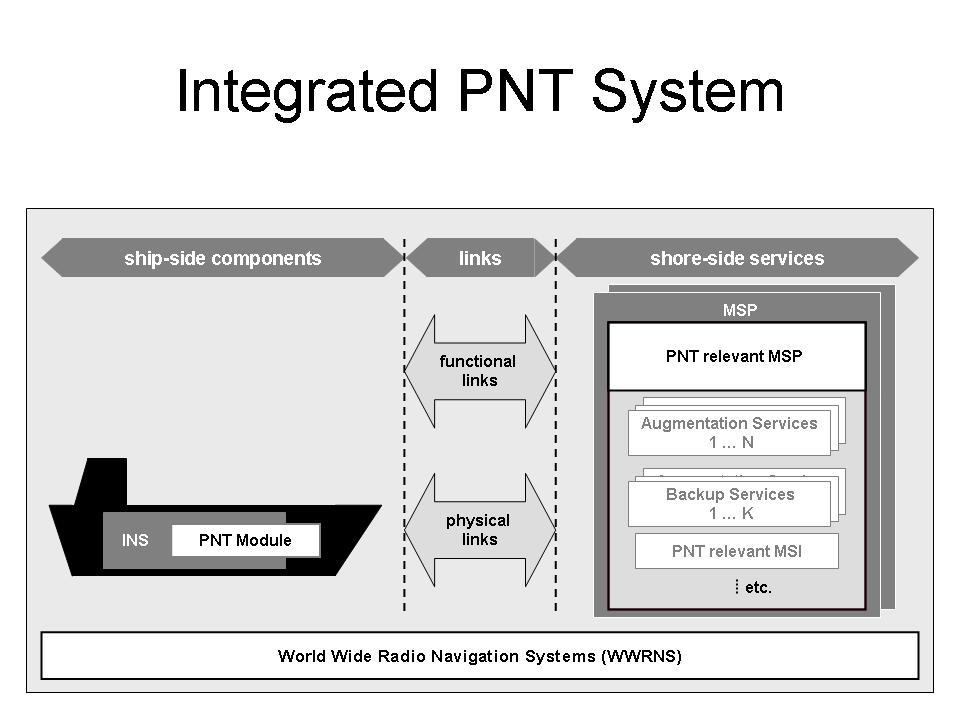


Figure 1 Generic architecture of the maritime Integrated PNT System

1. The PNT module represents the set of distributed ship-side HW and SW components. HW components (sensor layer) cover WWRNS sensors and other ship-side navigational sensors including data exchange in-between. SW components (data processing layer) can be either part of single sensors (classic approach) or can be realized by the PNT unit as part of INS. The ship-sided sensor layer depicts the set of sensors recognized for the provision of PNT data. The ship-side processing layer represents the applied methods for the determination of PNT data. The PNT concept provides a scalable approach for the following solutions:
   1. Classic approach operating with stand-alone equipment (Figure 2):

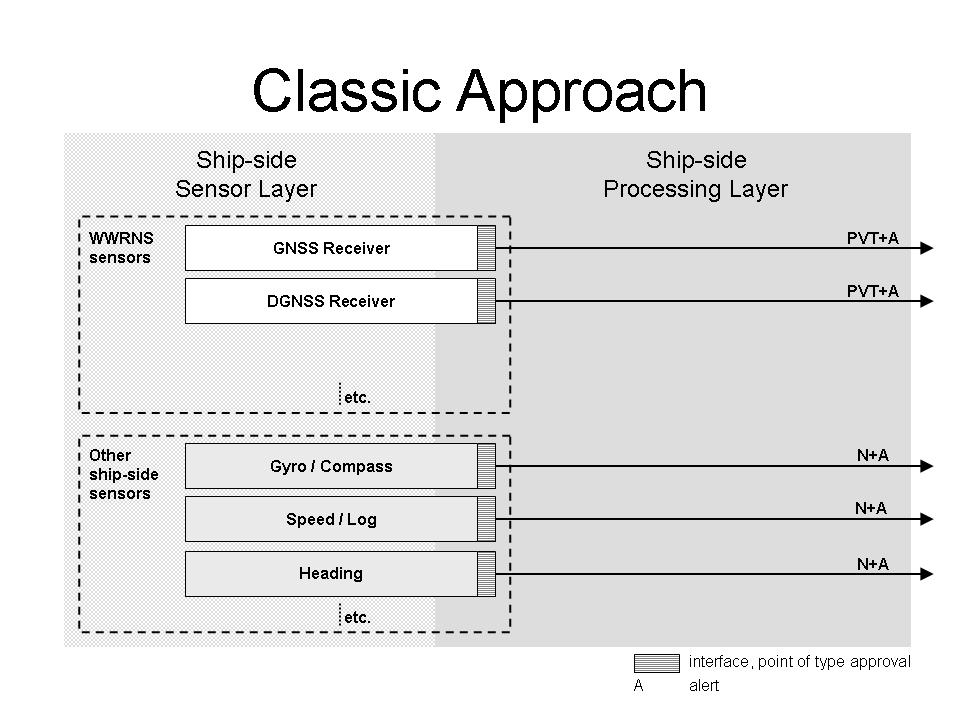


Figure 2 Classic approach of ship-side PNT module

Stand-alone equipment provides only sensor-specific PNT data e.g. the WWRNS sensors for PVT data and the other ship-side sensors for navigation data. The ship-side processing layer is part of the applied sensors and represents the internal methods for the provision of respective PNT data. The utilization of PNT relevant augmentation services is organized by WWRNS sensors based on included or connected communication equipment. Due to insufficient redundancy within single sensors and unsupported exploitation of multi-sensor based redundancy the classic approach is unable to meet e-navigation user needs such as improvement of reliability and indication of integrity based on monitored and assessed data and system integrity.

* 1. PNT unit approach as part of advanced INS (Figure 3):

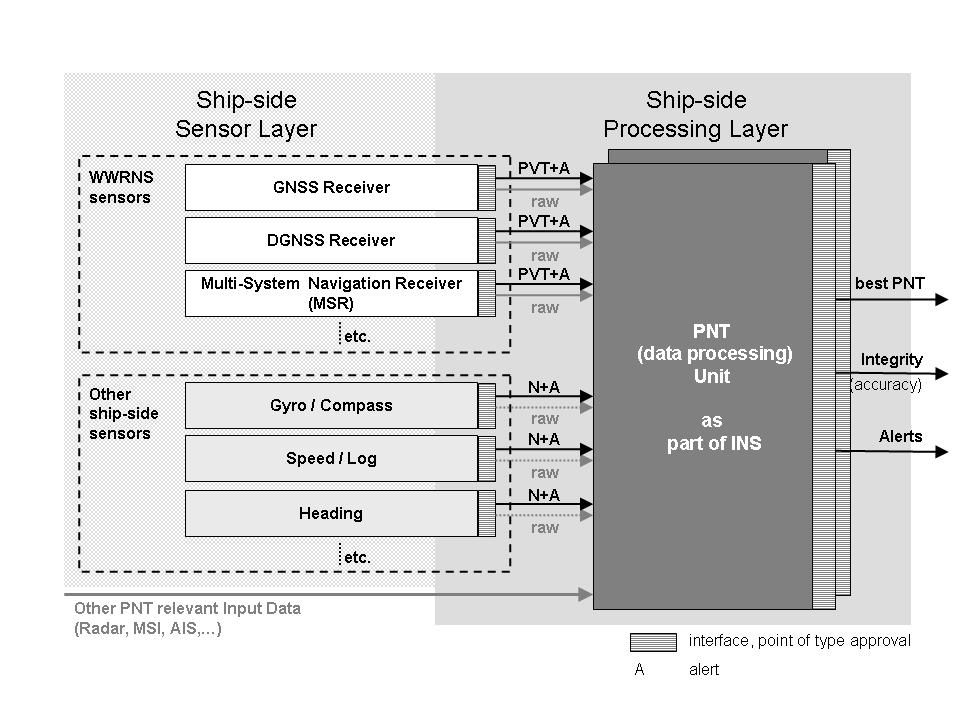


Figure 3 Ship-side PNT module with PNT (data processing) Unit

The PNT unit is an approach to meet identified user needs such as improvement of reliability and indication of data and system integrity. The presented approach enables the use of a variety of PNT relevant sensors and sources. Their combined use exploits the available redundancy by processing raw data to generate the best PNT. The utilization of PNT relevant augmentation coming from different services, the integration of additional PNT relevant data sources (e.g. ePelorus, racon), and the application of future PNT relevant MSI (Maritime Safety Information) is supported by this approach. By implementation of integrity monitoring the PNT unit has the potential to identify and provide the best PNT data and to indicate the current accuracy and integrity. Integrity information taking into account the achieved performance level is the basis for automatic reporting and improved alert management for individual sensors and the complete PNT process. At present the PNT unit is a concept for enhanced PNT data provision which would require the development of performance standards at a later stage.

Today’s INS concept supports the integrated PNT approach.

1. “The purpose of INS is to enhance the safety of navigation by providing integrated and augmented functions to avoid geographic, traffic and environmental hazards” (Resolution MSC.252(83)). The PNT (data processing) unit will be part of the Consistent Common Reference System (CCRS) within the INS to realize the provision of resilient PNT data related to a single consistent common reference point and to ensure the integrity monitoring of provided PNT data and applied PNT components.

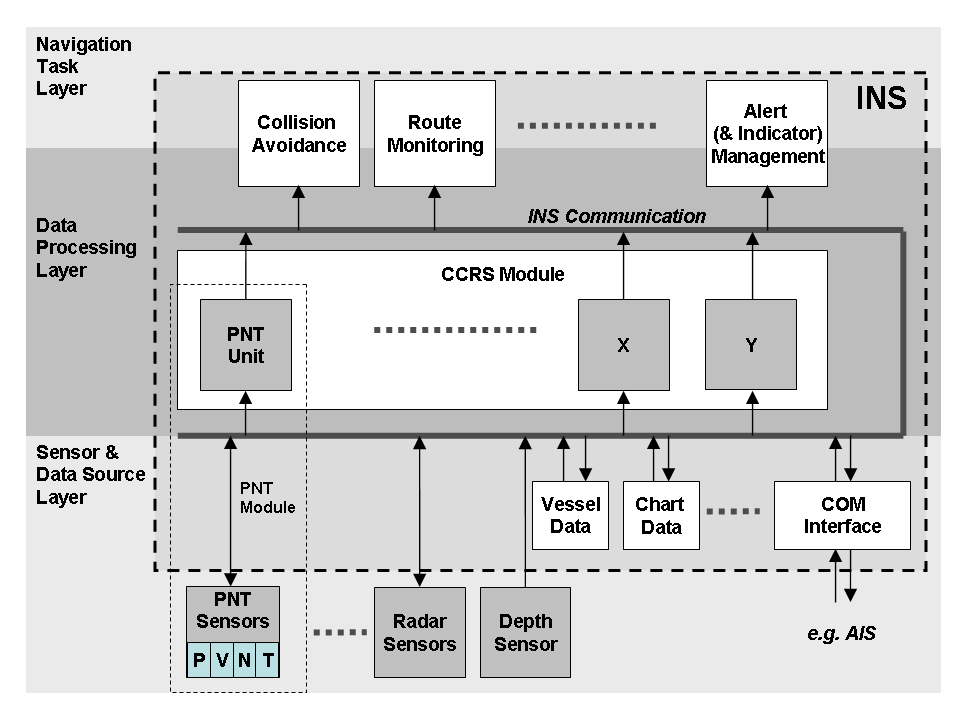


Figure 4 PNT unit as part of CCRS within INS

# Benefit of Integrated PNT Concept

1. The PNT unit as part of the INS data processing layer (CCRS) promotes a harmonized concept related to PNT data provision with respect to:

* standardized techniques for PNT data provision;
* applicable techniques to deliver outputs to achieve the different requirements associated with operational needs;
* supporting the exploitation of all PNT relevant data sources on raw data level to enable an automatic accuracy assessment of all provided PNT data;
* identification and indication of the achieved performance level;
* provision of summary alerts in event of unexpected degradation in the data sources;
* and unambiguous data content.

1. The integrated PNT concept

* promotes an open and modular architecture, which enables the use of existing and future PNT relevant sensors and services;
* and is open to use different PNT relevant services towards the improvement of accuracy and integrity of PNT data provision.

# Standardization aspects of integrated PNT system

1. SN.1/Circ.274 describes guidelines for application of the modular concept to performance standards. A new performance standard should include the specification of sensor/source module, operational/functional module, interfacing module and system/equipment documentation module.
2. By using a modular approach of the PNT concept, a single WWRNS sensor such as MSR can operate in the classic approach or can operate as a sensor for the PNT unit approach. The MSR will facilitate access to new radio navigation signals enabling resilient PNT data provision through the exploitation of current and future radio navigation systems including augmentation services.
3. The PNT Unit can be an operational/functional module of the CCRS within the INS and is assigned to the PNT data processing layer. Alternatively a stand-alone PNT Unit may offer enhanced functionality in the absence of an INS.
4. The modular PNT concept is suitable to achieve a „fast track“ change management process for global standardization and type approval of PNT components by applying the modular structure of future performance standards (NAV 54/25, 12).
5. Product specifications in accordance with IHO S-100 Data Registry should be developed for the PNT sensors (e.g. MSR) and PNT units.