



Bundesministerium  
für Verkehr und  
digitale Infrastruktur

# Coordinated Enhancement of the maritime PNT System: Road Map and Guidelines

MR Jan Reche (BMVI WS23)

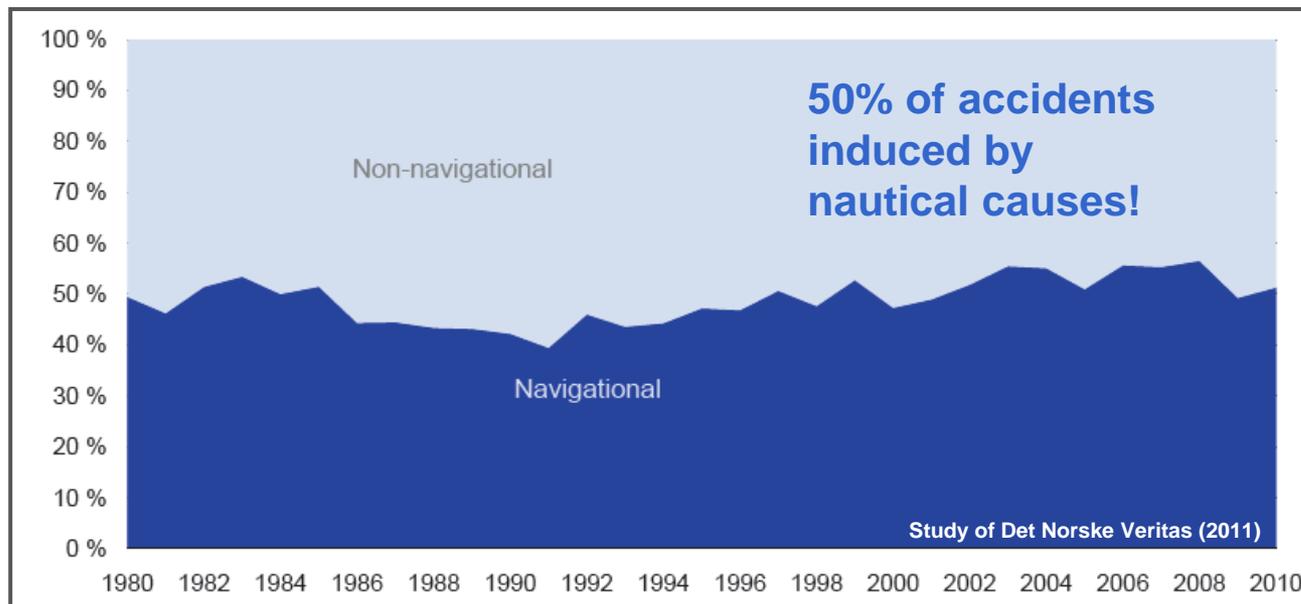
- + Christoph Becker (Raytheon)
- + Hans Callsen-Bracker (BMVI),
- + Tobias Ehlers (BSH),
- + Karl-Christian Ehrke (SAM),
- + Evelin Engler (DLR),
- + Michael Hoppe (WSV FVT),
- + Jochen Ritterbusch (BSH)





## Challenge: Safety

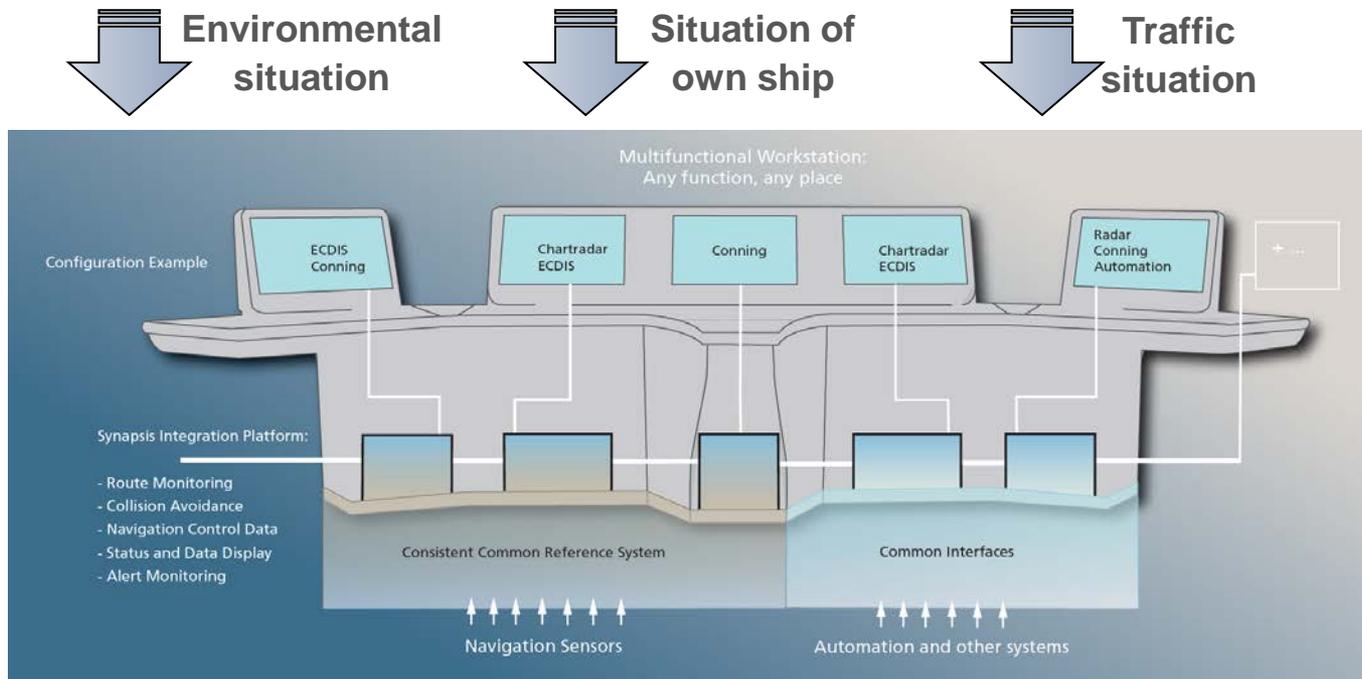
How the risk on collisions and groundings can be reduced ?



- malfunctions and failure of nautical equipment
- invalid or inaccurate nautical data
- misinterpretation of navigational data
- incomplete situation awareness
- incorrect decision finding and managing
- human factor

# Challenge: Situation Monitoring & Evaluation

Real need on means & measures including their enhancement?



1. Reliable provision of information for comprehensive situation monitoring
2. Standardized performance evaluation of safety-critical information
3. Automatic assistance functions to support threat detection and mitigation



# Fundamental Requirements on safety-critical Systems

What level of reliability, integrity and resilience is needed?

## Reliability:

Reliability is the ability of a system to perform its required functions without interruptions under specified conditions for a certain period of time. Reliability is measurable as probability that the specified functions were performed without failure under specified conditions for a specified time.

Required functions and performance?  
Specific conditions?

## Integrity:

Ability to provide users with warnings within a specified time when the system should not be used for navigation (IMO A.915(22)).

Decision criteria regarding usability/unusability?

## Resilience:

Resilience is the ability of a system to detect and compensate external and internal disturbances, malfunction and breakdowns in parts of the system. This should be achieved without loss of functionalities and preferably without degradation of their performance.

Required functions and performance? Significant threats?  
Redundant layout or backup?



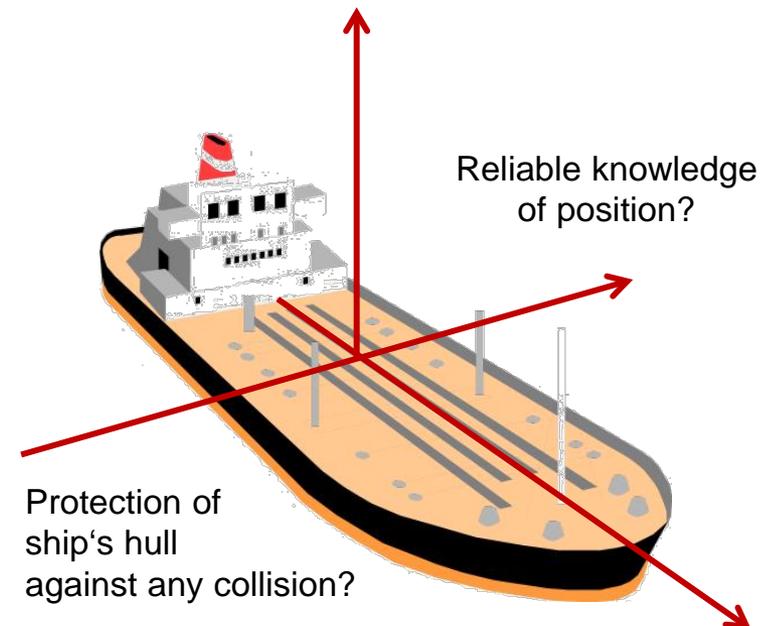
# Unambiguous Requirements on PNT Data Provision (1)

## Role of PNT data?

- describes ship's position and movement in real-time in a common reference system
- are necessary information to enable that a diversity of navigational tasks and functions can be performed;
- are safety-critical information by its relevance for the avoidance of collisions and groundings

## Application-dependent requirements on PNT data differ regarding

- needed types of PNT data
- minimum of PNT data quality
- safety aspects e.g. need on integrity monitoring



## Unambiguous Requirements on PNT Data Provision (2)

Diversity of PNT data types?

P

Horizontal or 3D-position of ship's consistent common reference point in a common coordinate system e.g. WGS 84: latitude, longitude, and altitude.

N

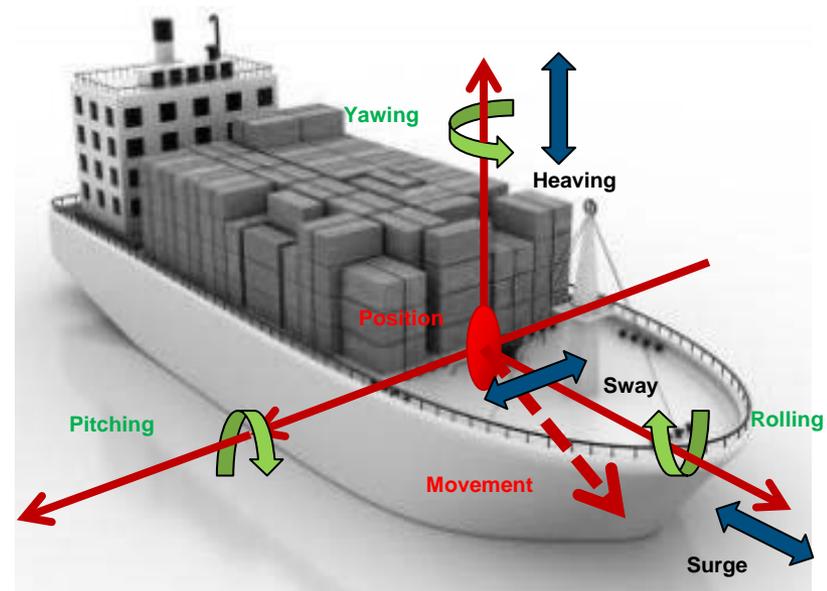
Horizontal or 3D-movement of the ship: SOG, ROT, Heading, COG, and.....

T

Time and date in a common time system e.g. UTC

I

Integrity information regarding PNT system in use and provided PNT data.





# Unambiguous Requirements on PNT Data Provision (3)

Minimum or Diversity of Performance Requirements?

Diversity of  
ships, nautical  
tasks,  
applications, ...



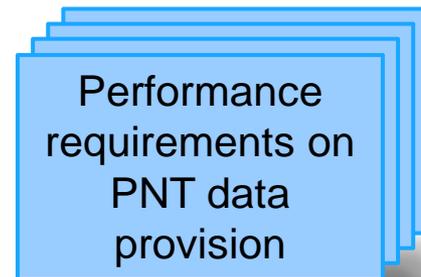
Complexity of  
situations, ...



Current and  
evolving user  
needs...



Diversity of requirements on  
PNT data provision



Sets  
1...N





# Unambiguous Requirements on PNT Data Provision (4)

Negotiation basis for harmonization and enhancement

## Appropriate classification of requirements on PNT data provision regarding

- 1) data types (position, attitude, movement, update rate...)
- 2) accuracy & integrity level per data type
- 3) reliability of data provision (continuity, availability) per supported accuracy/integrity level
- 4) resilience against threats reducing data quality (2) and/or reliability of data provision (3)

**Appropriate scaling between PNT system architecture (sensors and services), facilitated functions (techniques, methods) and supported performance levels of PNT data provision.**



## What is required?

### A Framework for the coordinated enhancement of onboard PNT Data Provision

- **establishing a modular system concept**
  - to facilitate differences in requirements and equipment;
  - to point out dependencies between system architecture, functions, methods, and requirements;
  - to enable that the technological progress of sensors, services, and techniques can be utilized effectively;
- **promoting the combined use of PNT-relevant data sources**
  - to procure redundancy in the database: multi-system-/multi-sensor-based solutions
  - to implement stepwise functions for the monitoring of data and system integrity
  - to enable detection and mitigation of significant malfunctions and disturbances
- **supporting the system awareness**
  - by establishing of transparencies between used system and achieved performance
  - by standardizing of integrity results to avoid the misinterpretation of safety information
  - to enhance the safety of ships' navigation



# Guidelines

## Purpose

1. to facilitate reliable PNT data provision (reliability) and continuative integrity monitoring (integrity) as well as detection and compensation of errors (resilience) based on
  - combined use of data provided by diversity of WWRNS and other onboard sensors (current and future)
  - supported use of multi-system- and multi-sensor-based techniques
  - pointed out dependencies between database, techniques, and performance level
2. to specify and harmonize data processing techniques as prerequisite of standardized data products (e.g. integrity information) and common system awareness
3. to facilitate evolving user needs and technical progress in an efficient manner



# Guidelines

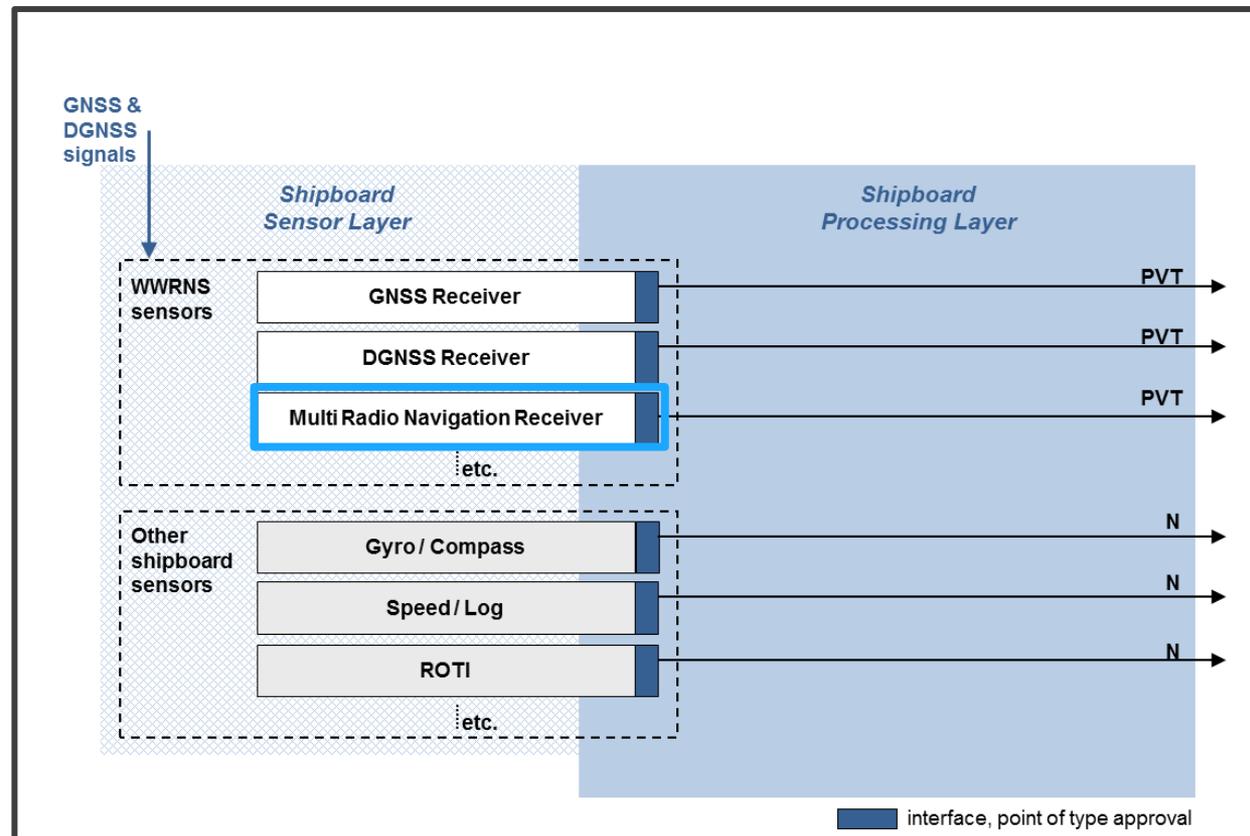
## Scope

- define major principles and functions for onboard data processing taking into account differences in requirements and dependencies on system architecture
- provide framework and structured approach for stepwise introduction of data and system integrity
- achieve standardized PNT output data including integrity information for improved system awareness of bridge teams and pilots
- provide rules to handle differences in equipment, current system in use, feasibility of tasks and functions, performance of data sources, as well as spatial/temporal usability services and infrastructures

# Application of Guidelines

## Classic Approach

- sensor internal data processing and integrity monitoring, if feasible

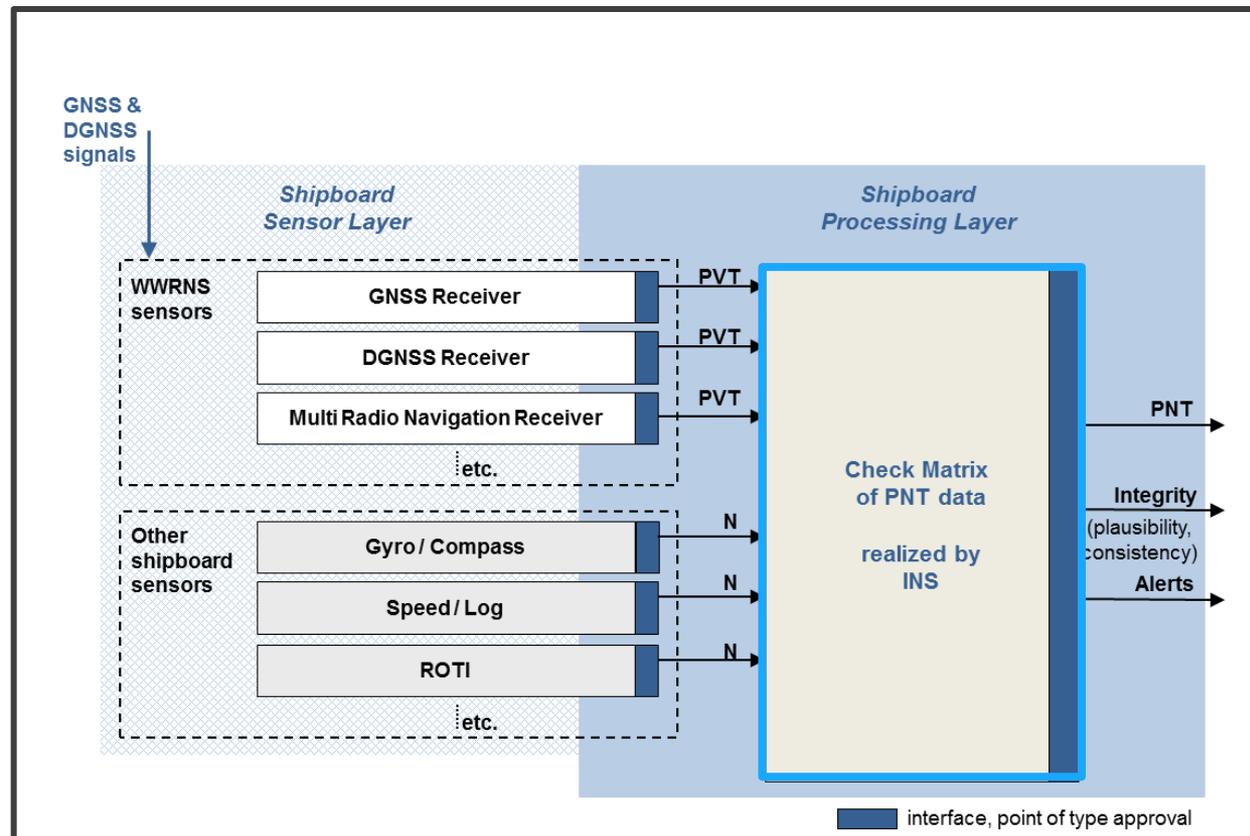




# Application of Guidelines

## Current PNT/INS Approach

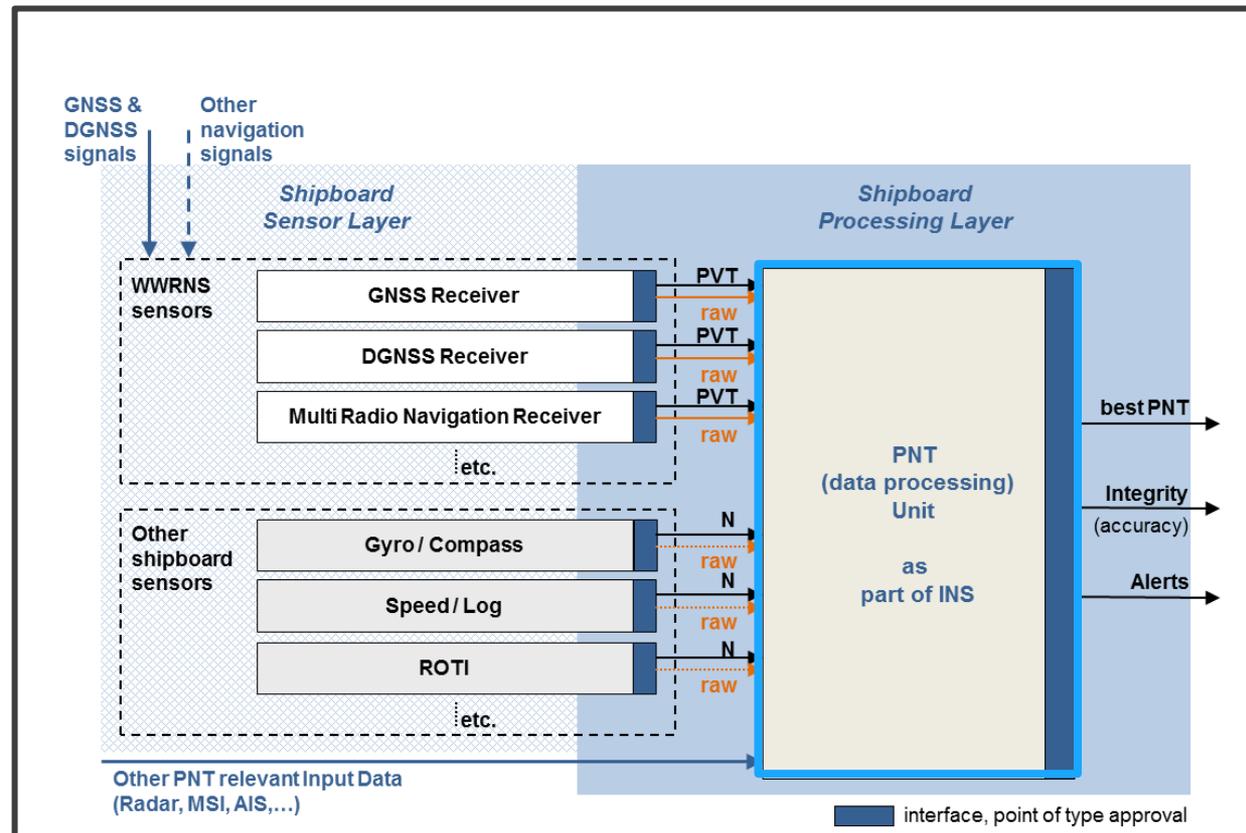
- combined processing of PNT relevant sensor and service data to enable integrity monitoring based on applied plausibility and consistency tests



# Application of Guidelines

## PNT (data processing) Unit Approach

- integrated processing of PNT relevant sensor and service data as indispensable prerequisite for consistent and enhanced integrity monitoring (accuracy)
- apply internal integrity monitoring results to control system operation towards resilience





# Road Map towards resilient PNT

## Proposed time schedule and milestones of Guideline

### NCSR2:

provision of draft guideline (**NCSR 2/7/1**),  
establish correspondence group,  
consolidate working schedule

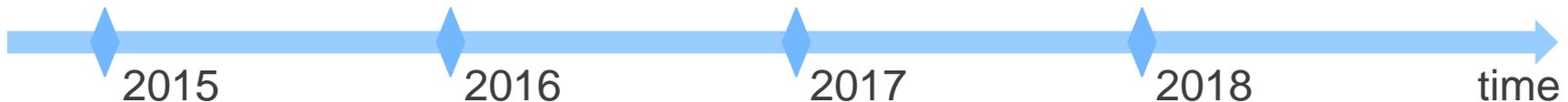
### NCSR3:

Provision of 1<sup>st</sup> full text  
version of guideline

### MSC 96:

Adoption of  
finalized  
guideline

periodic update



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SUB-COMMITTEE ON NAVIGATION,  
COMMUNICATIONS AND SEARCH AND  
RESCUE  
2nd session  
Agenda item 7

NCSR 2/7/1  
2 January 2015  
Original: ENGLISH

#### PERFORMANCE STANDARDS FOR MULTI-SYSTEM SHIPBORNE NAVIGATION SYSTEMS

Development of associated guidelines for shipborne position, navigation, and timing  
(DATA PROCESSING) unit

Submitted by Germany

#### SUMMARY

*Executive summary:* This document provides draft guidelines for reliable PNT (Position, Navigation, and Time) data processing based on multi-system/multi-sensor-based techniques as envisaged by e.g. multi-system radio navigation receivers. Within the guidelines an onboard PNT Unit facilitates reliability, integrity, and resilience for the improved provision of PNT data to onboard applications. The autonomous onboard inspection of all PNT relevant data sources performed by the PNT unit is an essential prerequisite to protect the onboard process of PNT data generation against intrusions by malicious actors (cybersecurity).



**Thanks for  
attention!**

*Any questions?*