Position Accuracy and Copernicus Requirements

User Consultation Platform@GSA

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The Prepare Ships Project

- develops a robust and accurate navigation solution based on the features of Galileo signals in combination with other in-ship sensors.
- reduces the risk for ship collisions,
- provide decision-support in fairway navigation,
- decrease environmental impact and emissions and
- provide a cornerstone for future automated navigation.
Why A shared Dynamic Predictor?

Navigational casualties represent 54% of the accidents in the EU.

• Limited situational awareness is the single most contributing factor.

• Ships future movements can be predicted with high confidence.

• Information can be exchanged between ships and to/from shore via VDES solutions increasing situational awareness.

• Environmental impact reduced by the predictor.

Close quarter situations occur as often as 2-3 per 1000 sailing hours.
Cyber Security

- GPS spoofing: GPS spoofing is an attack in which a radio transmitter located near the target is used to interfere with a legitimate GPS signals. Spoofing works by sending fake signals to a GPS receiver that mimic the ones that the real satellites send.

Port of Shanghai: Attack caused the transponders on multiple ships at once to show various erroneous positions that forms odd ring-like patterns “crop circles”
High Accuracy and Integrity in Position

Prepare Ships System will receive position, attitude and velocity data from the ANAVS GNSS receiver using the Galileo Open Service.

The ANAVS receiver uses
- the signals from Galileo satellites
- the carrier-phase positioning corrections from Network-RTK supported from Lantmäteriet (SWEPOS)
- information about the integrity of the RTK corrections
- ANAVS provides a reliable positioning service using sensor fusion.
SWEPPOS integrity data - Level 2
(VRS Computation integrity)

Vertical and Horizontal Protection Level and Alert Limit
MACHINE LEARNING FOR SHIP PREDICTIONS
Prepare Ships Requirements on Ship Positions Position and Attitude Accuracy

The position and attitude determination system shall feature the following accuracies:

RTK positioning accuracy (1 sigma):
- Horizontal positioning accuracy: 3 cm
- Vertical positioning accuracy: 6 cm

The horizontal positioning accuracy is typically by a factor of 2 better than the vertical positioning accuracy as satellites are visible from any azimuthal direction but only from positive (and not negative) elevation angles.

PPP positioning accuracy (1 sigma):
- Horizontal positioning accuracy: 30 cm
- Vertical positioning accuracy: 60 cm

The RTK accuracy is by factor of 10 better than the PPP accuracy as the HAS PPP corrections for the orbits and clocks are specified with an accuracy of only 20 cm.

Attitude accuracy:
- Heading accuracy: 0.5°/ baseline length
- Pitch/ roll angle accuracy: 1.0°/ baseline length
Prepare Ships Requirements on Ship Positions—IMO Guidelines

The IMO has defined 4 “application grades” to describe the accuracy of PNT-DP (Position, Navigation and Timing Data Processing).

The Prepare Ships project will provide a full PNT solution (based on its Multi-Sensor RTK module with 3 on-board GNSS antennas) with 3D position, 3D attitude and 3D motion information, i.e. it will target application grade IV.
Prepare Ships Requirements on Ship Positions - Integrity

A functional safety assessment has been performed in order to derive integrity requirements.

Resilience in PNT is essential for a reliable and secure navigation during jamming or spoofing events. The IMO has defined various integrity-levels and related them to accuracy levels as shown in Fig. 2. Integrity level 1 means no integrity. Integrity level 2 includes plausibility and consistency checks performed by single sensors, systems, services or sources. Integrity level 3 includes plausibility and consistency checks performed by different sensors, systems, services, and sources. Integrity level 4 is the highest level, which includes an estimation of the accuracy and over-bounds (protection levels). Prepare Ships targets at least integrity level 3.
Prepare Ships Requirements Copernicus

Requirements for Continuous, Real Time Operational Application
1) Spatial Resolution: At least 0.25° x 0.25° for wind and 0.083° x 0.083° for other data
2) Time Resolution: At least every 10-30 min for wind and current
3) Updating frequency: At least every hour
4) Spatial coverage: Global coverage, to be able to reach a global market
5) Data parameters: Wind speed and direction, possibly even surface currents and waves

Requirements for Testing and Validation
1) Spatial Resolution: At least 0.25° x 0.25° for wind and 0.083° x 0.083° for other data
2) Time Resolution: At least every 10-30 min for wind and current
3) Updating frequency: At least every hour
4) Spatial coverage: Coverage of at least Northern Europe
5) Data parameters: Wind speed and direction, possibly even surface currents and waves
The Prepare Ship Project

PREPARE SHIPS provides smart positioning solution by developing and demonstrating a data fusion of different sensor and signal sources to enable a robust navigation application.

Cornerstones are:

- accurate and high-integrity positioning based on EGNSS,
- data and machine-learning should be able to predict and future positions of the own and nearby vessels
- make use of state-of-the-art GNSS receiver including PPP for PNT,
- “go-areas” based on the S100 chart information in the next generation ECDIS
- novel use of RTK + VRS (Virtual Reference Station), and
- VDES, the next generation AIS, to communicate RTK correction and ship to ship exchange of the predictor.
- Internal (e.g. ship system) and external (e.g. Copernicus) data sources
THANKS!

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