ASGARD
The Galileo safety and security benefits in the maritime field

Webinar

14th June 2023

Agenda

- Welcome (15 min)
- ASGARD project: introduction, objectives & other high-level aspects (GMV, 10 min)
- Introduction to ASGARD new shipborne receiver for maritime users (GMV, 20 min)
- Identified benefits from ASGARD for maritime community (SAAB, 10 min)
- ASGARD Pending schedule, activities & way forward (SAAB, 10 min)
- Questions & Answers (All, 20 min)
- Conclusions (GMV, 5 min)

ASGARD project: Welcome

Promotional video

Welcome

Presenters at this webinar

- **Johanna Gustafsson** | Managing Director and Head of TransponderTech at Saab
- **Manuel Toledo** | Director of Navigation User Segment and PRS at GMV
- **Johan Lindborg** | Program Manager at Saab
- **Ana Cezón** | Head of Consultancy and Advanced Navigation Solutions at GMV

- **Marcos López** | Market Product Strategy at GMV and Head of ASGARD
- **Tobias Tisell** | Product Manager at TranspoderTech, IPS
- **Héctor Llorca** | GNSS Engineering at ASGARD

About Saab TransponderTech

- Pioneers in AIS technology (Automatic Identification System)
- More than 20 years of continuous development of products and systems for the maritime domain
  - > 25,000 AIS vessel transponder systems delivered
  - > 3,000 AIS base stations delivered to more than 50 countries
- Major supplier of Airborne AIS transponders
- Unique Secure AIS (encrypted) solutions
- Leading in next generation AIS (VDES) needed for
  - Increased sea traffic density in busy areas
  - New applications for E-navigation
- Global distribution and service network

TransponderTech's Products

Space AIS/VDES Products

Shore based AIS/VDES Products and Radar Interfaces

Shipborne AIS/VDES and Navigation Products

Airborne AIS/VDES Products

AIS/VDES Networks, Airborne Display ECS

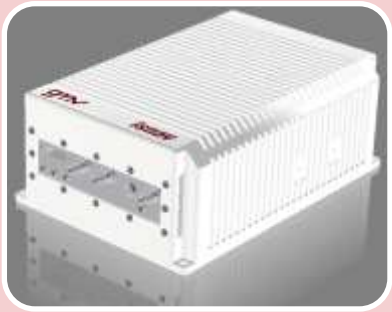
Secure W-AIS and Tender Tracking System

SAAB

Saab's Navigation Segment and ASGARD

- **R5/R6 NAV** – type approved DGNSS navigation system supporting Galileo, GPS, Glonass and Beidou
  - Installed on more then 15,000 merchant vessels sailing today with +1,000 per year
- **R6 NEO** – extended system, currently under development, compliant with the Panama Canal's new requirements for Neopanamax Vessels
  - Centimetre position accuracy
  - GNSS compass
  - Inertial navigation
- Strong trend towards an increasing customer need for Cyber Security and Resilient Positioning, Navigation and Timing (PNT)
- ASGARD is a perfect fit R&D project for resilient PNT in order to verify the authenticity of the Galileo navigation message using a multi-frequency receiver

GMV: 30 YEARS OF EXPERIENCE IN GNSS



GNSS Infrastructure

GNSS Services

GNSS User Segment Technology

Precise Timing Solutions

GMV: GNSS USER SEGMENT TECHNOLOGY

PRS RECEIVERS

GMV's PRESENCE Family of PRS Receiver Solutions

GNSS BREADBOARDS & RECEIVERS

For Signal and PNT Algorithms Development

Market Products

INTERFERENCE DETECTION

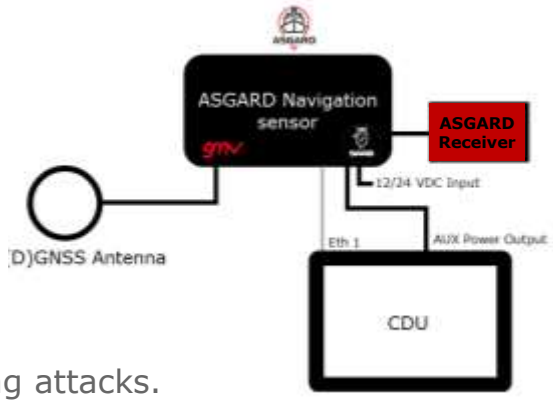
Real Time Monitoring of Interference in GNSS Bands

SBAS/PPP TERMINALS

Handheld portable user terminal compatible with *magicSBAS* and *magicPPP* services

ASGARD: MARITIME Receiver

- Dual-frequency multi-constellation (DFMC) shipborne receiver:
  - Compliant with maritime regulations IEC 61108-1, IEC 61108-3.
  - Application of IMO concept for multi-system receiver (MSR): MSC 401 (95) and MSC 432 (98).
- Supported GNSS signals:
  - GPS: L1, L5
  - Galileo: E1, E5a
- Operational modes:
  - Galileo only mode, GPS only mode and Galileo + GPS
- Galileo OSNMA implementation:
  - Robustness and resilience to spoofing attacks.
- Receiver Autonomous Integrity monitoring features (RAIM).
- Output:
  - Standardized communications interfaces (IEC 61162-1*, IEC 61162-450*)



ASGARD project: introduction, objectives & other high-level aspects

ASGARD Introduction & Objectives

In order to increase the penetration of Galileo in shipborne receivers, the EUSPA as part of GSA/GRANT/02/2019 Lot 1 looked for the development of type-approved against IEC 61108-3 standard Galileo double-frequency E1/E5a receivers.

The objectives pursued, which are the basis of ASGARD project are:

- **Objective 1:** Develop and test a dual-frequency (E1/E5a) shipborne multi-constellation receiver implementing Galileo, compliant with
  - IMO Performance standards for MSR: MSC.401(95) and MSC.432(98)
  - Galileo multi-frequency receiver in IMO MSC.233(88) and its corresponding IEC standard 61108-3.

- **Objective 2:** Demonstrate that the dual frequency shipborne receiver developed in the frame of the project is compliant to IEC 61108-3

- **Objective 3:** Implement the algorithms to use OS-NMA to support resilient PNT in maritime navigation following Galileo OS-NMA specifications issued by EC.

ASGARD Introduction & Objectives

IMO

Dual Frequency

Multi-constellation

- Take benefit of Galileo OS features (improved performance, dual-frequency capabilities) and also of Galileo **OSNMA** to support resilient PNT
- Aligned with maritime standards and applicable EU regulation (**MED**) versus **TRL-7** project target
- Compliant with IMO resolutions MSC.401, MSC.432 (Multi-system shipborne radio-navigation receivers)
  - Two independent GNSS recognized by IMO (WWRNS): **Galileo+GPS**
  - **Dual frequency** in L1/L5 and E1/E5a
  - Compliant with **IEC 61108-1**, **IEC 61108-3** specifications (includes DGNSS augmentation, RAIM), **IEC 61162-1, IEC 61162-450**, **IEC 62288**, **IEC 62923**

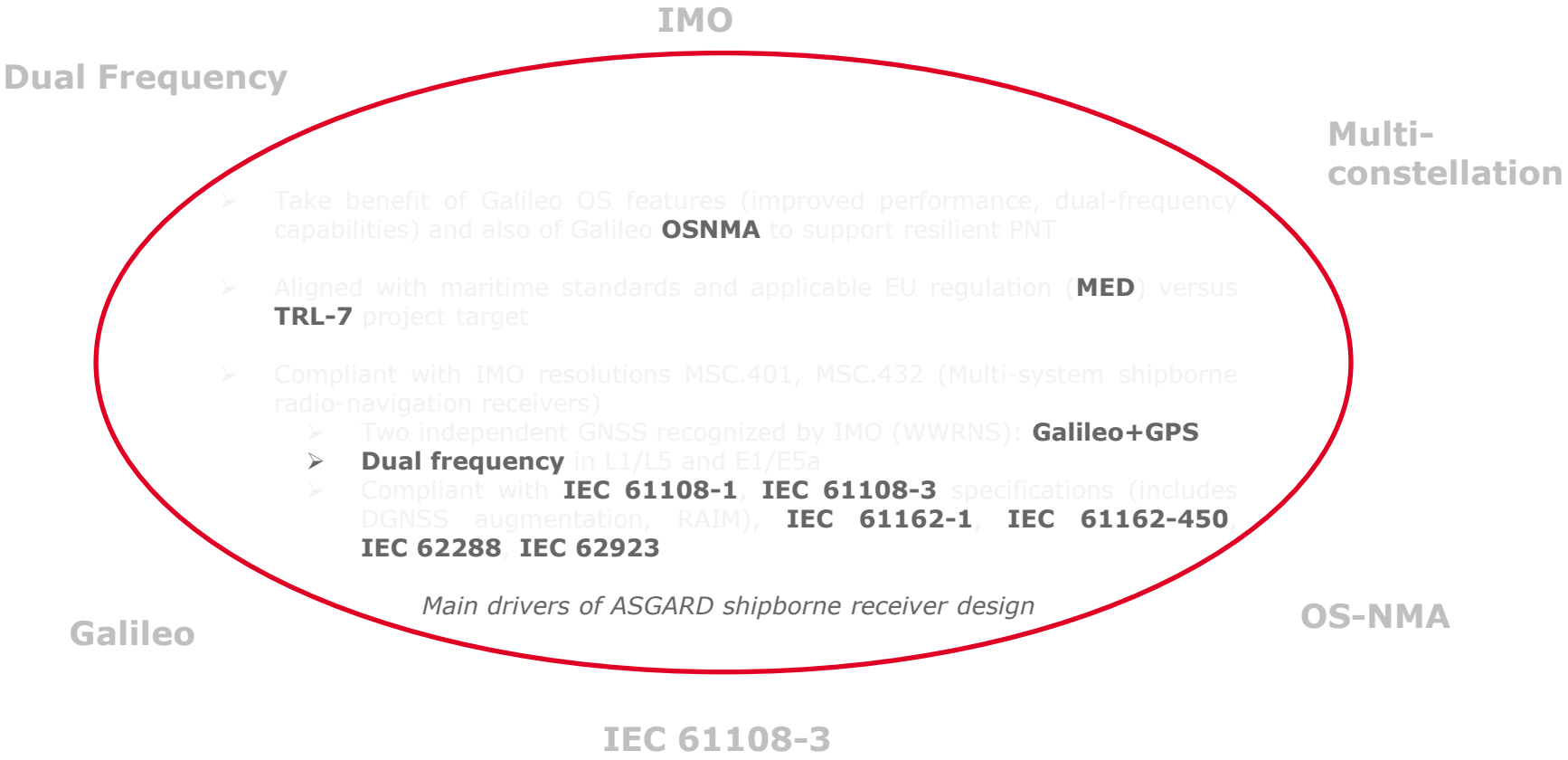
Main drivers of ASGARD shipborne receiver design

Galileo

OS-NMA

IEC 61108-3

ASGARD Introduction & Objectives



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Main drivers of ASGARD shipborne receiver design

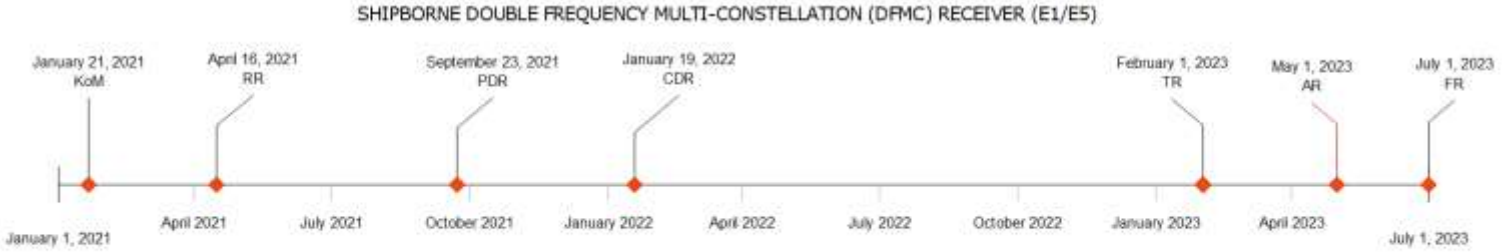
ASGARD High- level aspects: consortium

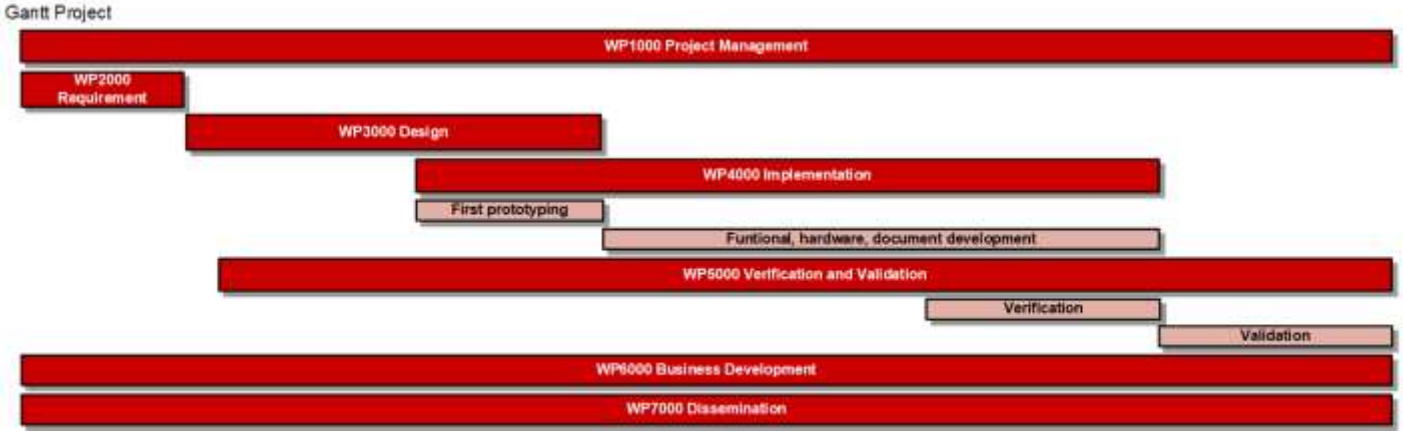
GMV is leading the project and acts **as project Coordinator**.
SAAB, a leading equipment manufacturer, providing its expertise & equipment.

In addition, a series of laboratories are providing support in the activities related to the ASGARD verification & validation:

- **BSH** (Bundesamt für Seeschifffahrt und Hydrographie)
- **JRC** (Joint Research Center)

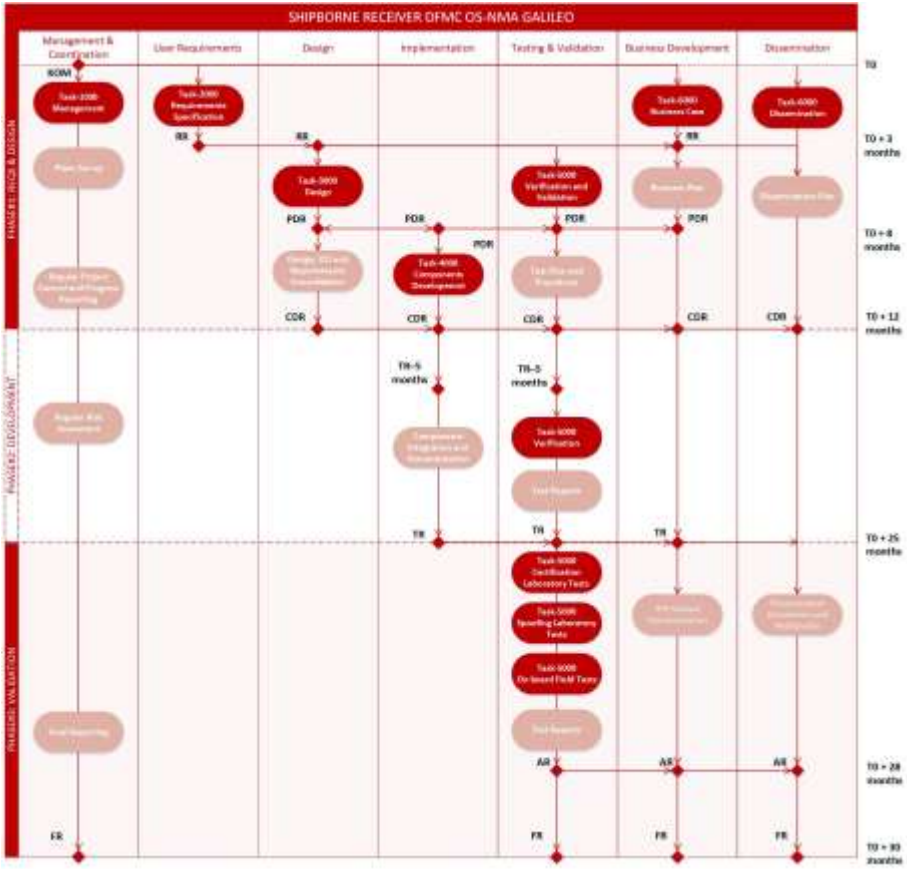
ASGARD High- level aspects: Schedule





ASGARD High- level aspects: Work plan

The Work Breakdown Structure (WBS) under development is presented in the following figure:



Introduction to ASGARD new shipborne receiver for maritime users

ASGARD Equipment overview: Navigation Sensor

SAAB Navigation System

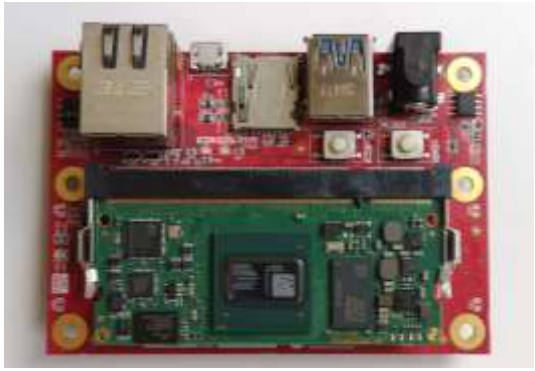
Basis for ASGARD receiver system are the **latest HW platform available from Saab**

- The R5 Navigation sensor HW and SW
- The R6 CDU HW and SW

The use of these platforms as a basis greatly reduces the R&D effort needed & ensure a **very cost effective HW solution**

Existing Saab customers would be able to upgrade to the new GNSS receiver with minimum effort.

ASGARD new shipborne receiver: GNSS Receiver



Main Functionalities:

- **Multi-GNSS receiver:**

it uses GALILEO & GPS to provide redundant positioning options.

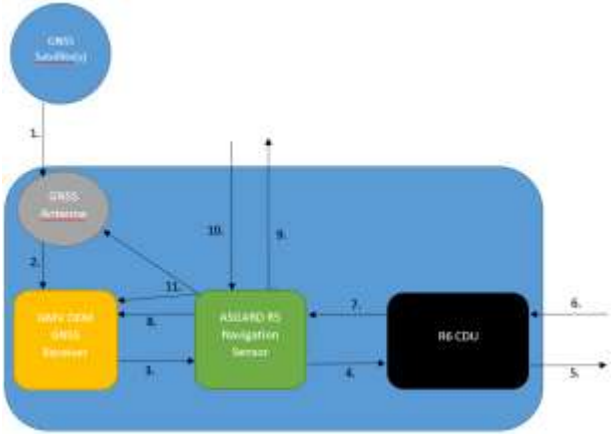
  - ➢ *This improves **navigation performance**, and if one constellation is jammed, spoofed, or not usable, the receiver can switch to the other.*

- **Spoofing alert:** it integrates the **OSNMA** functionality, which allows to detect a spoofing attack on GALILEO.
  - ➢ *This provides an additional layer of system **security** to **enhance maritime safety**.*
- **Multi-frequency:** it uses double-frequency capabilities
  - ➢ *This reduces the ionospheric effect, resulting in better performance in terms of **accuracy, availability & integrity**.*
- **Reliable:** it combines 2 established technologies produced by **Saab & GMV**, both companies with a long history in maritime communication & navigation field.
- **Integrity:** it includes an innovative integrity solution that leverages the MC&MF capabilities to enhance safety and alert crew when the receiver is not working on the desired performance operation levels.

ASGARD Equipment overview

It is based on a modular approach with 3 main components:

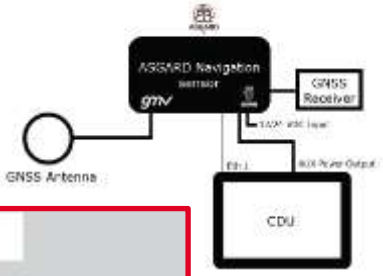
1. **GNSS Antenna**: active MF antenna to provide good reception of GNSS signals.
2. **ASGARD Navigation Sensor**: it provides power to the GNSS receiver & antenna, stores configurations, checks thresholds & generate status /perfo information (e.g. alerts). It has external bidirectional interfaces to connect external devices & networks.
   - ➢ It integrates the **GNSS Receiver** (GMV ASGARD ATHOR): MC/DF receiver needed to receive & process the GNSS signals from the antenna.
1. **R6 Control and Display Unit** ("CDU"): connected to the ASGARD Navigation Sensor by the external Ethernet interface & provides the operator with a user-friendly interface for system configuration & monitoring.



ASGARD new shipborne receiver: GNSS Receiver

Main Features:

- Standardized comm interfaces (IEC 61162-1&61162-450).
- Compliant with **IMO Resolutions** MSC.401 & MSC.432.
- Modular approach.
- **BAM** compliant.
- Graphical interface.
- **Multi-GNSS, multi-frequency** (see Data Sheet)
- **Robustness** & resilience to spoofing (Galileo OSNMA)
- Integrity **RAIM** algorithm.
- AIS/VDES capable 7” touch display in SAAB shipborne ecosystem.
- **Wide freq ranges** (925-2175MHz) to cover GNSS central freqs.
- Maximum analogue bandwidth of 80 MHz.
- **Web interface** allowing configuration & service in a “black box” installation, where CDU not available.
- Interface for processing **RTCM 2.3** data

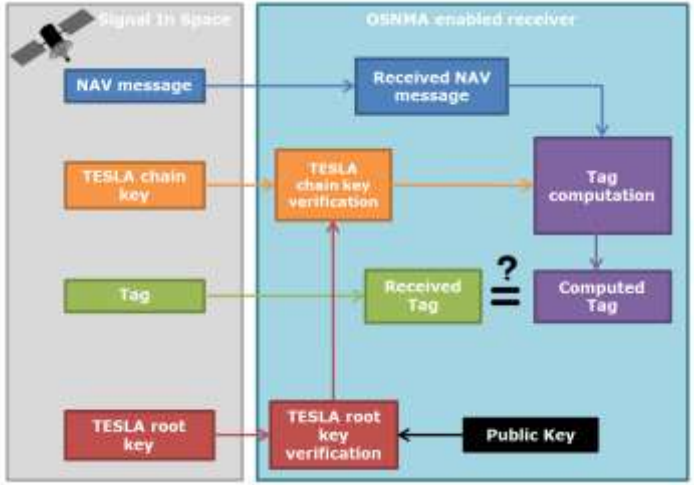


DATA SHEET

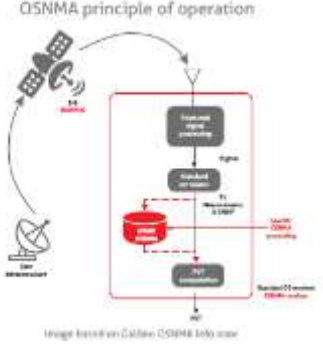
Supported bands	GPS L1C/A, GPS L5, Galileo E1, Galileo E5a.
Standards	IEC 61108-1, IEC 61108-3, IEC 61162-1, IEC 61162-450, IEC 62288, IEC 62923.
Operational modes	Single frequency, Single frequency with differential corrections, double frequency for Galileo and GPS.
Components	GNSS Antenna, Navigation sensor and chassis, GNSS Receiver, Control and Display Unit.
Outputs	Interface compliant with IEC 61162-1, IEC 61162-450.
Power supply	12/24 VDC.
Connections	2 RJ45, 8 output ports, 5 input ports, SD card slot.
Display	7" LCD Display panel.
Features	Differential corrections, OSNMA available, RAIM.

ASGARD new shipborne receiver: OSNMA Solution

ASGARD includes **Galileo's OSNMA**, a component of the end-to-end authentication system for Galileo's civilian navigation signals. If the ASGARD receiver detects a signal that can't be authenticated, it will alert the operator of a potential spoofing attack and prompt them to take alternative measures to validate the vessel's position.



Source: OSNMA Receiver Guidelines for the Test Phase. *Issue 1.0.*



1. **NAV data with OSNMA information is received**. A tag, the TESLA root key and the TESLA chain key are obtained.
2. By using a **public key**, already available in the receiver, the **TESLA root key** is **authenticated**.
3. **TESLA chain key** is **authenticated** by using the **TESLA root key or** with a **previously authenticated TESLA chain key**.
4. Once the **TESLA chain key** is authenticated, it is **used**, with the obtained NAV data to **locally generate** a **tag**.
5. The **generated tag** is **compared** with the obtained **tag from** the **NAV data**. If **match**, the **navigation data** is considered **authentic**.

ASGARD new shipborne receiver: Integrity

1. ASGARD offers an **innovative integrity solution**, ensuring system reliability & safety.
2. It operates by using a **protection by detection strategy**.
3. ASGARD's innovative integrity feature enhances the safety of maritime users, making use of multi-constellation capabilities and Protection Level concept and **sets the stage for the future approach to maritime safety**
4. ASGARD is a one-of-a-kind safety system that **augments the security element** of current Navigation: Using Galileo's OSNMA, the system provides an essential validation and authentication of message integrity for safe maritime navigation.
5. The use of OSNMA in combination with this advanced integrity solution makes ASGARD the **first certified security and safety approach, compliant with SOLAS and IEC regulations for maritime safety**.

ASGARD Verification and Validation

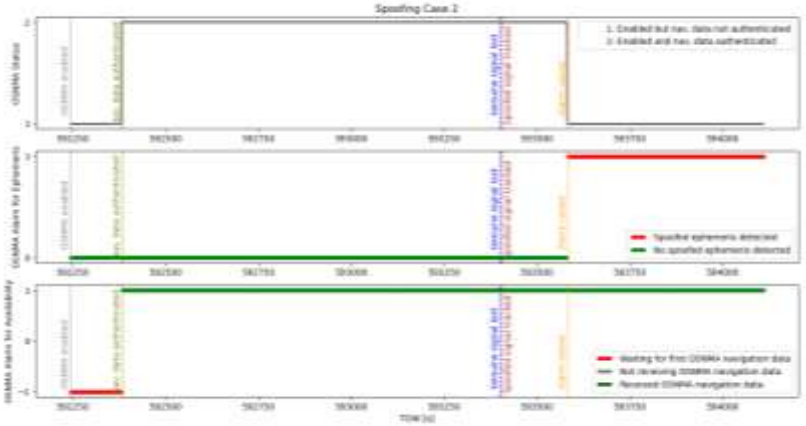
- Tested at GMV and SAAB facilities.
- Tested in an **IEC campaign** to get IEC certifications.
- Tested with a tailored **OSNMA/Spoofing campaign**.
- Tested on field within a **Vessel campaign** in Spain.

ASGARD IEC campaign

- Tests performed at BSH laboratory (Hamburg).
- IEC 61108-1 and IEC 61108-3 type tests showing the equipment has the required GNSS performances for a multi-constellation receiver
- IEC 61162-1 and IEC 61162-450 type tests for the equipment interfaces.
- IEC 62288 type tests for the Display.
- IEC 62923 type tests for bridge alert management.

ASGARD OSNMA/Spoofing campaign

- OSNMA functional tests performed using EUSPA OSNMA test vectors.
- Spoofing tests performed in JRC laboratory in a conducted mode using a RFCS simulator.
- Different spoofing attacks designed to alter different parts of the Galileo navigation messages and in different conditions.
- Real meaconing (record&replay attack) test performed in a controlled manner.



The equipment shows it is resilient to those spoofing attacks, and it alerts to the user

ASGARD Vessel campaign

- Equipment installed into a rental vessel to be tested in real situation
- A two-day campaign starting from Seville, Spain and navigating through port, inland and coast environments.
- The performances are as expected also in real environments and not only in laboratory environment.
- Navigated safely with OSNMA.

Day 1 route

Day 2 route

Identified benefits from ASGARD for maritime community

Benefits from ASGARD shipborne receiver for maritime community

Benefit from Multi-constellation(GNSS)

- Improves **resilience, availability & accuracy**
- Better coverage at **high latitudes** (poles) improving Arctic navigation.
- **Increased safety** in operations: Multi-constellation provides additional information source to perform **information integrity checks** and protection from a complete constellation failure.

Benefit from Double Frequency

- Use of DF Galileo satellites: enhances **service robustness against interferences**.
- Use of Galileo E5 band for improved accuracy & robustness **against multipath**.
- Improved performance in areas of **sky obscuration**.

Benefits from ASGARD shipborne receiver for maritime community (cont.)

Benefit from Galileo

- **Spoofing detection & mitigation** based on authentication (Galileo OSNMA).
- Civilian GNSS Constellation

Benefit from SAAB NAV Platform

- Drop in installation to the SAAB R6 Navigation System
- Parallel with existing SAAB R6 Navigation System
- Existing SAAB R6 Navigation Functions
- Easy to use
- RTCM for DGNSS
- Alignment with regulatory approvals

ASGARD Pending schedule, activities & way forward

ASGARD Pending schedule, activities & way forward

ASGARD Short Term(1-2 years):

- **Deploy multiple pilots** for proof of concepts, together with Current **SAAB Nav users**
- **Close contact** with **insurance companies**, Standard Equipment onboard
- **Wheel Mark**

ASGARD Long Term(2-5 years):

- **Pro Asgard Navigation Sensor,** support E6 Signals and feasible functions
  - **HAS(High Accuracy Service)** together with PPP (E6-B)
  - **SAR(Search and Rescue)**
- Add product approvals outside of Europe
- **MASS**(Maritime Autonomous Surface Ships), **reliable and integrity** of positon data
- **PRS**

Questions & Answers

CHECK ALSO
ASGARD project website:
https://asgard.gmv.com/

Conclusions

Conclusions

- ASGARD is an **important step forward** in the development of robust and reliable cyber security systems for the maritime industry.
- Once released, ASGARD is expected to have a **significant impact on the maritime industry**, improving safety and security for vessels and crews.
- It is also expected to **boost the uptake of Galileo in the maritime sector**, when ASGARD is certified according to maritime safety regulations (SOLAS) & maritime standards (IEC).

❖ *For more information about ASGARD, please visit the project's website: https://asgard.gmv.com/about-asgard/*

@AsgardGnss

ASGARD GNSS project

Thank you

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CHECK ALSO
ASGARD project website:
https://asgard.gmv.com/