EUROPEAN SPACE WEEK

ONLINE EDITION

#EUSpaceWeek

ADVANCED SHIPBORNE GALILEO RECEIVER DFMC (ASGARD)

*'The slides presents the project submitted by GMV under the GSA Call for proposals **GSA/GRANT/02/2019, Shipborne double frequency multi-constellation receiver (E1/E5)**.*

Such project has been awarded by the GSA. However no grant agreement has been signed yet with the GSA and the award does not imply any commitment on the part of the GSA. The project will be implemented only if the grant agreement will be signed with the GSA'.

2020 User Consultation Platform

Marcos López Cabeceira 2.0

Organised by:

European Global Navigation Satellite Systems Agency

European Commission

Under the auspices of:

eu2020.de

EU Space Programme:

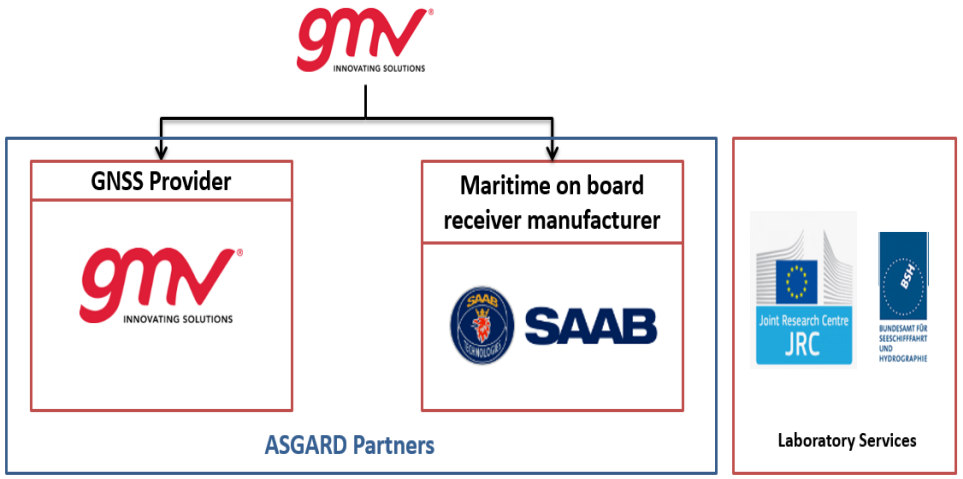
Copernicus

EGNOS

GALILEO

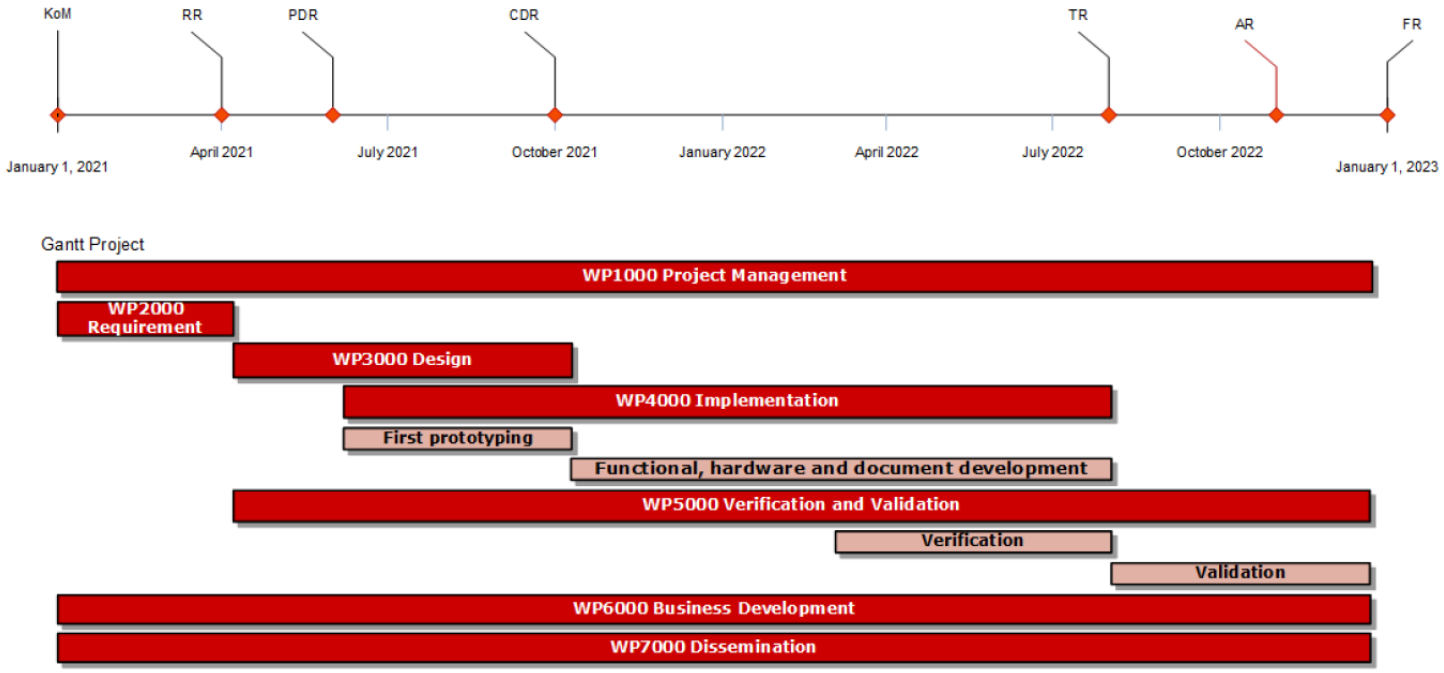
ASGARD

- Founded by **GSA** (GRANT/02/2019, Fundamental Elements)
- Two years development: 2021-2022.
- **Scope of the project:** design, integration and V&V of a shipborne Dual-frequency Multi-constellation **Galileo** OS enabled including **OS-NMA authentication** and IEC GNSS approval.
- Consortium: GMV & SAAB.



ASGARD Project activities

- ASGARD shipborne receiver will take **benefit** of all **Galileo** OS features (improved performance and robustness thanks to **dual-frequency** and **OS-NMA** capabilities), in **compliance** with the corresponding legal framework for maritime equipment at both **EU** and **IMO** level.
- A set of activities will also be carried out in the frame of the project to **test** and **demonstrate** the capabilities of the product, enabling the **dissemination** and **business** plan activities required to maximize the penetration of shipborne Galileo receivers in the corresponding market.

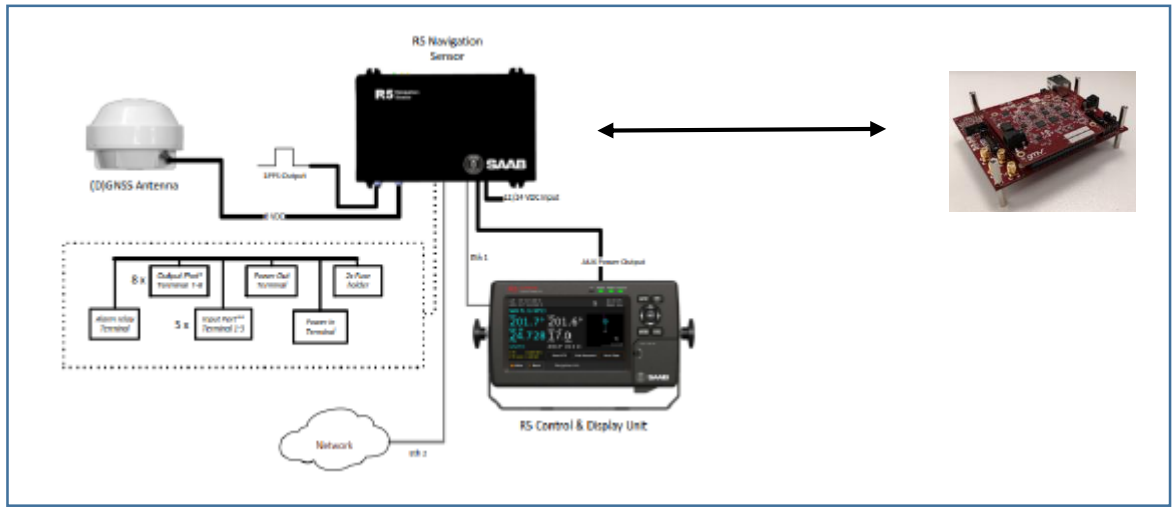


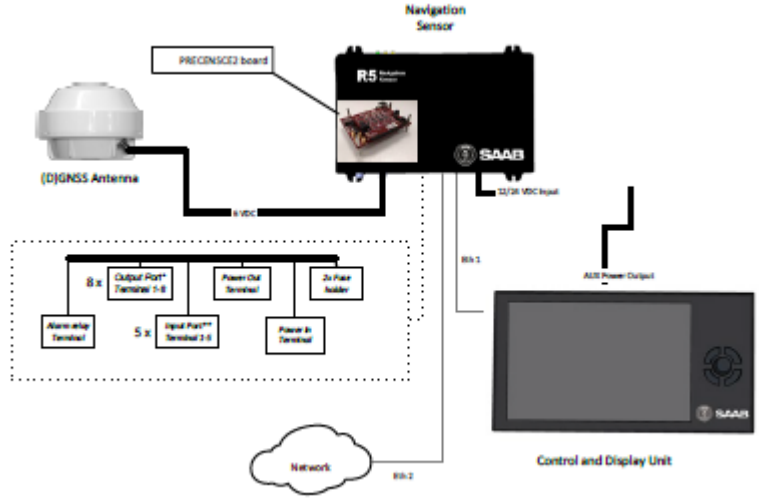
Objectives of ASGARD

1. Development of a **double-frequency** (E1/E5a) shipborne **multi-constellation** Galileo OS & GPS shipborne receiver compliant with **IMO** resolutions **MSC.401**, **MSC.432** and **MSC.233**.
2. **Type approval** for **Galileo** receiver following **IEC standard 61108-3**.
3. Implement the algorithms to use the **OS-NMA** to support Resilient-PNT in maritime navigation, following GSA specifications.

Objective 1: Development of DFMC Galileo shipborne receiver

- Design and integration of the shipborne receiver, starting point:
  - SAAB R5 Navigation System
  - GMV PRESENCE2 GNSS OEM receiver





Objective 1: Development of DFMC Galileo shipborne receiver (Cont.)

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

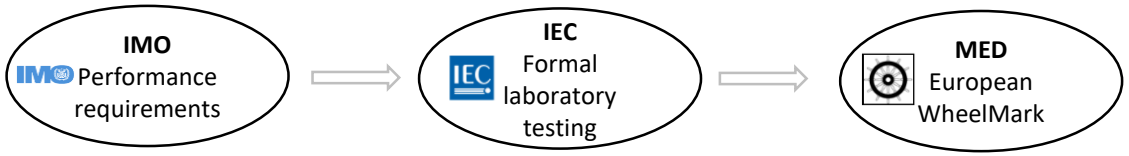
Objective 2: Type approval IEC 61108-3

- Static and dynamic laboratory test campaign in the laboratory following **IEC 61108-3 (Galileo) and IEC-61108-1 (GPS): Type approval.**
- Planned dynamic test campaign on a **vessel**

Objective 2: TRL-7 & 61108-X vs MED

IMO	IEC	Description	MED
MSC 112 (73)	61108-1	GPS receiver equipment: performance standards, methods of testing and required test results.	Into 4.14
MSC 233	61108-3	Galileo receiver equipment: performance requirements, methods of testing and required test results	Into 4.56
MSC 401 (95)		Performance standards for multi-system shipborne radionavigation receivers	
MSC 432		Amendment to MSC 401	

	Type approval requirements & Carriage and performance requirements	Testing standards	Galileo Navigation Equipment (MED/4.56 MED EU 2019/1397)	Comments
Type approval requirements	SOLAS 74 Reg V/18 SOLAS 74 Reg X/3 SOLAS 74 Reg V/19 IMO Res.MSC.36(63), IMO Res.MSC.97(73)		Mandatory	
Carriage and performance requirements	IMO Res.A 694(17)	EN 60945:2002 incl. IEC 60945 Corr. 1: 2008 Series EN 61162: EN 61162-1: 2016 EN 61162-2: 1998 EN 61162-3: 2008 + A1: 2010 + A2:2014 IEC 61162-450:2018	Mandatory	Required tests at very different level: electromagnetic radiation and immunity, power supply, environmental (temperature, vibration, rain, corrosion, others).
	IMO Res.A 813(19)		Mandatory	EMC
	IMO Res.MSC.36(63),		Mandatory	High Speed Craft
	IMO Res.MSC.97(73)		Mandatory	High Speed Craft
	IMO Res.MSC 191 (79)	EN 62288:2014	Mandatory	Required tests at a level of: visualization of information to crew
	IMO Res.MSC 302 (87)	IEC 62923-1:2018 IEC 62923-2:2018	Mandatory	Required tests at a level of alerts management with the crew
	IMO Res.MSC 233 (82)	EN 61108-3:2010	Mandatory	Galileo maritime receiver



Objective 3: Galileo OS-NMA implementation

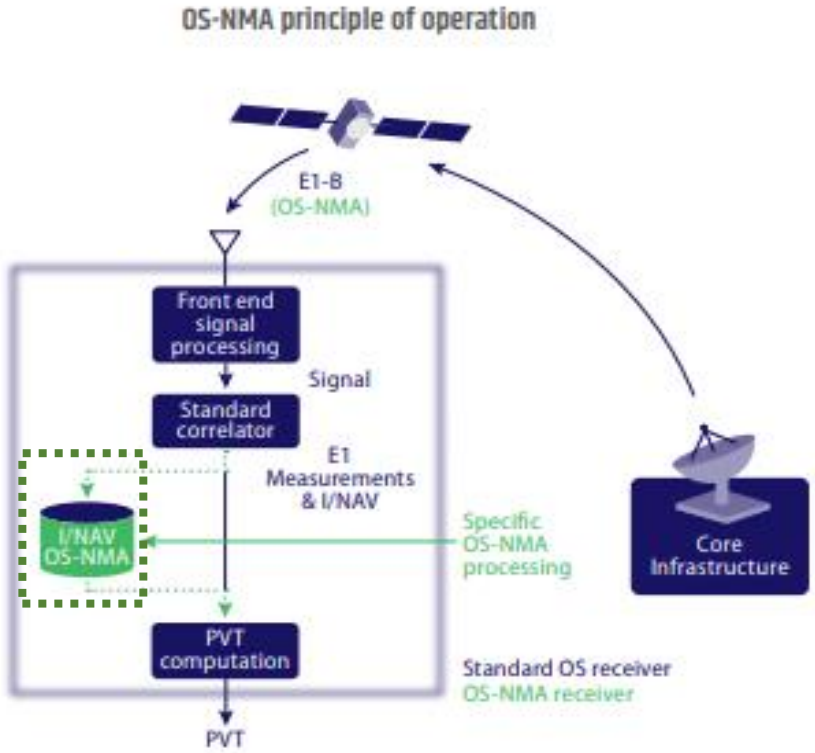
- First, what Galileo OS-NMA is **NOT**:
  - A checksum to validate navigation data integrity
  - Secret encryption of Navigation signal “for your eyes only” (i.e.:PRS)
- OS-NMA verifies the **authenticity** of the Galileo navigation message
  - To confirm the message received has been **transmitted by Galileo** OS System.
  - High level of **robustness** against simplistic and intermediate **spoofing/meaconing** attacks.
- Tests campaign in the **laboratory**, including a spoofing attack.

Objective 3: Galileo OS-NMA implementation - system level point of view

- NMA MACs are generated using **symmetric key encryption**, being the symmetric key disclosed **AFTER** the navigation message has been signed and broadcast. Such keys belong to a **TESLA chain**, in which each key can be used to derive a previous one.
- The **TESLA root key** is signed with an **asymmetric signature**. The public key involved in the TESLA root key validation can be obtained either from the OS SIS (verification required) or from the European GNSS Service Centre.
- If the locally computed MAC matches the broadcast one, the navigation message is considered to be authentic.

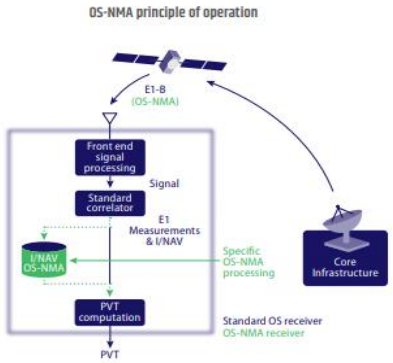
Objective 3: Galileo OS-NMA implementation - user level point of view

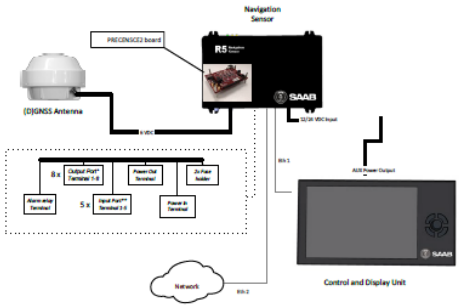
- By using **reserved fields of the I/NAV,** OS-NMA broadcast does not introduce extra overhead to the system. Standard OS receivers can ignore the dedicated NMA fields and keep functioning with the same level of performance (fully **backwards compatibility**).
- As showed in the figure on the right, an OS-NMA capable receiver differs from a generic OS receiver only by the **additional firmware/software** required to:
  - Retrieve the **OS-NMA related fields** from the navigation message;
  - Locally compute the MAC corresponding to a particular navigation message (using the information provided by the NMA field) to confirm whether this is authentic, matching in this case the broadcast one.

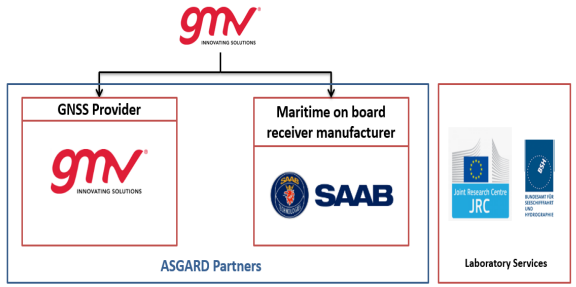


Thank you

Q&A


OS-NMA principle of operation
E1-B
(OS-NMA)
Front end signal processing
Signal
Standard correlator
E1
Measurements & I/NAV
I/NAV OS-NMA
Specific OS-NMA processing
Core Infrastructure
PVT computation
Standard OS receiver
OS-NMA receiver
PVT


Navigation Sensor
PRECONSCE2 board
R5
SAAB
(D)GNSS Antenna
Control and Display Unit
Network


GNSS Provider
Maritime on board receiver manufacturer
SAAB
ASGARD Partners
Joint Research Centre
JRC
Laboratory Services

Linking space to user needs

How to get in touch:

European GNSS Agency

www.GSA.europa.eu

EGNOS-portal.eu

GSC-europa.eu

UseGalileo.eu