

GALILEO

HIGH ACCURACY SERVICE

DAYS



Galileo HAS Market Adoption

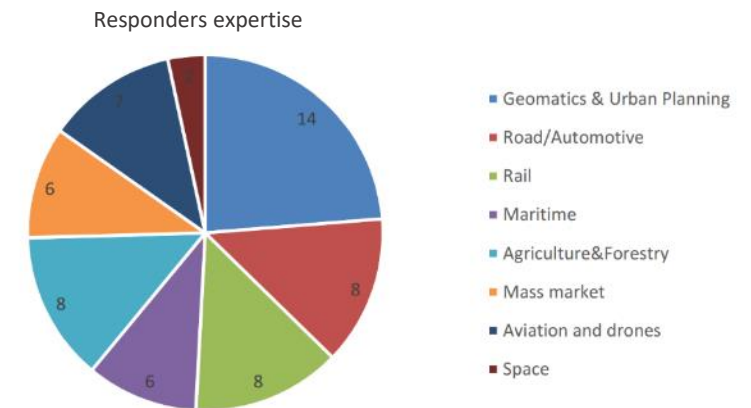
Applications and funding opportunities

Carmen Aguilera / EUSPA



HAS is tailored to the final users needs: the consultation

- 2020-2021 - EUSPA launched a tailored Galileo HAS Survey, aimed at gathering feedback on:
 - User requirements
 - Planned Galileo HAS features and performance
 - Validation and complementation of target applications
- Findings on needs and market expectations:



Barriers	Incentives
Accuracy	Worldwide coverage
Convergence times	Free-of-charge
Availability of E6 receivers	Cellular networks independence

HAS from the perspective of a final user: the resulting service

- Galileo has become the first constellation able to provide a high-accuracy PPP service globally directly through the Signal in Space
- High-accuracy data also provided via the internet
- 24/7 and free of charge

HAS commitment	Service Level 1	Service Level 2*
Hor. Accuracy (95%)	<20cm	<20cm
Vert. Accuracy (95%)	<40cm	
Convergence time	<300s	<100s

* SL2 available within the European Coverage Area

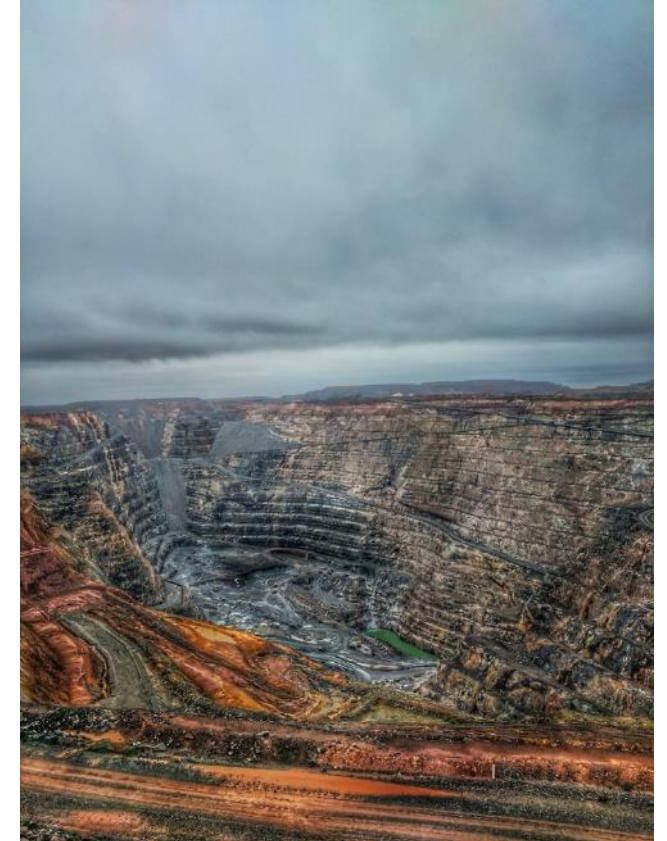


Other features highlighted by users

Remote and/or sky obstructed environments

- Other services delivered by:
 - GEO satellite
 - Internet connection
- Galileo HAS delivered by:
 - **24 MEO satellites**
 - Internet
- **HAS minimizes the risk of losing high-accuracy data**

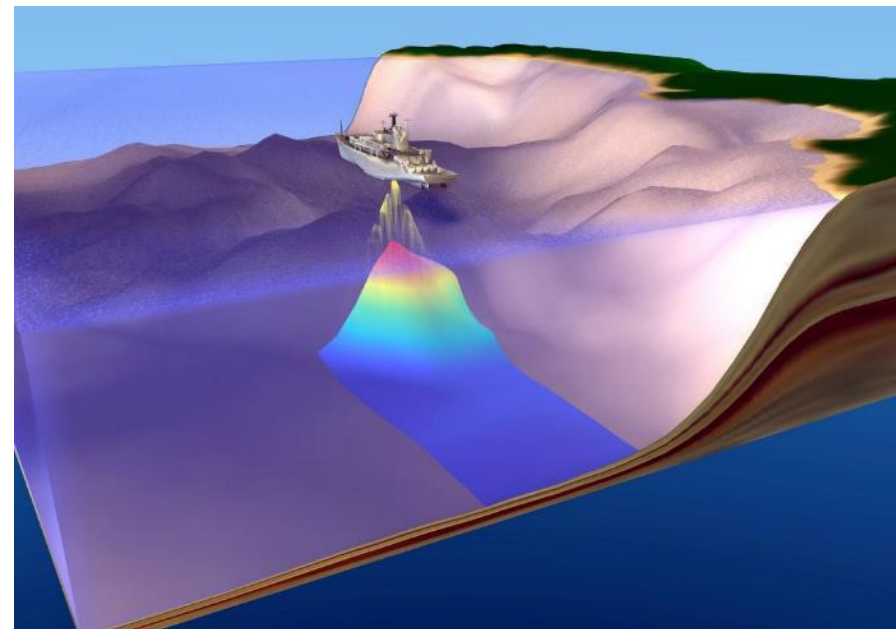
Use cases in e.g. agriculture or mining →



HAS serves a wide range of Applications in different market segments

Market Segment	Applications
	GIS/Mapping . Cadastre in rural areas, hydrographic survey. Offshore exploration.
Agriculture	Guidance, VRA-low applications, farm machinery positioning , site-specific data analysis applications.
Aviation and Drones	Airport integrated surface management systems. Flight validation. Drones positioning and navigation system (urban), and geo-awareness system.
Consumer Solutions, Tourism and Health	LBS , gaming, health, AR for leisure/professional, geo-marketing, robotics.
Maritime and Inland Waterways	Merchant navigation and pilotage operations in ports. Pilotage in IWW. Port bathymetries and riverbed and coastal seabed surveys. Offshore supply vessels with dynamic positioning. Port terminal cranes and straddle carriers navigation. Autonomous surface vessels.
Rail	Cold movement detection. Odometer calibration. Door control supervision. Infrastructure and gauging surveying.
Road and Automotive	Autonomous driving , infrastructure survey.
Space and New Space	Precise orbit determination (incl. autonomous formation flying and in-orbit rendezvous and docking). Attitude determination. Civilian launchers (e.g. for precise orbit injection).

HAS supports innovative applications in mobility



HAS synergies with other space data for user uptake: examples

Precision agriculture

GNSS and EO for Variable Rate farming equipment



Inland waterways

GNSS for accurate navigation and EO for information on the water levels



Supporting the market readiness for HAS RXs since years

- **Fundamental Elements:** 9 projects on HAS receivers
- **Horizon 2020:** 5 projects on early HAS applications
- **HAUT:** HAS reference algorithm and user terminal used for the HAS Service Validation
- **HAS testing** with dedicated test infrastructure enabling the involvement of key stakeholders in 2021/22:
 - AALECS: HAS demo and receiver prototypes. Transmitting SIS HAS corrections since 2021.
 - PAULA: HASlib, a public python library to decode the HAS SIS message (<https://github.com/nlsfi/HASlib>)



Fundamental
Elements



Receivers available in the market upon service declaration

Pioneer use cases

Commercial receivers hit the market following the Service Declaration

As per information managed by EUSPA on 20th June 2023

Manufacturer	Model	Segment or applications	Status
ANAVS	Multi-Sensor RTK/PPP Module	Autonomous Vehicles, Robots, UAVs and Vessels	Available
BeyondGravity	PODRIX	Space, LEO POD	Available (TRL 7)
BeyondGravity	NavRIX PinPoint	Space, LEO POD	Available (TRL 7)
EOS	Arrow Gold+™	GIS, mapping, maritime pilotage	Available
Rokubun	SPEAR (SW engine)	Road, robotics, LBS, agriculture or IoT	Available
SpaceOpal	HAUT	HAS validation: surveying, maritime, machine control, aviation	Available (licensing process from EC underway)
ComNav		Maritime, int. driving, agriculture, GIS	Under development
Unicore Comm.		Surveying and mapping, agriculture, UAVs, and autonomous robots	Under development
Hemisphere		GIS, agriculture, and machine control	Under development
Hemisphere		Agriculture, machine control, marine, OEM	Under development
Bad Elf		Mapping and surveying	Under development
Deimos	G3STAR	Space, POD	Under development



We would be delighted to consolidate the list.
Contact us!

Note: readiness of Receivers as stated by manufacturers (i.e. not tested by EUSPA)

And more coming soon: Low cost HAS receiver for Agriculture

Project **PHOENIX** by  **IFEN**

- **Objective:** develop a prototype HAS receiver (TRL 7) meeting the application requirements of small-hold farmers
- **Galileo E1/E6/E5ab triple-frequency PPP** embedded in receiver
- Miniaturisation of HW and improved interference resilience also part of the project

ON-GOING

Project end date:

30/11/2023

Galileo differentiators:

Galileo HAS

Multi-frequency (E1 + E5 + E6)



And more coming: High Definition maps for autonomous vehicles with HAS

Project **GAMMS** by



- **Objective:** Autonomous Terrestrial Mobile Mapping System, based on the tight integration of autonomous vehicle, navigation/geodetic, and artificial intelligence technologies, for cm-level accurate and certifiable mapping to serve the needs of High Definition maps for autonomous vehicles.
- **Galileo E1+E6+E5 AltBOC triple-frequency receiver** capable of processing E6 HAS data and making use of OSNMA to ensure a high accuracy and robust navigation solution.
- GNSS receiver integrated with trajectory determination software combining GNSS with CSAC clock, IMU and odometer measurements.

ON-GOING

Project end date:

31/12/2023

Galileo differentiators:

Galileo HAS

Galileo OSNMA

Multi-frequency (E1 + E6 + E5AltBOC)



EU projects delivering HAS Rx and/or apps in our event

NEWSPAPER

FINISHED

Objective: GNSS receiver for New Space market applications

Real-time Precise Orbit Determination (POD), with PPP based on Galileo's E6 HAS



beyond gravity

Afternoon's session

SCORPION (H2020)

ON-GOING

Objective: autonomous precision spraying tool integrated into a robotics platform

Sensor's fusion, including HAS. Integration tests on-going!

INESCTEC

TEYME
Smart Spraying

eurecat

INNOVI
Clúster Vitivinícola Català

IPN
INSTITUTO PEDIOLÓGICO

WAGENINGEN
UNIVERSITY & RESEARCH

spi
the world's agricultural partner



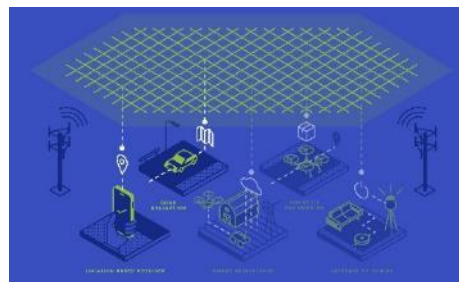
Day 2 project's station

UNION (Grant)

FINISHED

Objective: positioning engine providing accurate and real-time navigation for mass-market

Achieving **decimetric accuracy** in mass-market devices (e.g. automotive, LBS)



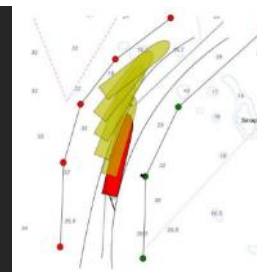
Day 2 project's station

PREPARE SHIPS

FINISHED

Objective: accurate positioning solution allowing vessels to predict future positions of nearby vessels

Utilization of **machine-learning** and Galileo HAS.

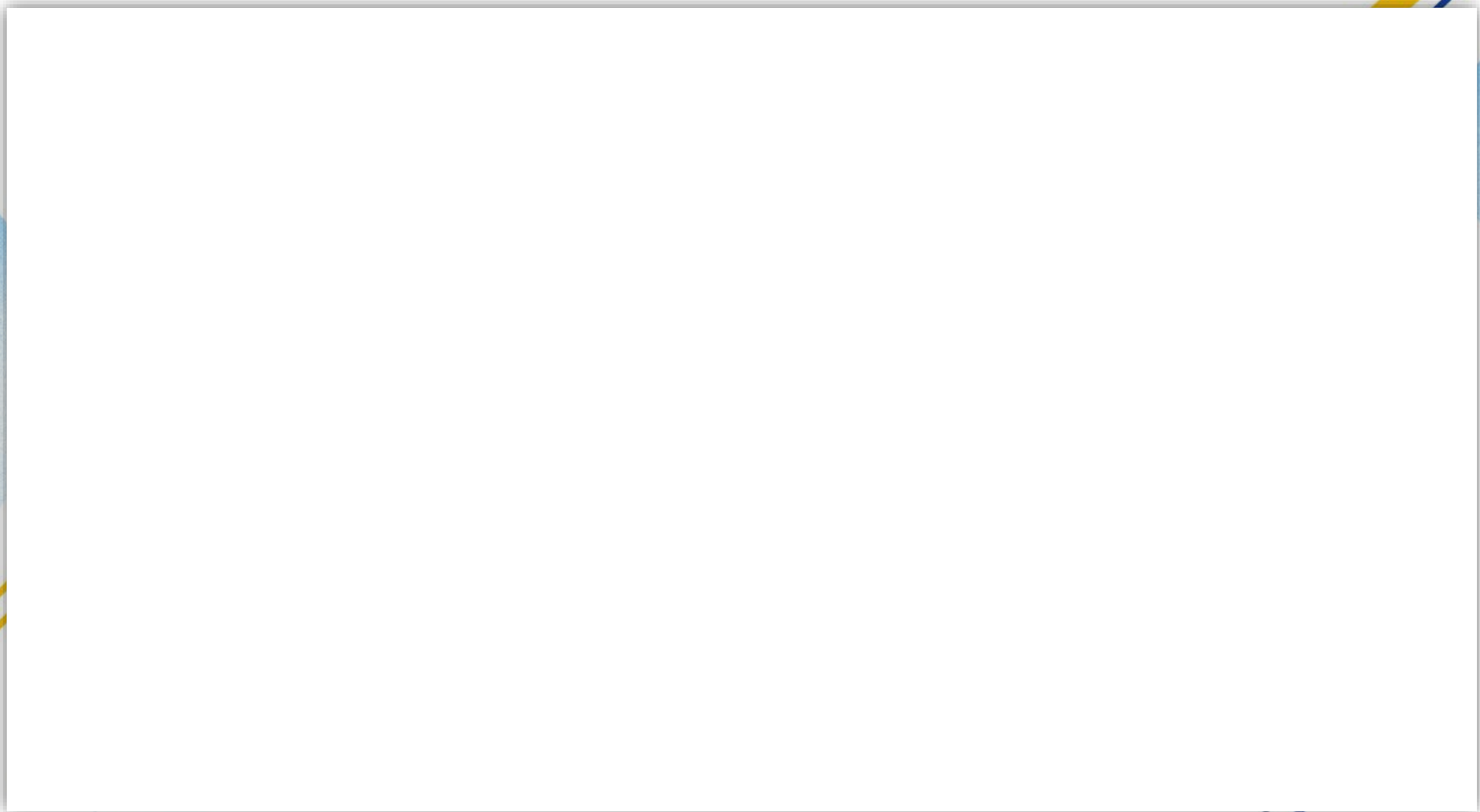


LANTMÄTERIET

StenaLine

SAAB

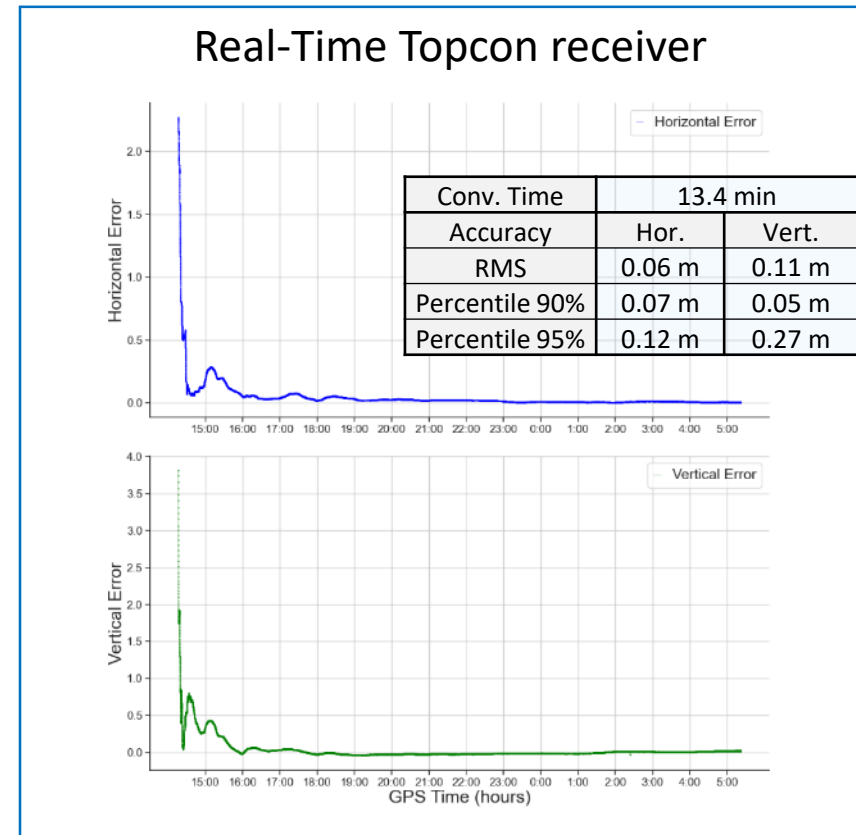
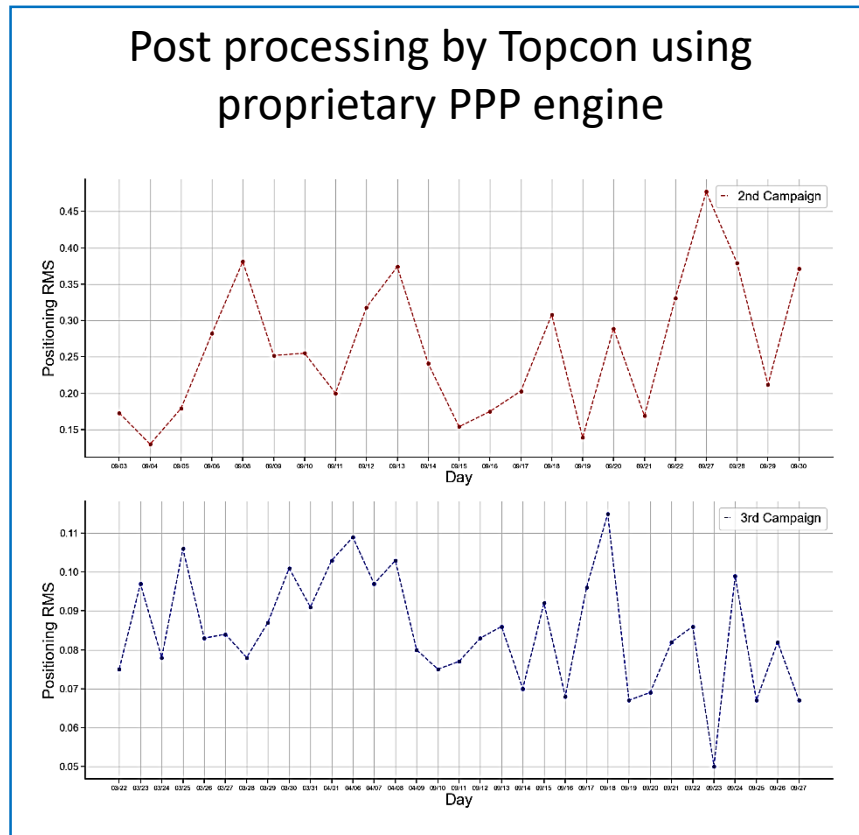
Afternoon's session



Testing HAS with manufacturers and users: static environment



Excellent performance achieved in 3 Galileo HAS testing campaigns before declaration (2021 and 2022)



Adapted from **Topcon Positioning Systems**, EU Space Week 2022
<https://www.euspaceweek.eu/programme/05-10-2022/galileo-status>

HAS testing in user dynamic scenarios: Drones navigation

Objective: Test Galileo HAS accuracy for drone navigation in post processing

Equipment and location:

- CATUAV/BCN Drone center
- EUSPA ATMOS-8 fixed-wing drone
- Rokubun MEDEA GNSS receiver
- Rokubun JASON, HAS reference algorithm, EUSPA tools

HAS provides much better accuracies than non-corrected ones and follow a smoother shape



ROKUBUN



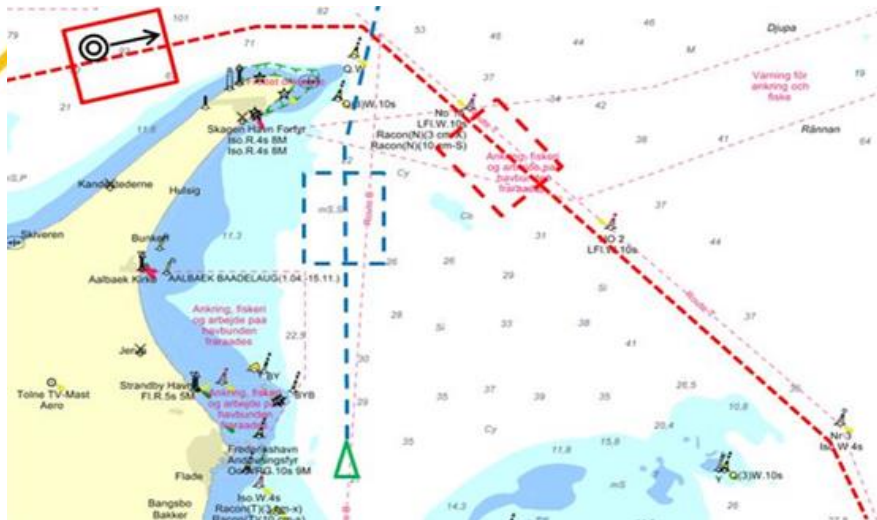
HAS testing in user dynamic scenarios: maritime campaign

Objective: Testing HAS in Real Time for River and Port Environment to support applications like Pilotage and water level measurement.

Location and equipment:

- Ireland (thanks to General Lighthouse Authority)
- HAUT receiver
- Vessel: ILV Granuaile
- 30-days test campaign – July/August '23

Results after summer



OSNMA + HAS implementation in Road/Autonomous Vehicles

Publication September 2023

Objectives

- Integration of the **Galileo HAS** and the **Galileo OS-NMA**, following the published ICD in the receiver solution for autonomous vehicles
- **Sensor fusion of the GNSS information**, together with other data to achieve seamless navigation in challenging environments and assessment of the achieved performances
- Definition of performance requirements for the intended operation (automation level 4/5) according to the relevant standards

Up to **2 projects** to be awarded
Maximum budget: **3.0M€**

Foreseen results

- Galileo **OS-NMA** and Galileo **HAS** capable OBU
- Performance assessment against the intended operation level in laboratory and demonstration
- Contribution to relevant standardisation and proposal for evolution

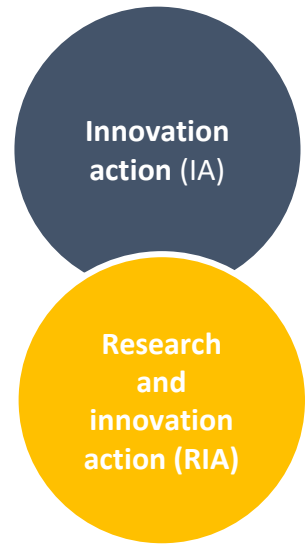
UPCOMING opportunities **HORIZON-EUSPA-2023-SPACE**

Deadline: February 2024



HORIZON EUROPE

Type of Action	Topic	Indicative budget (EUR mln)
IA	EGNSS - Transition towards a green, smart and more secure post-pandemic society	3.5
IA	EGNSS - Closing the gaps in mature, regulated and long lead markets	8
RIA	Copernicus-based applications for businesses and policy-making	7
RIA	Designing space-based downstream applications with international partners	6
IA	EU GOVSATCOM for a safer and more secure EU	10
Total budget:		34,5



Activities to produce plans and arrangements or **designs for new**, altered or **improved products**, processes or services.

Activities to **establish new knowledge** or to **explore the feasibility** of a new or improved technology, product, process, service or solution.

3,5
mEUR

EGNSS - Transition towards a green, smart and more secure post-pandemic society

TRL 7-9

The action aims to:

- Stimulate the development and use of commercial downstream solutions based on **synergies** between the EU space programme components and digital technology
- Foster the development of space technologies that improve the **quality of life** in Europe: efficient mobility, energy efficiency and environmental friendliness, green digital transition of the construction industry
- Exploit digitalisation and the **adaptation of business processes** in the post-pandemic environment in order to improve prospects of businesses
- Proposals can also target **personal solutions** such as personal assistance, healthcare, support to the elderly and city dashboards
- They can address the challenge of higher reliance on existing infrastructure, the increased use of remote resources and the associated **cyber-threats**

Innovation Action

For the full description of the topics please see the Horizon Europe 7. Work Programme 2023-2024





8
mEUR

HORIZON-EUSPA-2023-SPACE-01-42

EGNSS - Closing the gaps in mature, regulated and long lead markets

TRL 7-9



Broadening the reach of EGNSS by supporting its **adoption in long lead markets** including rail, maritime inland waterways, fisheries and aquaculture, road and automotive, and aviation.



- Development of industry-accepted **certification and standardization schemes** that exploit the use of EGNSS and its differentiators, as well as addressing certification bottlenecks



- **Rail safety critical applications** that support the rail network efficiency converging towards a pan-European EGNSS-based solution adoption

- **Road** and automotive market
- **EGNSS-supported operations** in coastal, harbour and **maritime** areas, including for energy production
- **Aviation**
 - **Integrations** of Dual Frequency Multi-constellation (DFMC) SBAS & Copernicus
 - **Drones' urban air mobility**, e.g. urban air deliveries through EGNSS supported by EO data
- Proposals could explore **synergies with Copernicus and/or GOVSATCOM**, addressing the certification and regulatory aspects that their use might bring

Innovation Action

For the full description of the topics please see the Horizon Europe 7. Work Programme 2023-2024



Photo: European Union

HORIZON-EUSPA-2023-SPACE-01-46

Designing space-based downstream applications with international partners

TRL 3-4

6
mEUR

- **Use of EGNSS and sharing of expertise** with public and/or private entities to introduce EU-space based solutions
- The **use of Copernicus** data, to develop jointly algorithms, services and/or products
- The **combined use of EGNSS and Copernicus** to develop innovative downstream applications
- **Create business-oriented partnerships** between European industry and international partners
- Exploit **integration of EO data with positioning data and ICT** (e.g. cloud computing) from international partner countries
- Proposals dealing with EGNSS are encouraged to **involve relevant organisations on the European side** (e.g. EASA, ESSP, EMSA)
- Participation of a partner from a country that has signed a Copernicus Cooperation Arrangement is required for Copernicus-based applications

Legal entities established in countries that have signed an administrative cooperation arrangement on Copernicus data access and Earth observation data exchange are exceptionally eligible for Union funding: United States, Australia, Ukraine, Chile, Colombia, Serbia, African Union member states, India and Brazil

For the full description of the topics please see the Horizon Europe 7. Work Programme 2023-2024

**Research &
Innovation Action**



¡THANK YOU!

Carmen Aguilera / EUSPA



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