EU SPACE

Galileo High Accuracy Service
OVERVIEW

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EUSPA
European Union Agency for the Space Programme

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- Galileo Services Portfolio
- Why the Galileo HAS
- What is the Galileo HAS
- Galileo HAS users and applications
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GAL Services driven by the users

- **EU Space Regulation:** Reg.(EU) No 2021/696 as defined by the EU Member States
- **User Needs!**
  - At the very core of EU Space Regulation and the Galileo Programme
  - Systematically monitored by EUSPA as Galileo Services Provider
  - Regularly addressed in the EU Space week and User Consultation Platform.

- Galileo Services Baseline: exploitation, services and operations are specified to address the user needs and ensure the service provision continuous improvement

Services Performance Monitoring	Services Delivery and User interfaces	Operability requirements	Maintainability requirements	System - Infrastructure Requirements

GAL Current Service Portfolio

OS

PRS

SAR

HAS

Current Services

New Services

Early Phases

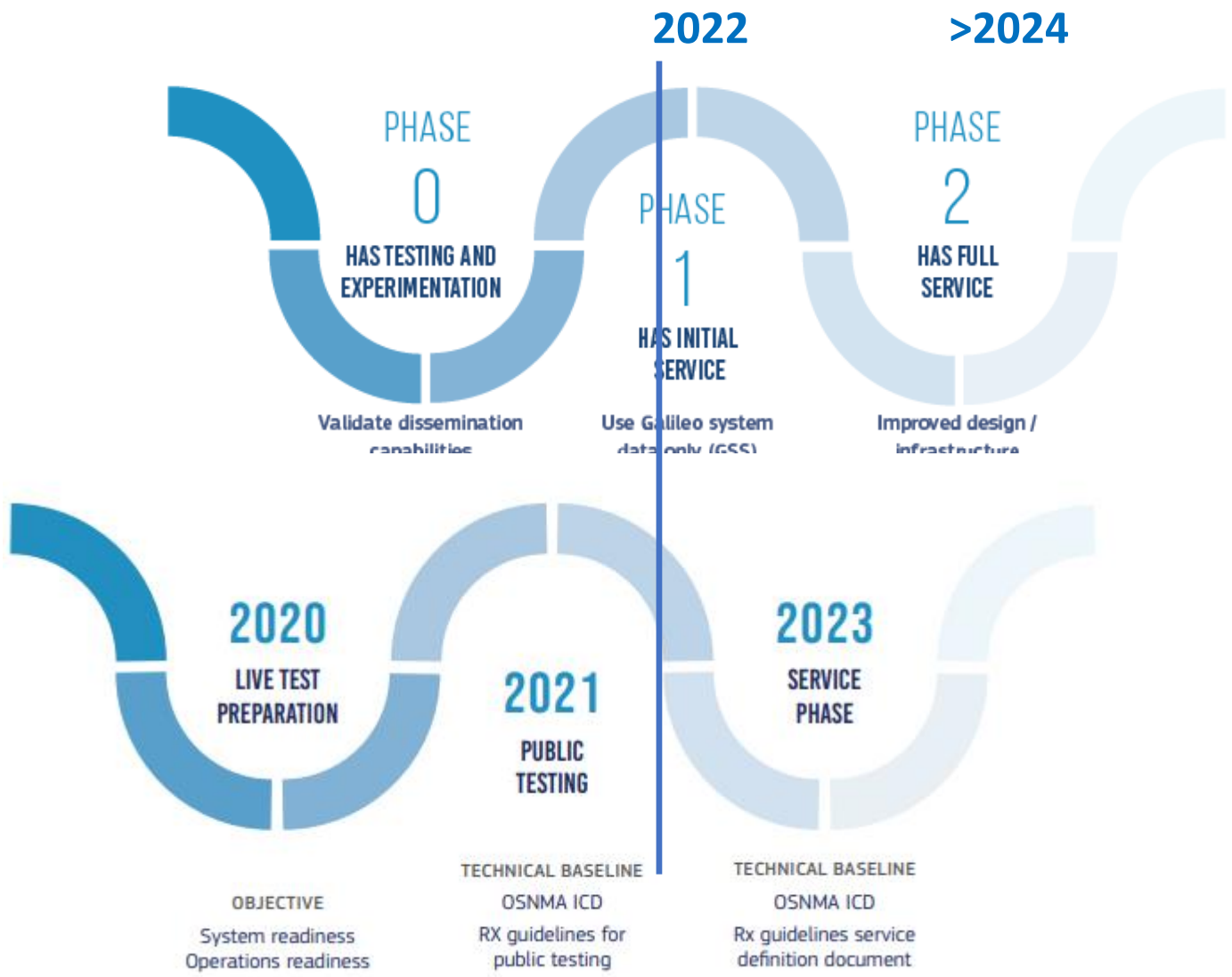
Incoming evolutions

New Galileo Services in the pipeline

HAS is there, OSNMA is coming…

HAS

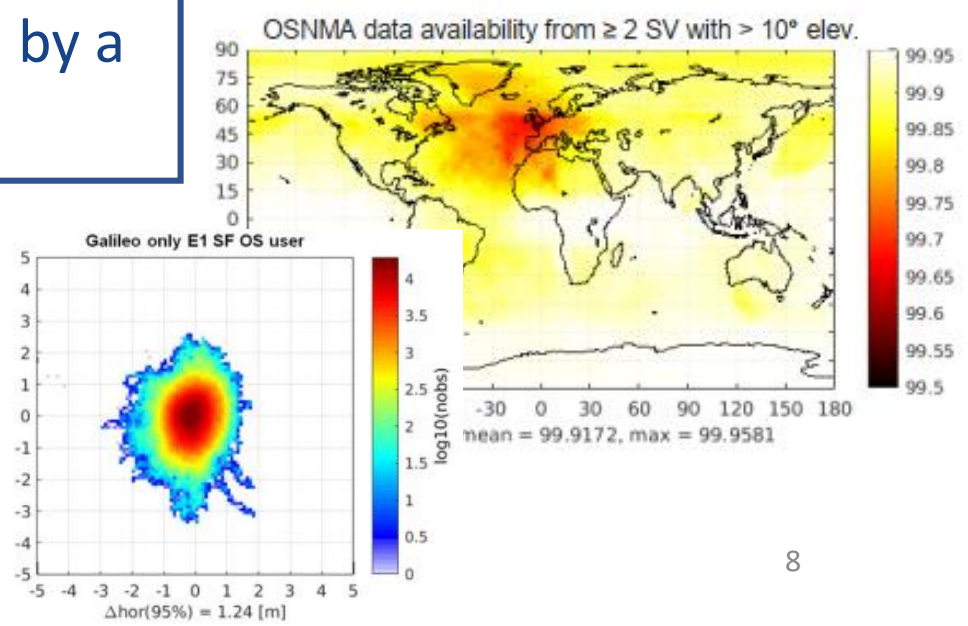
OSNMA



OSNMA is coming…

OSNMA

1st ever authentication test signal provided by a GNSS enabled now by Galileo worldwide



OSNMA Public Observation phase Status (since Nov 2021):

- Targeting RX manufacturers, apps developers and research LINK
- OSNMA SiS provided globally with very good availability

Galileo Service Portfolio evolution

- Galileo Services Portfolio evolution defined to follow the evolution of **the user needs and main trends:**
  - Multifrequency / multipurpose authentication capabilities
  - Autonomous vehicles (including drones)
  - Internet of things
  - Safety-critical and liability-critical transport
  - Critical infrastructure
- The Galileo **Service Portfolio is driving the Galileo G2 developments while ensuring:**

Service Continuity	Backward Compatibility	Lessons Learned

Services Planned Evolution Highlights

Services Planned Evolution Highlights

- **OS (Navigation)**
- **Timing Service**
- **Contribution to SoL (**EGNOSv3, ARAIM)
- Quasi pilot signal
- Space Service Volume

OS

- **Improved performance**

PRS

- **Improved location accuracy** (new beacons), RLS latency
- On-demand **Remote Beacon activation**
- **Advanced services**, TWC, DPS

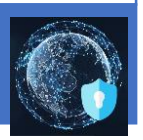
SAR

- **On-demand broadcast of emergency alerts** to population in minutes over target area
- **Authenticated**, latency 1-10 min

EWS

- **OS Ranging Authentication**
- **OSNMA**: Navigation Message authentication

OS-AUTH



- **Range and Data Authentication**
- Improved **robustness**

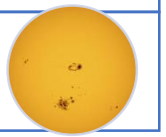
SAS

- **SL1: Improved accuracy** (sub-dm)
- **SL2: Impr. Convergence** in EU (<100 s)

HAS

- **Monitoring and forecast of ionospheric activity**
- Contribution to the global Iono Prediction ecosystem

CIP



Galileo Services Documentation

The GSC is the portal making available to the user communities the Galileo Services reference documents, performance reports and service information. Check it out! GSC webpage

Galileo – **Open Service**
Service Definition Doc

Galileo – **Open Service**
SiS Interface Control Doc

Iono Correction Algorithm for Gal. **OS** Single Frequency Users

Galileo – **Search and Rescue**
Service Def. Document

Galileo – **High Acc. Service**
SiS Interface Control Doc

Galileo – **High Accuracy Service** Information Note

OSNMA Public Observation Documents

Galileo – **OSNMA**
SiS Interface Control Doc for Test Phase

Galileo – **OSNMA** Information Note

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Why the Galileo HAS

Official Journal of the European Union

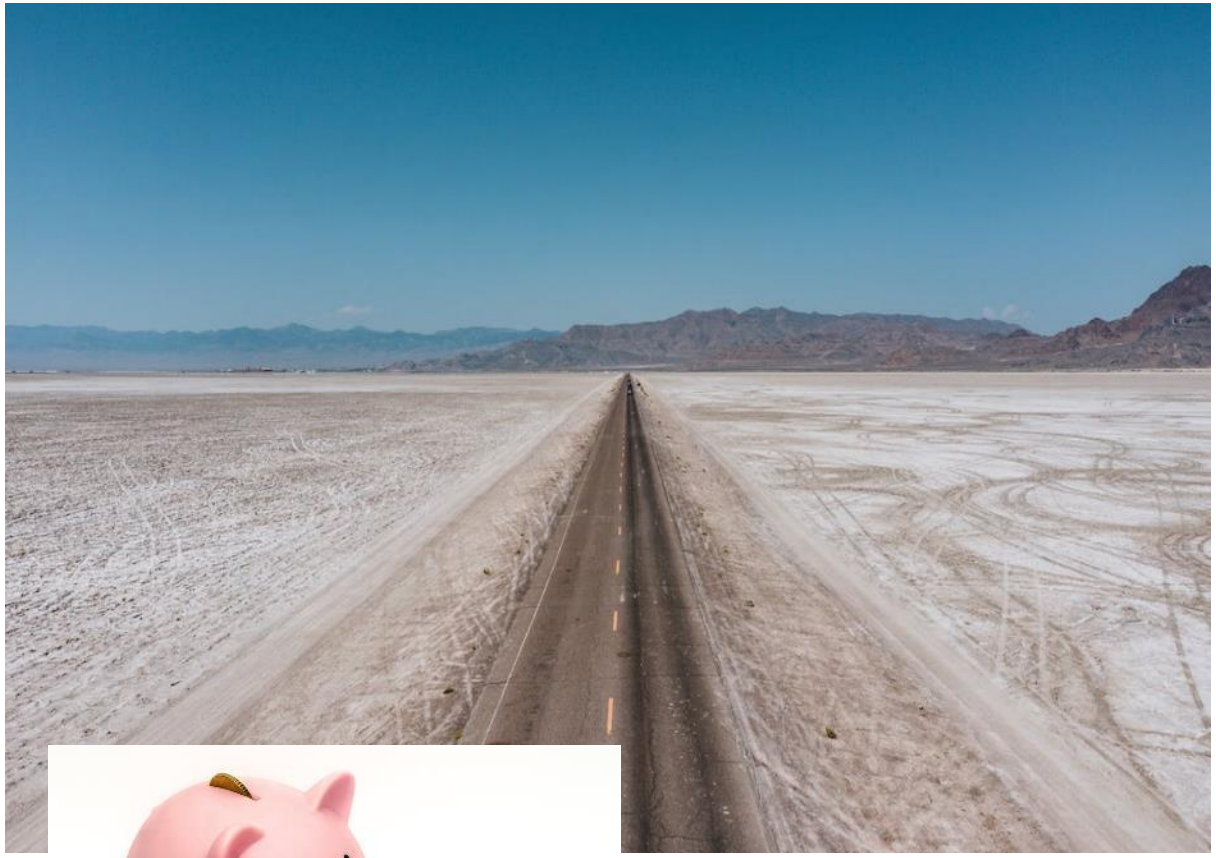

L 62/34 EN Official Journal of the European Union 5.3.2018

COMMISSION IMPLEMENTING DECISION (EU) 2018/321

of 2 March 2018

amending Implementing Decision (EU) 2017/224 setting out the technical and operational specifications allowing the commercial service offered by the system established under the Galileo programme to fulfil the function referred to in Article 2(4)(c) of Regulation (EU) No 1285/2013 of the European Parliament and of the Council

- March 2018: EU Decision to provide Galileo HAS for free, with a target 20-cm accuracy. But why?
- Follows a natural GNSS trend
- Part of an ecosystem, yet first of its kind: global, free, 24/7. And standalone
- Meets user demands
- Leaves room for classic commercial applications and user level innovation: cm/mm-level applications, PPP integrity…
- Provided with existing Galileo infrastructure



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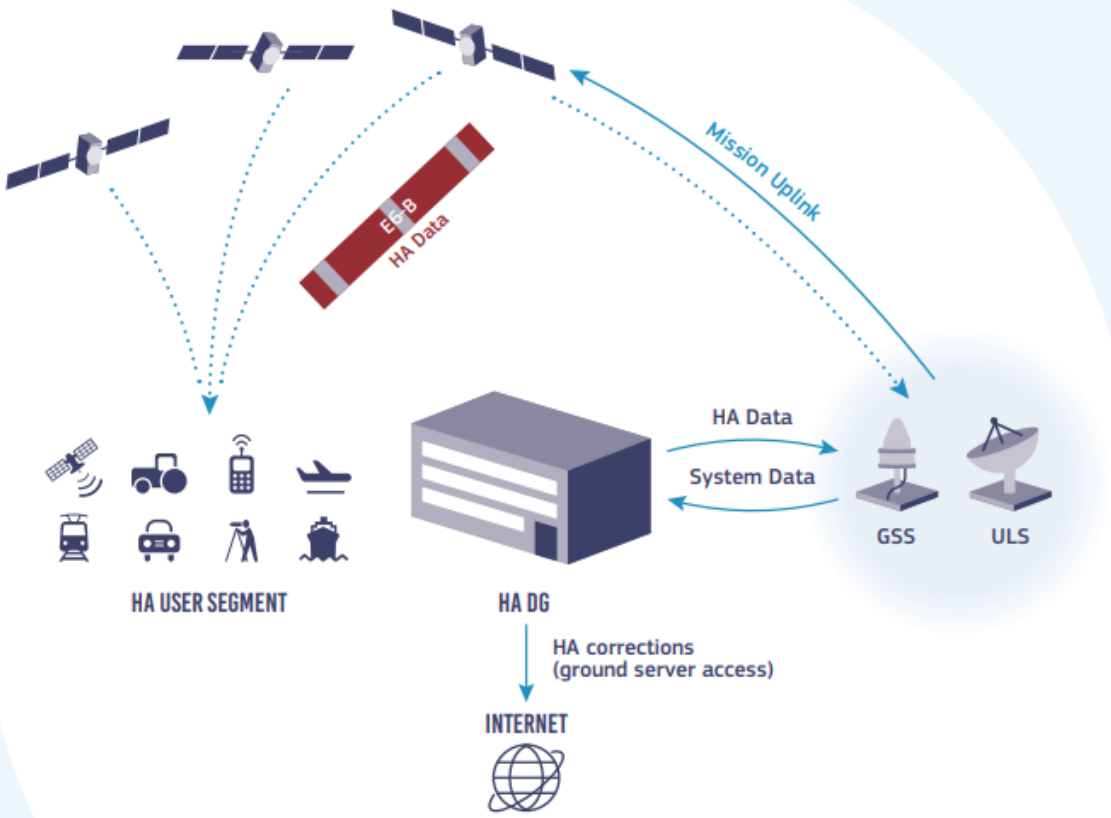
What is the Galileo HAS

- Galileo HAS provides precise corrections for satellite orbit, clock and signal biases
- Galileo HAS corrections distributed via
  - Galileo satellites, E6-B signal (1278.75 MHz)
  - Internet
- Typical accuracy in the decimetre level (after convergence), with Precise Point Positioning (PPP) receivers
- (Almost*) global coverage and free



**global coverage of corrections but no global performance commitment yet*

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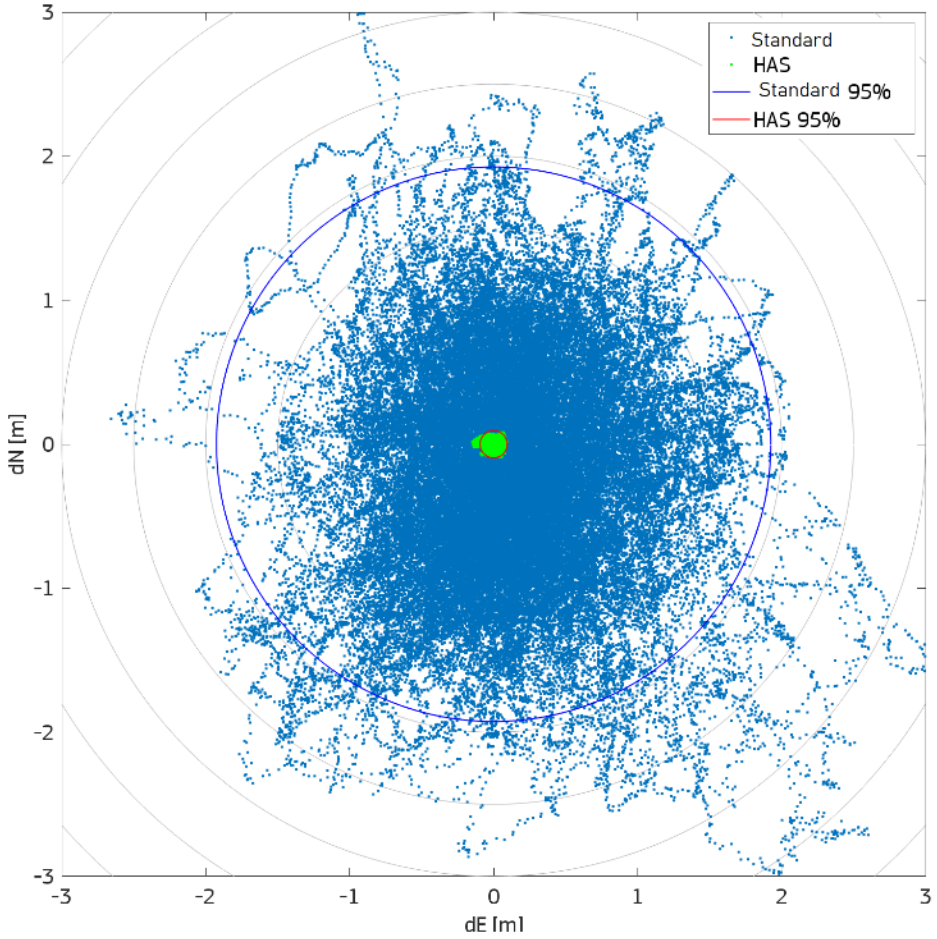


Galileo/GPS single epoch standard positioning vs. HAS positioning
Horizonal position error, JRC, Ispra (IT), 7/Sept/2023
(Gal E1-E5b/GPS L1CA-L2C single epoch solution vs.HAS float solution)

Standard horizontal accuracy 95%: 1.925 m

HAS horizontal accuracy 95%: 0.094 m

What is HAS – Ground Infrastructure

GNSS Service Center / HA data generator

Service development and validation

Operations and Maintenance

Security Accreditation

Service Provision – user's interface

14+1 Galileo sensor stations

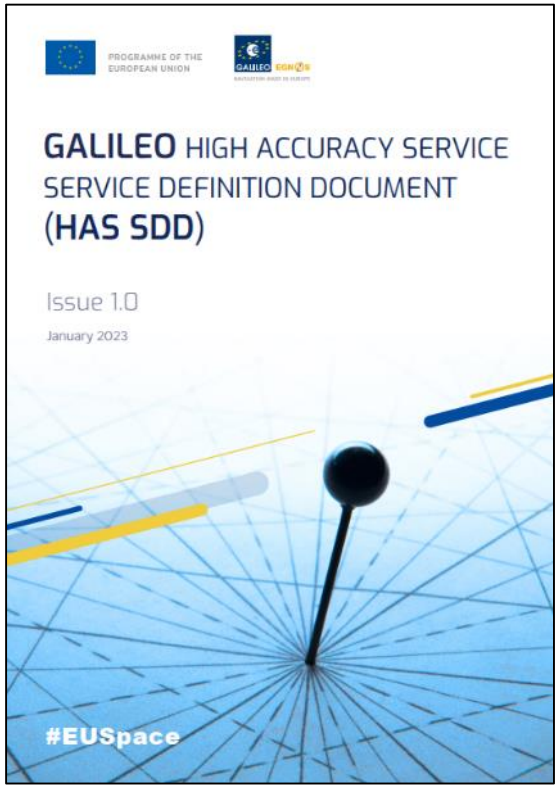
Ground Control Centers

Up-Link Stations

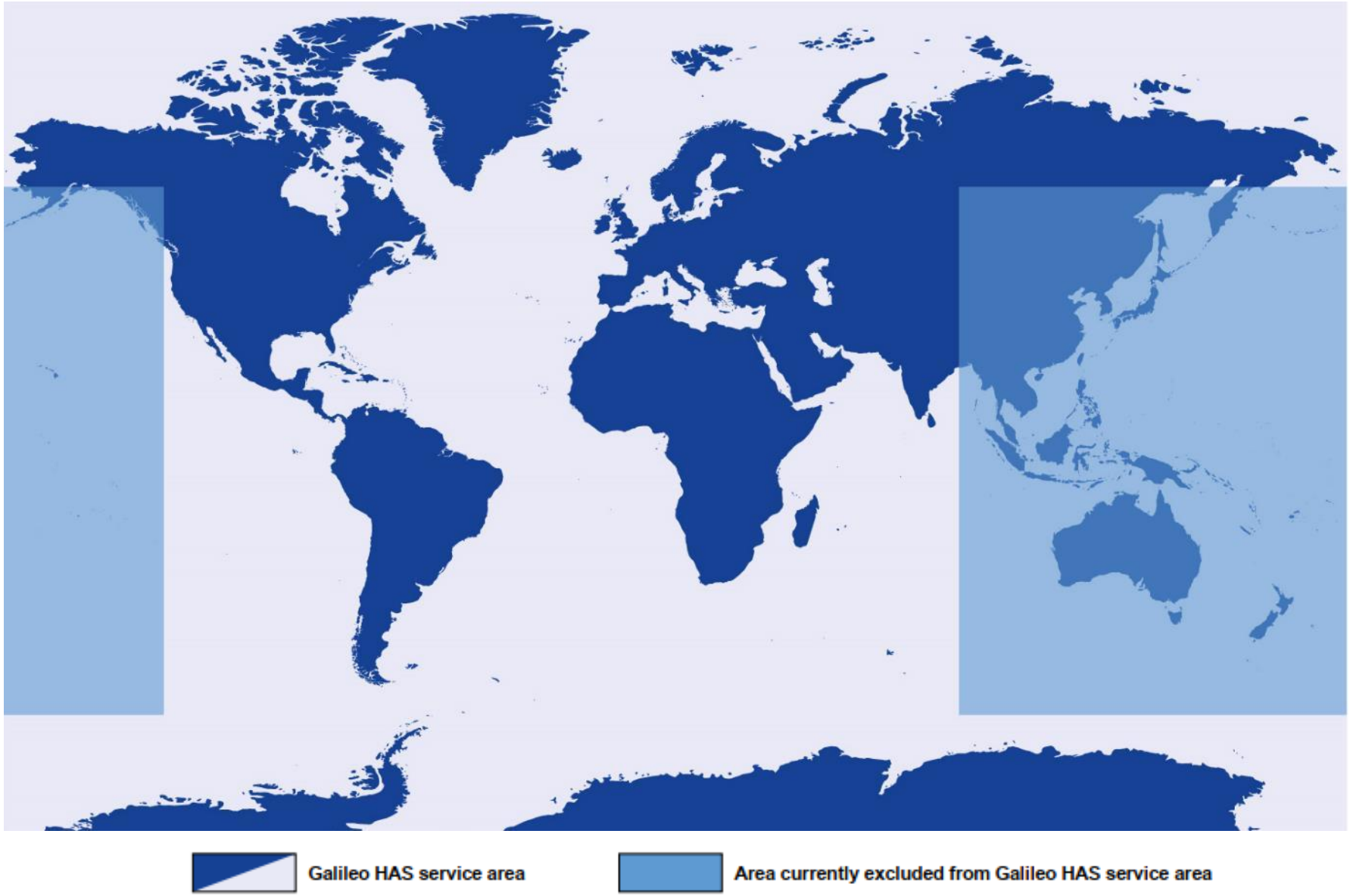
Space segment

Support to experimentation and Validation

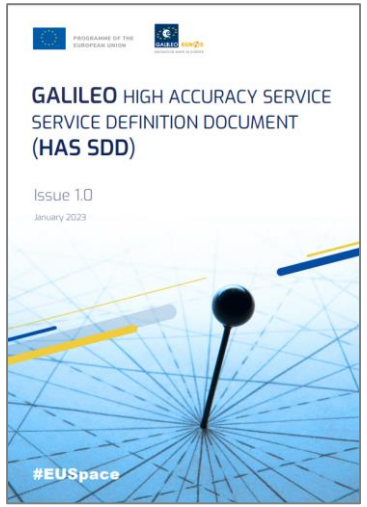
What is HAS – Initial Service Area



European Union Agency for the Space Programme (EUSPA), *HAS SDD [Online]: https://www.gsc-europa.eu/sites/default/files/sites/all/files/Galileo_HAS_SDD.pdf*

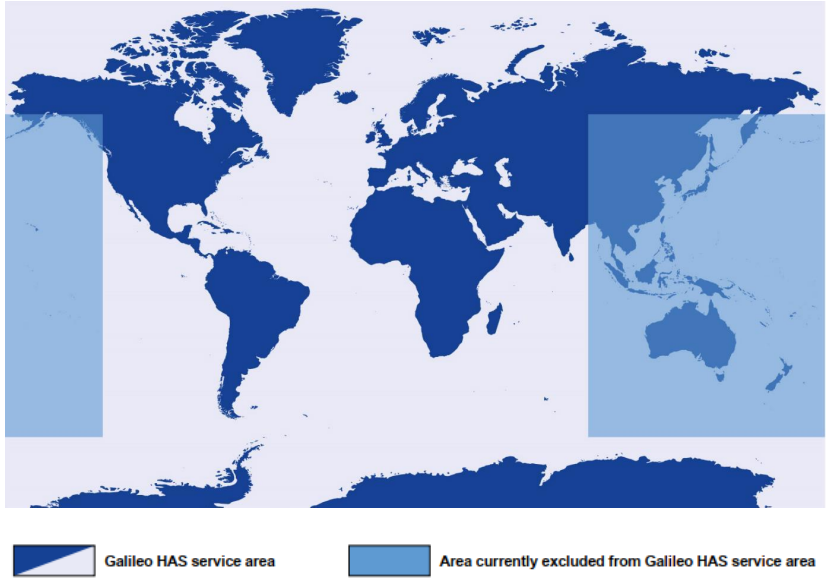


What is HAS - Initial Service Performance



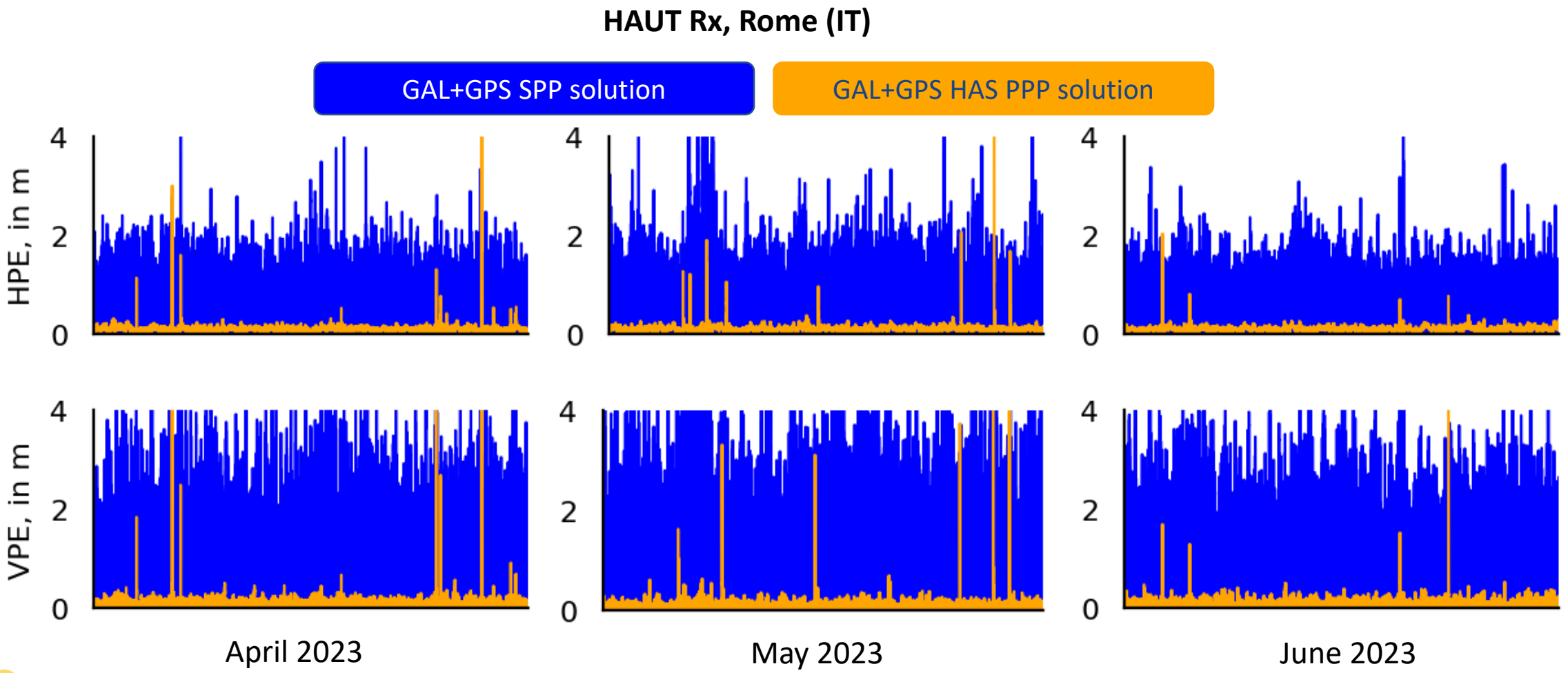
- **Full compliance to HAS SDD MPLs** since HAS service declaration.

HAS MPLs	target	2023 February	March	April	May	June
accuracy of HAS corrections, in m						
orbit						
Galileo	≤ 0.20	■■	■■	■■	■■	■■
GPS	≤ 0.33	■■	■■	■■	■■	■■
clock						
Galileo	≤ 0.12	■■	■■	■■	■■	■■
GPS	≤ 0.15	■■	■■	■■	■■	■■
code bias						
Galileo	≤ 0.50	■■	■■	■■	■■	■■
GPS	≤ 0.50	■■	■■	■■	■■	■■
availability of HAS corrections, in %						
Galileo only (≥ 5 corrected satellites)	≥ 87	■■	■■	■■	■■	■■
Galileo and GPS (≥ 8 corrected satellites)	≥ 95	■■	■■	■■	■■	■■
service coverage, in %						
availability of corrections	100	■■	■■	■■	■■	■■
■■	SiS Dissemination | IDD Dissemination					



- **HAS Quarterly Performance Reports** regularly published at the GSC website (https://www.gsc-europa.eu/electronic-library/performance-reports/galileo-high-accuracy-service-has)

What is HAS - Initial Service Performance



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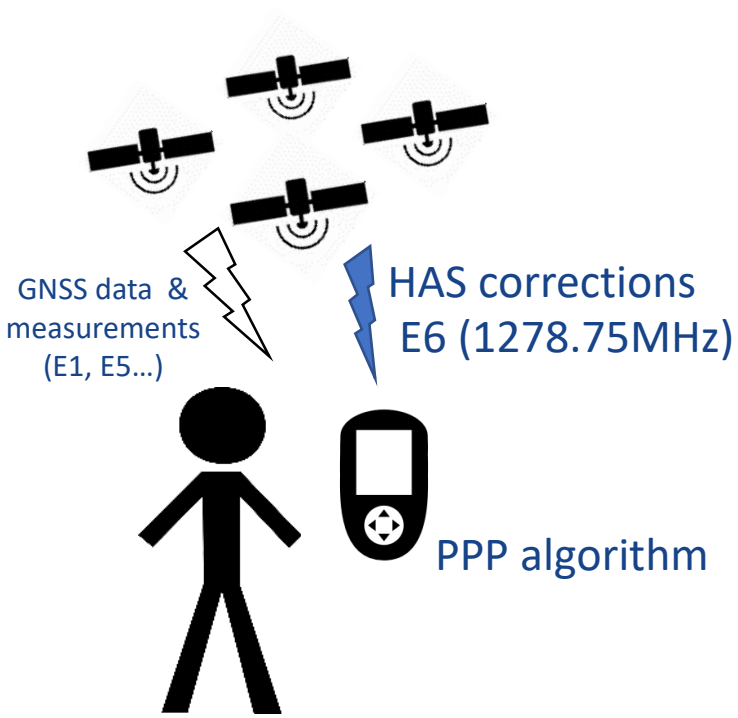
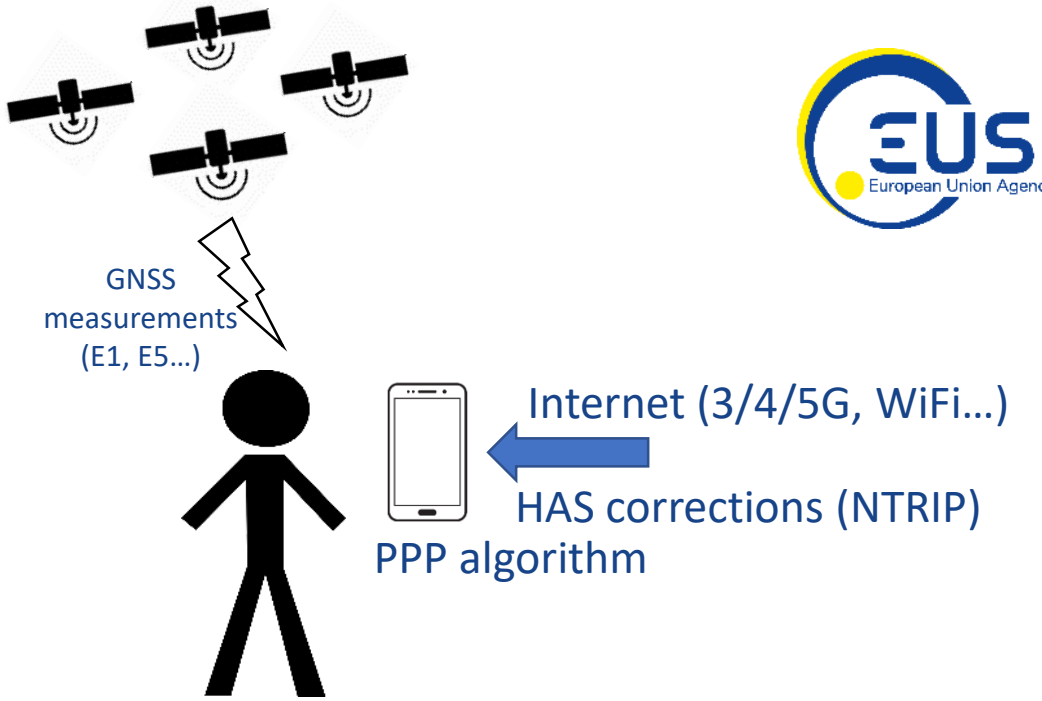
Galileo HAS Users and Applications

What does a user need to benefit from HAS?



Standalone mode
(Sat Signals in Space)

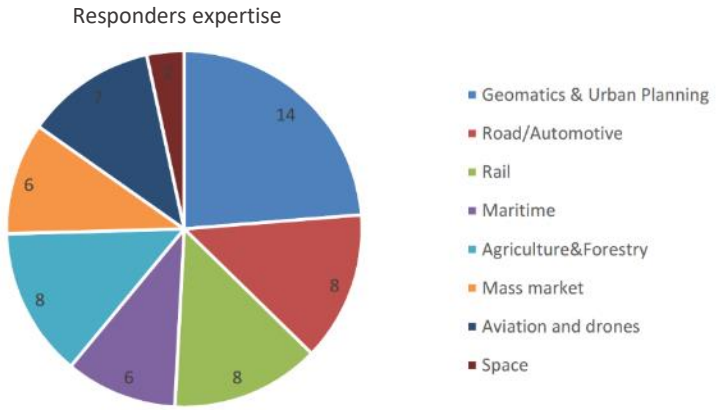


Assisted mode
(HAS via internet)

Users will need an GNSS (Gal/GPS) E6 capable or connected RX with a PPP algorithm

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:

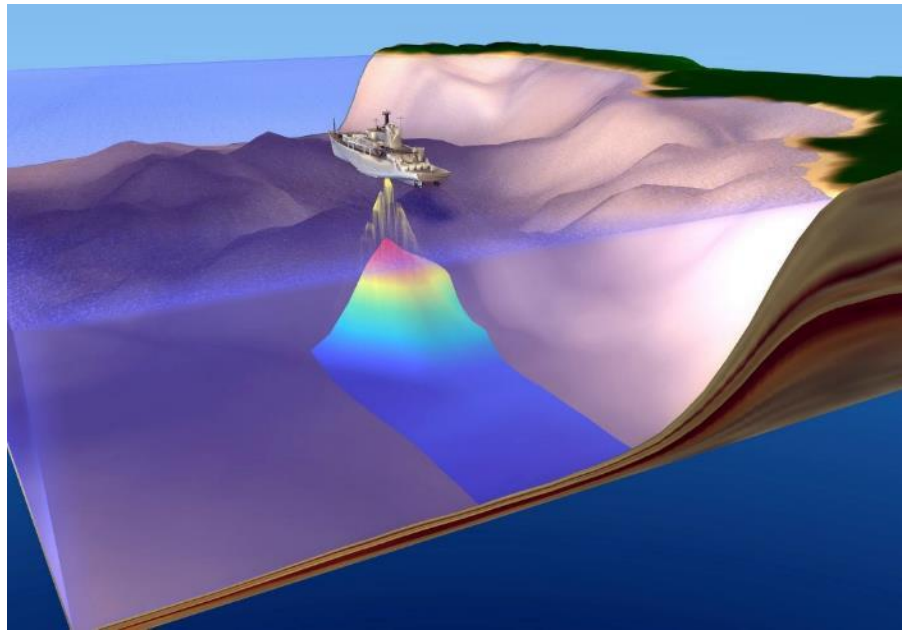


Barriers	Incentives
Accuracy	Worldwide coverage
Convergence times	Free-of-charge
Availability of E6 receivers	Cellular networks independence

HAS 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).

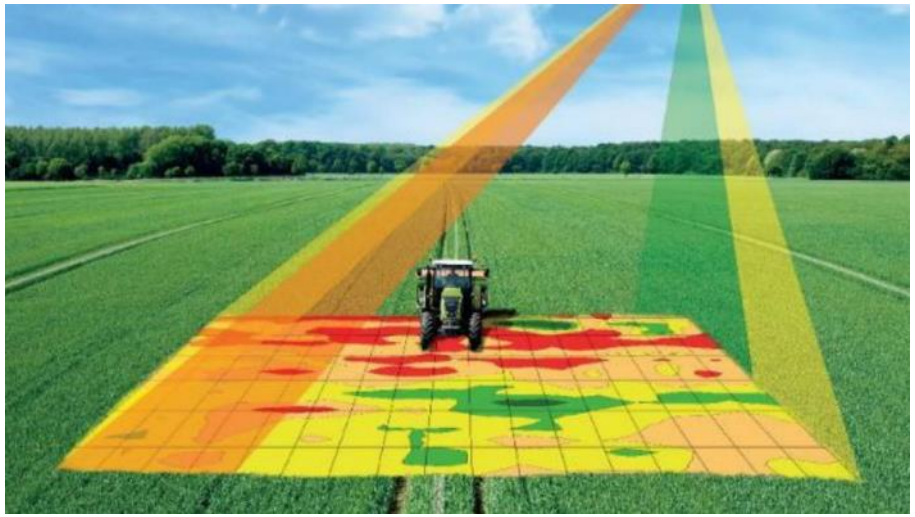
HAS supports innovative aplications in mobility



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

HAS market readiness development

- **EU is supporting the early development of HAS prototype RXs since years:**
  - **F.E projects**: Fantastic, eMAPs, ERASMO, ACCURATE… 9 projects
  - **H2020 projects**: GISCAD-OV, PrepareShips, ESRIUM… 5 projects
  - **HAUT**: HAS reference algorithm and user terminal used for the HAS Service Validation.
  - **Key stakeholders** were involved in the **HAS testing** in 2021/22 to anticipate the development of their HAS prototypes
- **GNSS E1/E5/E6 Signal or Internet connected receivers are already available**
- HAS RXs will become commercially available progressively after the HAS Service Declaration **based on PPP commercial solutions** in the market since years

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

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

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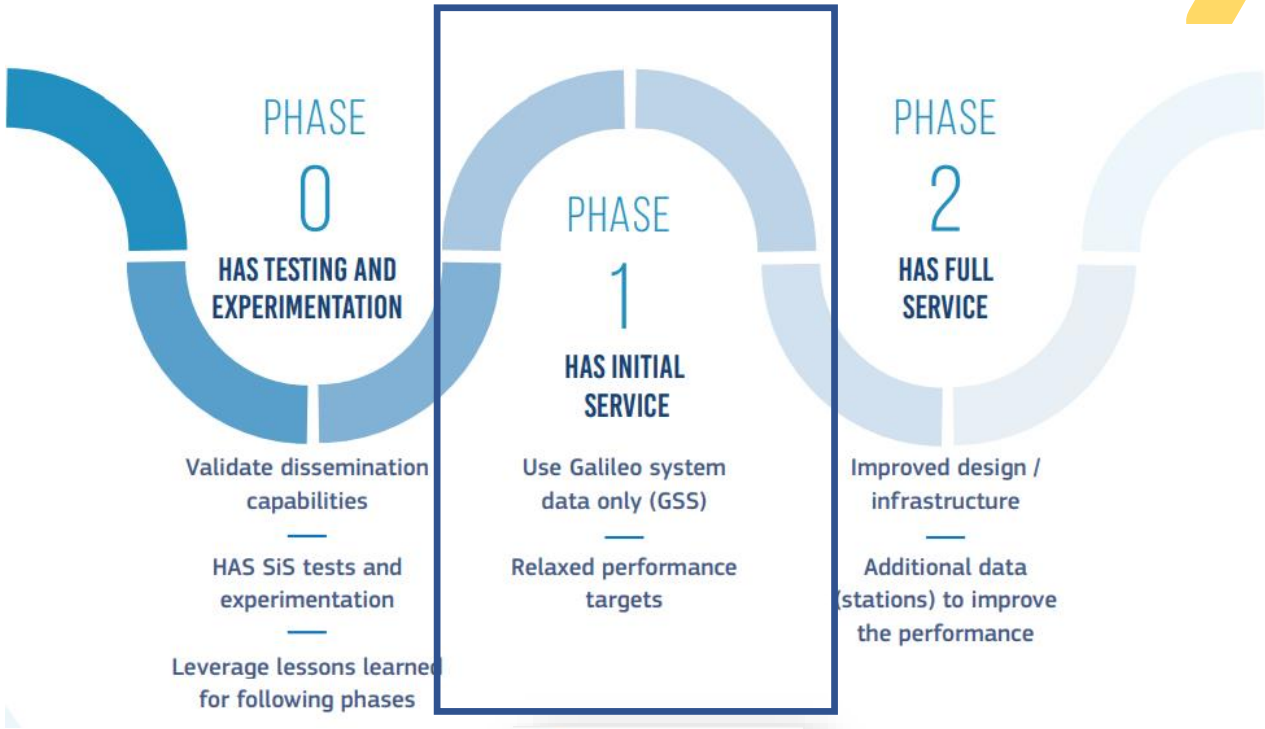
Galileo HAS
What comes next?

- **Short-term: use it!**
  - User segment development
    - More HAS-enabled receivers
    - HAS R&D actions
    - HAS Reference Algorithm publication
  - HAS based applications development

- **Mid / long-term: HAS Full Service**
  - Increased global performance (e.g. better accuracy)
  - Faster positioning in EU (atmospheric corrections)
  - HAS authentication and error characterization



https://www.gsc-europa.eu/electronic-library/programme-reference-documents

Bonus content: A HAS Showcase…


THE FUTURE
European GNSS Service Center
And many more…

EU SPACE

Thank you for your attention!

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