



EU SPACE

# Galileo High Accuracy Service

ICG PPP Interoperability Task Force  
2nd Workshop

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European Commission

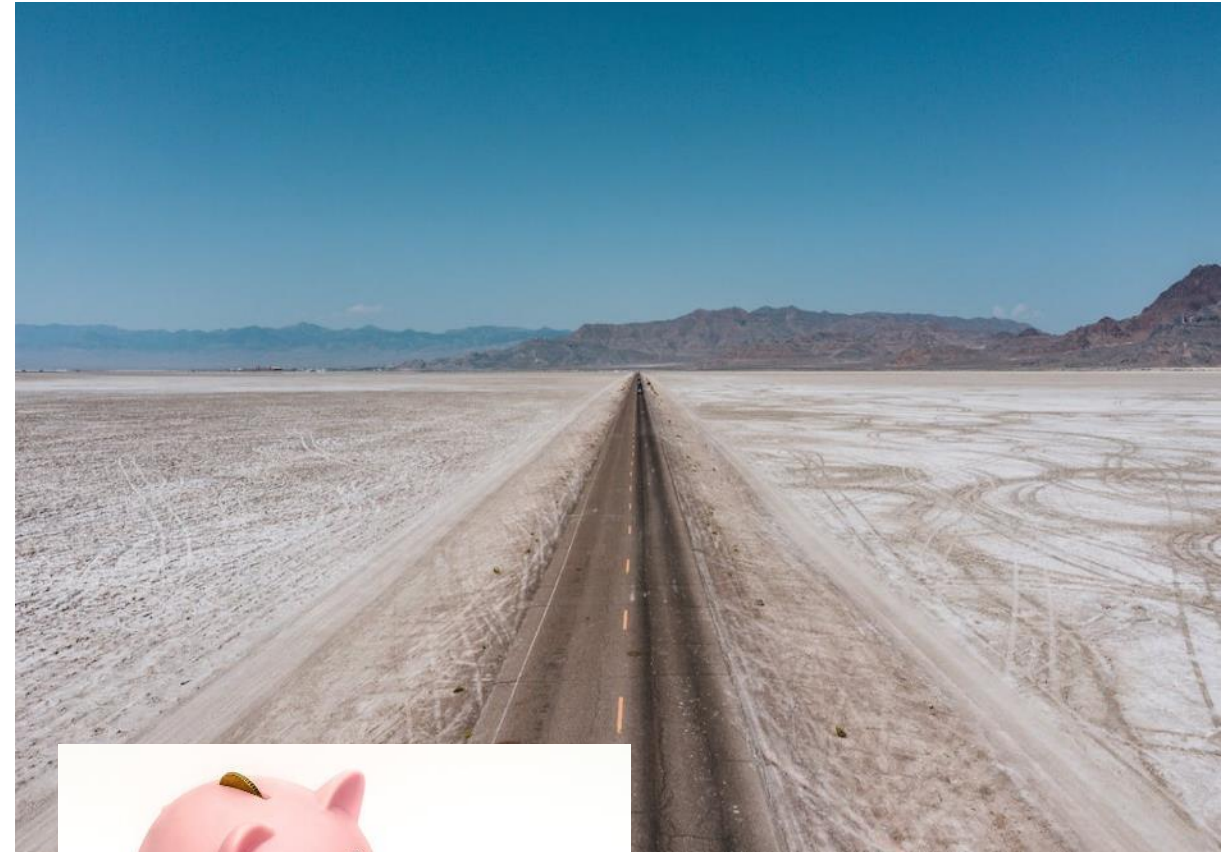
# Table of contents

- Why the Galileo HAS
- What is the Galileo HAS
- Galileo HAS users and applications
- Galileo HAS: What comes next

# Why the Galileo HAS

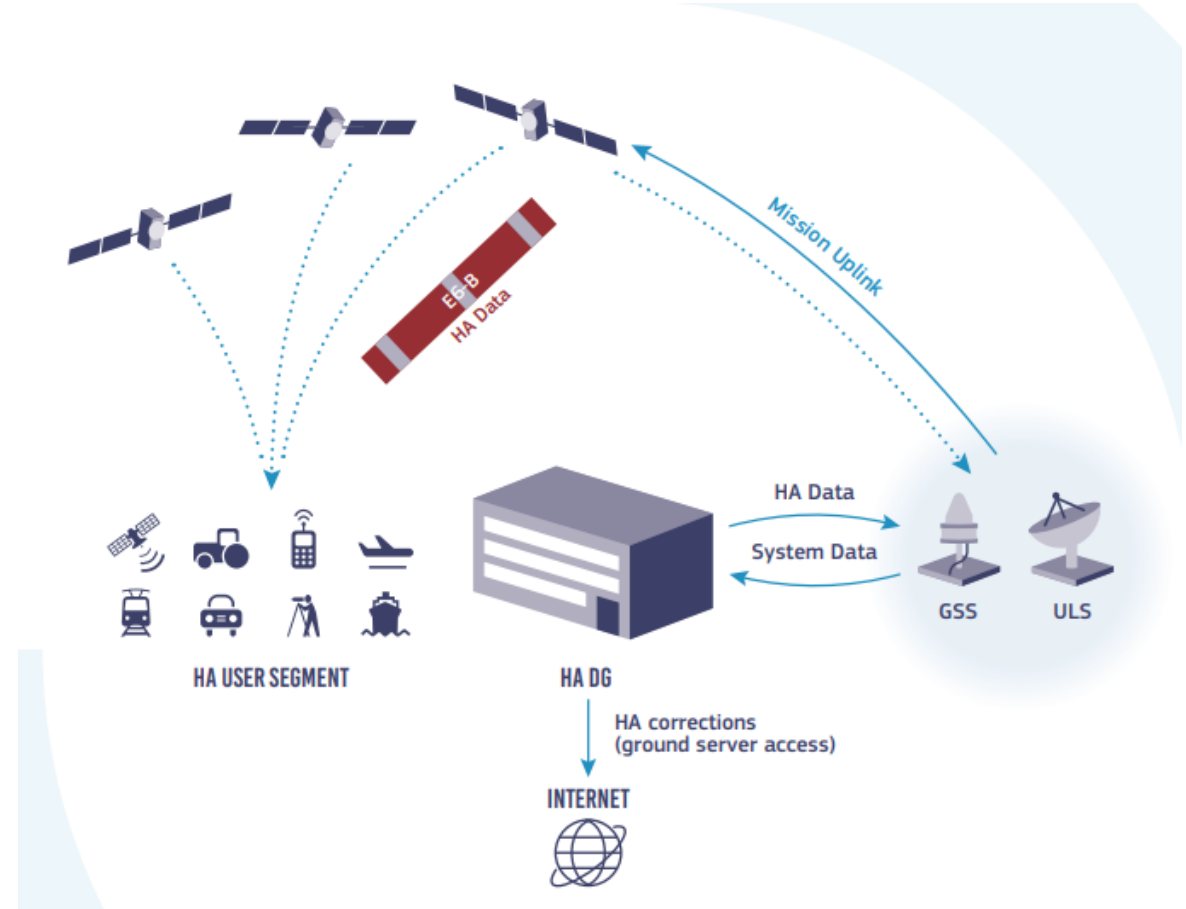


- March 2018: EU Decision to provide Galileo HAS for free, with a target 20-cm accuracy. But why?
- Follows a natural GNSS trend
- Part of an ecosystem, yet first of its kind: global, free, 24/7. And standalone
- Meets user demands
- Leaves room for classic commercial applications and user level innovation: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



# What is the Galileo HAS

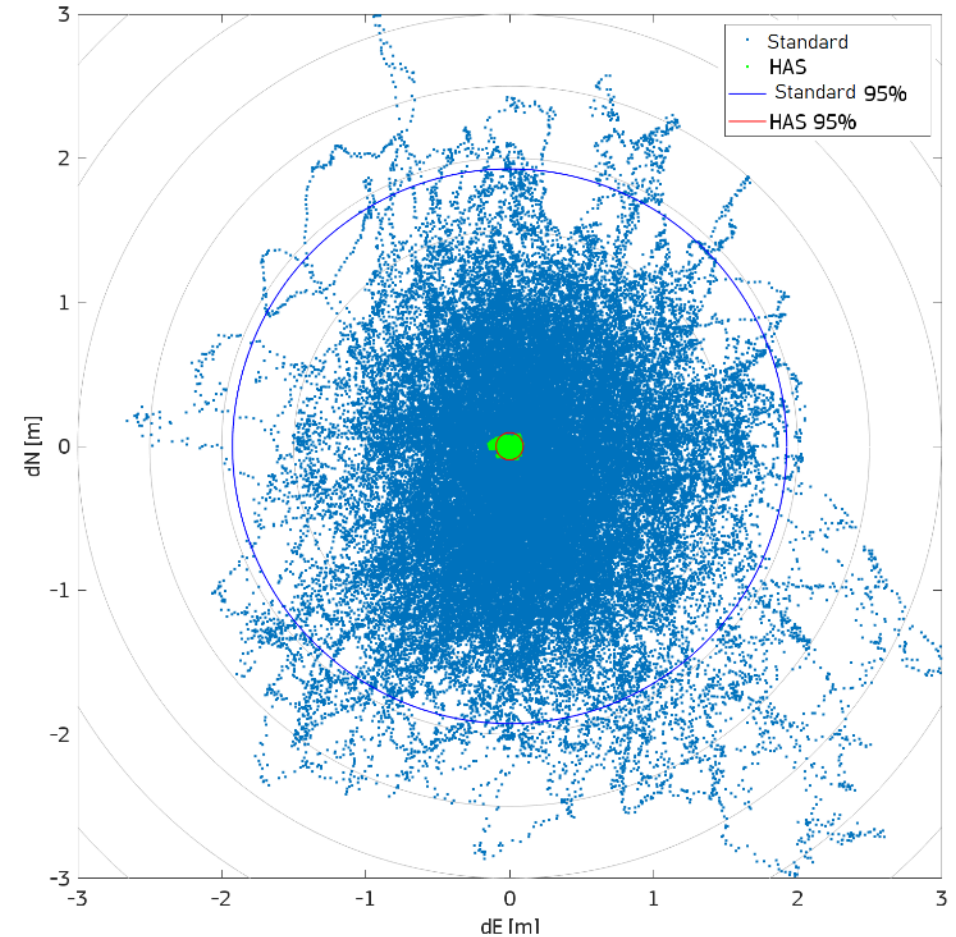
- Galileo HAS provides precise corrections for satellite orbit, clock and signal biases
- Galileo HAS corrections distributed via
  - Galileo satellites, E6-B signal (1278.75 MHz)
  - Internet
- Typical accuracy in the decimetre level (after convergence), with Precise Point Positioning (PPP) receivers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





Horizontal 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**

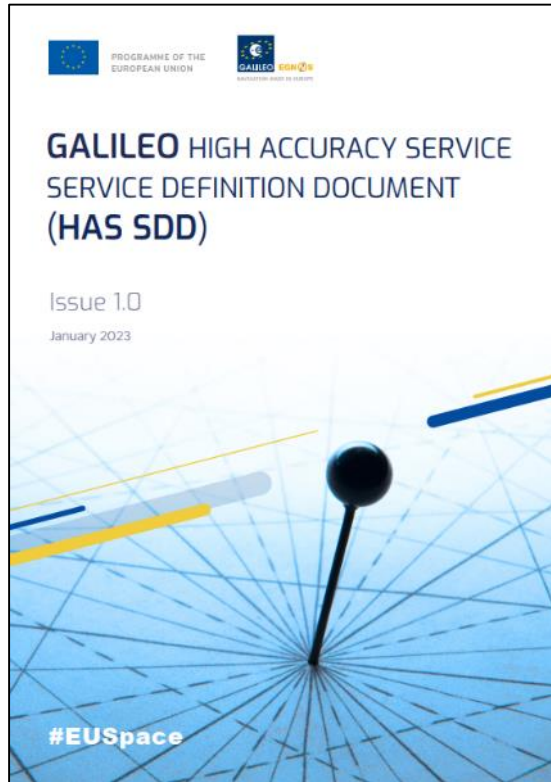
# What is the HAS – Ground Infrastructure

-  GNSS Service Center / HA data generator
- Service development and validation
- Operations and Maintenance
- Security Accreditation
- Service Provision – user's interface

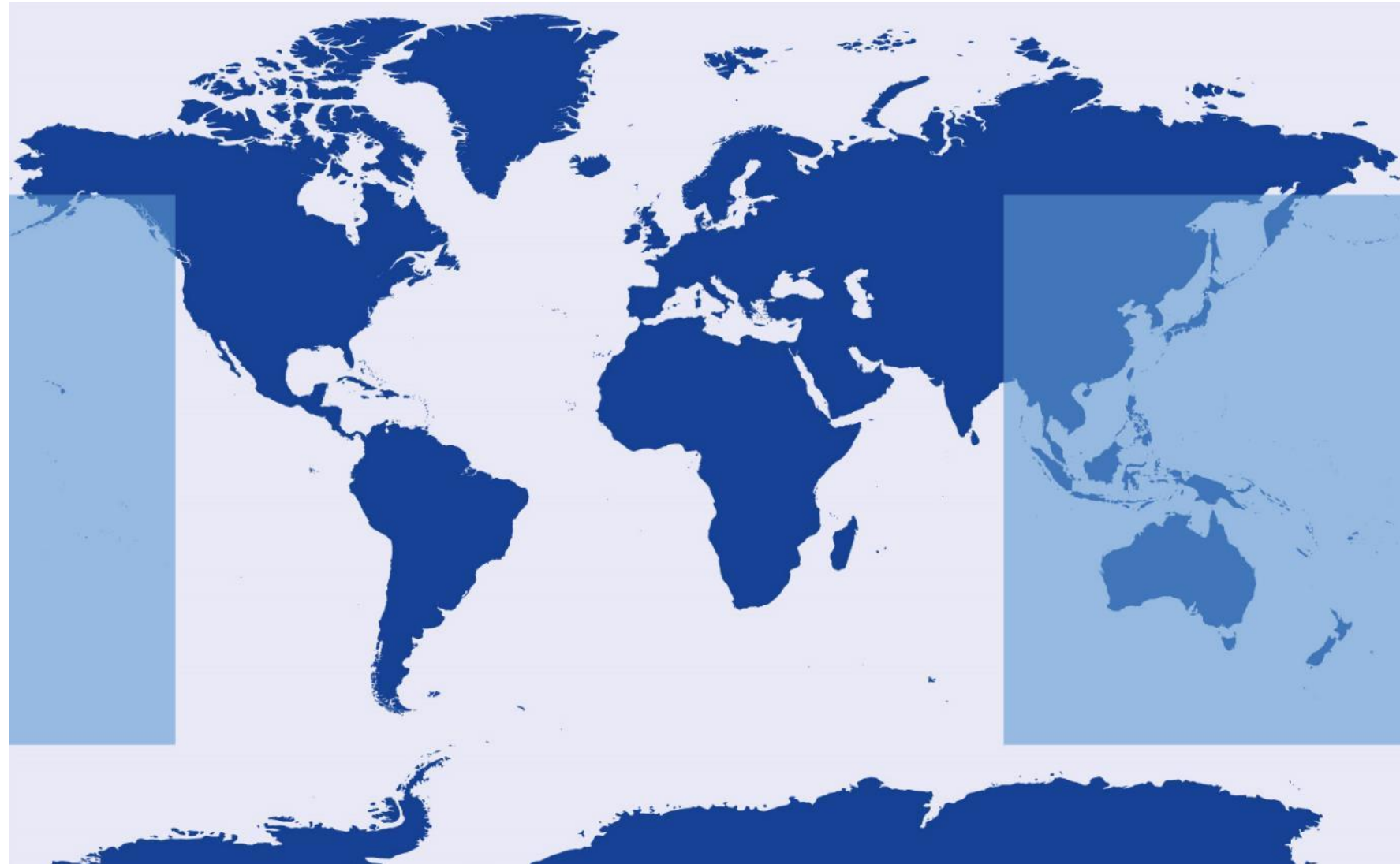
-  14+1 Galileo sensor stations
-  Ground Control Centers
-  Up-Link Stations
-  Space segment
- Support to experimentation and Validation



# 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](https://www.gsc-europa.eu/sites/default/files/sites/all/files/Galileo_HAS_SDD.pdf)



Galileo HAS service area



Area currently excluded from Galileo HAS service area

# What is HAS - Initial Performance

Product/DOY		244	245	246	247	248	Avg	
Galileo Corrections Accuracy	Orbits (cm)	RMS-1D	6.5	6.1	5.8	5.1	5.6	5.8
		RMS-3D P95	18.5	13.2	14.6	12.9	15.6	15.0
	Clocks (cm)	SIGMA	3.7	4.2	3.5	3.6	3.9	3.8
		RMS P95	9.6	8.3	9.3	8.6	8.0	8.7
	Code Bias (cm)*	RMS P95: C1C	12.0	10.9	21.7	9.6	10.4	12.9
		RMS P95: C5Q	11.5	10.7	21.1	8.9	9.4	12.3
		RMS P95: C7Q	11.5	10.7	21.0	9.0	9.3	12.3
		RMS P95: C6C	11.1	10.2	20.9	8.7	9.2	12.0
GPS corrections accuracy	Orbits (cm)	RMS-1D	5.1	5	5	4.9	5.2	5.0
		RMS-3D P95	10.7	13.5	11.4	10.7	10.8	11.4
	Clocks (cm)	SIGMA	6.4	6.3	6.6	7.3	7.6	6.8
		RMS P95	17.6	18.0	19.0	24.7	19.2	19.7
	Code Bias (cm)*	RMS P95: C1C	13.7	15.8	13.0	18.3	14.2	15.0
		RMS P95: C2P	13.7	15.8	12.9	18.2	13.9	14.9
GAL & GPS Corr. Availability	Orbits (%) Mean	96.0	97.0	98.2	98.8	99	97.8	
	Clock (%) Mean	93.5	94.3	93.2	94.3	91.0	93.3	
	Code bias (%) Mean	100	100	100	100	100	100	

TABLE 1 HAS corrections performance (period: September 1, 2022 (DOY=244) to September 5, 2022 (DOY=248)).

\*Code bias accuracy after HAS declaration should be below 10 cm, 95%.



	Errors RMS (cm)			Errors P95 (cm)	
	North	East	Height	Horizontal	Vertical
Europe & Africa					
SPTR	4.5	6.6	13.8	19.5	26.5
ROBU	5.7	6.6	14.0	17.3	26.8
SWOJ	6.5	6.1	14.6	13.5	28.3
NAWI	4.0	5.3	14.4	18.1	25.3
America	North	East	Height	Horizontal	Vertical
USNA	6.0	8.3	17.5	19.8	32.9
CABU	6.1	9.0	21.9	21.4	38.1
CHSA	8.8	13.7	24.0	26.5	36.1
FRTA	9.1	9.7	24.2	27.0	40.7
Asia	North	East	Height	Horizontal	Vertical
INKO	5.8	8.7	21.8	19.1	35.7
TATA	8.6	15.9	27.0	33.1	52.2

TABLE 2 Summary of HAS positioning performance results. Period: 8/31/22 to 9/5/2022.



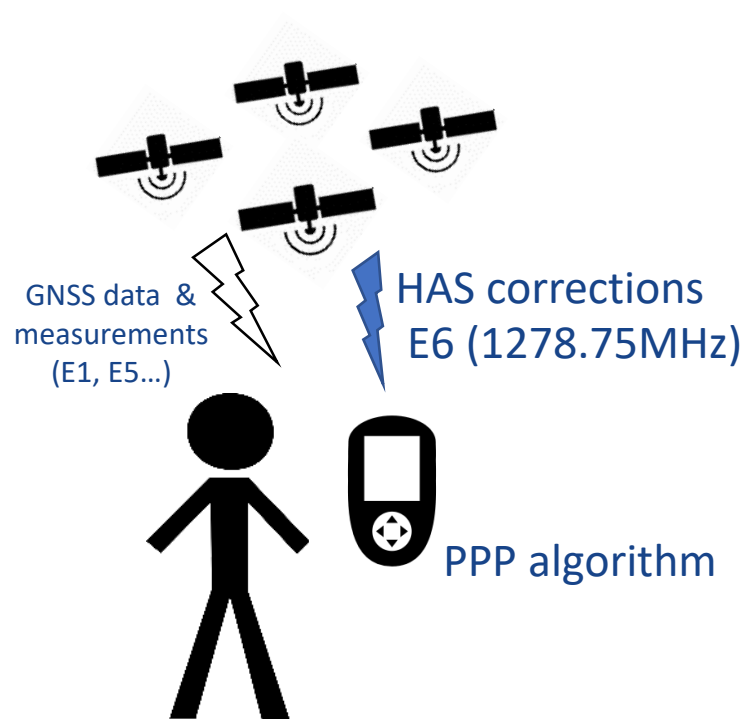
# Galileo HAS Users and Applications

- Galileo HAS addresses both traditional and emerging markets and a myriad of applications
- It will feed innovative applications in transport, agriculture, geodesy, entertainment and many other sectors

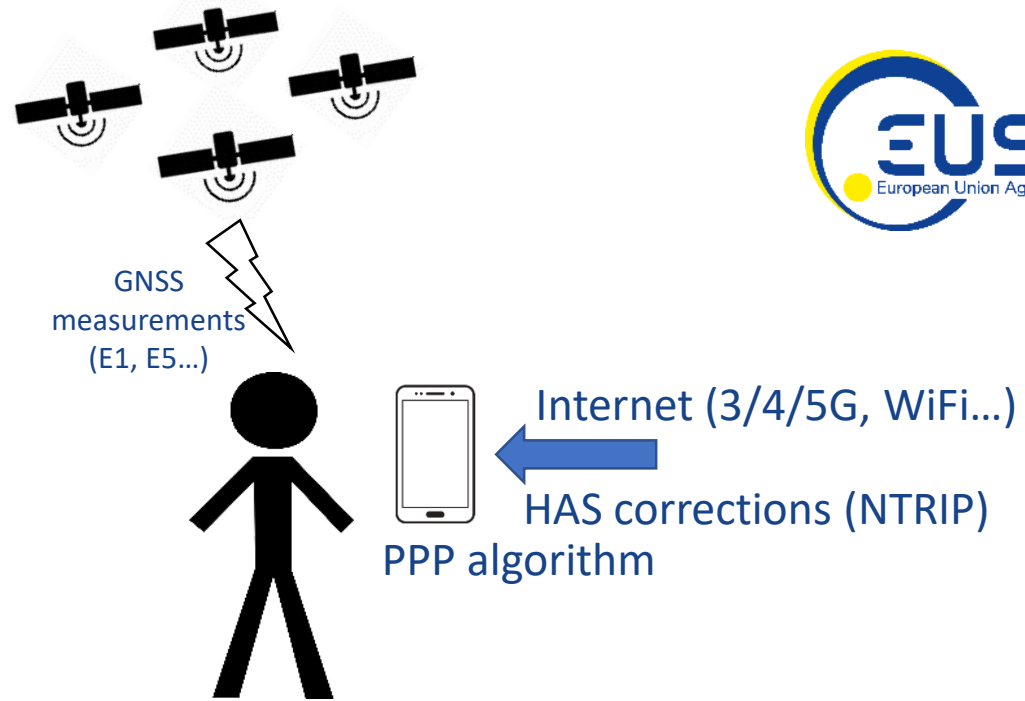


# Galileo HAS Users and Applications

## 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**

# Galileo HAS Users and Applications

- **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

# Galileo HAS

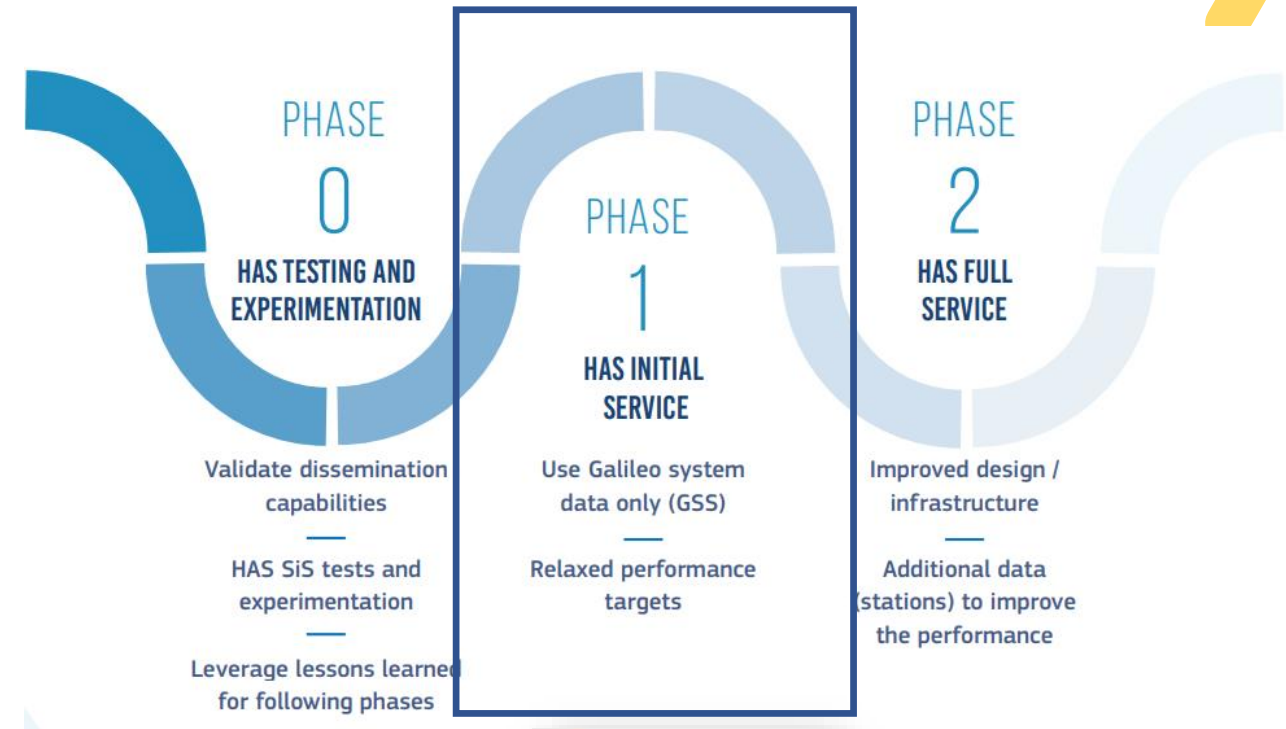
## What comes next?

### ▪ 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





THE FUTURE

RESEARCH AND RESCUE SERVICE

European GNSS Service Center

And many more...



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*(based on EUSPA/EC Galileo HAS Initial Service Declaration presentation)*