FIG WORKING WEEK 2019

22–26 April, Hanoi, Vietnam

"Geospatial Information for a Smarter Life and Environmental Resilience"

ORGANISED BY FIG

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BELS+ Special Session

”Galileo: status and innovative solutions for precise positioning”

Galileo: Status and Perspectives

Dr Pavlina Nikolova,
European Commission
EU Satellite Navigation Programmes


European
Commission
1- Galileo
2- EGNOS

Galileo is the European GNSS offering a wide range of services

- Freely accessible service for positioning, timing and navigation message authentication

- **Encrypted service** designed for **greater robustness** and **higher availability**

- Assists **locating people in distress** and **confirms** that **help is on the way**

- **Freely accessible high accuracy** positioning service

- Authentication service based on the **E6 signal code encryption and OS-NMA**, allowing for **increased robustness of professional applications**

Open Service (OS)

OS-Navigation Message Authentication (OS-NMA)

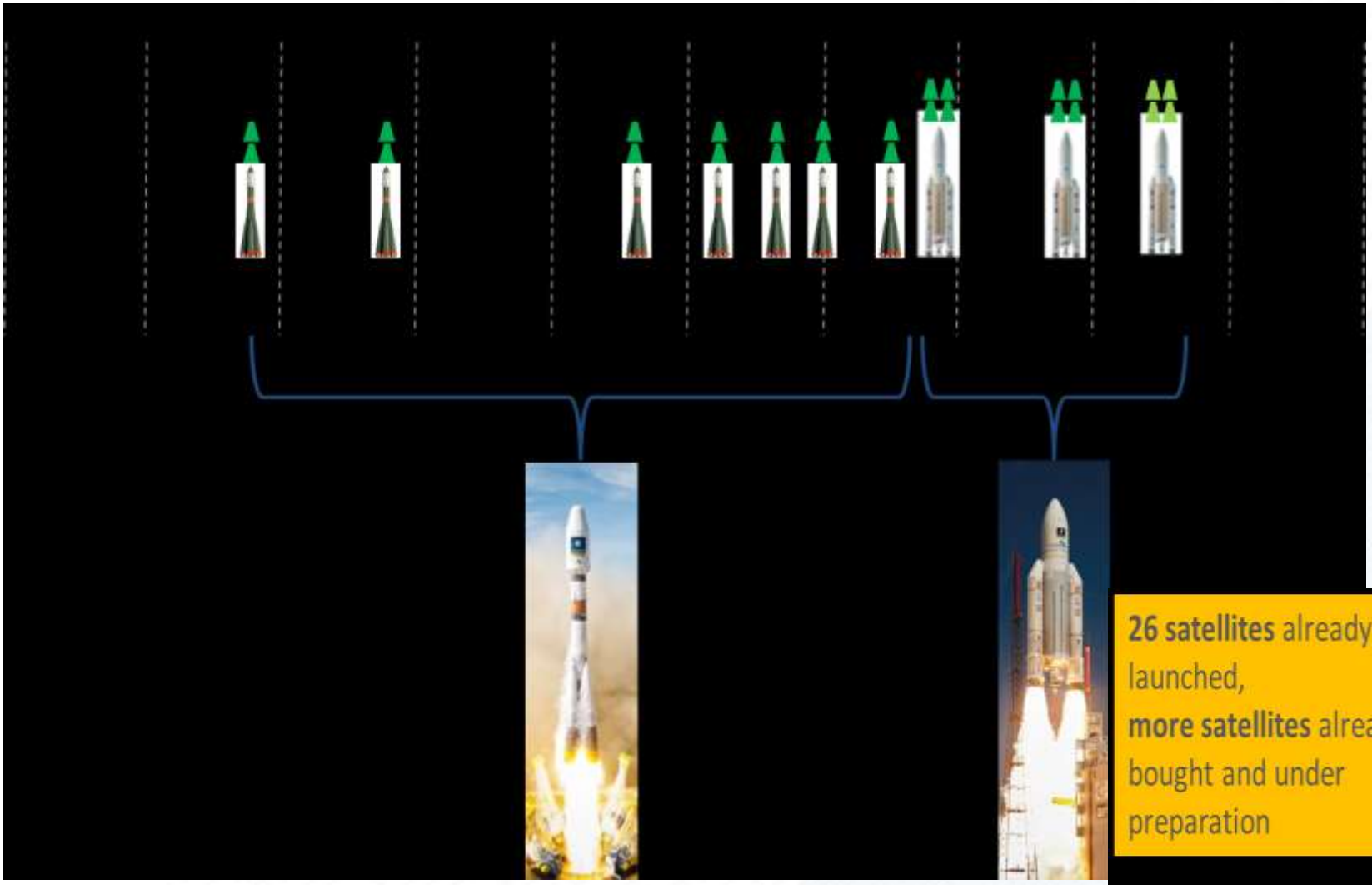
Public Regulated Service (PRS)

Search and Rescue Service (SAR)

High Accuracy Service (HAS)

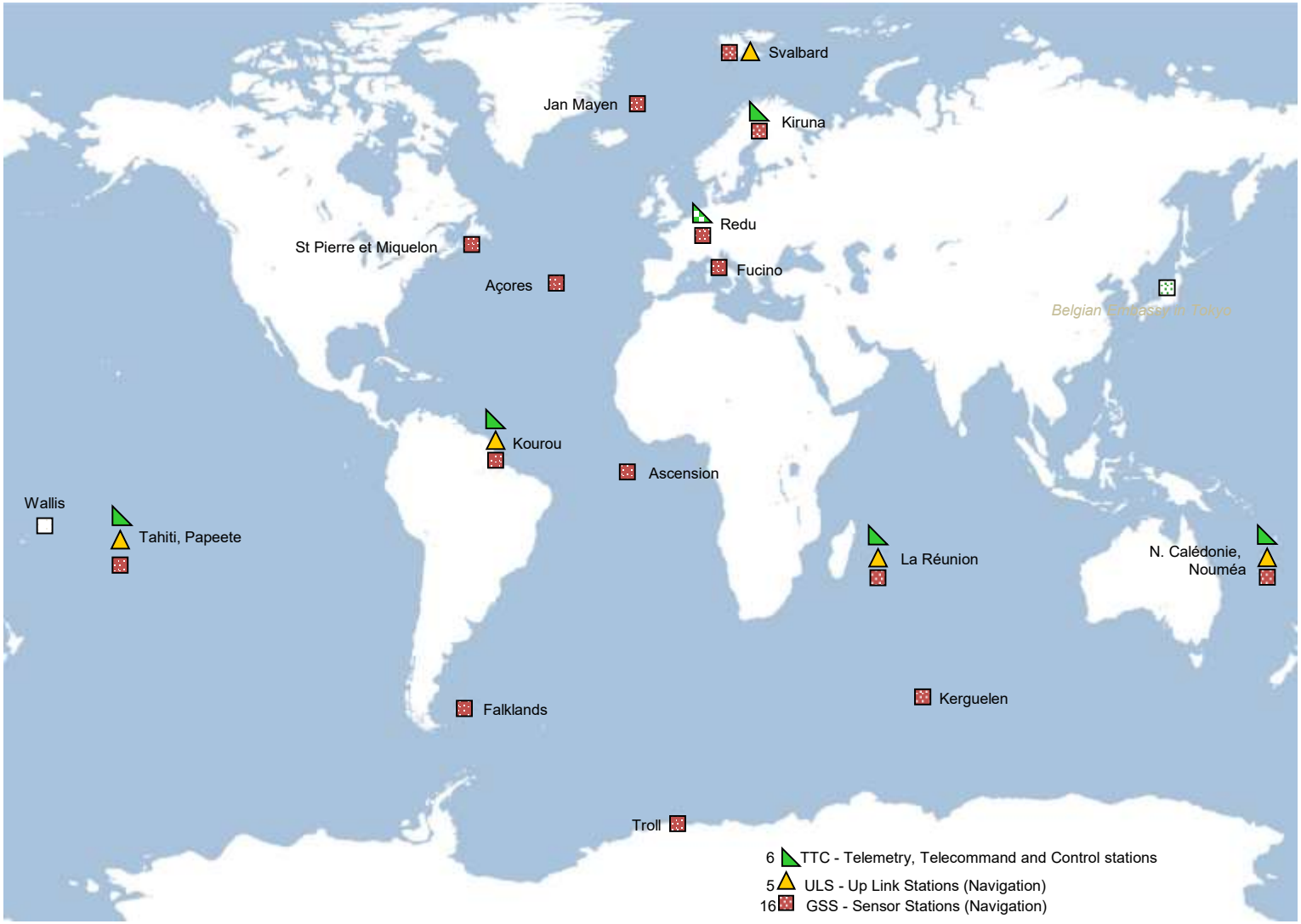
Signal Authentication Service (SAS)

GALILEO SPACE SEGMENT



26 satellites already launched,
more satellites already bought and under preparation

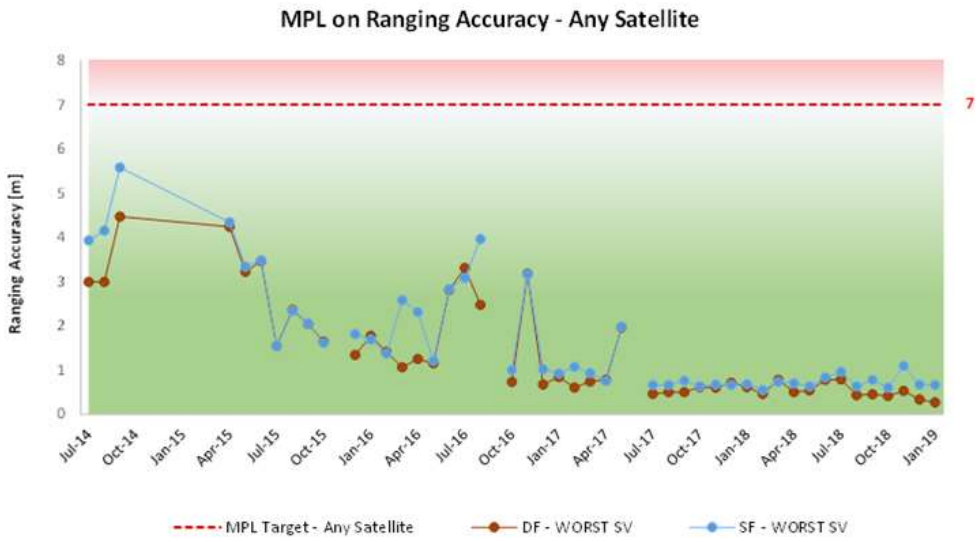
GALILEO GROUND SEGMENT

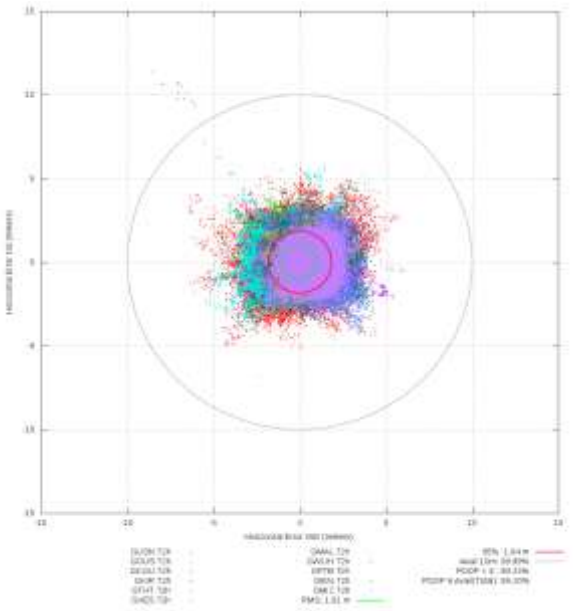


GALILEO GROUND SEGMENT

REMARKABLE PERFORMANCES

Measurements of:
Distance: ~20 cm
Position: ~1.5 m
Time: ~8 ns





Definition	Committed Target	Item	October 2017 to September 2018	November 2018	December 2018	January 2019
Ranging accuracy (DF, 95%)	< 7.0 m	Best Satellite	0.25 m	0.23 m	0.19 m	0.18 m
		Worst Satellite month	0.79 m	0.53 m	0.33 m	0.27 m
	< 2.0 m	Constellation Average	0.54 m	0.31 m	0.24 m	0.23 m

=> New monthly record !

GALILEO PERFORMANCE - A NEW REFERENCE

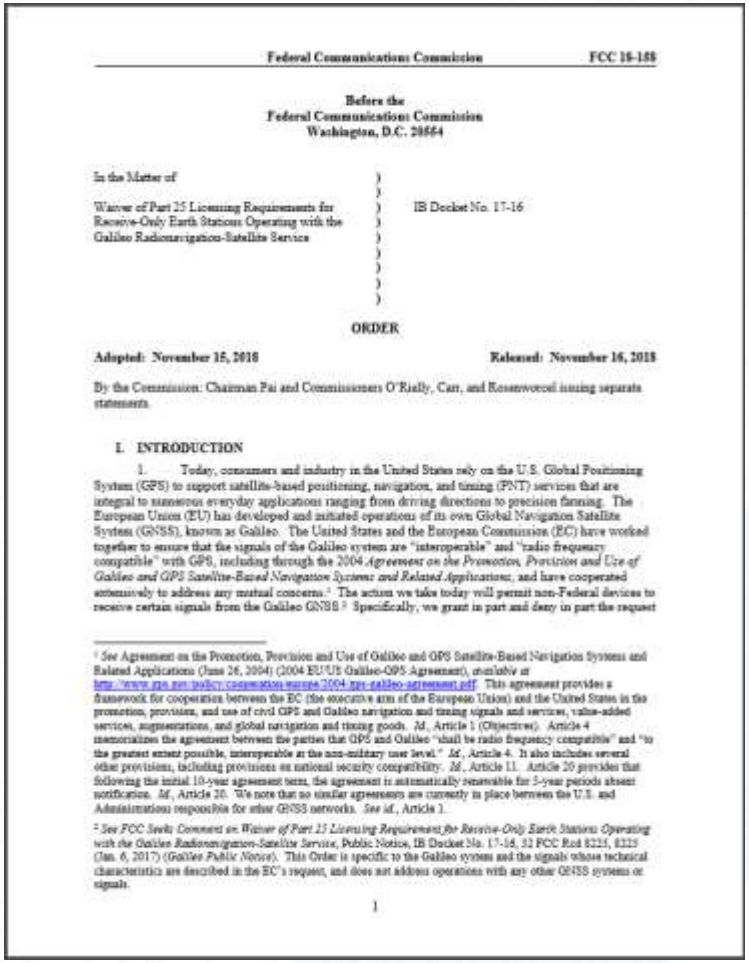
Galileo Reference Centre
Noordwijk (The Netherlands)

Delivers reference products for OS performance assessment since 2018
- -Daily/Weekly/Monthly Reports
- -Quarterly Reports published

Network of EU Member States capability to feed performance monitoring and anomaly analyses

Cooperation with EASA to deliver performance compliance monitoring for aviation

U.S. FCC



Federal Communications Commission FCC 18-148

Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of	)	
	)	
Waiver of Part 25 Licensing Requirements for Receive-Only Earth Stations Operating with the Galileo Radionavigation-Satellite Service	)	IB Docket No. 17-16
	)	
	)	
	)	
	)	

ORDER

Adopted: November 15, 2018 **Released: November 16, 2018**

By the Commission: Chairman Pai and Commissioners O'Rielly, Carr, and Rosenworcel issuing separate statements.

I. INTRODUCTION

1. Today, consumers and industry in the United States rely on the U.S. Global Positioning System (GPS) to support satellite-based positioning, navigation, and timing (PNT) services that are integral to numerous everyday applications ranging from driving directions to precision farming. The European Union (EU) has developed and initiated operations of its own Global Navigation Satellite System (GNSS), known as Galileo. The United States and the European Commission (EC) have worked together to ensure that the signals of the Galileo system are "interoperable" and "radio frequency compatible" with GPS, including through the 2004 *Agreement on the Promotion, Provision and Use of Galileo and GPS Satellite-Based Navigation Systems and Related Applications*, and have cooperated extensively to address any mutual concerns.[1] The action we take today will permit non-Federal devices to receive certain signals from the Galileo GNSS.[2] Specifically, we grant in part and deny in part the request

[1] *See* Agreement on the Promotion, Provision and Use of Galileo and GPS Satellite-Based Navigation Systems and Related Applications (June 26, 2004) (2004 EU/US Galileo-GPS Agreement), *available at* http://www.gps.gov/policy/cooperation/europe/2004/gps-galileo-agreement.pdf. This agreement provides a framework for cooperation between the EC (the executive arm of the European Union) and the United States in the promotion, provision, and use of civil GPS and Galileo navigation and timing signals and services, value-added services, augmentations, and global navigation and timing goods. *Id.*, Article 1 (Objectives). Article 4 memorializes the agreement between the parties that GPS and Galileo "shall be radio frequency compatible" and "to the greatest extent possible, interoperable at the non-military user level." *Id.*, Article 4. It also includes several other provisions, including provisions on national security compatibility. *Id.*, Article 11. Article 20 provides that following the initial 10-year agreement term, the agreement is automatically renewable for 5-year periods absent notification. *Id.*, Article 20. We note that no similar agreements are currently in place between the U.S. and Administrations responsible for other GNSS networks. *See id.*, Article 1.

[2] *See FCC Seeks Comment on Waiver of Part 25 Licensing Requirement for Receive-Only Earth Stations Operating with the Galileo Radionavigation-Satellite Service*, Public Notice, IB Docket No. 17-16, 32 FCC Rcd 8225, 8225 (Int. 6, 2017) (*Galileo Public Notice*). This Order is specific to the Galileo system and the signals whose technical characteristics are described in the EC's request, and does not address operations with any other GNSS systems or signals.

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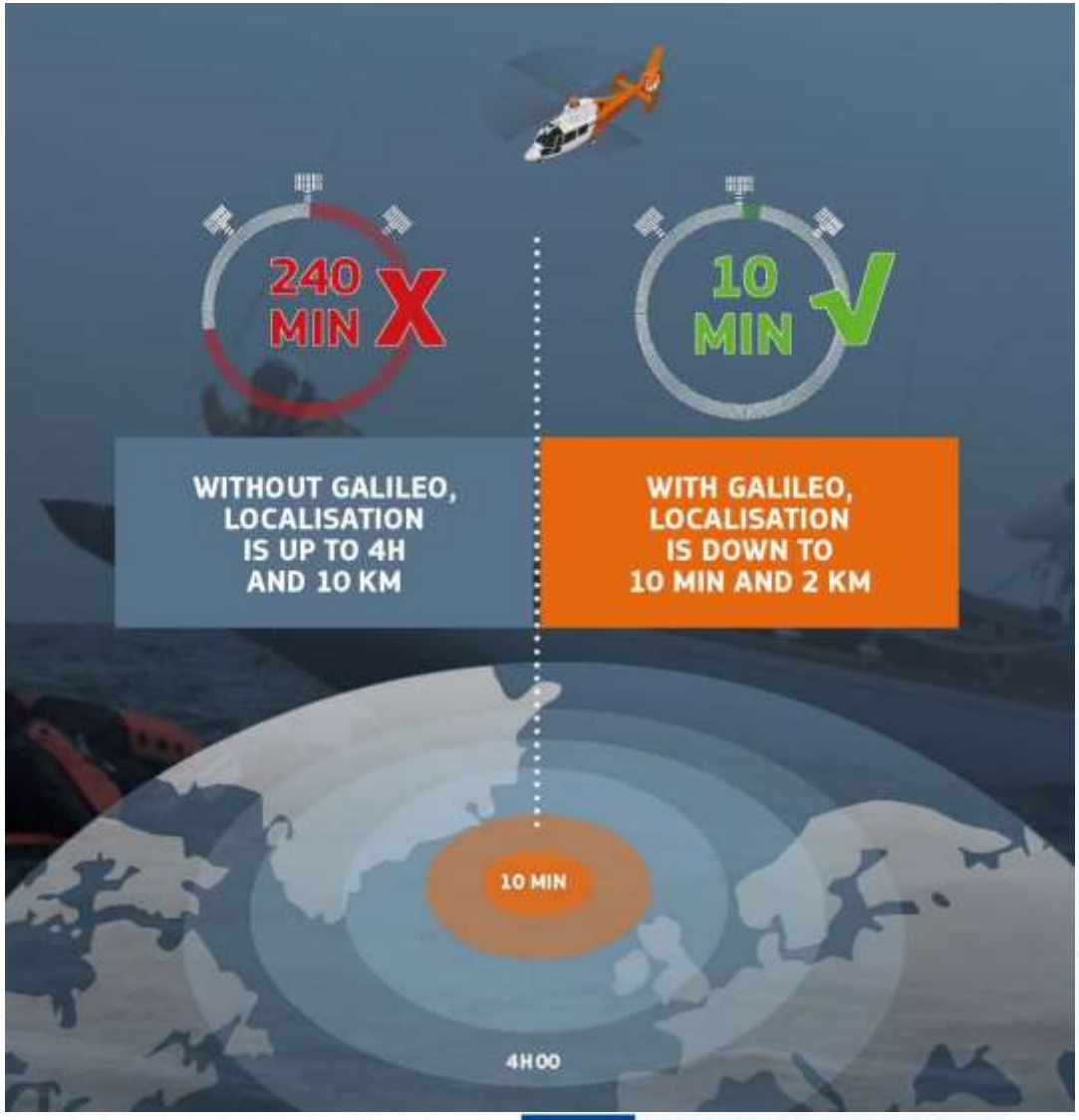
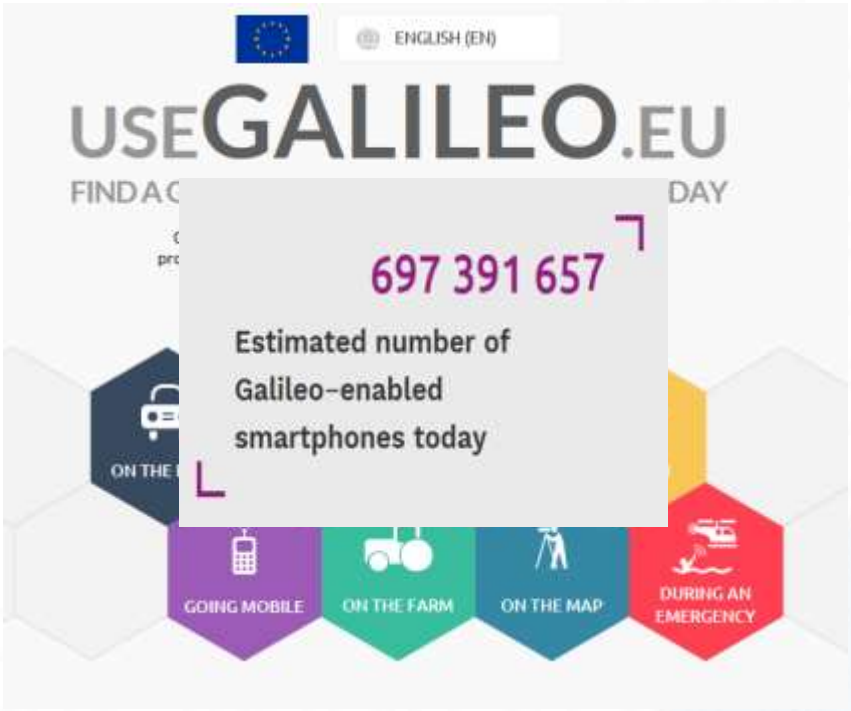
GALILEO PERFORMANCES

Search and Rescue Scoreboard



Galileo is used today on the majority of professional devices and increasingly many consumer platforms



Smart City components rely on GNSS

Positioning Timing&Synchronisation Navigation

Example

A Growing potential for high-precision solutions delivered through mass market devices

GALILEO EGNOS
NAVIGATION SOLUTIONS POWERED BY EUROPE

Android 7+ access to raw GNSS measurements

Over 125 smartphones models **Galileo** enabled

GSA GNSS Raw Measurement Task Force

Dual frequency mass market receivers

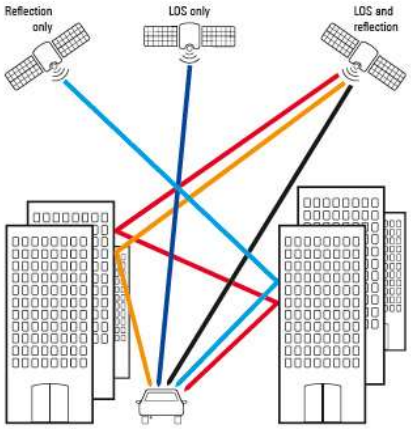
World's **first two dual-frequency GNSS smartphones** hit the market

Democratisation of mapping and affordable augmentation services

High-precision positioning entering the mass market

Galileo Open Service improves positioning performance for high-precision applications

Advantages of Galileo Open Service E1/E5/E6 multi-frequency

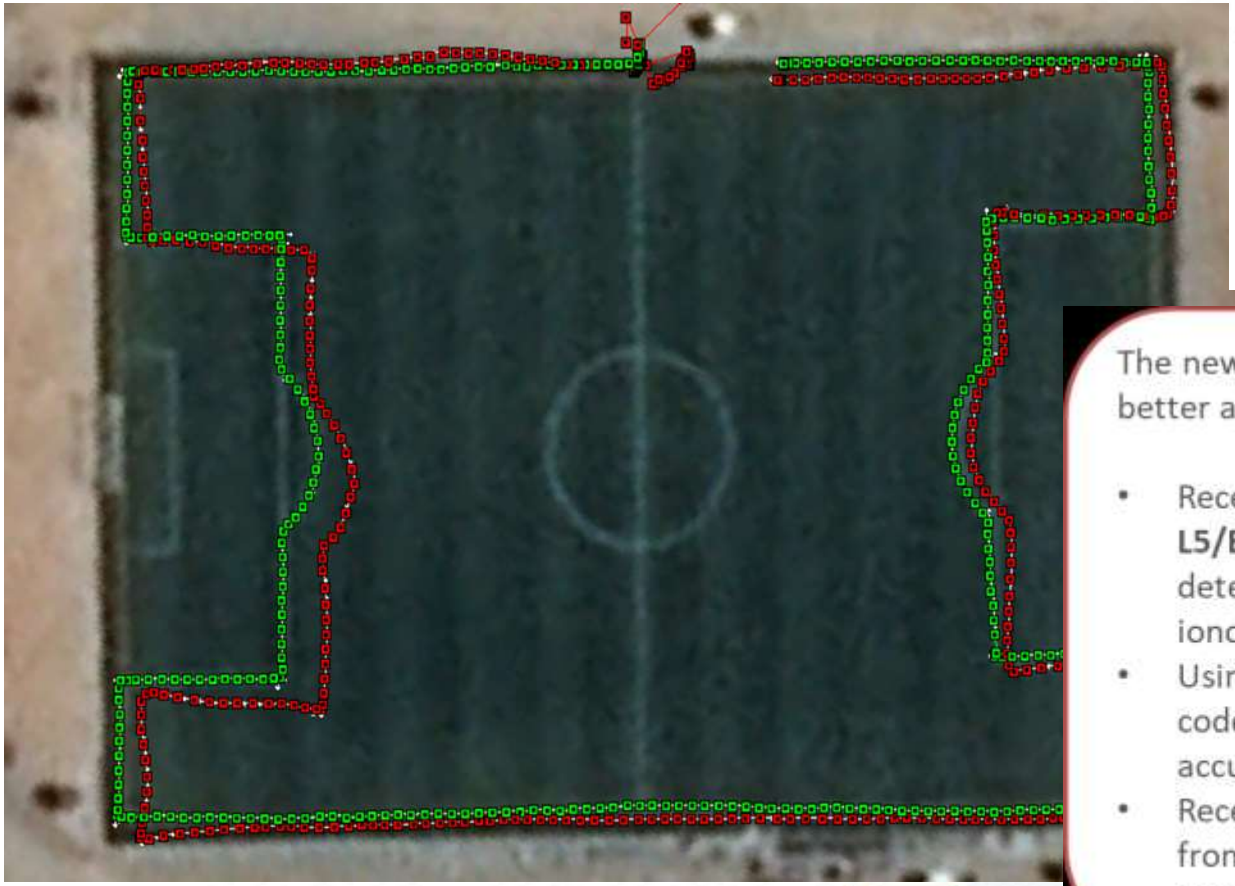


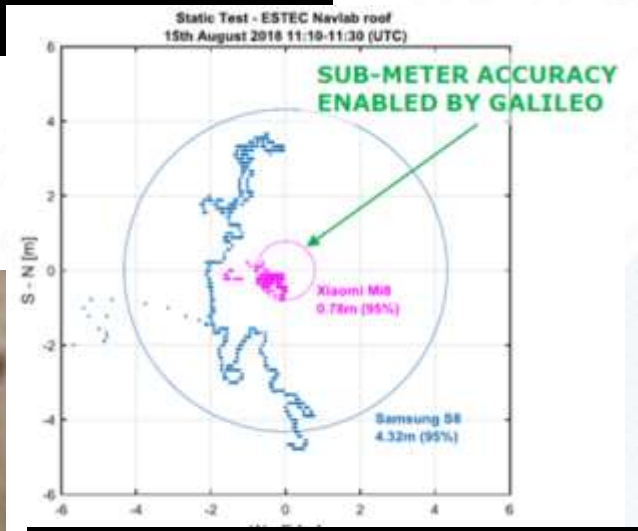
- **Better results** in **harsh environment** (urban canyons, tree canopy, etc.) enabled by:
  - ✓ **Easier mitigation** of **multipath errors** by E5 AltBOC modulation
  - ✓ **Higher SNR** (signal-to-noise ratio)
  - ✓ **Additional satellites** (Galileo + existing constellations)
- **Increased availability, continuity and reliability** of measurements enabled by:
  - ✓ **Additional satellites** (Galileo + existing constellations)
  - ✓ **Improved geometry**
- **Improved convergence time** when integrated in PPP solutions

Dual frequency brings better positioning performance

GALILEO EGNOS
NAVIGATION SOLUTIONS
POWERED BY EUROPE

- Red: BCM4774 (L1)
- Green: BCM4775 (L1+L5) – dual frequency





The new dual-frequency chipsets can achieve better accuracy, thanks to

- Receiving simultaneously **L1/E1 and L5/E5**, which help correct multipath, detect reflected signals and correct ionospheric errors.
- Using the **carrier's phases**, as opposed to code measurements only, for the high accuracy position algorithms
- Receiving **orbital & clock corrections** from ground stations, for even further accuracy and faster convergence time

User Requirements discussed with industry leaders, users and experts to shape the future of Galileo Services

User driven E-GNSS

- The interaction with users is essential for the success of E-GNSS
- User needs drive E-GNSS
- During the UCP all available knowledge on user needs shared

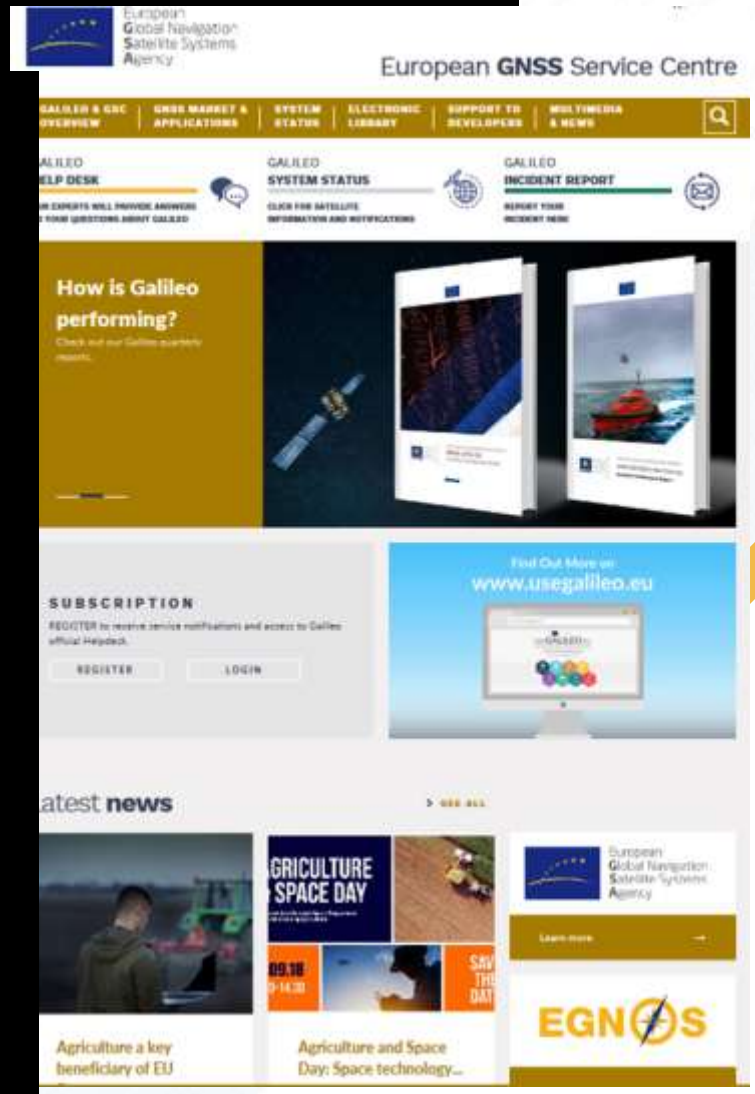
USER REQUIREMENT DOCUMENT

https://www.euspaceweek.eu/

The European GNSS Service Centre provides a single and unique interface with the users

GSC Nucleus

- Web portal
- Information on:
  - system status
  - almanacs
  - and user notifications
- Electronic Library
  - Iono Doc, OS SIS OSD, OS SIS ICD, future SDD
- Helpdesk:
  - User queries
  - Galileo incident reporting
- EGNSS Dissemination Platform
- User surveys
- Galileo performance reports

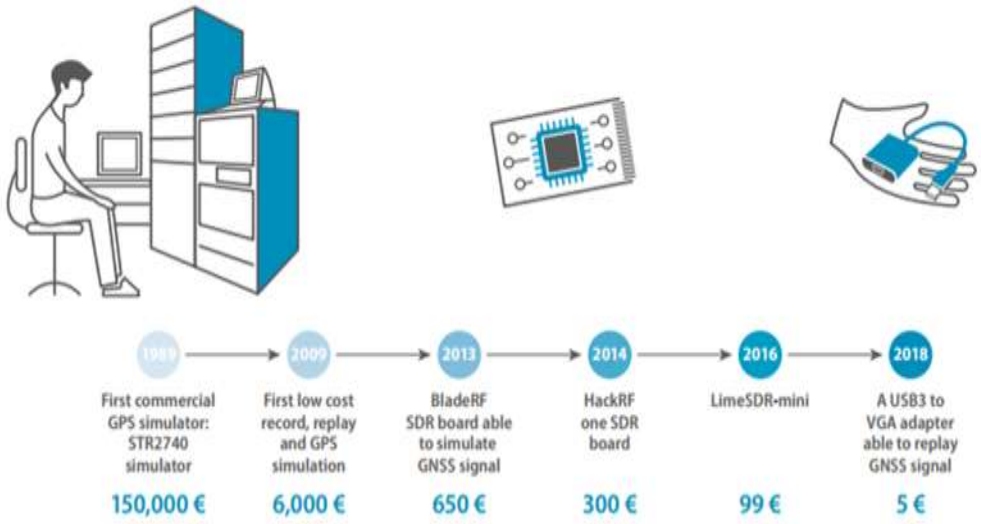


Spoofing, the emerging threats across applications sector

The 2nd Galileo User Assembly held in Marseille in December 2018:

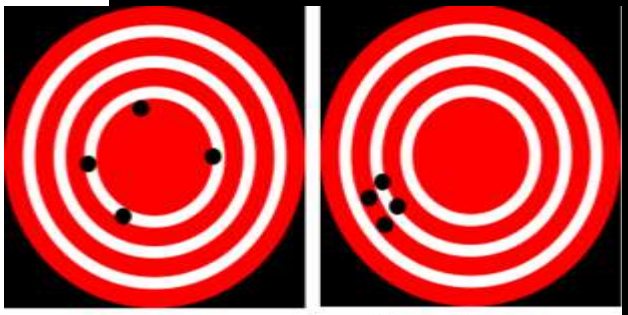
The importance of protecting against vulnerabilities was strongly highlighted as a common theme of user demands across all segments

GNSS SPOOFING CAPABLE DEVICES EVOLUTION COST



Galileo OS-NMA is the ability of the system to **confirm to the users** that they are **utilising navigation data**, which **comes from Galileo satellites** (and not from any other sources).

Galileo High Accuracy Service



High Accuracy
Low Precision

Low Accuracy
High Precision

Galileo High Accuracy Service

- User
  erro
- No n
  chan
- No n
  corre
- Triple
  redu
- Impr
  latitu

GSA has been leveraging two main R&D programmes as tools to stimulate the offer and increase E-GNSS adoption

HORIZON 2020

Aims to foster adoption of EGNSS via content and application development and supports the integration of services provided by these programmes into devices and their commercialisation

Fundamental Elements

Fundamental Elements projects focus on fostering the development of innovative Galileo and EGNOS enabled receivers, antennas and chipsets technologies

H2020 projects in Mapping and Surveying

mapKITE

- Tandem system composed by **UAV** and **Vehicle** equipped with cameras and LiDAR and operating as a virtual kite (the UAV follows the Vehicle by receiving its navigation information), also introducing novel element for images geo-referencing, Kinematic Ground Control Points
- Potential game-changer for **operational simplicity and cost savings**
- High-resolution terrestrial-aerial sensing system

GIMS

- **Geodetic Integrated Monitoring System**
- Low-cost system based on EGNSS, Copernicus SAR and other in-situ sensors, for monitoring ground deformations with a focus on landslides and subsidence


European
Commission
1- Galileo
2- EGNOS

EGNOS OPERATIONAL SINCE 2009

- **EGNOS** is the European SBAS system augmenting GPS signal over ECAC area
- **EGNOS** meets stringent Aviation requirements (ICAO) for all phases of flight
- **EGNOS** also used in a wide range of other application domains
- **EGNOS** is fully interoperable with all other SBAS worldwide Provides 3 services (Open Service, Safety of Life, EDAS).


USEGALILEO.EU
FIND A GALILEO-ENABLED DEVICE TO USE TODAY
Galileo is Europe's Global Satellite Navigation System (GNSS), providing users with improved positioning and timing information.
Click on the icons to find Galileo-enabled devices.
ON THE ROAD
ON THE WATER
ON THE TRAIN
IN THE AIR
GOING MOBILE
ON THE FARM
ON THE MAP
DURING AN EMERGENCY

THANK YOU !!!

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