European Global Navigation Satellite Systems Agency

European GNSS for Surveying and Mapping

Communication Workshop of the PosKEN

Alina Hriscu
Market Development
European GNSS Agency (GSA)

Brussels, 26 April 2018

GALILEO EGNOS
NAVIGATION SOLUTIONS
POWERED BY EUROPE

Launch

Ariane Flight VA240
Ariane 5 ES launches Galileo FOC-M7 satellites
12 December 2017

Agenda

- GSA: Who We Are and What We Do
- EGNOS and Galileo: State of Play
- Market and Technology Trends
- E-GNSS for Surveying and Mapping
- GSA Strategy Towards Galileo Adoption

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GSA in a nutshell

What?

Gateway to Services

- Galileo & EGNOS Operations and Service Provision
- Market Development of the applications and the receivers

Gatekeeper of security

- Security Accreditation
- Operation of Galileo Security Monitoring Centre, governmental service (PRS) activities

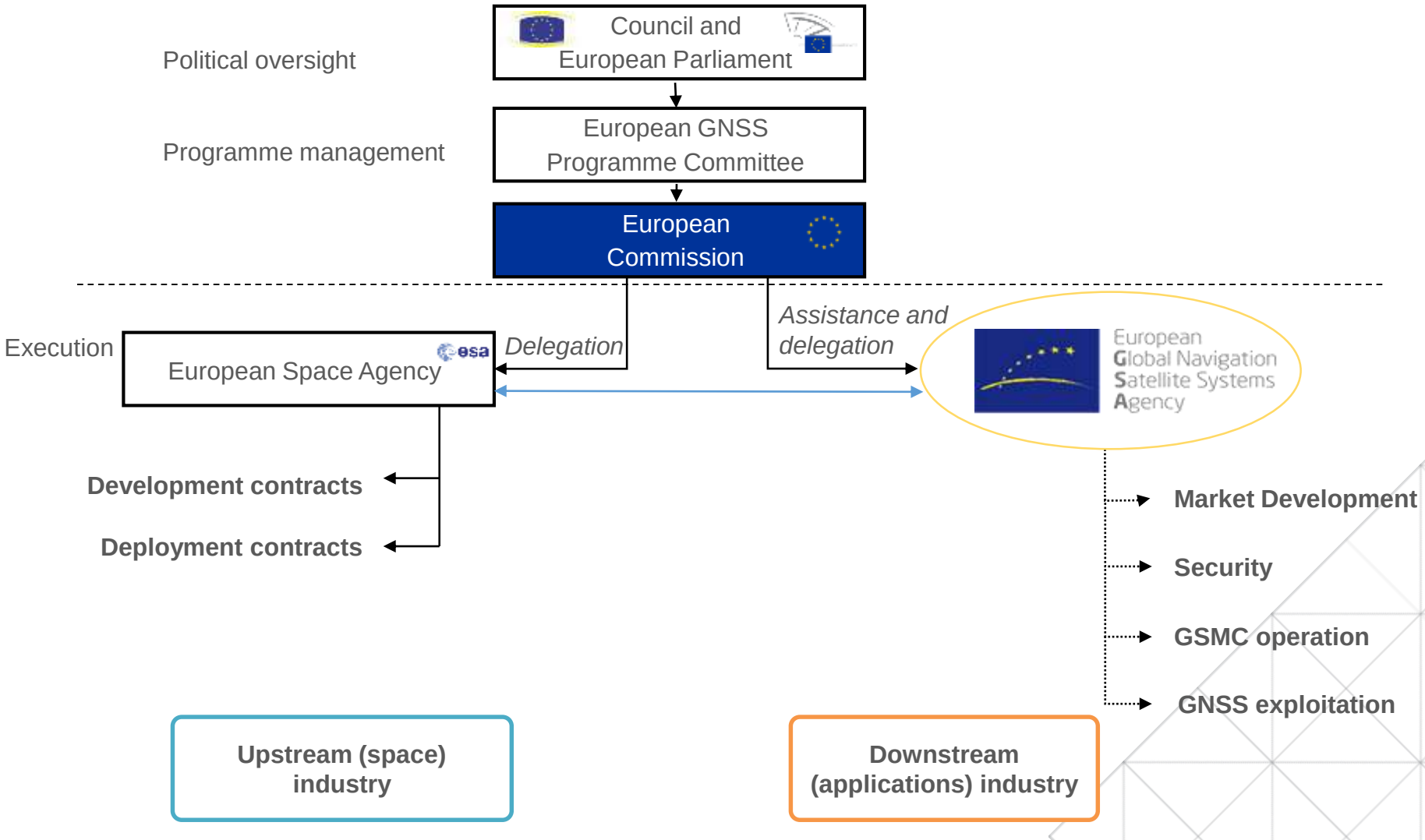
Who and where?

160 Staff

21 Nationalities

Prague, CZ Rep – HQ
St. Germain en Laye, FR – GSMC
Swanwick, UK – GSMC
Torrejon, ES – GSC
Noordwijk, NL – GRC
Toulouse, FR – EGNOS

How GSA fits in the EU structure



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EGNOS already available serving EU citizens and industry

- Accuracy ~**1m, free**

Open Service (OS)

- Accuracy ~1m, **compliant to aviation standards** by providing correction data and **integrity**

Safety of Life Service (SoL)

- Accuracy <1m, **corrections provided via internet**

EGNOS Data Access Servi (EDAS)

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)

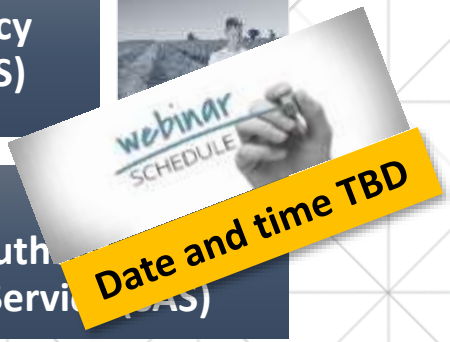
OS-Navigation Message Authentication (OS-NMA)

Public Regulated Service (PRS)

Search and Rescue Service (SAR)

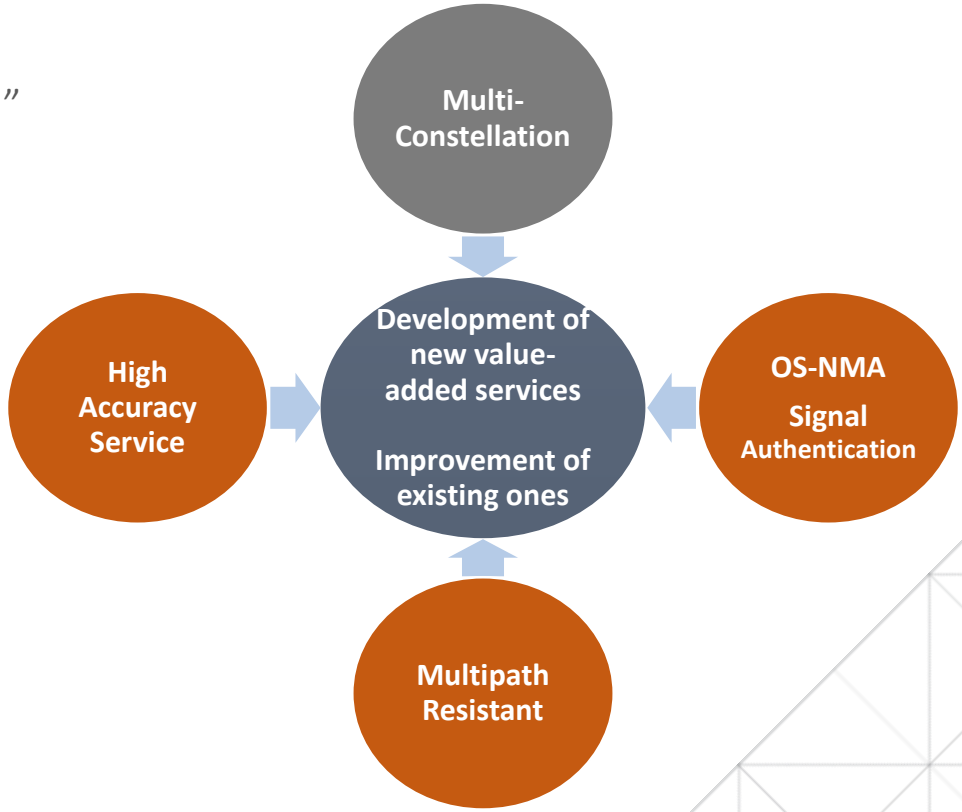
High Accuracy Service (HAS)

Auth… Servi… (…AS)



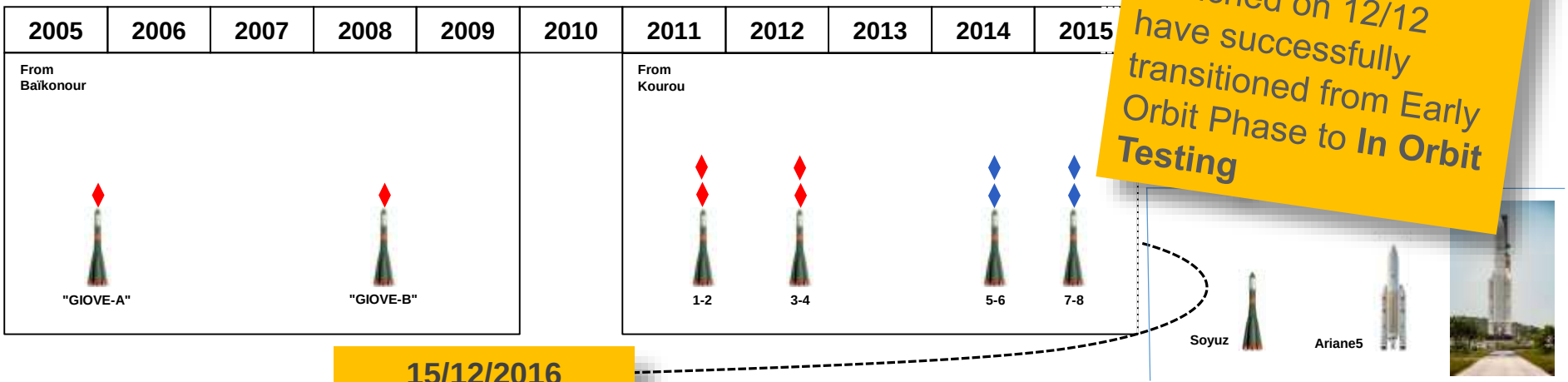
Galileo is the European GNSS under civilian control, delivering unique features

- Worldwide navigation system "**made in EU**"
- Only constellation **under civilian control**
- Fully **compatible with other GNSS constellations**
- **Open service free of charge**, delivering **multiple frequencies**
- Only constellation that provide **Signal authentication providing trustability for civilians** and **global high-accuracy service for free**

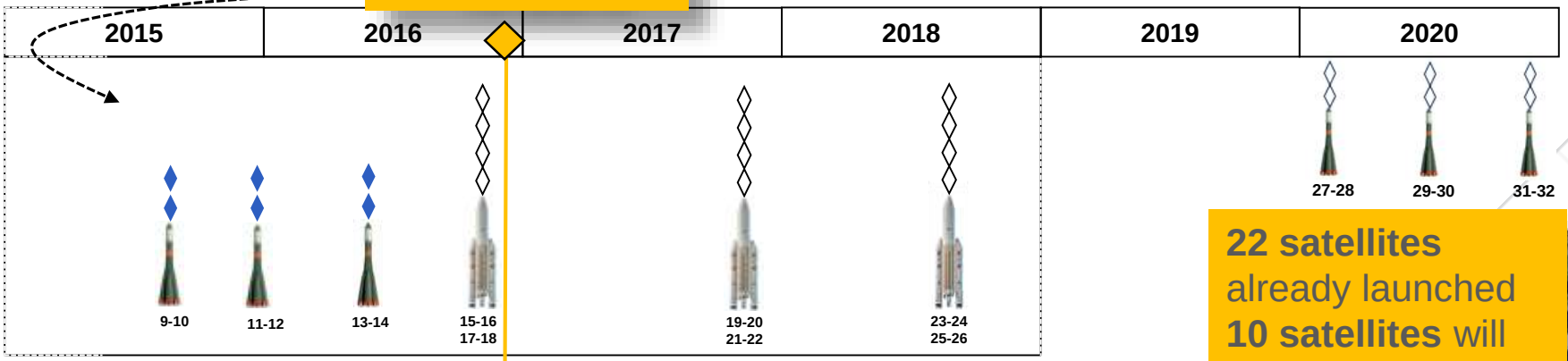


Galileo's implementation is progressing with Full Operation Capability in 2020

4 Galileo satellites launched on 12/12 have successfully transitioned from Early Orbit Phase to **In Orbit Testing**



15/12/2016



Galileo Initial Services

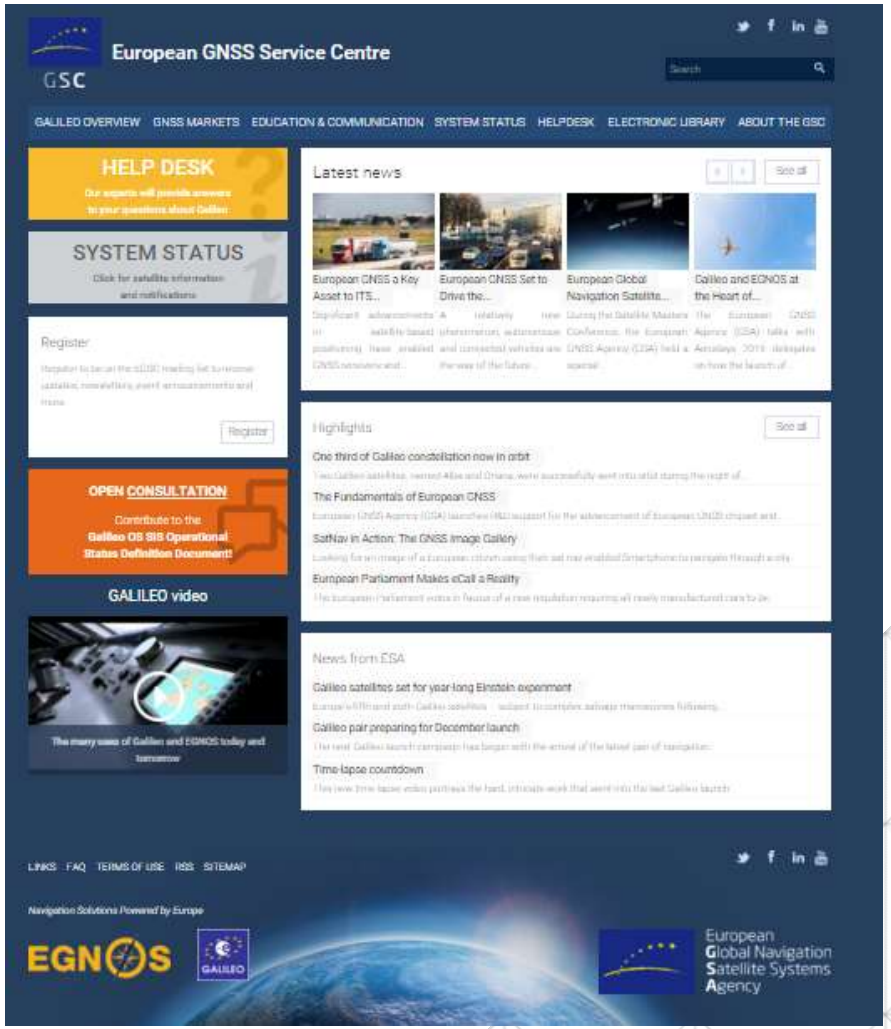
22 satellites already launched **10 satellites** will follow by 2020

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

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



www.gsc-europa.eu

Galileo Initial Open Service Public Quarterly Performance Report confirms good performance of Galileo

Available at GSC website

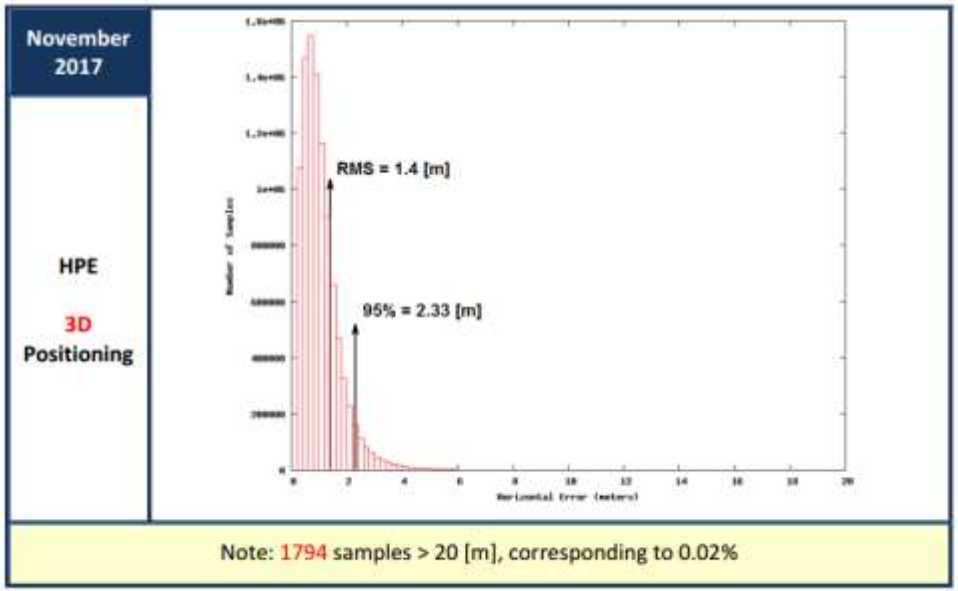


Figure 14: Horizontal Positioning Error (HPE) for "Galileo-only" users (November 2017)

https://www.gsc-europa.eu/electronic-library/performance-reports

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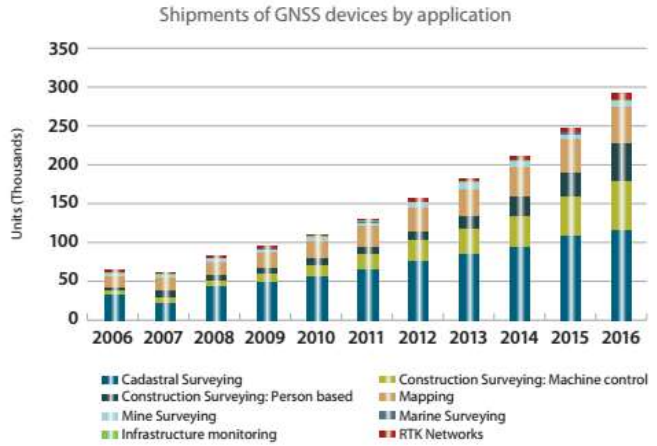
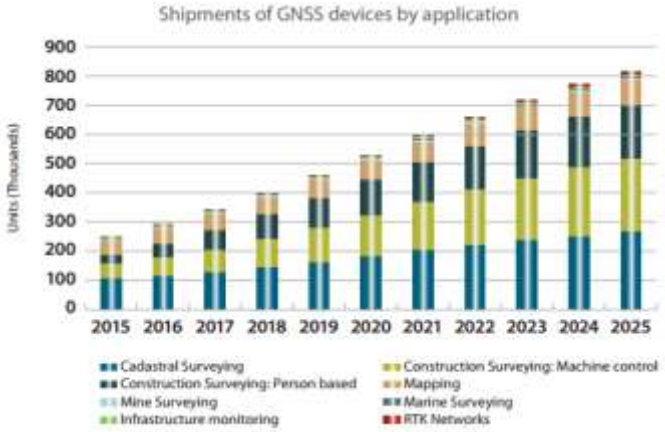
Construction, mapping and cadastral industries stimulated growth in shipments of GNSS surveying equipment



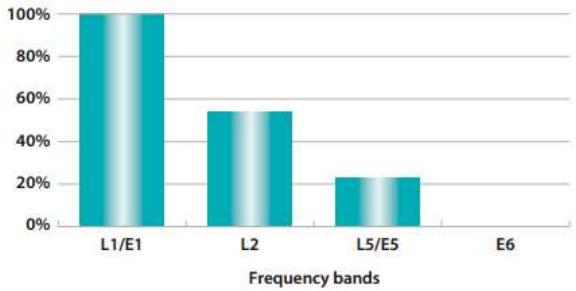


Surveying, Mapping and Construction (both person-based and machine control), accounted for **95% of the shipments of GNSS devices in high precision market in 2016**

In the coming decade, the total **amount of shipments** is expected to reach 815,000 units worldwide, representing **almost a 4-fold increase over 2015**

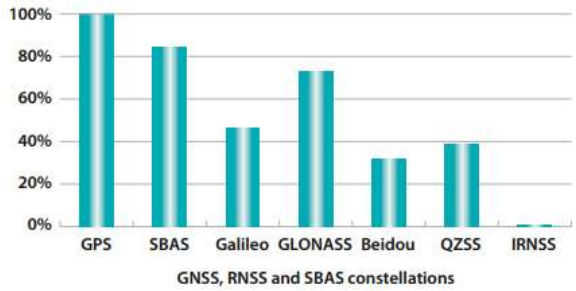
Multi-constellation and multi-frequency are widely adopted to fulfil stringent accuracy requirements

Frequency capability of GNSS receivers[1]



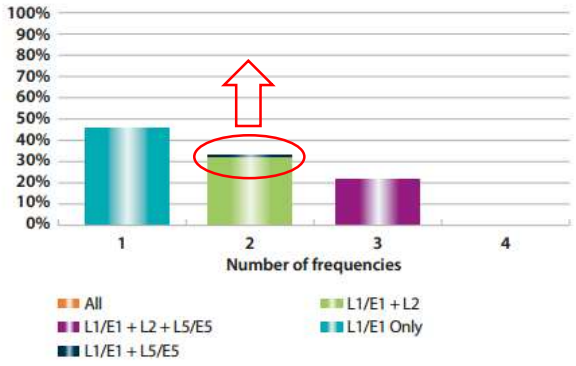
[1] shows percentage of receivers supporting each frequency band

Constellation capability of GNSS receivers[2]



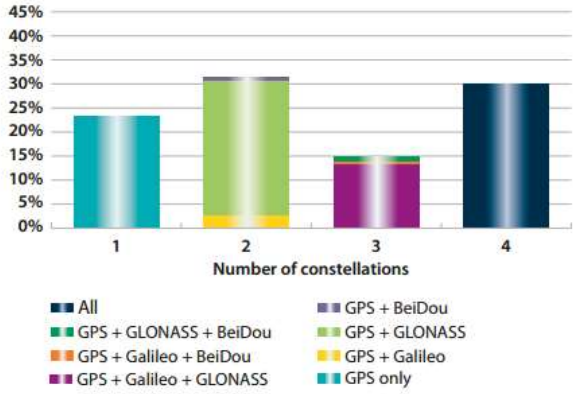
[2] shows percentage of receivers capable of tracking each constellation

Supported frequencies by GNSS receivers[3]



[3] shows percentage of receivers capable of tracking 1, 2, 3 or all the 4 frequencies

Supported constellations by GNSS receivers[4]



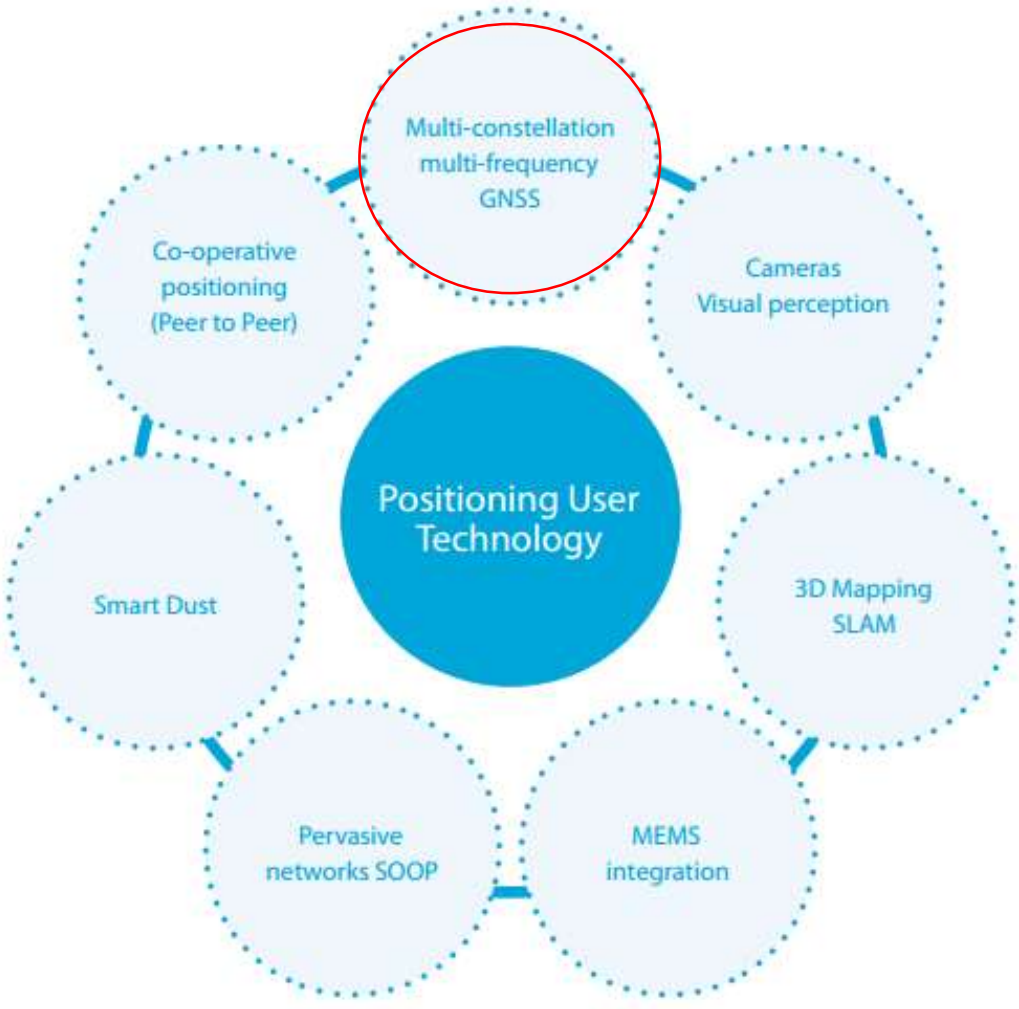
[4] shows percentage of receivers capable of tracking 1, 2, 3 or all the 4 GNSS constellations

Trends and Prospects in surveying and mapping

Main drivers and trends:

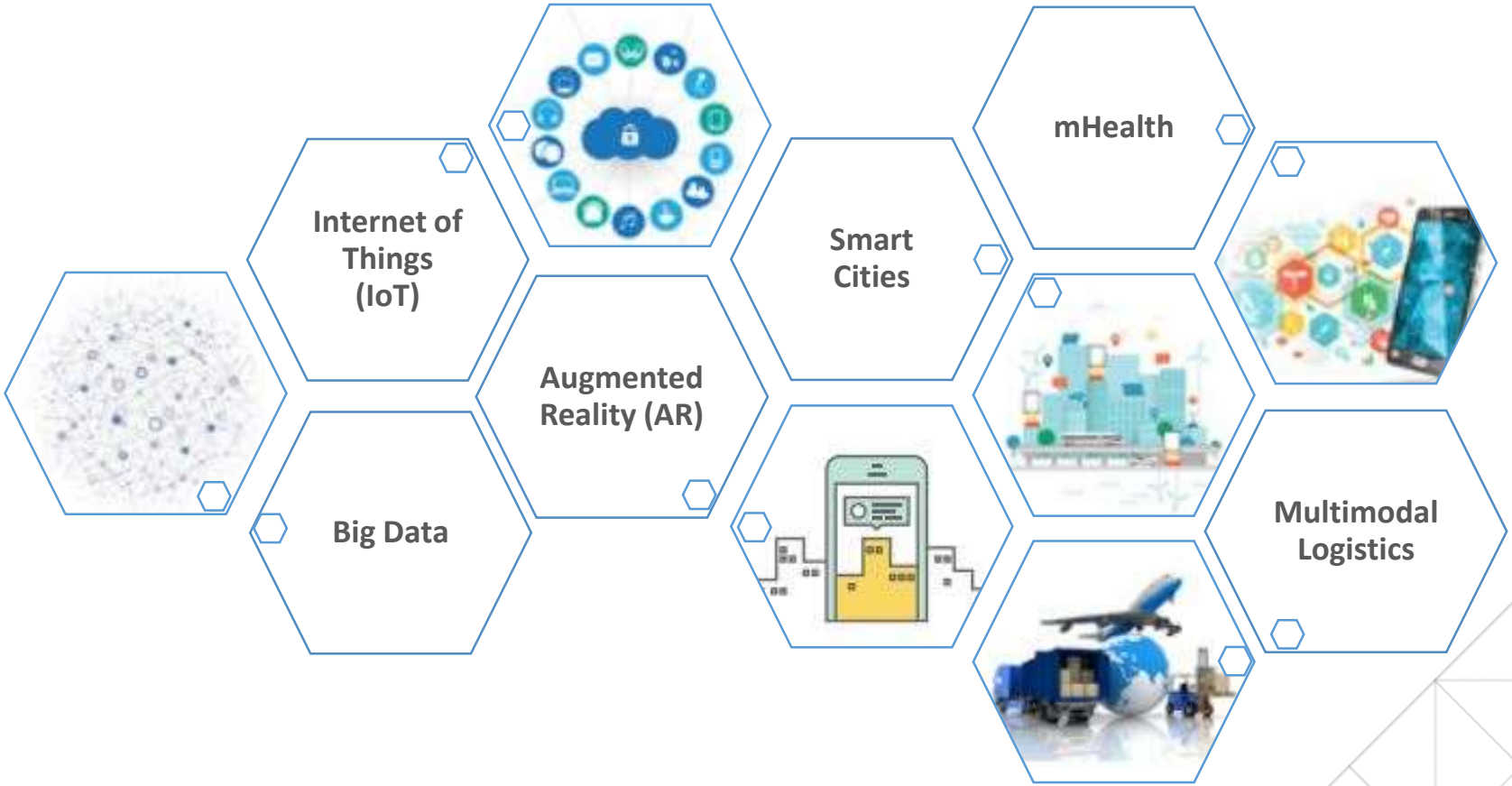
- Increased availability **of low-cost equipment** delivering cm/dm-level precision (incl. **multi-frequency and multi-constellation** support)
- Uptake of **PPP**
- **Integration** of GNSS with **other complementary technologies** (LIDAR, robotics, mobile mapping, etc.)
- **Synergies** between **GNSS and Earth Observation**
- **UAV penetration** into mapping

Innovation areas and emerging concepts likely to influence future positioning and navigation



GNSS is the **most cost-effective outdoor positioning technology currently available** – and **will remain** so for the foreseeable future

GNSS contributes to a rapidly diversifying range of technologies and applications



Many emerging applications require higher accuracy of geolocation

Augmented reality

Self-driving cars

Drones

Smart cities

Automation on the farm

Emerging apps and democratisation of mapping are drivers for the new evolution of the High-Precision Services

52 smartphones models **Galileo** enabled

SAMSUNG

Android 7+ access to raw GNSS measurements

Dual frequency mass market receivers

Democratisation of mapping

Need for the "absolute" high-precision location of autonomous cars, drones and other emerging apps

High-precision positioning penetrating to mass market

GNSS Raw Measurements set to be a game changer for GIS?

- With Android 7.0+ access to raw GNSS measurements
- This empowers the development of algorithms to provide better location performances

To help get a better understanding of this feature's true potential and to promote its use to application developers, the GSA established the [Raw Measurements Task Force]

Interested to know more? Download GSA GNSS Market and GNSS User Technology reports

GNSS market trends & applications

https://www.gsa.europa.eu/market/market-report

GNSS receiver trends & technology

https://www.gsa.europa.eu/european-gnss/gnss-market/2016-gnss-user-technology-report

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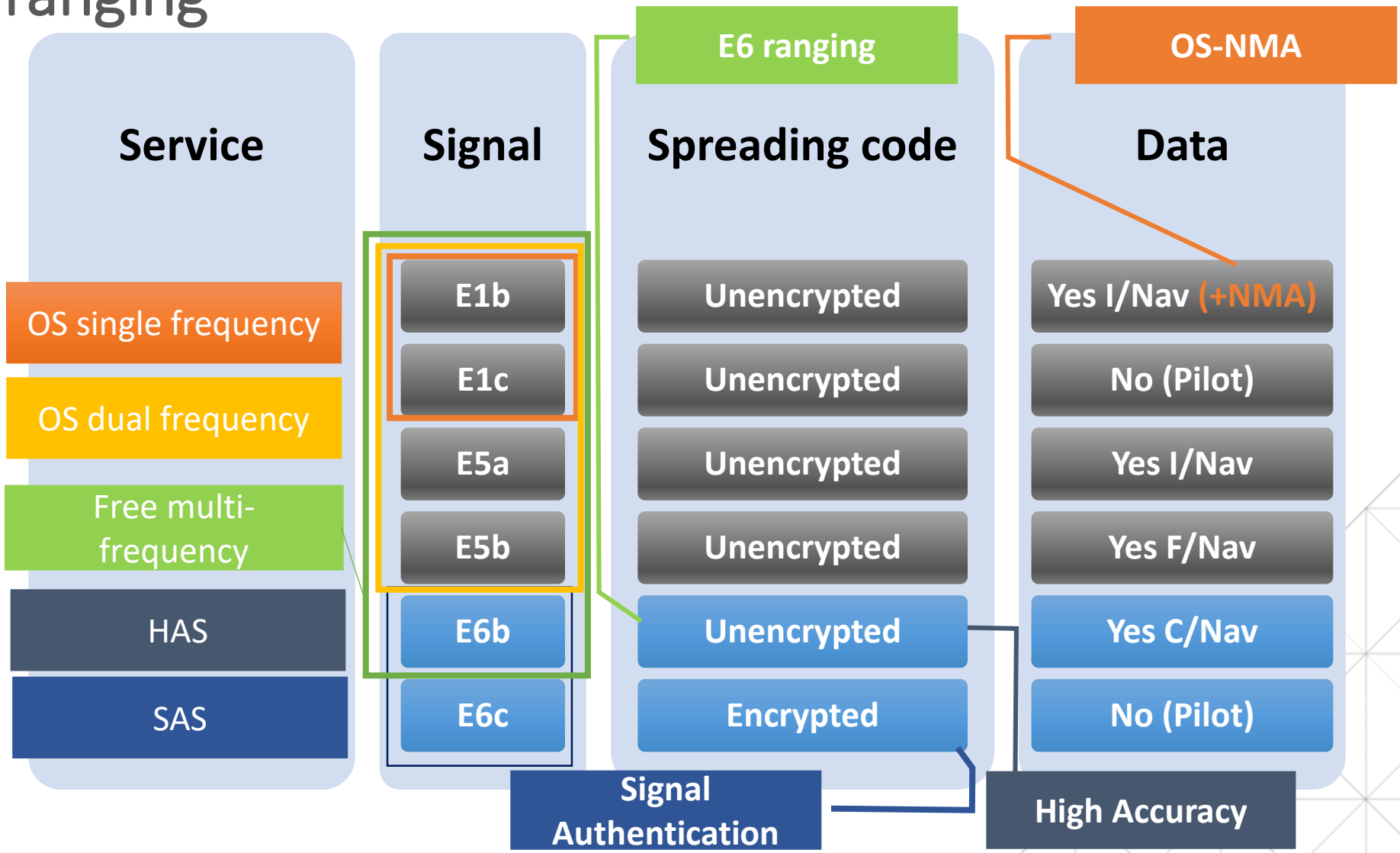
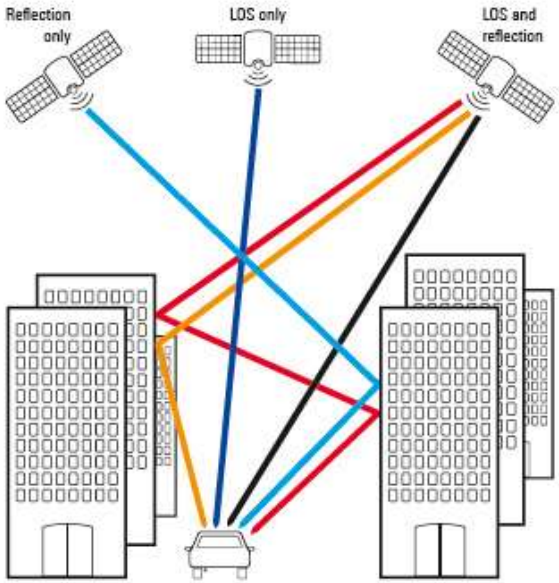
Overview of signals
Open service / Commercial service / E6 ranging



Galileo Open Service improves positioning performance

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



Easier **mitigation of multipath errors**

Higher SNR (signal-to-noise ratio)

Multi GNSS : provides additional advantages

- **Increase availability, continuity and reliability**
- **Improved geometry**

Better results **in harsh environement** (urban canyons, tree canopy, etc.)

OS-NMA: **spoofing detection**

Choice for 2nd and 3rd GNSS frequency

E5/L5: 2nd Frequency

- E5/L5, a protected frequency
- Shared by all GNSS and SBAS
- More widely separated from L1, thus minimising the iono-free linear combination errors

E6: 3rd Frequency

- E6 High quality open signal (modulation, chip rate)
- Best frequency for tri-laning
- Multiple signals bring greater reliability and accuracy

Commercial Service goes for FREE

- Decision to redefine the High Accuracy service and provide it for **free** (Stakeholder Consultation complemented by industry and market analysis)
- The Decision has just been taken and most service features are currently under definition EC/GSA/ESA
- Full service provision is planned in FOC (2020+) with the following features:
  - Accuracy expected in the range of 20cm.
  - Global coverage, including high latitudes
  - Possible regional enhancement by ionospheric corrections to reduce time to precise fix
- Between 2019 and FOC, the service will be incrementally deployed. A lower accuracy/coverage may be delivered in this period.

	Signal and Data features
Frequency	1278.75 MHz
Signal	E6B
Min. Power	-158 dBW
Modulation	BPSK(5)
Chip Rate	5.115 Mcps
Code Length	1 ms
Symbol Rate	1000 sps
Data Rate	492 bps
HA Data Rate	448 bps (TBC)
Data Coding	FEC, as per Galileo OS SIS ICD, + interleaving 123 x 8
Spreading Code Encryption	No
Data Format	TBD, but based on an open ICD.
Data (TBC)	Orbit and clock corrections, code and phase biases, SQM, flags, ionospheric information.

Augmentation service providers are accelerating the adoption of Galileo

RTK

- **Majority of RTK providers upgraded or have started to upgrade**
  - SWEPOS (SE), GeoSoft (ET), SAPOS (DE), SOGEI (IT), GEONET (JP), TERIA (FR),etc.

"Our customers needing reliable high-precision are already reporting improvements with Galileo RTK-corrections"

PPP

VRS NOW and CENTERPOINT RTX support Galileo

President and CEO of NovAtel, Michael Ritter stated
"Our OEM customers are already benefiting from t**he enhanced reliability, availability and accuracy the Galileo constellation adds to the GNSS**."

Anders Haneborg, Fugro commercial manager said
"Galileo's Initial Services operations […] a **key consideration for our customers** during critical positioning operations**"**

Graham Purves, President and CEO of Veripos stated

"As an European company, we are **particularly proud and excited about the opportunities the Galileo services create** for our customers. The **reliability and safety enhancements** made possible to continue to expand the capabilities of our cutting edge safety critical positioning solutions."

Augmentation for cm-level precision

- Augmentation service providers ●
- Receivers for augmentation services ○

Receivers by surveying applications

- Infrastructure monitoring ○
- Land surveying ○
- Machine control ○
- Mapping & GIS ○
- Marine surveying ○

Surveying system integrators ○

Manufacturer	Geographical Coverage
CZEPOS	Czech Republic
FBIHPO	Bosnia and Herzegovina
FLEPOS	Belgium
Fugro G4	Worldwide
GeoNET	Japan
Geosoft	Estonia
Geotrim Oy	Finland
Orpheon	France and French West Indies
RTX	Worldwide
SAPOS	Germany
SKPOS	Slovakia
Sogei	Italy
SWEPOS	Sweden
Teria	France

GSA workshops "Integrating Galileo in RTK networks: success stories and open challenges" during CLGE GA

Invited speakers

- Roberto Capua from **Sogei (IT)**
- Paul Chambon from **Terria (FR)**
- Mattias Eriksson from **SWEPOS (SE**)
- Hugo Toll from **Gesosoft (EE)**

- ✓ Usability of the Galileo constellation in high-precision RTK applications
- ✓ **Improved availability, reliability, and accuracy and time-to-fix in difficult measuring environments** (urban canyons and under tree canopy).

- ✓ End-users understand Galileo added value: **69% of the respondents** are convinced that Galileo will improve their work.

- ⚠ Ongoing **issue with the inter-operability between the different brands of RX manufacturers within RTK-network**
- ⚠ Inclusion of Galileo into RTK network is cost demanding.

Three main pillars towards E-GNSS adoption – the bigger picture

MARKET SEGMENTS

- Road
- LBS
- Aviation
- Rail
- Maritime
- Agriculture
- Surveying & Mapping
- Timing & Synchronization
- Governmental

DOWNSTREAM VALUE CHAIN

Bodies influencing the market → Navigation Signal Providers → Chipset, receiver → Devices → Content & Apps → Service providers

Understand **market and user needs and satisfaction**

User Satisfaction

Stimulate

DEMAND & ADOPTION

- EGNSS added Value
- Cooperate with receivers and aps
- Roadmaps with stakeholders
- Support EC policies

Fundamental Elements

Fundamental Elements

Support EU

COMPETITIVE OFFER

of Services and applications applications

E-GNSS USER ADOPTION

EU PUBLIC BENEFITS

The GSA's funding mechanisms promote the development of Galileo compatible solutions

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

140 €mln budget **in the H2020 call**

Fundamental Elements

Fundamental Elements projects focus on fostering the development of innovative Galileo- and EGNOS-enabled receivers, antennas and chipsets technologies. The objective is to achieve products that address user needs in priority market segments

€75.5 M for non-PRS projects

http://www.gsa.europa.eu/r-d/gnss-r-d-programmes

The next call is just published
H2020-SPACE-EGNSS-2019

Type of Action	Topic	Indicative budget (EUR mln)	Funding rate	Indirect costs
IA	EGNSS applications fostering green, safe and smart mobility	**10.00**	70% (except for non-profit legal entities, where a rate of 100% applies)	25% of the total eligible costs excluding: • Subcontracting • Costs of resources made available by 3rd parties • Financial support to 3rd parties
IA	EGNSS applications fostering digitisation	**4.00**		
IA	EGNSS applications fostering societal resilience and protecting the environment	**4.00**		
CSA	EGNSS awareness raising and capacity building	**2.00**	100%	
	TOTAL budget:	**20.00**		

Opening: 16 October 2018
Deadline: 05 March 2019

IA: activities aimed at producing plans and arrangements or designs for new, altered or improved products, processes or services
CSA: consisting of accompanying measures such as standardisation, dissemination, awareness-raising and communication, networking, policy dialogues and studies

Mapping & Surveying: project examples and success stories

mapKITE – EGNOS-GPS/GALILEO-based high-resolutionterrestrial-aerial sensing system

- 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 georeferencing - Kinematic Ground Control Points
- Potential game-changer for **operational simplicity and cost savings**

mapKITE is protected by the **Spanish patent**, no. ES239454!

LARA: Augmented Reality Assistive System for Utilities Infrastructure Management through Galileo and EGNOS

Developing a mobile solution for underground utility management that **takes advantage of the Galileo and EGNOS**:

- Uses and integrates mobile **Augmented Reality (AR) interfaces**.
- 3D models of complex underground utilities infrastructure (water, gas, electricity, etc.)
- Easy to understand and use during field work

Copernicus is EU's Earth Observation programme offering free data through six services

- Revolutionary Earth Observation and Monitoring programme
- Delivers openly and freely in a wide range of application areas:
  - operational data
  - information services

Atmosphere (CAMS)

Marine (CMEMS)

Land (CLMS)

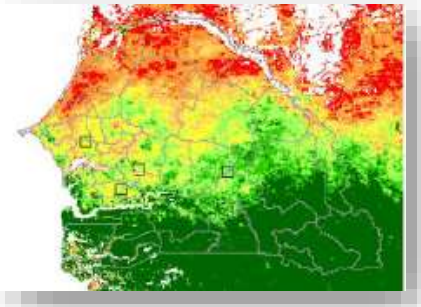
Climate (C3S)

Emergency (EMS)

Security

> 8 Petabytes / year

Synergies generated due to joint use of EGNSS and Copernicus enable a wide range of applications….

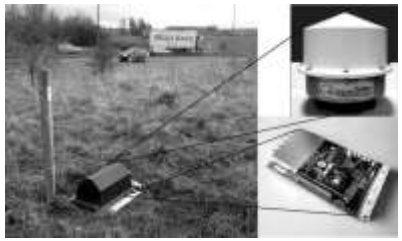


/EGNOS together
arth Observation

Project examples and success stories

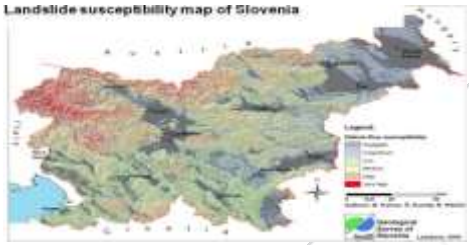
GIMS - Geodetic Integrated Monitoring System

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



- **Vertical displacements** (via synthetic aperture radar interferometry InSAR)

- **Horizontal displacements**
- Temporal interpolation
- Geo-localisation of the in-situ sensors



Features of upcoming products:

- Register deformations with millimetric level accuracies and daily acquisition rate
- Real-time alerts in case of sudden movements

I2GPS - Integrated Interferometry and GNSS for Precision Survey

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 to be published for public in Q2 2018

1ST GALILEO USER ASSEMBLY MADRID

EGNOS

GALILEO

GSA supports Young Surveyors

CLGE Annual Young Surveyors' Prize:
fresh ideas to feed the surveying industry evolution

GSA is **sponsoring a special prize dedicated to Galileo, EGNOS and Copernicus** as part of the annual Council of Geodetic Surveyors' Young Surveyors prize

2018 edition open

Linking space to user needs

How to get in touch:

GSA Newsletter

GNSS YouTube Channel

GSA Twitter - @EU_GNSS
EGNOS Twitter - @EGNOSPortal

European GNSS Agency LinkedIn Page
GNSS Market, Research & Development

GNSS Facebook page

GNSS Slideshare Page (presentations)

www.GSA.europa.eu

European
Global Navigation
Satellite Systems
Agency

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NAVIGATION SOLUTIONS
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Thank you!

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