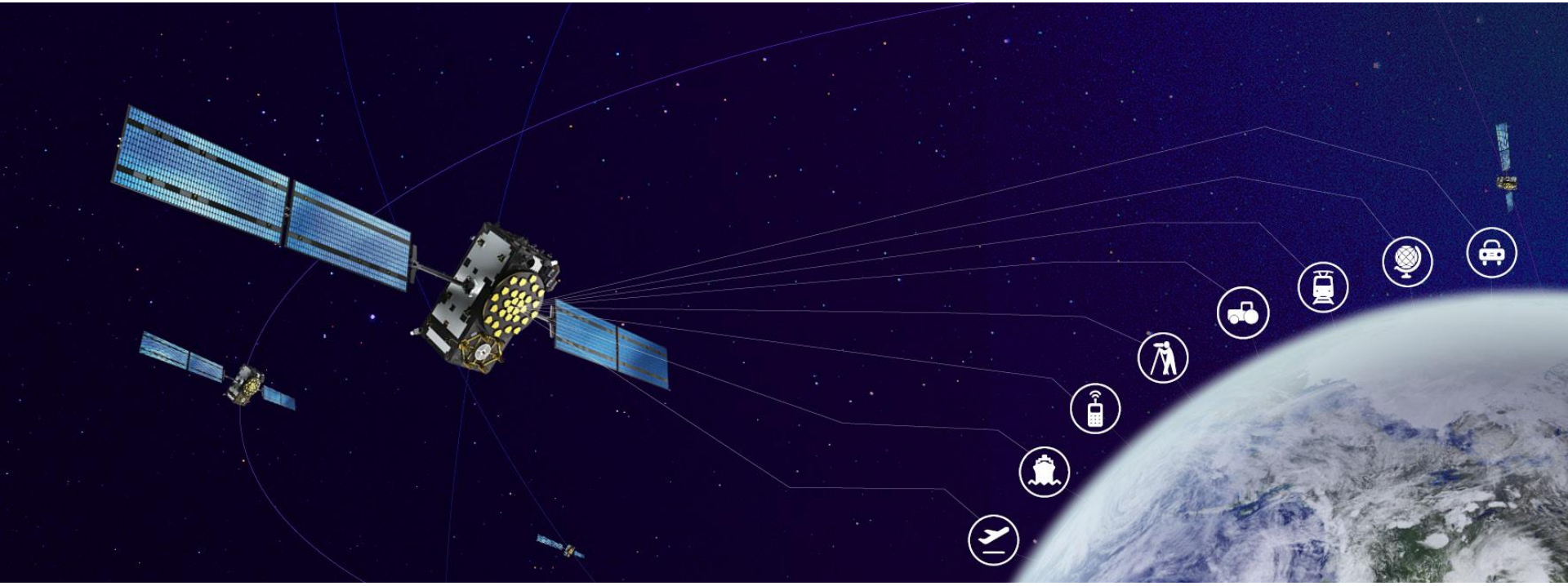

European Global Navigation Satellite Systems Agency

GALILEO EGNOS

NAVIGATION SOLUTIONS POWERED BY EUROPE

European GNSS for Surveying and Mapping

EUREF 2018 Symposium

Alina Hriscu
Market Development
European GNSS Agency (GSA)

Amsterdam, 1 June 2018

This presentation can be interpreted only together with the oral comments accompanying it

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
- R&D and funding opportunities

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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

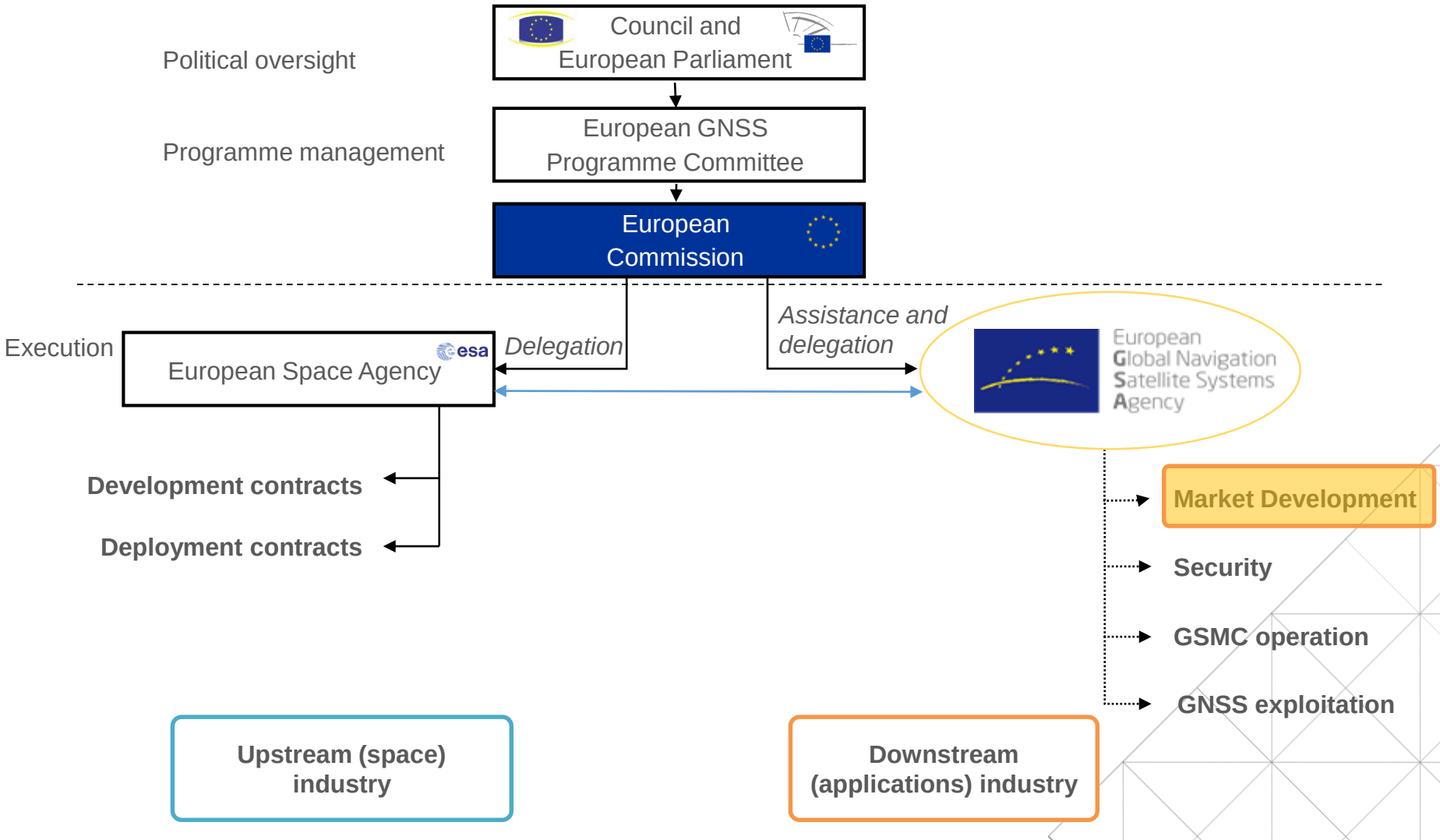
Who and where?

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



Understand the users and market, stimulate the demand, create a competitive EU offer

MARKET SEGMENTS

- Road
- Maritime
- Aviation
- Rail
- Location Based Services
- Agriculture
- Surveying & Mapping
- Timing & Synchronisation
- Governmental

DOWNSTREAM VALUE CHAIN

Navigation Signal Providers → Chipset, receiver → Devices → Content & Apps → Service providers

UNDERSTAND MARKET & USER NEEDS

STIMULATE DEMAND & ADOPTION

CREATE EU OFFER

HORIZON 2020

Fundamental Elements

E-GNSS USER ADOPTION

EU PUBLIC BENEFITS

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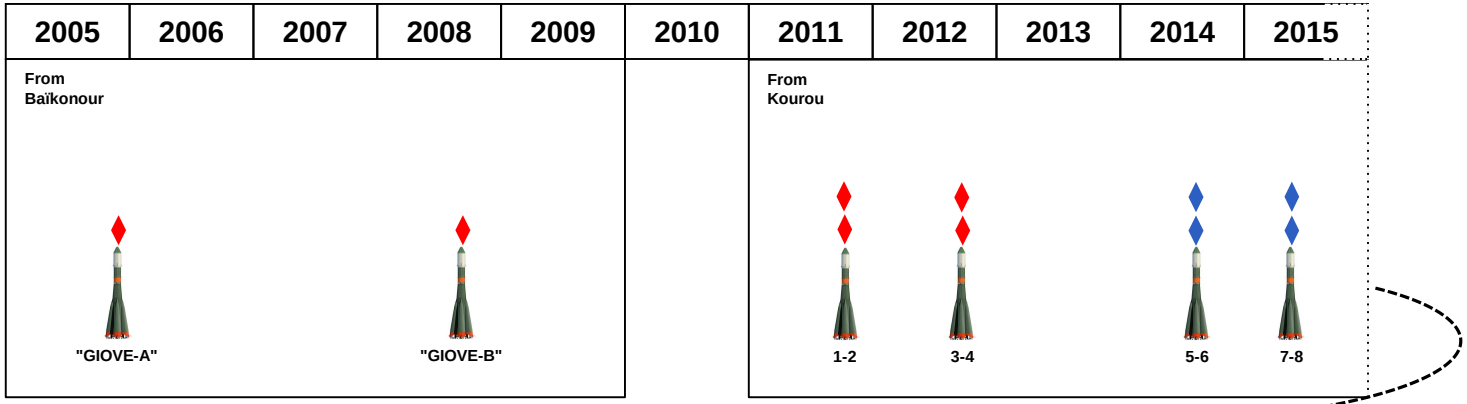
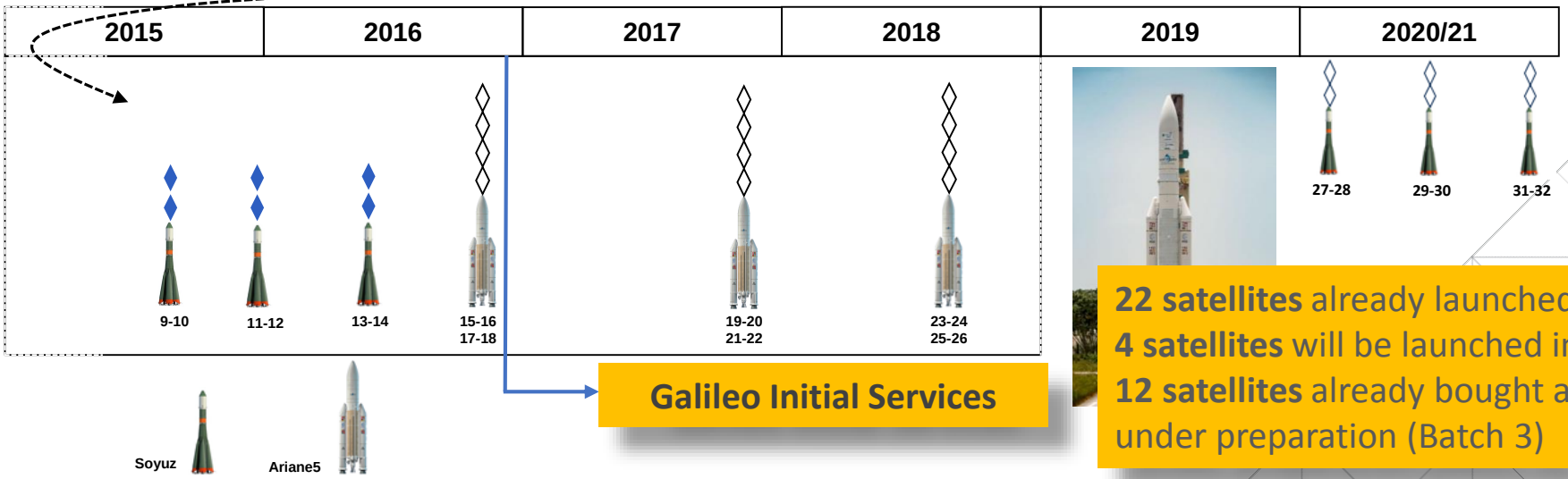
Galileo deployment is progressing





22 satellites already launched
4 satellites will be launched in 2018
12 satellites already bought and under preparation (Batch 3)

Galileo Open Service Performance

Definition		Committed Target	March 2018
Ranging accuracy Dual Frequency (95%)	Worst Satellite month	**< 7.0 m**	**0.78 m**
	Constellation Average	**< 2.0 m**	**0.50 m**
Ranging accuracy (Single Frequency (95%)	Worst Satellite month	**< 7.0 m**	**0.73 m**
	Constellation Average	**< 2.0 m**	**0.51 m**
Availability of Dual Frequency Ranging (global average)		**> 87%**	**100%**
Per Satellite Availability of Signal in Space (monthly, OS, global average, healthy SF/DF)		**> 87%**	**>98.75%**
UTC Time dissemination uncertainty (DF, 95% over campaign period)		**< 30 ns**	**5.5 ns**
Availability of UTC dissemination		**> 87%**	**100%**
GST - GPS time offset uncertainty (95% over campaign period)		**< 20 ns**	**5.6 ns**
GST - GPS time offset availability (over campaign period)		**> 80%**	**98.75%**

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

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

Next UCP: Marseille, December 2018

1ST GALILEO USER ASSEMBLY MADRID

EGNOS

GALILEO

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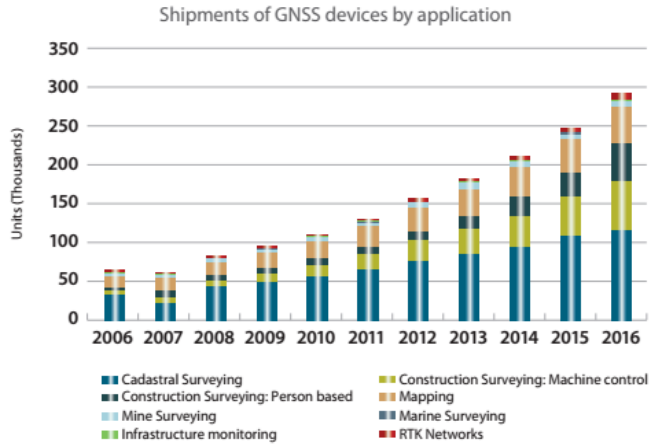
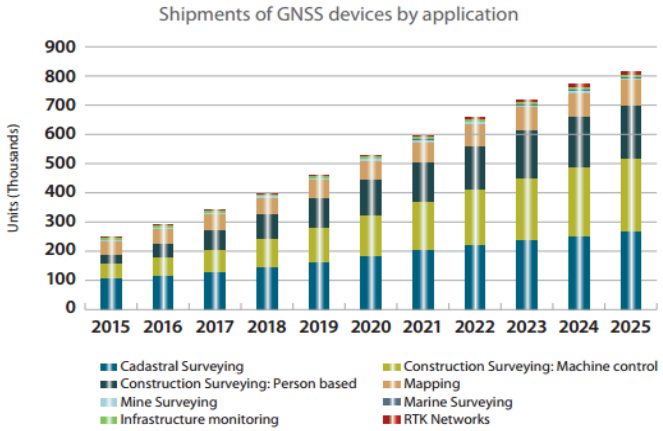
Construction, mapping and cadastral industries stimulated growth in shipments of GNSS surveying equipment





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**

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

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

52 smartphones models **Galileo** enabled

HUAWEI

SAMSUNG

Android 7+ access to raw GNSS measurements

GSA GNSS Raw Measurements Task Force

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

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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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 Service (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)

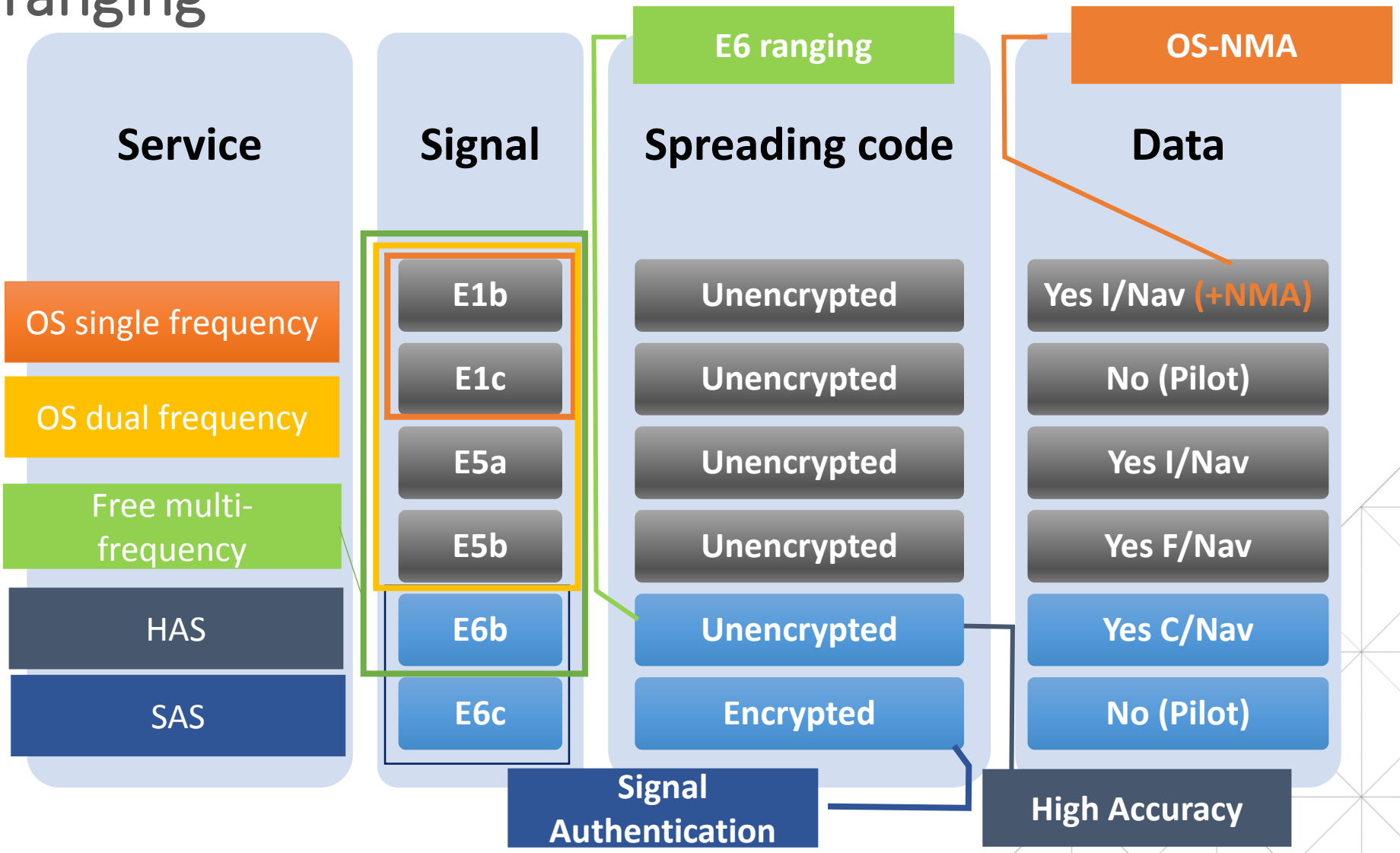
Public Regulated Service (PRS)

Search and Rescue Service (SAR)

High Accu Service (HA

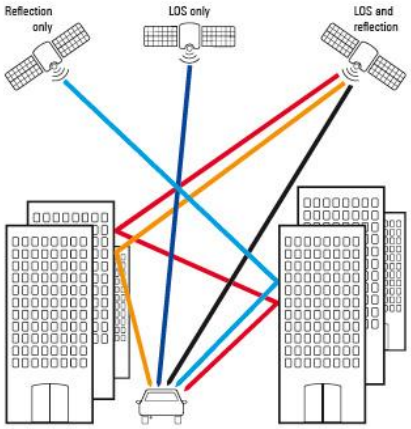
Auth Servi AS)

Overview of signals
Open service / Commercial service / E6 ranging



Galileo Open Service improves positioning performance for surveyors

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

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

Galileo High Accuracy Service (HAS) (E6)

- PPP-like accuracy without additional communication channel
- Does not require proximity to base stations to access corrections
- Improved line-of-sight and better coverage at high latitudes
  - All the three due to broadcasting external data in real time across the globe (PPP – Precise Point Positioning) via Galileo E6
- Further reduced convergence time
  - Due to triple frequency

	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.

Current status of Galileo in Surveying

Augmentation service providers

- **Majority of RTK providers upgraded** or have started to upgrade to Galileo Capabilities (incl. NETPOS (NL))
- **First providers started to transmit full Galileo solution**: Galileo enabled network-RTK corrections
  - **Pioneers** (SWEPOS (SE), GeoSoft (ET), ORPHEON (FR))
- **The main PPP** providers **support Galileo corrections**

NovAtel

G4

Fugro

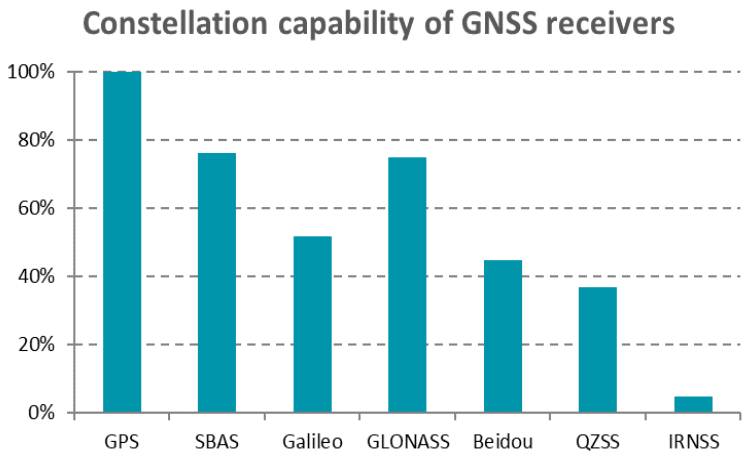
veripos ON TARGET

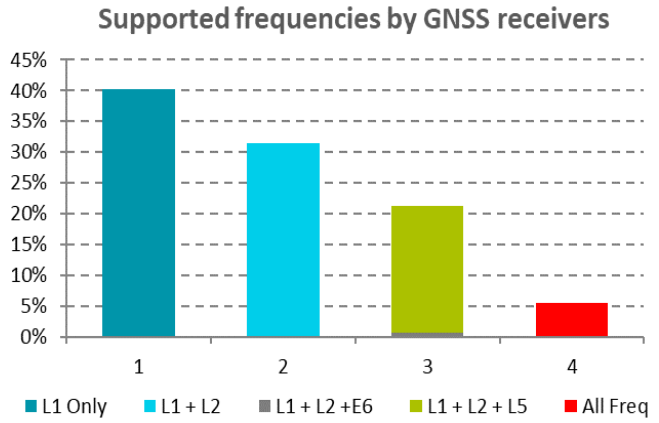
TERRASTAR

RTX + VRS NOW

Trimble

Receiver Capabilities*





*professional receivers (surveying+agri+timimng)

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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 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-resolution terrestrial-aerial sensing system

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 georeferencing - Kinematic Ground Control Points

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

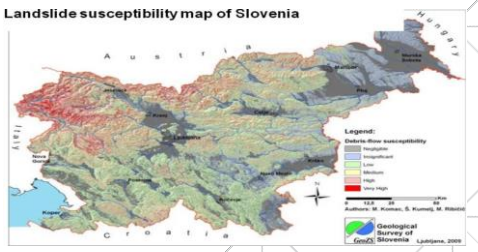
Features of developed product:

- Innovative **3D-mapping** tandem **for corridor** reconstructions
- Potential game-changer for **operational simplicity and cost savings**

GIMS - **Geodetic Integrated Monitoring System**

Gims

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

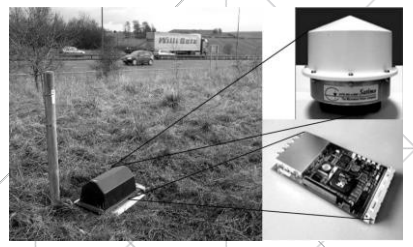


Copernicus Europe's eyes on Earth

- Vertical displacements (via synthetic aperture radar interferometry InSAR)

GALILEO

- Horizontal displacements
- Temporal interpolation a
- 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

GSA supports Young Surveyors

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

2018 edition open

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

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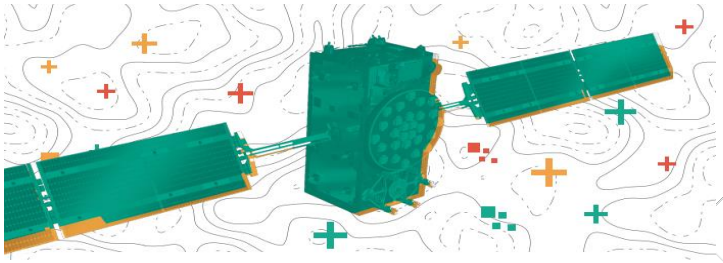


YOUNG SURVEYOR'S PRIZE 2018

Linking space to user needs

How to get in touch:

GSA Newsletter

GNSS YouTube Channel

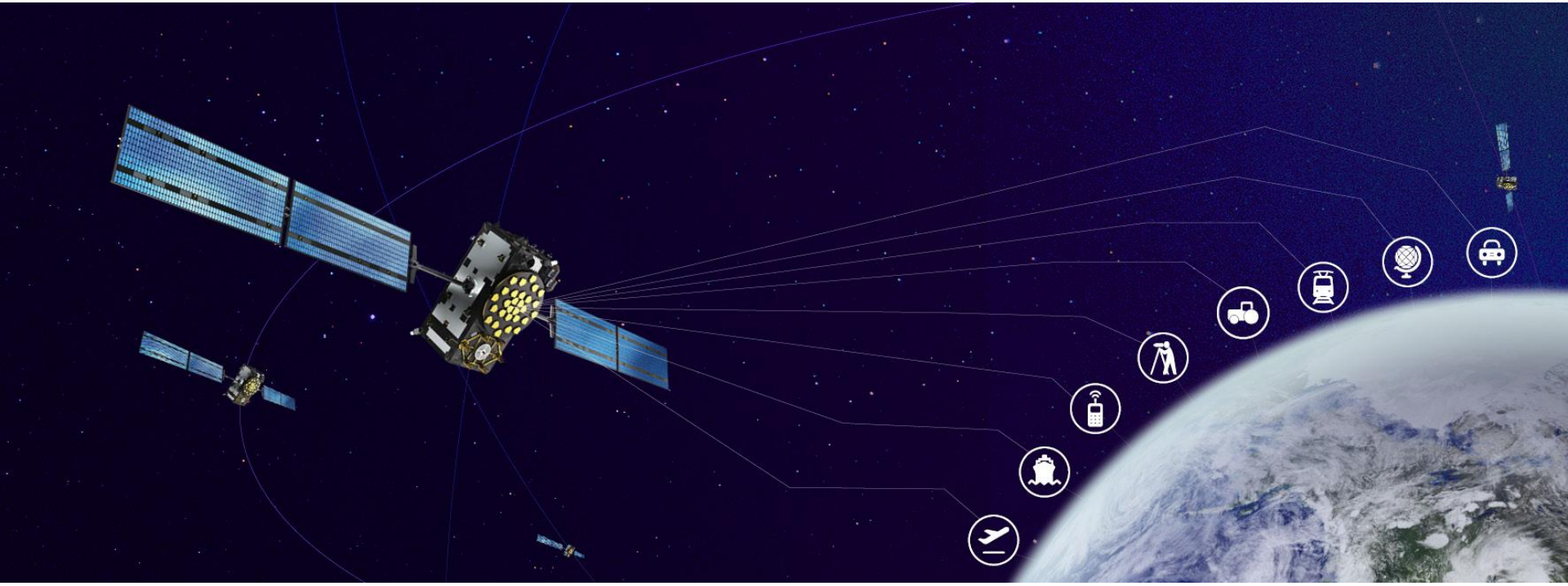
GSA Twitter - @EU_GNSS
EGNOS Twitter - @EGNOSPortal

European GNSS Agency LinkedIn Page
GNSS Market, Research & Development

GNSS Facebook page

GNSS Slideshare Page (presentations)

www.GSA.europa.eu



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Thank you!

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