UPDATE ON GALILEO DEVELOPMENTS AND THE AVAILABLE SERVICES
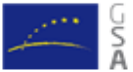
EUPOS Council and Technical Meeting

The third meeting of the Positioning Knowledge Exchange Network (PosKEN)

Prague, The Czech Republic
15-16 November 2016

Alina Hriscu

Michal Babacek

Market Development

European GNSS Agency

Agenda

European GNSS Agency (GSA)

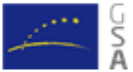Galileo Services, Signals and Implementation plan

GSA R&D

Agenda

European GNSS Agency (GSA)

Galileo Services, Signals and Implementation plan
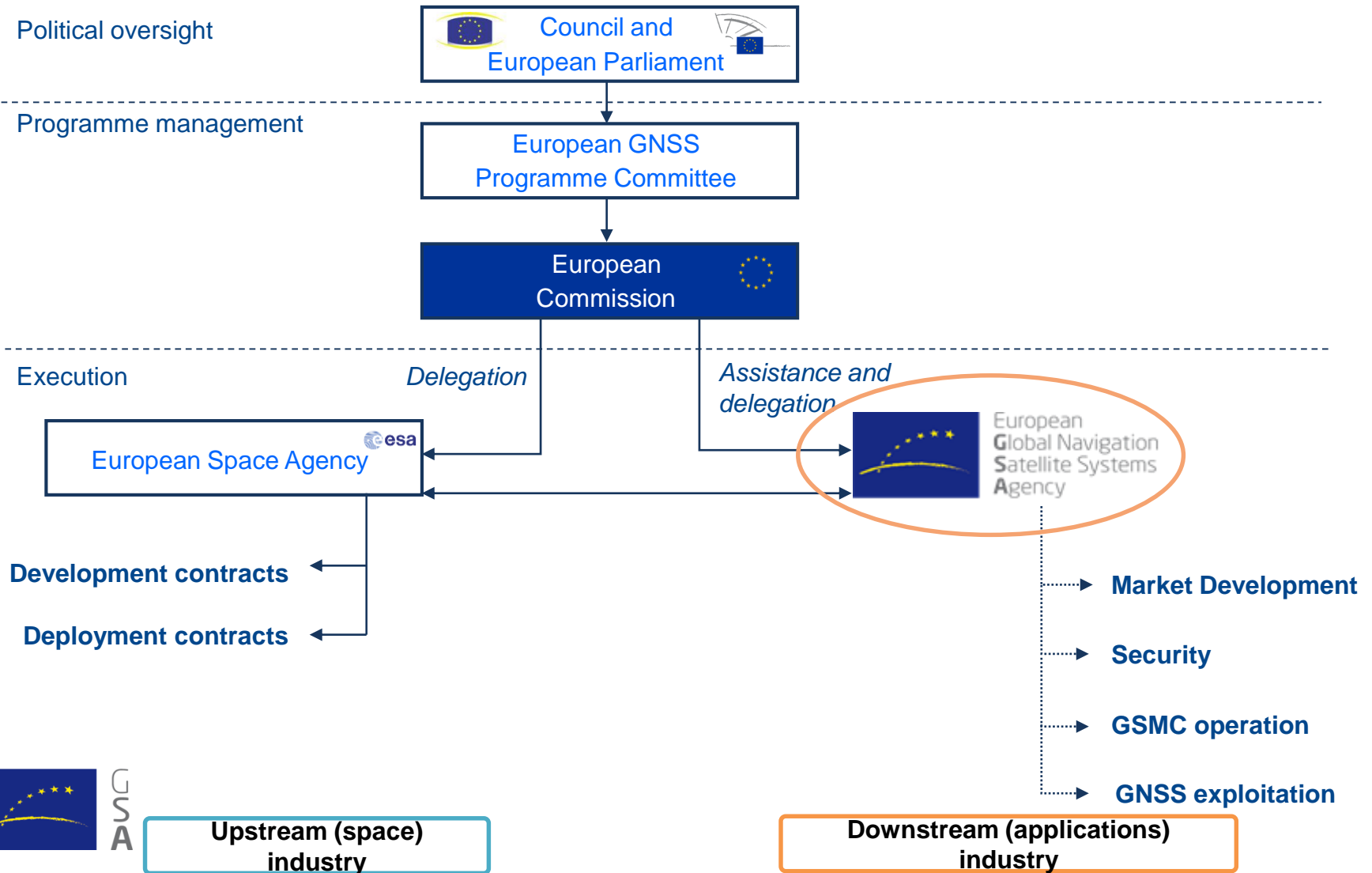
GSA R&D

European
Global Navigation
Satellite Systems
Agency

European GNSS Agency (GSA)

- Staff: **135**

- Nationalities: **21**

- Headquarter: **Prague, Czech Republic**

- Security monitoring centres: **Swanwick (UK) and St Germain en Laye (France)**

- European GNSS Service Centre (GSC): **Torrejon (Spain)**

How GSA fits in the EU structure

Political oversight

Council and European Parliament

Programme management

European GNSS Programme Committee

European Commission

Execution

Delegation

Assistance and delegation

European Space Agency

European Global Navigation Satellite Systems Agency

Development contracts

Deployment contracts

Market Development

Security

GSMC operation

GNSS exploitation

Upstream (space) industry

Downstream (applications) industry

Agenda

European GNSS Agency (GSA)

Galileo Services, Signals and Implementation plan

GSA R&D

European
Global Navigation
Satellite Systems
Agency

EGNOS already available serving EU citizens and industry

- Satellite Based Augmentation System (SBAS)
- Improves GNSS performance
- European coverage (but under extension in other regions, e.g. North Africa)
- Available NOW, <u>free of charge</u> and widely adopted in off-the-shelf receivers

EGN⊗S

'It's there, use it'

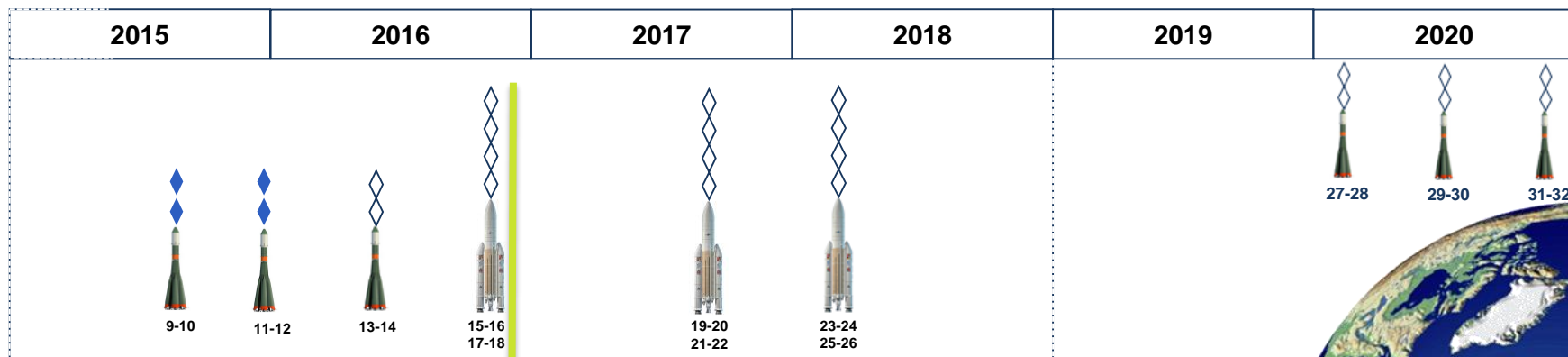|			
Open Service (OS)	Accuracy ~1m, free	Available since October 2009	
Safety of Life Service (SoL)	Accuracy ~1m, compliant to aviation standards	Available since March 2011	
EGNOS Data Access Service (EDAS)	Accuracy <1m, corrections provided by terrestrial networks	Available since July 2012	

Galileo is the European GNSS offering four services

- Worldwide navigation system "made in EU"
- Fully compatible with GPS
- Open service <u>free of charge</u>, delivering dual frequencies
- Signal authentication will provide trustability

Open Service (OS)	Freely accessible service for positioning and timing	
Public Regulated Service (PRS)	Encrypted service designed for greater robustness and higher availability	
Search and Rescue Service (SAR)	Assists locating people in distress and confirms that help is on the way	
Commercial Service (CS)	Delivers authentication and high accuracy services for commercial applications	

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

2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015

From Baïkonour

"GIOVE-A" "GIOVE-B"

From Kourou

1-2   3-4   5-6   7-8

2015	2016	2017	2018	2019	2020

9-10   11-12   13-14   15-16 17-18   19-20 21-22   23-24 25-26   27-28   29-30   31-32
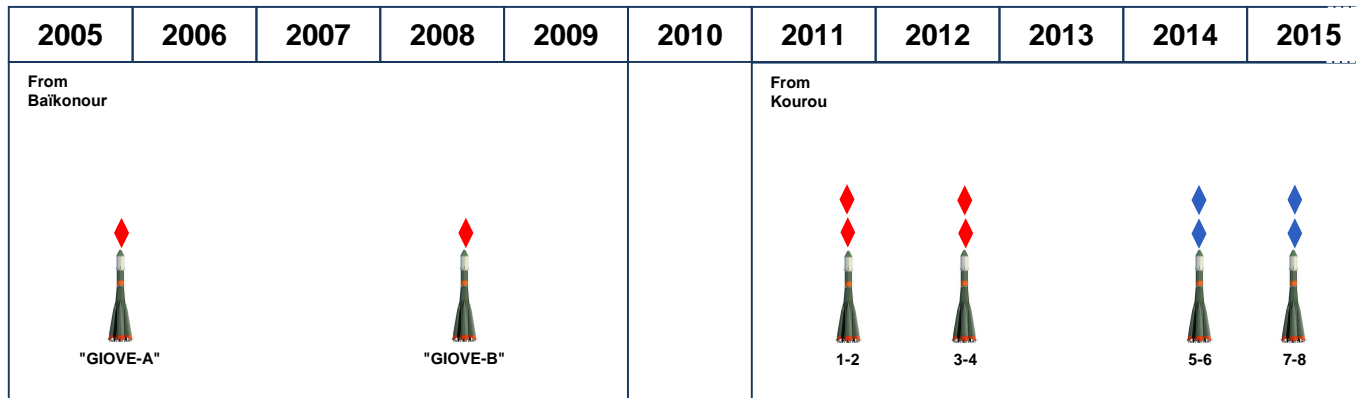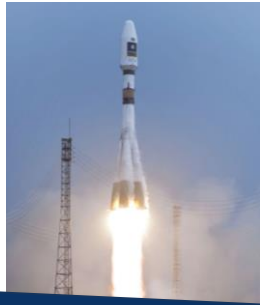
Soyuz   Ariane5

Galileo Initial Services

The Galileo implementation plan accelerates providing Initial Services in 2016

2 satellites launched on 24th May => Accelerating the implementation

On the 17th of November, 4 Galileo satellites will be launched for the first time by an adapted Ariane 5 launcher

Galileo is implemented in a step-wise approach

- **14 satellites** have been launched
- **18 satellites** are in production/being procured:
  - ✓ 4 to be launched in Q4 2016
  - ✓ The remaining ones by 2020

2016/2017

Initial Operational Capability
Initial services for Open Service (OS),
Search and Rescue Service (SAR),
Public Regulated Service (PRS),
and demonstrator for Commercial Service (CS)

2018/2019

Test signal for
OS Navigation Message Authentication
(OS-NMA) and CS High Accuracy (CS-HA)

2020

Full Operational Capability
Full services, 30 satellites
An independent civilian infrastructure

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

www.gsc-europa.eu

Current usage of GSC services

Some GSC figures (from 1st Jun 2013 to 31st August 2016):

- More than **86k visits** from **199 different countries**
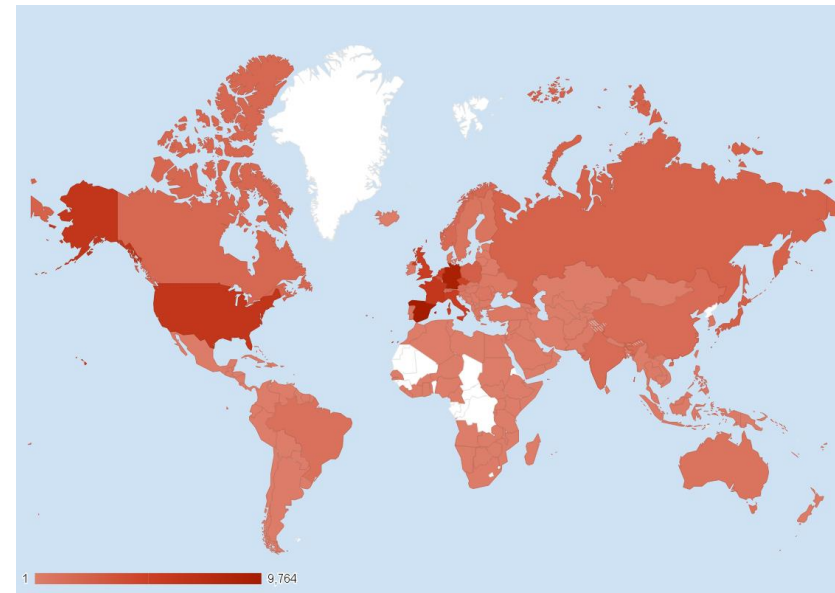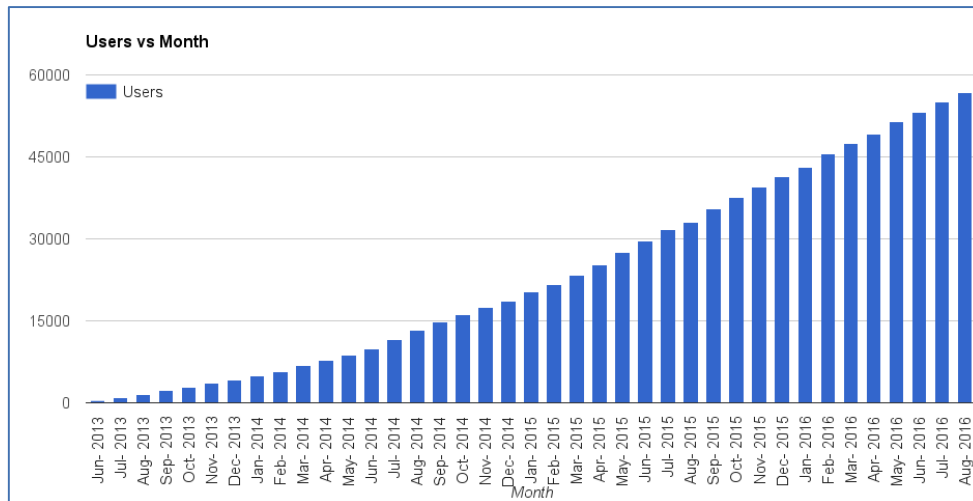
- **170** user **requests** handled and **122 NAGUs** published

- **416 registered users** on the GSC web portal

Overview of signals
Open service / Commercial service / E6 ranging

Service	Signal	Spreading code	Data
		E6 ranging	**OS-NMA**
OS single frequency	E1b	Unencrypted	Yes I/Nav (+NMA)
OS double frequency	E1c	Unencrypted	No (Pilot)
triple frequency	E5a	Unencrypted	Yes I/Nav
	E5b	Unencrypted	Yes F/Nav
CS	E6b	Unencrypted TBC (CS HA)	Yes C/Nav
	E6c	Encrypted TBC (CS Auth)	No (Pilot)

CS Authentication

CS High Accuracy
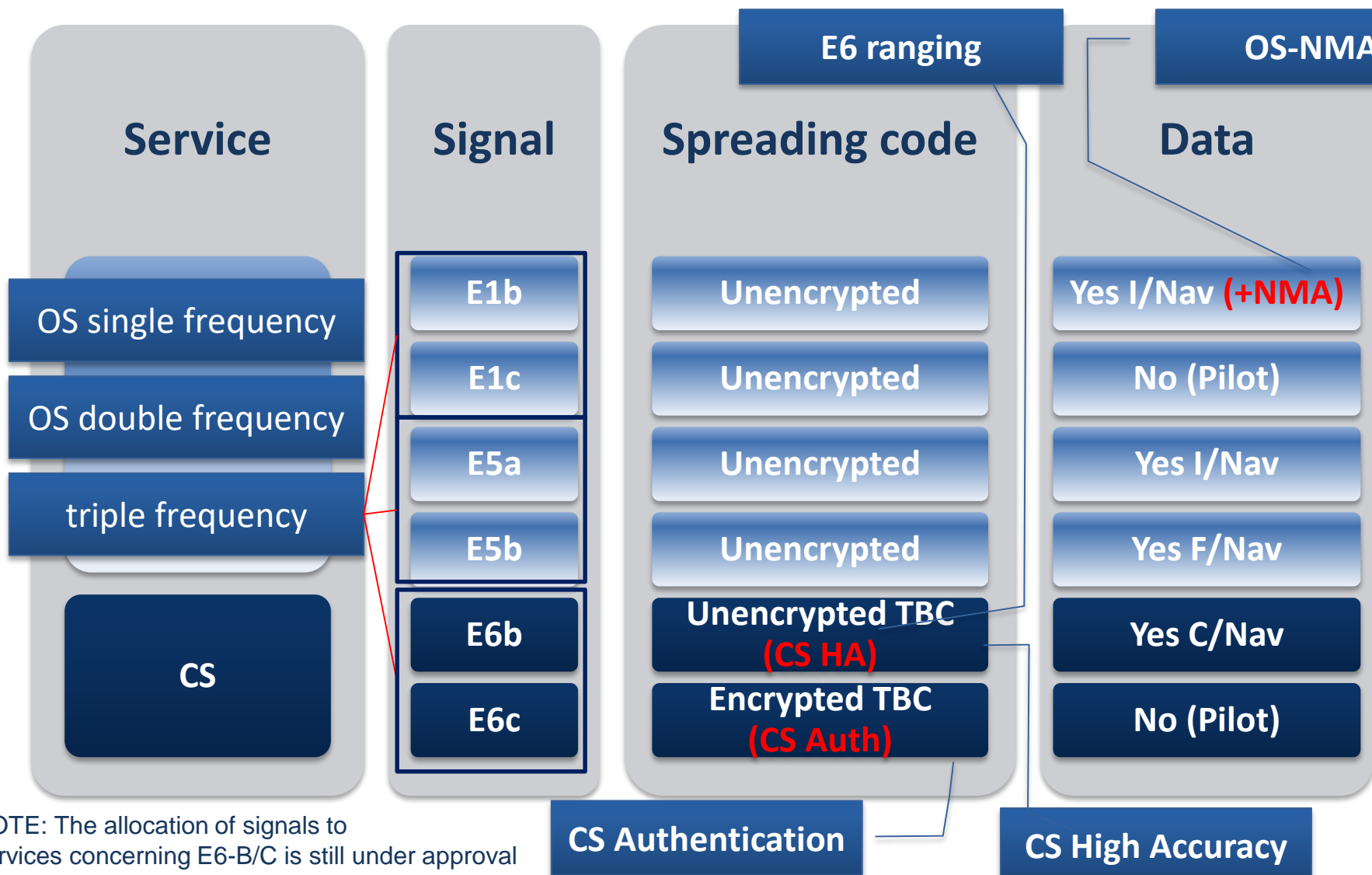
NOTE: The allocation of signals to services concerning E6-B/C is still under approval

Open Service:
Key points

Advantages of Galileo OS E1/E5 bands

(some of them starting with Initial Services)

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 frequency E6 ranging

Choice for the 2nd frequency

Clearly, the obvious choice for the future 2nd frequency is L5/E5, because it is:

➢ A protected frequency

➢ Shared by all GNSS

➢ And all SBAS

➢ More widely separated from L1, thus minimising the iono-free linear combination errors

Specific key advantages of L5/E5 signal
- Better multipath mitigation and better accuracy using L5/E5 signals vs using L2
- Higher received power for L5/E5 vs L2C

Choice for the 3rd frequency

E6b unencrypted
Best option for tri-laning

→ The question is that of the 3rd frequency for high accuracy applications (e.g. worldwide PPP):

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

* References:
- Stansell Munich Summit 2015 / IGC workshop Krasnoyarsk 2015
- Hatch ION GNSS 2006
- Humphreys et al. IGS workshop 2008

Commercial Service
General Definition

Galileo Commercial Service

CS High Accuracy
CS-HA

CS Authentication
CS-Auth

CS-HA - a controlled high accuracy service based on Precise Point Positioning (PPP) corrections transmitted in the E6 CS signal (E6-B, data component)

CS-Auth – a controlled authentication service for commercial non-institutional users, with the possibility to be used by some institutional users, based principally on the encrypted spreading codes in the E6 CS signal

Extracts from the EU GNSS Regulation 1285/2013

— CS shall enable"…the development of applications for professional or commercial use by means of improved performance and data with greater added value than those obtained through the open service"

— CS is based on "commercial ranging and data, whose access shall be controllable in order to allow fees to be levied."

This is understood as a Commercial platform that…

— Produces **revenue** to the EU

— Maximises **social benefits**

Commercial Service: Key features

Advantages of Galileo CS-HA →

High Accuracy (CS-HA): receiver positioning accuracy with an **error below one decimetre**

Broadcast external data in real time across the globe (**PPP – Precise Point Positioning**) via Galileo E6 **without the need for an additional communication channel**

Does not require proximity to base stations to access corrections

Triple frequency to further **reduce convergence time**

Improved line-of-sight and better coverage at high latitudes

There are different Steps towards a full Galileo Commercial Service Provision

11 SVs

2016
- System Deployment
- Initial Services Declaration (OS, PRS, SAR)

2017
- CS-HA Architecture Definition
- CS Real Time Test with CSP

15 SVs

2018
- CS Real Time Test available for the Users

19 SVs

2019
- CS-HA enabled Receivers

23 SVs

2020 — **Commercial Service Provision**

29 SVs

G
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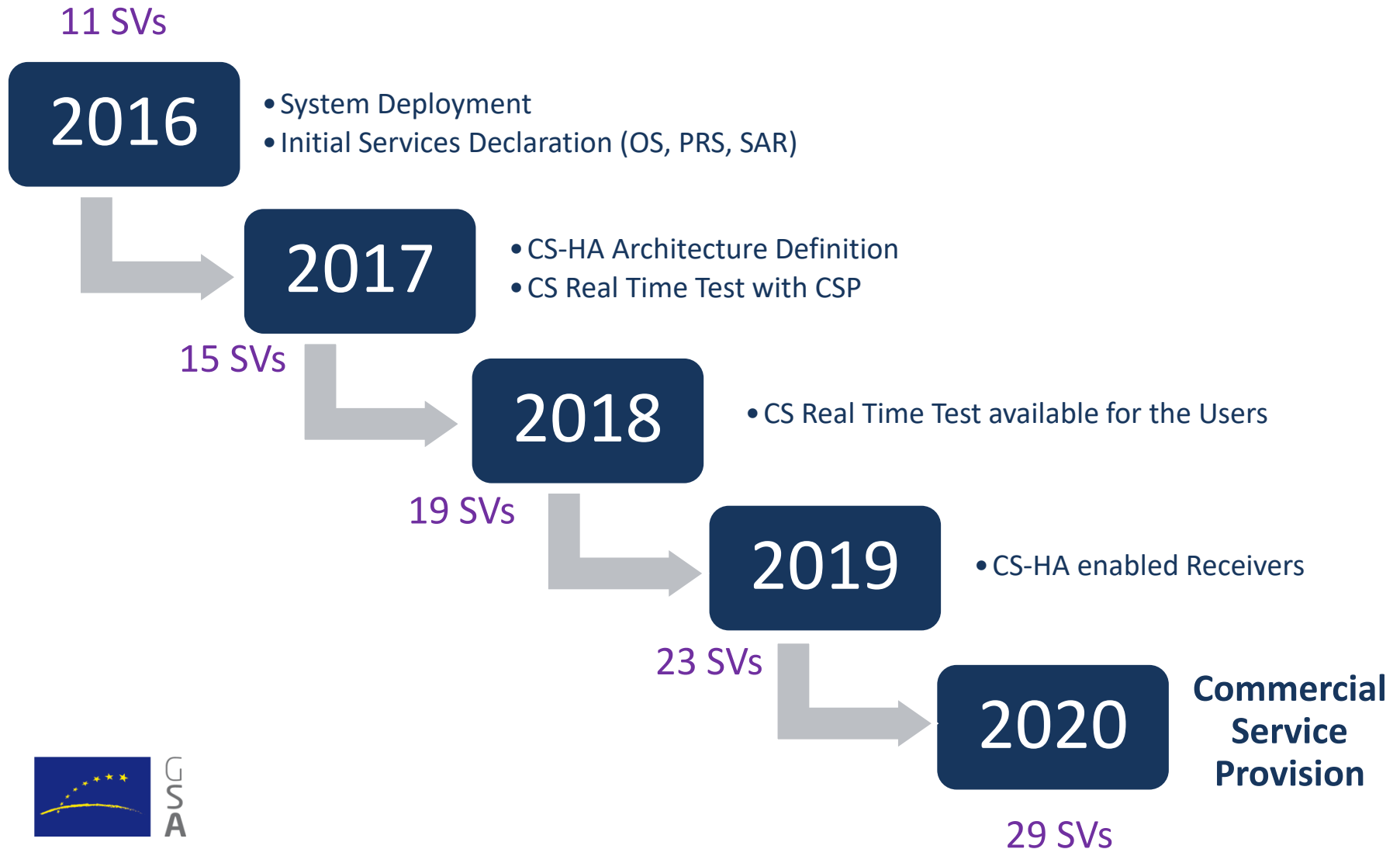
Adding Galileo constellation to RTK network

Adding a new constellation to RTK network

✓ Open-sky conditions:
  - No considerable improvement in terms of integer ambiguity resolution

✓ Real-life environment (under tree canopy, urban canyons, comes out from the bridge, etc.)
  - In order to set-up and maintain ambiguity resolution: nr. of satellites play crucial role
  - Extra satellites help by:
    - ✓ quicker RTK integer ambiguity resolution in harsh environment
    - ✓ RTK can be maintained when much more of the sky is blocked

Galileo features

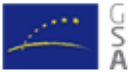✓ Galileo dual frequency: the same frequencies as GPS
  - L1/E1, L5/E5 = much easier for the RTK algorithm (x GPS-GLONASS)
    - ✓ Easier integration
    - ✓ Less computation and power consumption

✓ RTK in future – Galileo to offer triple frequency
  - Allow longer baseline
    - ✓ Less dense network
    - ✓ Less costs for infrastructure
    - ✓ Extended coverage
  - Faster fix for end-users

GALILEO

Agenda

European GNSS Agency (GSA)

Galileo Services, Signals and Implementation plan

GSA R&D

European
Global Navigation
Satellite Systems
Agency

R&D funds to support Galileo integration– the bigger picture

DOWNSTREAM VALUE CHAIN

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

MARKET SEGMENTS

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

Understand **market and user needs and satisfaction**

GNSS MARKET REPORT
ISSUE 3

Seven billion GNSS devices by 2022 – almost one for every person on the planet

Excellent
Good
Averag

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

HORIZON 2020

E-GNSS USER ADOPTION

EU PUBLIC BENEFITS

H2020 R&D funding

Applications in Satellite Navigation-Galileo-2017

Type of Action	Topic	Budget (EUR mln)	Funding rate	Indirect costs
IA	EGNSS Transport Applications	14.50	**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 Mass Market Applications	9.00		
IA	EGNSS Professional Applications	8.00		
CSA	EGNSS Awareness raising and capacity building	1.50	**100%**	
	Total budget:	33.00		

Innovation Actions: activities aimed at producing plans and arrangements or designs for new, altered or improved products, processes or services.

Coordination and Support Actions: consisting of accompanying measures such as standardisation, dissemination, awareness-raising and communication, networking, policy dialogues and studies.

The 2017 H2020 Call for applications promotes the EGNSS use for Professional Market Applications

- Opening date: **8th November 2016**

- Deadline **1st March 2017**

- 8 €mln budget

- **Scope:**

Developing new innovative applications, building also on the EGNSS differentiators in combination with Earth Observation and Copernicus services, with commercial impact.

- **Areas:**
  - Agriculture
  - Surveying and Mapping
  - Timing & Synchronisation
  - Other Professional Applications

- **Expected Impact:**
  - **Improve the productivity and decrease the environmental impact** (agriculture)
  - Development of **highly innovative applications** taking advantage of EGNSS added value
  - To contribute to **coping with emerging network and synchronisation needs** (accuracy, robustness)

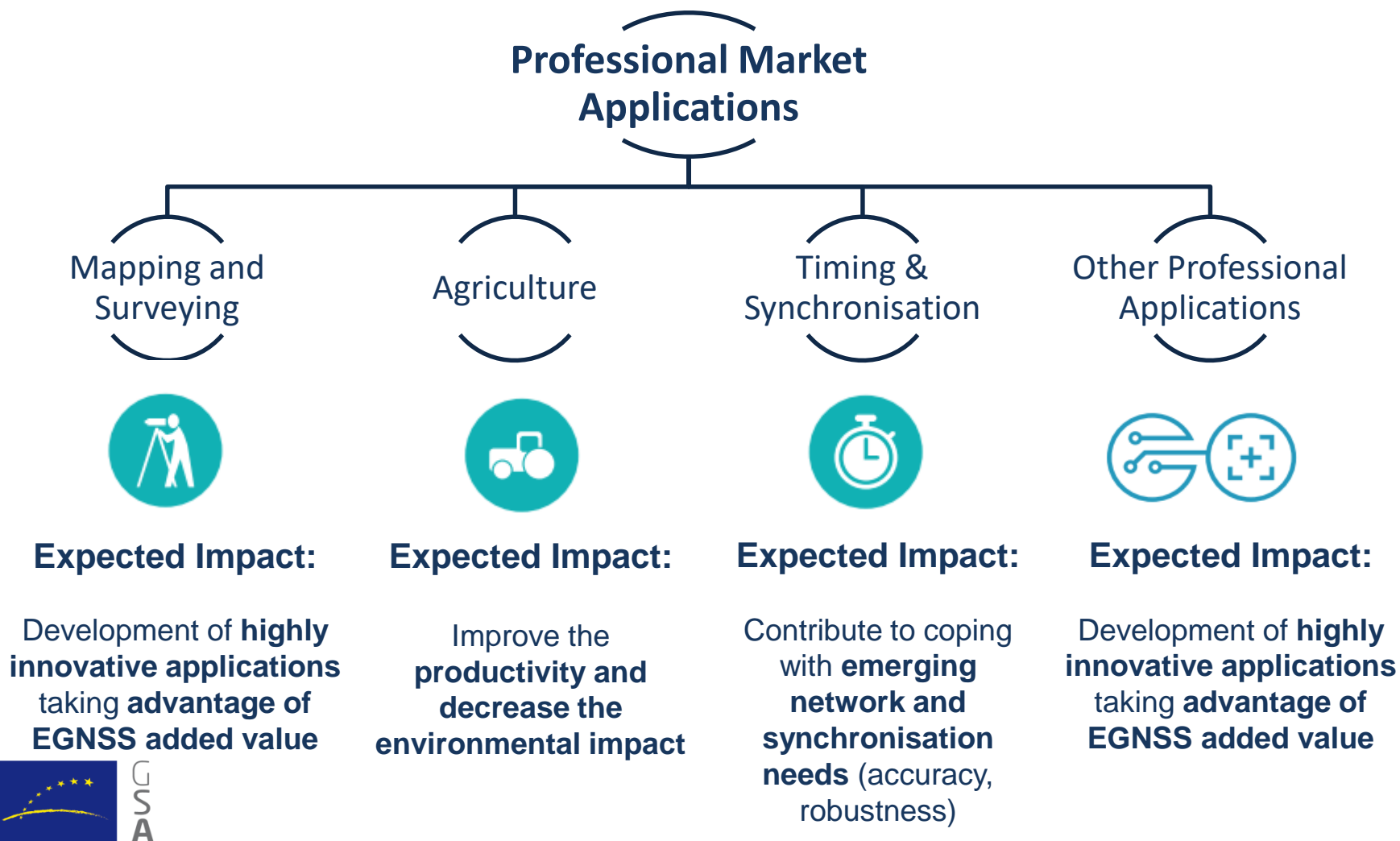http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/galileo-3-2017.html

Professional Market Applications

Professional Market Applications

Mapping and Surveying

Agriculture

Timing & Synchronisation

Other Professional Applications

Expected Impact:

Development of **highly innovative applications** taking **advantage of EGNSS added value**

Expected Impact:

Improve the **productivity and decrease the environmental impact**

Expected Impact:

Contribute to coping with **emerging network and synchronisation needs** (accuracy, robustness)

Expected Impact:

Development of **highly innovative applications** taking **advantage of EGNSS added value**

What are Fundamental Elements?

- Fundamental Elements Programme was created by the 2013 GNSS Regulation

- Specific Research and Development activities related to chipsets and receivers development

- High-level objectives
  - **Facilitate the adoption of the European GNSS Systems building on innovative services and differentiators**

  - **Increase the EU industry competitiveness**

  - **Address the user needs in priority market segments, maximising the benefits for the citizens**

- Budget envelope
  - 111,5 million Euros

- The end product target all the users in all market segments

https://www.gsa.europa.eu/r-d/gnss-r-d-programmes/fundamental-elements
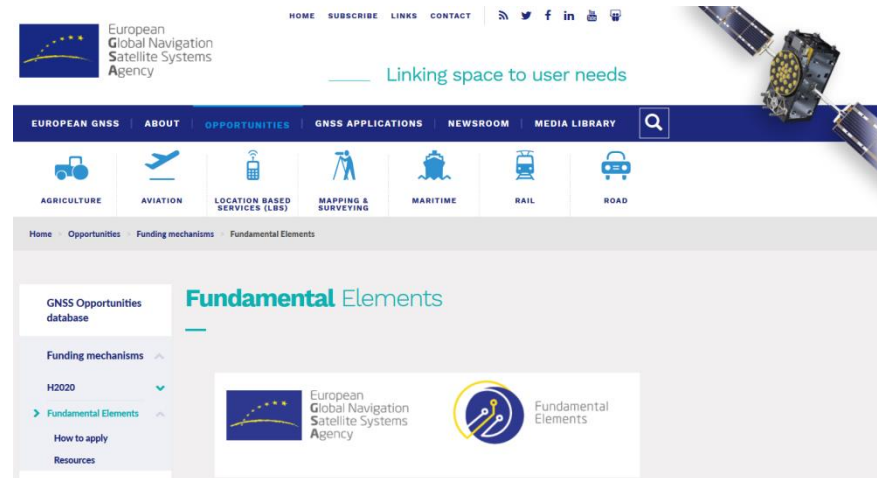
A full analysis of GNSS receiver capabilities available in the GSA's Technology Report

Available for download

HTTP://BIT.LY/2CGARXF

An in-depth analysis of 3 GNSS Macrosegments :

- **MASS MARKET SOLUTIONS**

- **TRANSPORT SAFETY AND LIABILITY-CRITICAL SOLUTIONS**

- **HIGH PRECISION, TIMING AND ASSET MANAGEMENT SOLUTIONS**

https://www.gsa.europa.eu/system/files/reports/gnss_user_technology_report_webb.pdf

THANK YOU!

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