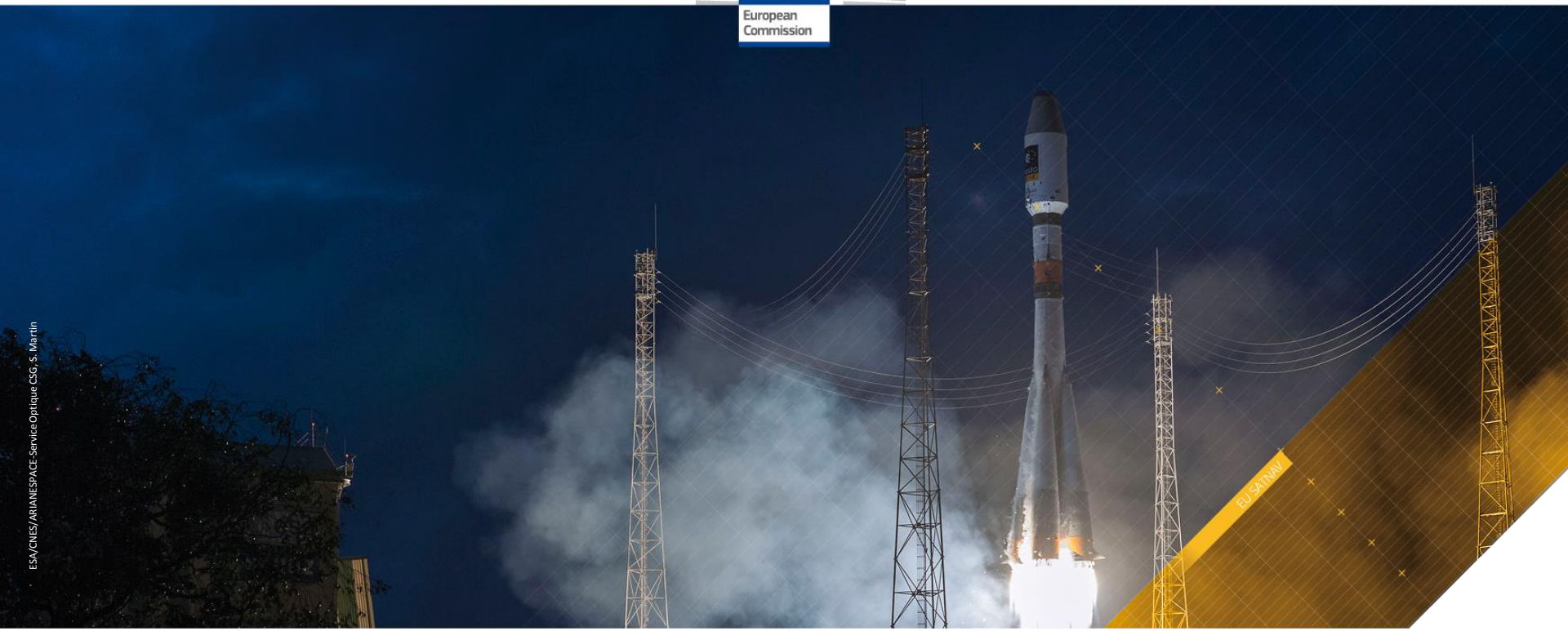


ESA/CNES/ARIANESPACE-Service Optique CSG, S. Martin

GALILEO EGNOS
NAVIGATION SOLUTIONS
POWERED BY EUROPE

CÓRDOBA, 19 DE MARZO 2018

GALILEO SERVICES

GALILEO EGNOS
NAVIGATION SOLUTIONS
POWERED BY EUROPE

Open Service (OS)

- Freely accessible service for positioning, navigation and timing

Public Regulated Service (PRS)

- Encrypted service for greater robustness and higher availability

Search and Rescue (SAR) - contribution

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

Commercial Service (CS)

- Authentication and high accuracy services for commercial applications

Safety-of-Life (SoL) - contribution

- Provides vital integrity information for life-critical applications

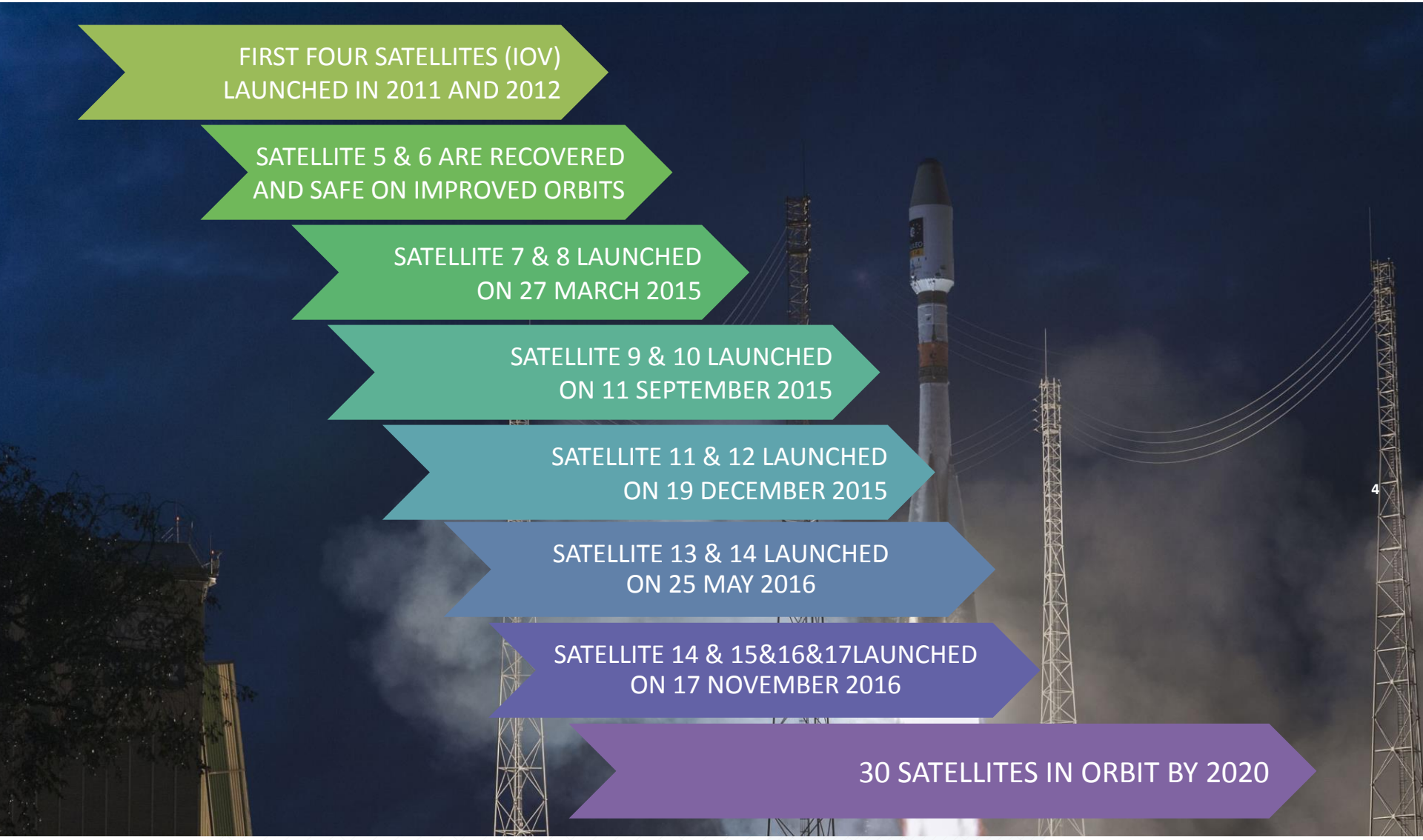
GALILEO INITIAL SERVICES DECLARED IN DECEMBER 2016

- **Open Service**
  - Free
  - Interoperable with other GNSS
  - worldwide access

- **Public Regulated Service**
  - Access controlled by "Competent Authorities"
  - Worldwide coverage

- **Search and Rescue**
  - Free
  - Worldwide coverage (Cospas-Sarsat)
  - Locate emergency beacons

GALILEO SYSTEM LAUNCHES



FIRST FOUR SATELLITES (IOV)
LAUNCHED IN 2011 AND 2012

SATELLITE 5 & 6 ARE RECOVERED
AND SAFE ON IMPROVED ORBITS

SATELLITE 7 & 8 LAUNCHED
ON 27 MARCH 2015

SATELLITE 9 & 10 LAUNCHED
ON 11 SEPTEMBER 2015

SATELLITE 11 & 12 LAUNCHED
ON 19 DECEMBER 2015

SATELLITE 13 & 14 LAUNCHED
ON 25 MAY 2016

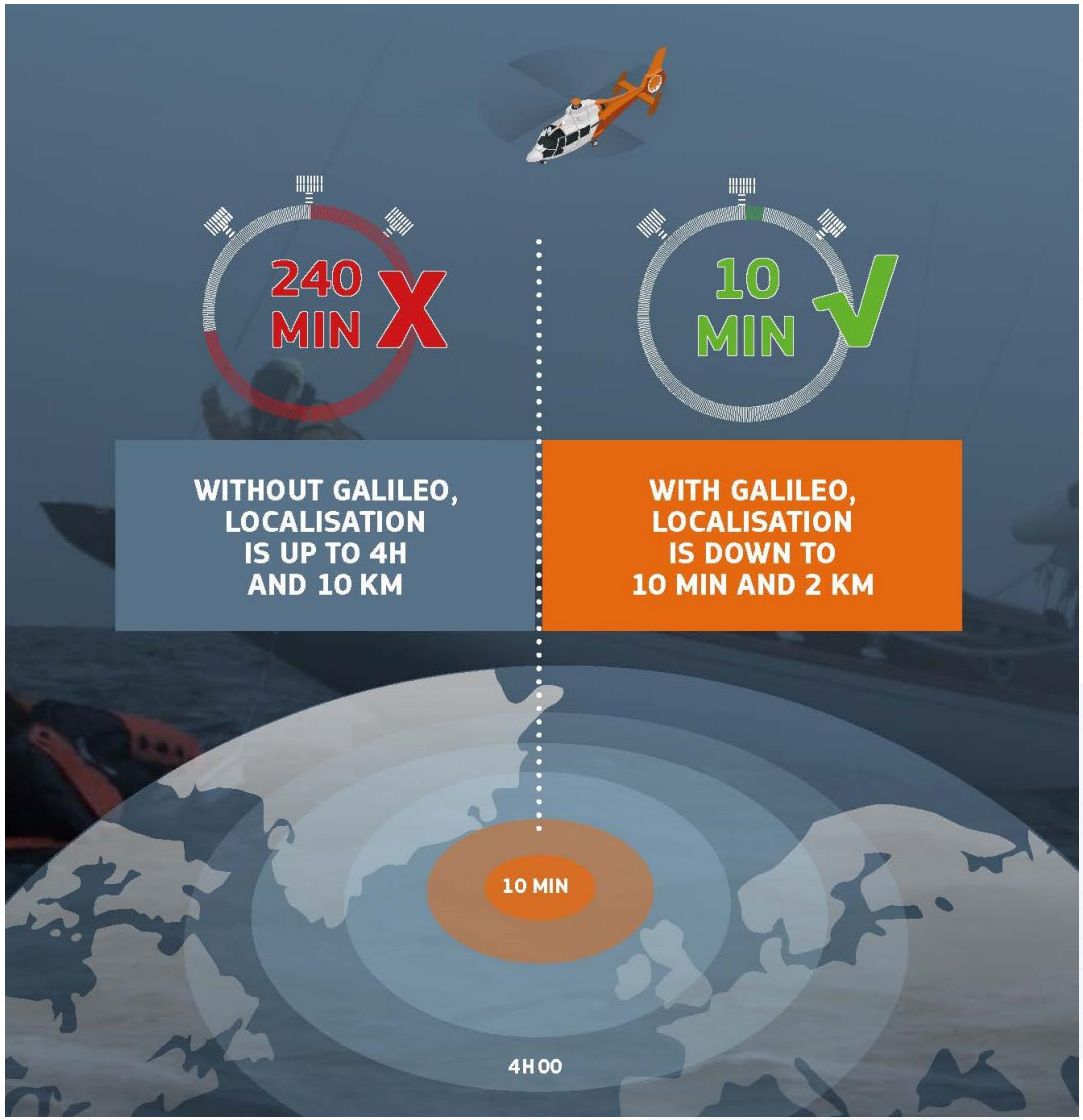
SATELLITE 14 & 15&16&17LAUNCHED
ON 17 NOVEMBER 2016

30 SATELLITES IN ORBIT BY 2020

GLILELO OS PERFORMANCE - NAVIGATION

Definition		Committed Target	Worst Case Dec 2016 July 2017	August 2017	Sept. 2017	Oct. 2017	Nov. 2017
Ranging accuracy (DF, 95%)	Worst Satellite month	< 7.0 m	461 m	0.50 m	0.50 m	0.61 m	0.60 m
	Constellation Average	< 2.0 m	35.8 m	0.41 m	0.38 m	0.45 m	0.44 m
Ranging accuracy (SF, 95%)	Worst Satellite month	< 7.0 m	461 m	0.66 m	0.76 m	0.63 m	0.67 m
	Constellation Average	< 2.0 m	35.9 m	0.55 m	0.56 m	0.50 m	0.50 m
Availability of DF Ranging (global average)		> 87%	95.48%	100%	100%	100%	100%
Per Satellite Availability of SiS (monthly, OS, global average, healthy SF/DF)		> 87%	94.71%	98.18%	100%	99.35%	99.09%
UTC Time Diss. Uncertainty (DF, 95% over campaign period)		< 30 ns	11.7 ns	9.3 ns	9.3 ns	9.3 ns	9.0 ns
UTC Freq. Diss. Uncertainty (DF, 95% over campaign period)		< 3e-13	6.7E-14	5.7E-14	5.7E-14	5.7E-14	2.7E-14
Availability of UTC dissemination (%)		> 87%	95.48%	100%	100%	100%	100%
GST-GPS time offset uncertainty (95% over campaign period)		< 20 ns	7.3 ns	7.2 ns	7.2 ns	7.2 ns	7.0 ns
GST-GPS time offset availability (%) (over campaign period)		> 80%	92.52%	97.9%	97.8%	97.7%	97.9%

GALILEO IMPROVES SEARCH AND RESCUE

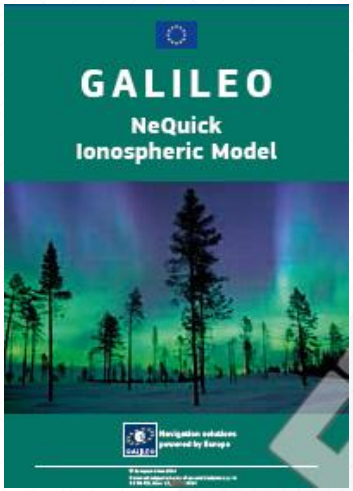


INITIAL SERVICES QUARTERLY PERFORMANCE REPORTS

GALILEO REFERENCE DOCUMENTATION

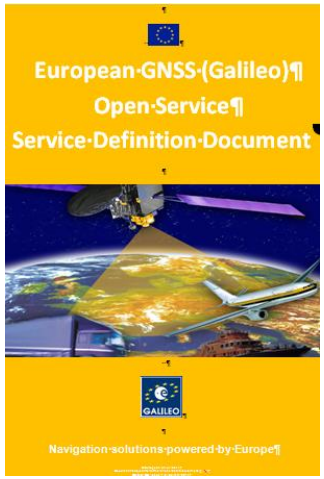
Galileo Open Service Signal In Space Interface Control Document (OS SIS ICD)

Version 1.2 to be published
end 2015



Galileo NeQuick Ionospheric Model

Version 1.1 published
in April 2015



Galileo SIS Operational Status Definition

Version 1.0 published
in September 2015

Galileo OS Service Definition Document

First version in 2016 with Initial Service performance

Updated version in 2017-18 with more consolidated FOC performance

NEW SERVICES TO COME: HIGH ACCURACY AND AUTHENTICATION

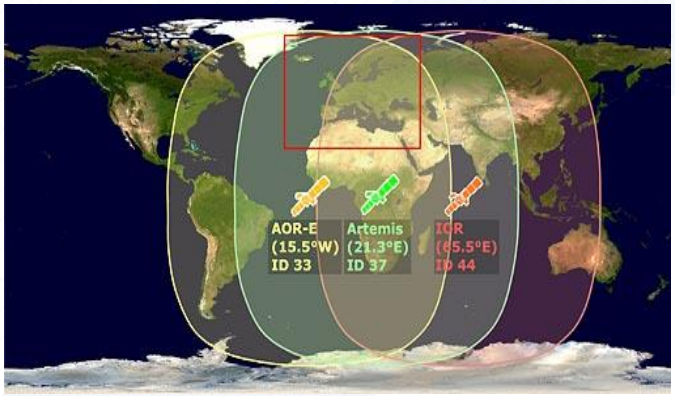
- **High Accuracy** will be based on PPP transmission in E6B.
  - **Free of charge to the users**
  - Gradual implementation between **2018 and 2020**

- **Authentication** will be based on a
  - **Navigation Message Authentication:**
  - Integrated in the E1 OS. Aimed at consumer users and offered for free. Already prototyped and under testing
  - **Spreading Code Authentication**: based on the E6 Spreading Code Encryption.

SEARCH AND RESCUE RETURN LINK IN 2018

EGNOS IS FULLY OPERATIONAL

- EGNOS Open Service is operational since October 2009
- Its Safety of Life service has been declared operational in March 2011
- The EGNOS Data Access Service (EDAS) was declared in July 2012
- Around 249 approach procedures making use of EGNOS for aircraft landings approved in 20 Countries

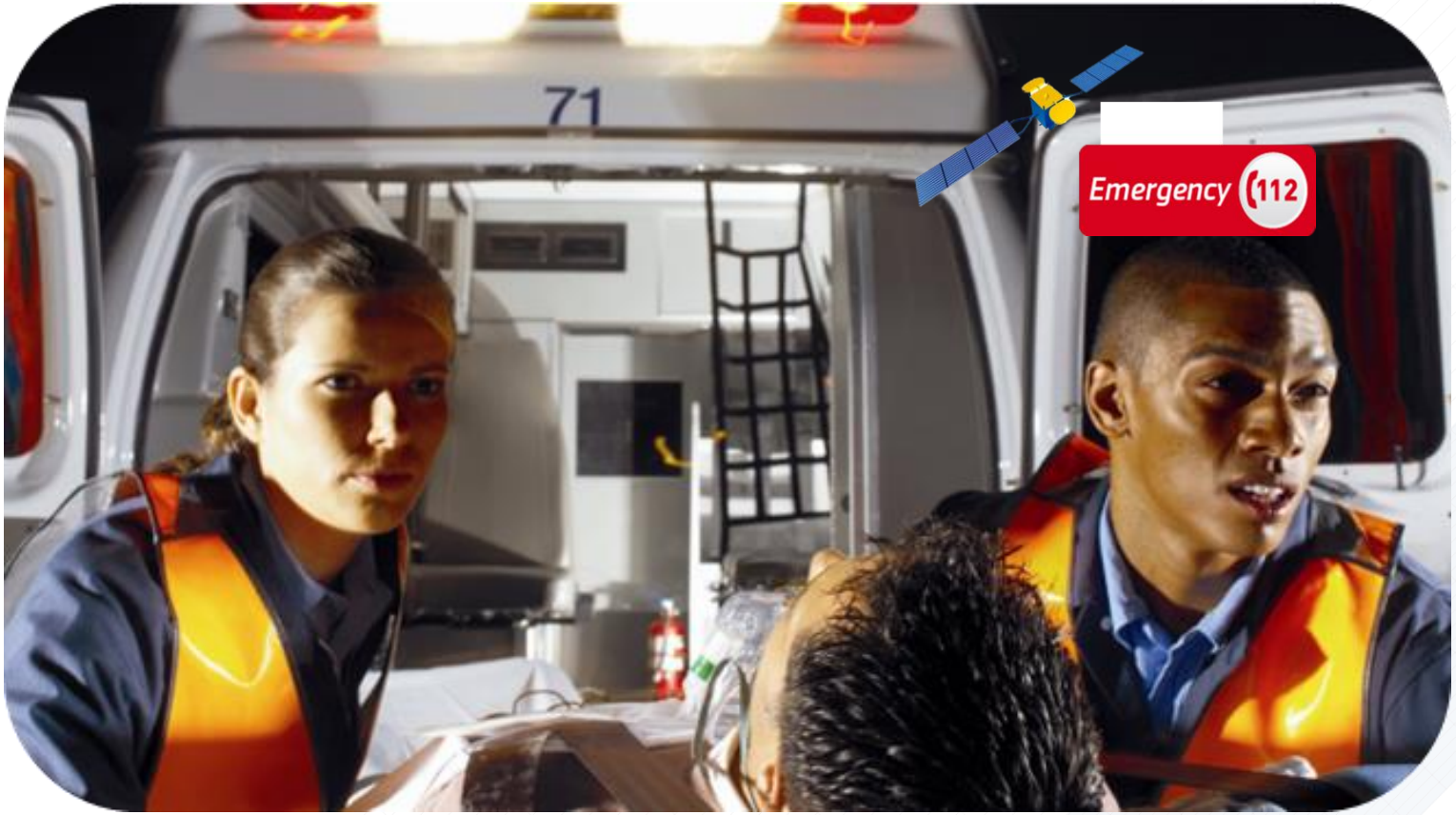


GALILEO - INCREASINGLY CRITICAL TO EU POLICIES

- ENERGY UNION policy: more energy-efficient, modern and cleaner mobility solutions
- Road: eCall, Digital Tachograph, eTolling
- Aviation: PBN, Drones, Surveillance & Tracking, ….
- Timing for Critical Infrastructures
- Approved as a Global Maritime Distress & Safety System

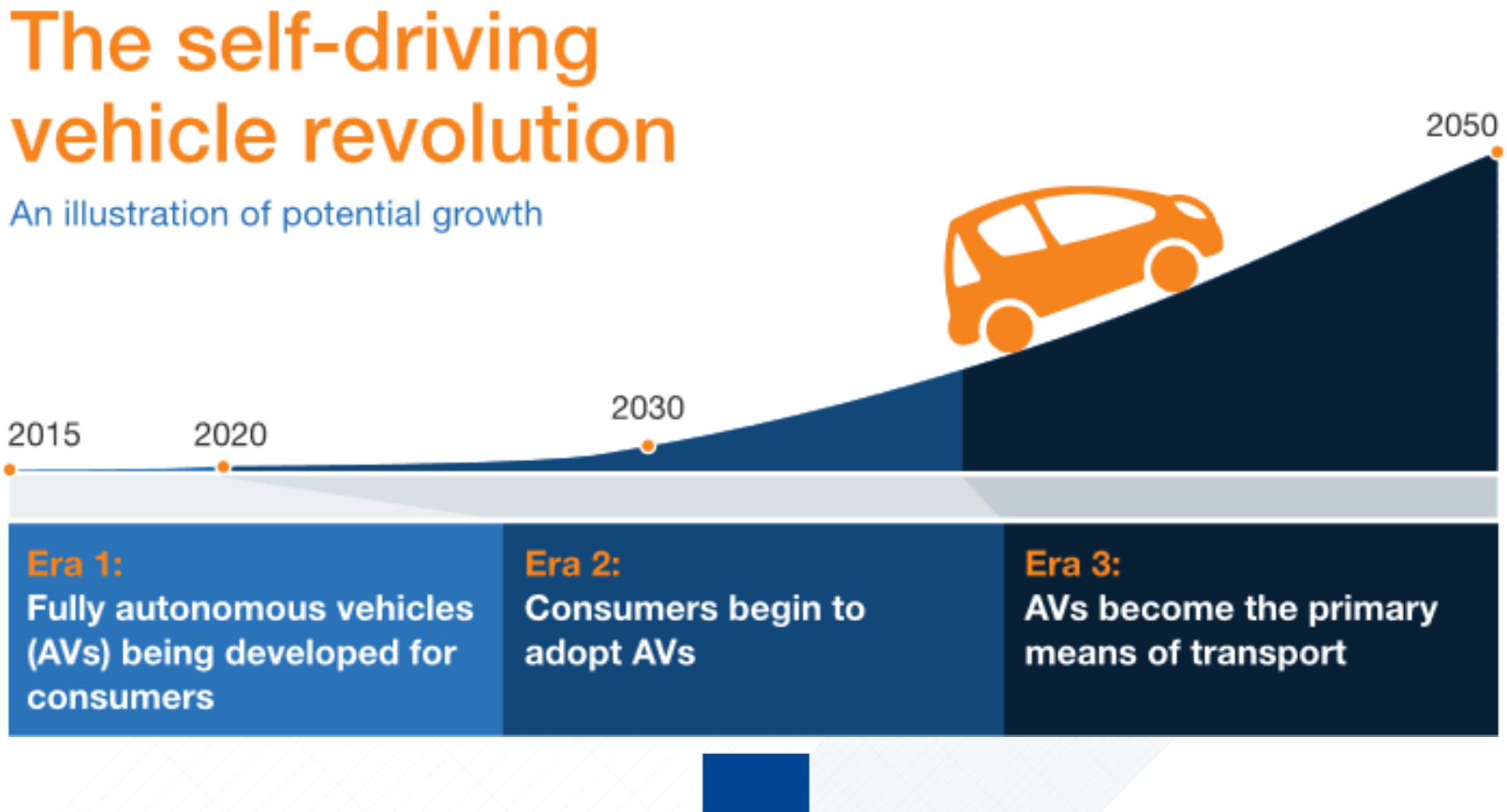
- European Radio-Navigation Plan
  - modernise infrastructure
  - rationalise investments
  - synergies between sectors

ALREADY THERE : eCALL COMPULSORY AS FROM APRIL 2018



COMING SOON: GALILEO FOR AUTONOMOUS VEHICLES

Autonomous vehicles need robust, high accuracy positioning – human lives will be at stake.



COMPATIBLE RECEIVERS

GALILEO EGNOS
NAVIGATION SOLUTIONS
POWERED BY EUROPE

2010

u-blox
septentrio
STMicroelectronics

2017

TIMING

spectracom
Synchronizing Critical Operations

SMARTPHONES/MASS MARKET

intel
QUALCOMM
BROADCOM
MEDIATEK

AUTOMOTIVE

STMicroelectronics
CSR
QUALCOMM

UAVs

u-blox

HIGH PRECISION

THALES
FURUNO
Leica Geosystems
NovAtel
JAVAD
Trimble
TOPCON
septentrio

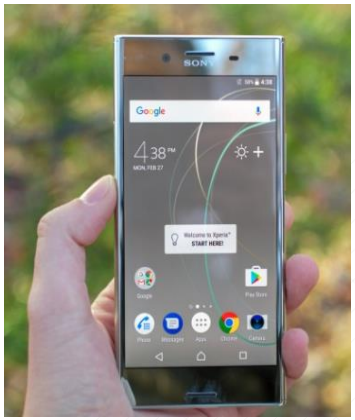
95% of global supply

GALILEO-ENABLED PIONEERS

GALILEO EGNOS
NAVIGATION SOLUTIONS
POWERED BY EUROPE

Bq Aquaris X5
July 2016

Sony Xperia XZ
March 2017



Huawei P10
March 2017

Samsung S8
April 2017

Apple Iphone 8, 8s and X
Sept 2017

GNSS MARKET **MACROTRENDS**

GALILEO EGNOS
NAVIGATION SOLUTIONS
POWERED BY EUROPE

GNSS essential in major technology developments: the Internet of Things, Big Data, mHealth, Augmented Reality, Smart Cities, and Multimodal Logistics.

Internet of Things (IoT)		A major development in the role of the internet, the IoT allows physical devices, vehicles, buildings and other objects to be **interconnected** and **controlled remotely** across network infrastructures. IoT is relying on a wide range of **different sensors** and technologies, one of them being **GNSS** which provides **localisation** and **timing information**.
Big Data		With traditional data processing unable to deal with the skyrocketing volumes of data that are produced every single day, **complex systems** are being created to allow for **big data processing**. GNSS is a major data source providing **location** and **timing information** to the world of Big Data. The proliferation of GNSS devices is boosting the quantity of location and timing data.
mHealth		**Mobile Health (mHealth)** is a sub-segment of eHealth and covers medical and public health practice supported by mobile devices. Key mHealth application categories include **disability assistance, preventive medicine** and **emergency**, and leverage fusion of big data with GNSS.
Augmented Reality (AR)		**AR** integrates **digital information** with the user's **environment**. Unlike virtual reality, which creates a totally artificial environment, AR uses the existing environment and overlays new information on top. **GNSS** provides a globally available source of georeferenced information that **brings augmented reality into the open**. GNSS allows the creation of a direct link between the surrounding reality and digital objects.
Smart Cities		**Smart Cities** feature an integrated system for collecting, measuring, collating and broadcasting city data and for making it easily **accessible** to citizens, municipalities and city planners. GNSS is one of the key technologies used within **infrastructure design** and **mobility** of smart cities, offering numerous opportunities to **citizens, local governments** and **city planners** alike.
Multimodal Logistics		Multimodal logistics refers to the transport of goods by at least two different modes of transport in the framework of a single multimodal transport contract. Logistics service providers draw on GNSS for **efficiency, security** and **safety.** GNSS contributes to the monitoring of **cargo** along the entire supply chain and enables pivotal **asset management** applications.

GNSS MARKET REPORT

https://www.gsa.europa.eu/system/files/reports/gnss_mr_2017.pdf

DESIGNED FOR SERVICE: GALILEO SERVICE CENTER (MADRID)

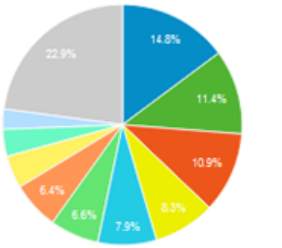
- ★ Operated by GSA

  www.gsc-europa.eu
- ★ Publication of Galileo official documents
- ★ Publication of the state of the constellation, NAGUs (Notice Advisory to Galileo Users) and Galileo performance
- ★ Helpdesk

✓ Visiting countries

EU-28	Non EU Europa	Asia	America	Africa	Oceania
28	9	26	12	9	2

		Pageviews	%
1.	Spain	1,589	
2.	Belgium	1,095	
3.	Germany	999	
4.	Netherlands	254	
5.	Czech Republic	238	
6.	United Kingdom	156	
7.	Italy	121	
8.	France	114	
9.	United States	106	
10.	Poland	105	
	Other		



* **USA:** 93 visits; 3.89 % of total
India: 42 visits; 1.76 % of total
Japan: 34 visits; 1.42 % of total
China: 23 visits; 0.93 % of total
Russia: 18 visits; 0.75 % of total

★ Increased number of user visits and questions

R&D FOR EGNOS & GALILEO

H2020

R&D programme launched for GNSS in the context of Horizon 2020: ~408M€

- Promote applications
- Develop Infrastructure & Technology
- Define Mission and Services

FUNDAMENTAL ELEMENTS

Fundamental Elements: ~112M€

- Promote the development of Galileo and EGNOS enabled chipsets and receivers

R&D FOR EGNOS & GALILEO

CALL — EGNSS MARKET UPTAKE 2019-2020

Topics	Type of Action	Indicative budget (€ million)		
		2018	2019	2020
SPACE-EGNSS-1-2019-2020: **EGNSS applications fostering green, safe and smart mobility**	**IA**		**10.0**	**10.0**
SPACE-EGNSS-2-2019-2020: **EGNSS applications fostering digitisation**	**IA**		**4.0**	**5.0**
SPACE-EGNSS-3-2019-2020: **EGNSS applications fostering societal resilience and protecting the environment**	**IA**		**4.0**	**5.0**
SPACE-EGNSS-4-2019: **Awareness raising and capacity building**	**CSA**		**2.0**	

OTHER ACTIONS FOR 2018-2020 (SUB-SET)

Topics	Type of Action	Indicative budget (€ million)		
		2018	2019	2020
Activity 7 – **Galileo Evolution, Mission and Service related R&D activities**	**Public Procurement**		**2.6**	**1.8**
Activity 8 – **EGNOS Mission and Service related R&D activities**	**Public Procurement**		**0.4**	**0.2**
Activity 9 – **GNSS evolution, infrastructure-related R&D activities**	**DA - ESA**	**36.0**	**31.0**	**10.0**
Activity 13 – **Horizon 2020 project monitoring and audits EGNSS**	**Expert Contracts**		**0.5**	**0.5**

INTERNATIONAL COOPERATION

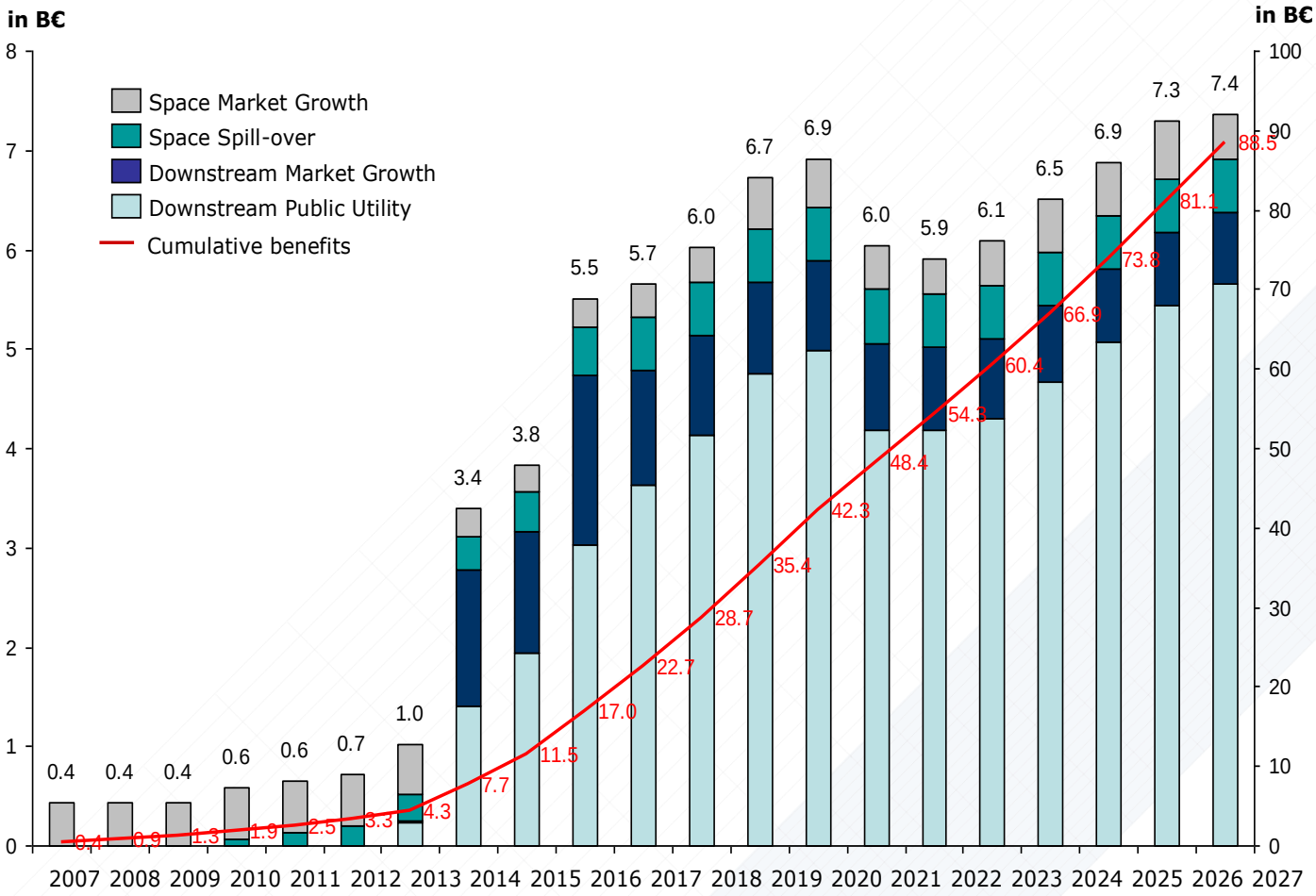
International cooperation is crucial for the development of European GNSS

Objectives of international cooperation

- Promoting and expanding worldwide the use and uptake of the services offered by the European GNSS programmes;
- Ensuring access to relevant key technologies and the security of its supply for the exploitation of the European GNSS systems;
- Coordinating with other GNSS providers on issues such as frequency questions, interoperability and security.

EGNSS PUBLIC BENEFITS

EGNOS and Galileo will provide cumulative indirect benefits of around 90 B€ over the next 20 years to the EU



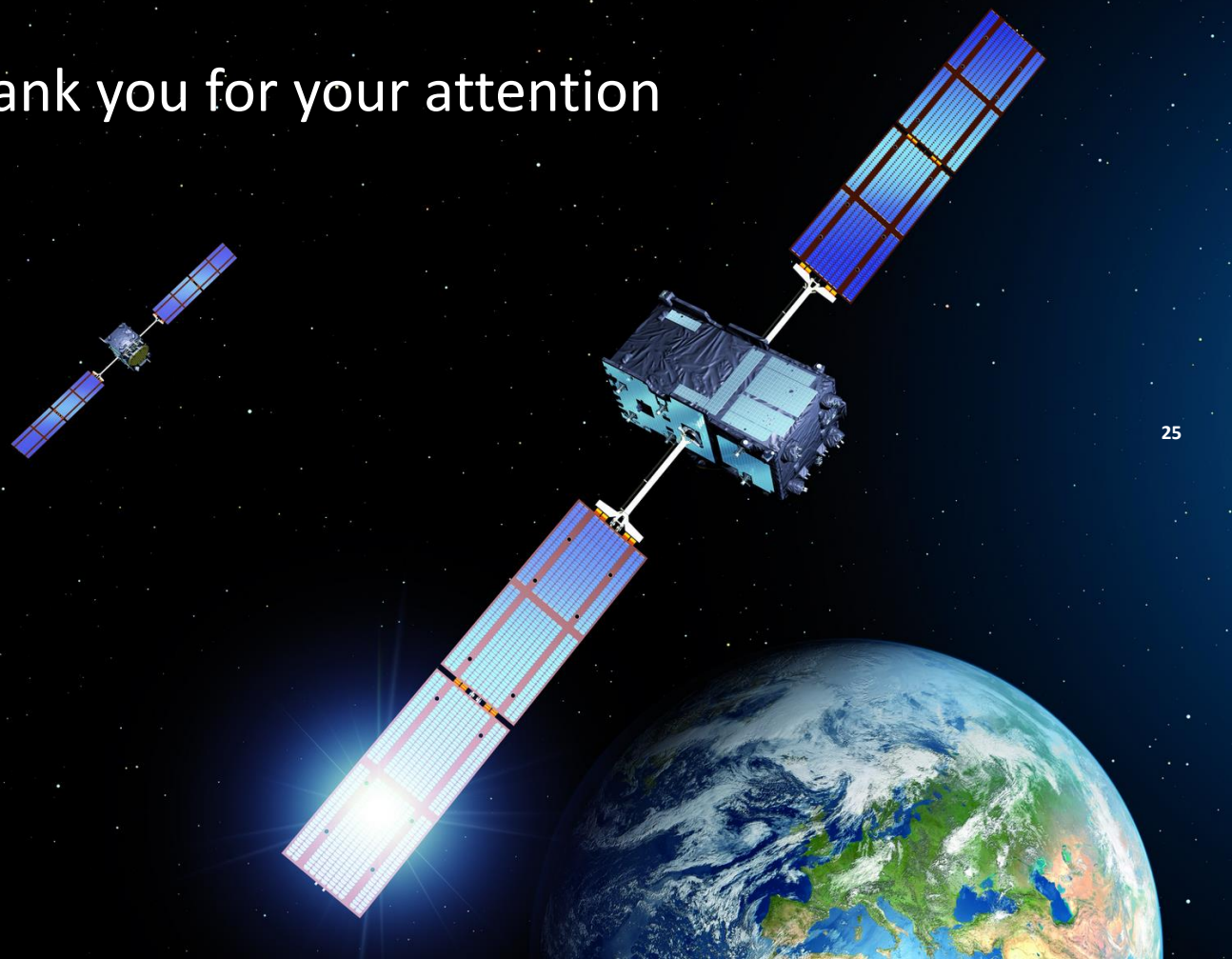
Source: Roland Berger; GSA Analysis

INTERNATIONAL COOPERATION

Possible mutual benefit cooperation on:

- Market development and responses to user requirements;
- System and service development, including ground or space-based augmentation systems;
- Frequency issues, including coordination of frequency planning;
- Radio-navigation planning;
- Promotion of industrial collaboration;
- Development of standardisation policy and certification methodology for applications;
- Training and exchange of experts.

Thank you for your attention



http://ec.europa.eu/galileo
http://ec.europa.eu/egnos