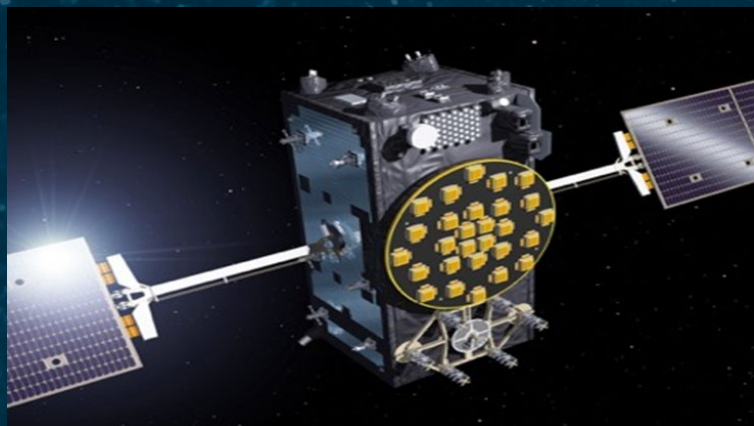




Galileo System Status

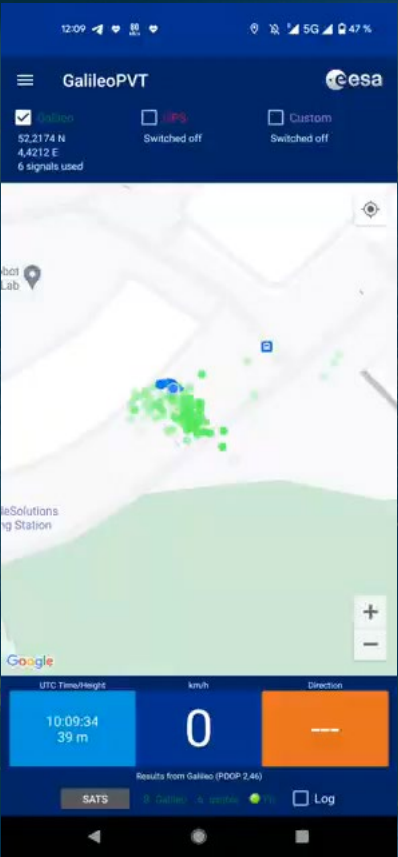
David Ibáñez

ESA Head of Galileo G1 System Engineering Unit

Tour de l'IGS 6th Stop: Galileo Constellation Spotlight

23 May 2023

Satellite Navigation “made in Europe”



GalileoPVT



GNSS View



Satellite Navigation “made in Europe”



Putting Europe at the forefront of this strategically and economically important sector

Galileo provides a highly accurate, guaranteed global positioning service under civilian control



~ 4 Billion

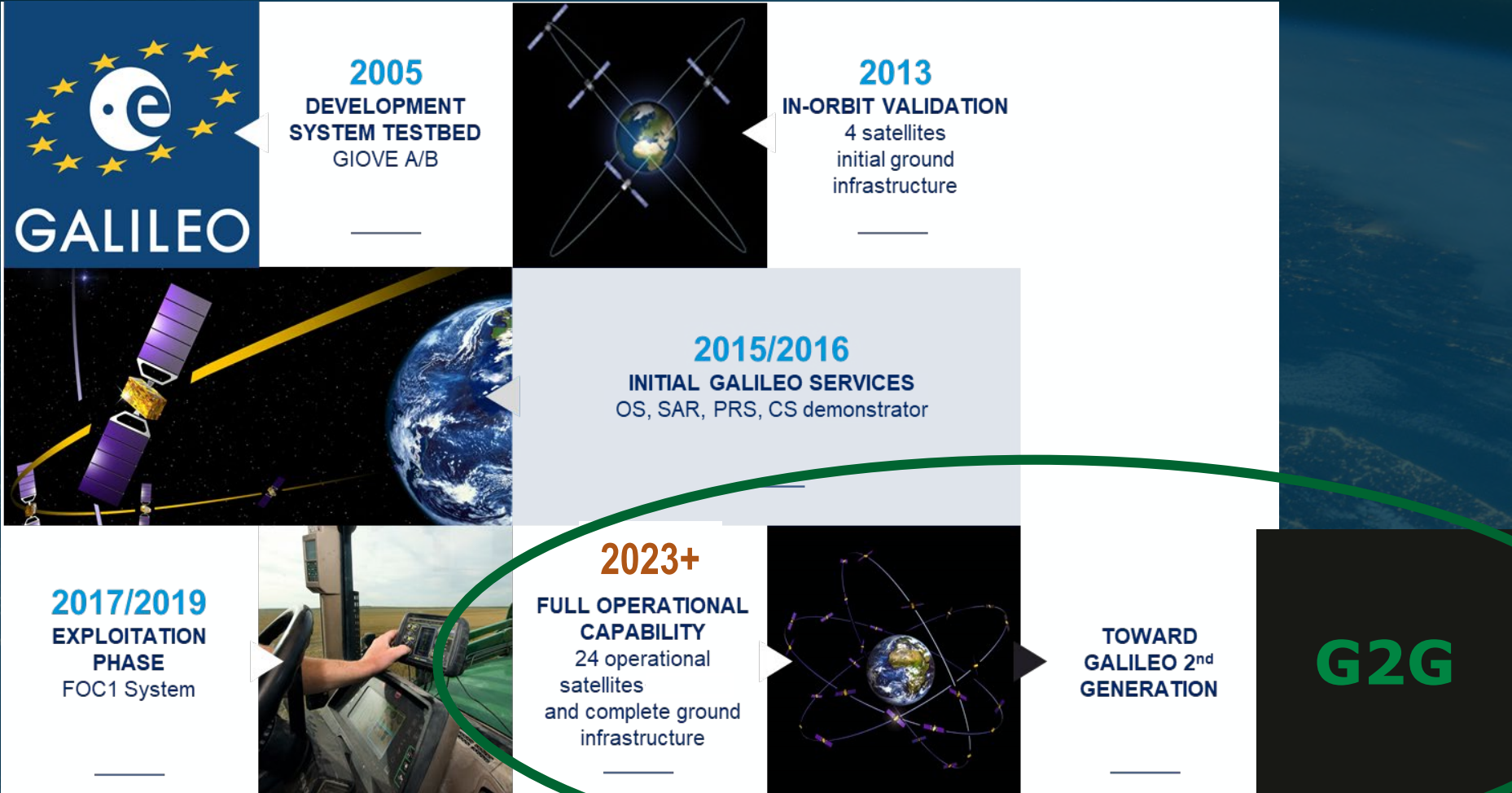
Estimated number of Galileo enabled smartphones sold until today

BRAND	MODEL
Allview	Soul X5 Pro
Apple	iPhone 6s, 6s Plus, 7, 7 Plus, 8, 8 Plus, X, XR, XS, XS Max
Asus	Zenfone 4, 4 Selfie, 4 Selfie Lite, 4 Selfie Pro, 4 Max, 4 Pro
BlackBerry	Evolve, Evolve X
BQ	Aquaris X, X Pro, X5 Plus, U2, V, V Plus
CAT	S61
Google	Pixel 2, Pixel 2 XL
Huawei	P10, P10 plus, P20, P20 Pro, Mate 9, Mate 9 Pro, Mate 9 Porsche Design, Mate 10 Porsche Design
Lenovo	ZUK Edge
LG	Q Stylus, V30, V30S ThinQ, V40 ThinQ
Meizu	PRO 7, PRO 7 Plus, 16, 16 Plus
Motorola	Moto X
Nokia	Nokia 8, 8 Sirocco
OnePlus	OnePlus 5, 5T, 6
Samsung	Galaxy S8, S8+, S9, S9+, Note7, Note8, Note9, Tab S3, Tab S4
Sony	Xperia XZ Premium, XZ1, XZ1 Compact, XZ2, XZ2 Compact, XZ2 Premium, XZ3
Vernee	Apollo 2
Wiko	WIM
Xiaomi	Mi 8, Mi 8 SE, Mi 8 Explorer Edition

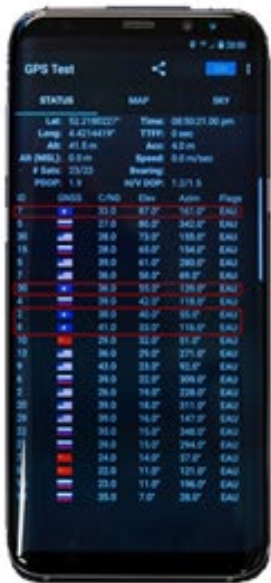
www.usegalileo.eu

Click here to find out if your phone is Galileo-enabled

Galileo Roadmap



Galileo Services (starting point)



OS

Open Service (OS)	Freely accessible service for positioning, navigation 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



PRS



CS

Integrity Monitoring Service (EGNOS)	Provides vital integrity information for life critical application
--------------------------------------	--

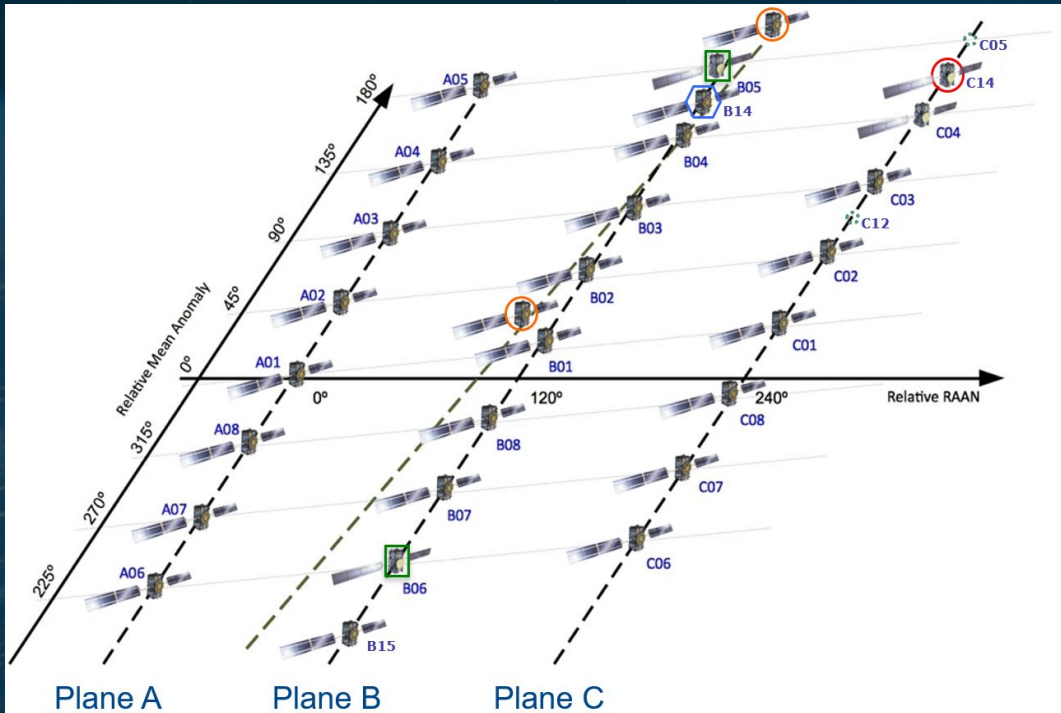


EGNOS



SAR

Today's Galileo Constellation Status



28 satellites in orbit

2 unhealthy (NAV P/L only)

2 inactive spares

1 unavailable

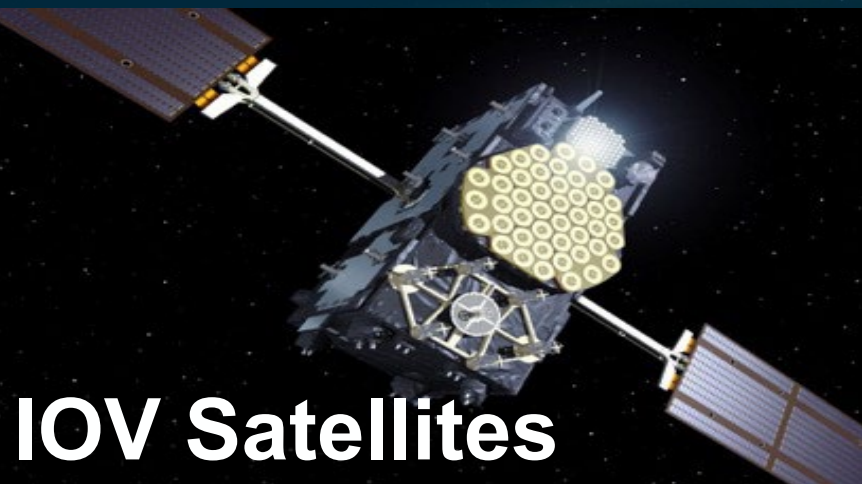
2 no SAR (by design)

L11: GSAT223/224 entered into Service on 29 August 2022

Q1/2023 Statistics SISE FNAV DF values computed at average user location (SISE Global Average)

Satellites SISE RMS daily statistics		Constellation SISE RMS daily statistics		Monthly SISE 95% statistics	
BEST SAT	WORST SAT	BEST DAY	WORST DAY	BEST SAT	WORST SAT
GSAT0219 0.018m 17 th January 2023	GSAT0210 2.25m 23rd March 2023	0.096m 12th January 2023	0.18m 12th February 2023	GSAT0215 0.19m March 2023	GSAT0102 0.33m March 2023

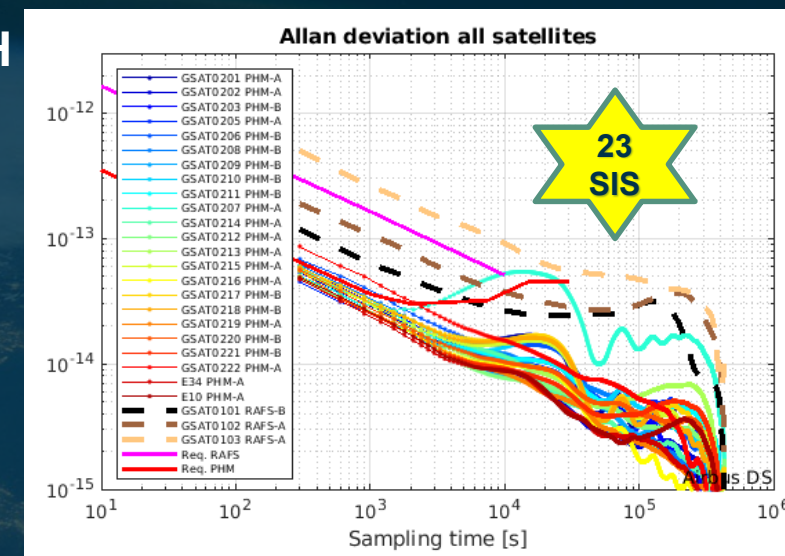
Today's Galileo Satellites In Orbit



IOV Satellites

S/C Prime Contractor **Astrium GmbH**
(now Airbus Defence & Space)

All 4 satellites in-orbit

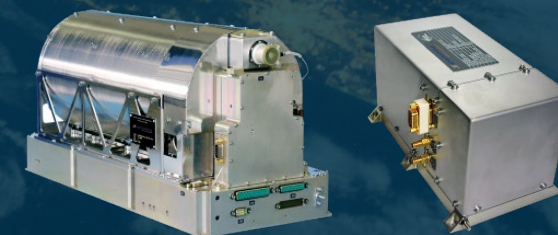


FOC Satellites

S/C Prime Contractor **OHB Systems GmbH**
P/L Prime Contractor **SSTL Ltd**

24 satellites in-orbit

Embarked Clocks:
Rubidium Atomic Frequency Standard
Passive Hydrogen Maser

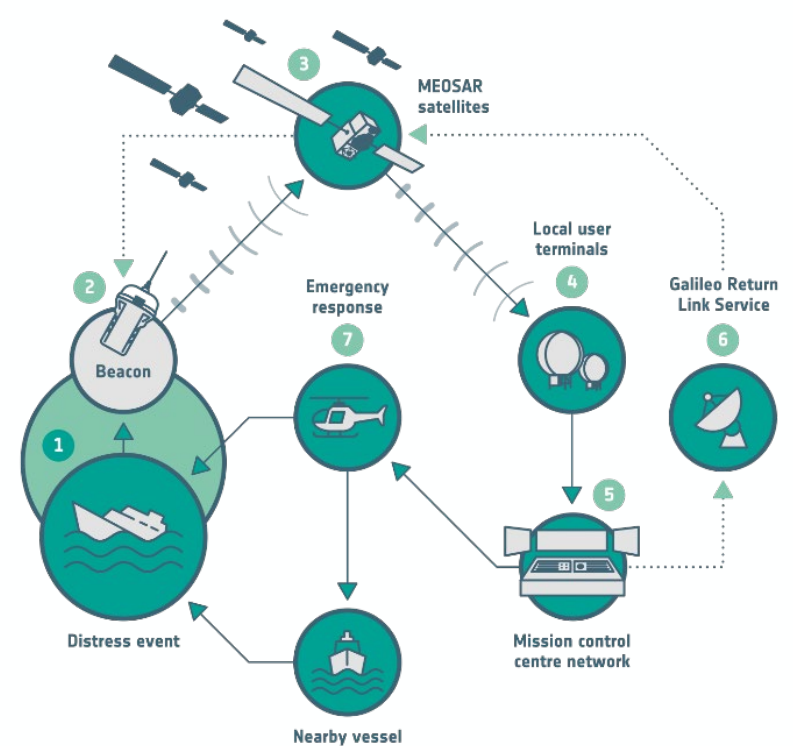
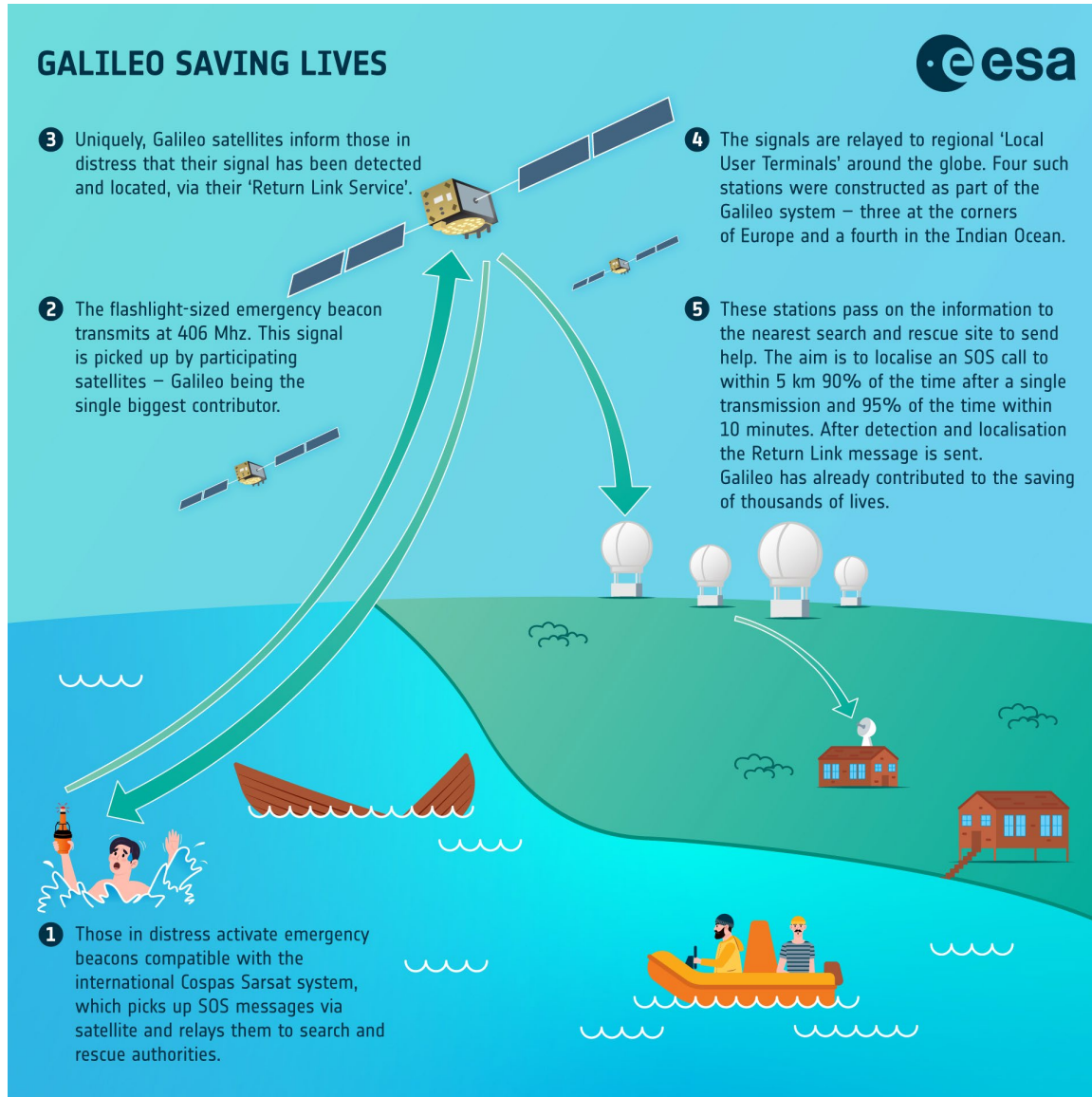


Interoperable w. GPS



100%

Search and Rescue Service – In Service



-
- The Galileo PRS**
- Secure EU satellite navigation
for government use
- © Microm



Version 1.2, November 2021



Issue 2.0, January 2021



Issue 1.0, January 2023



Issue 1.0, May 2022



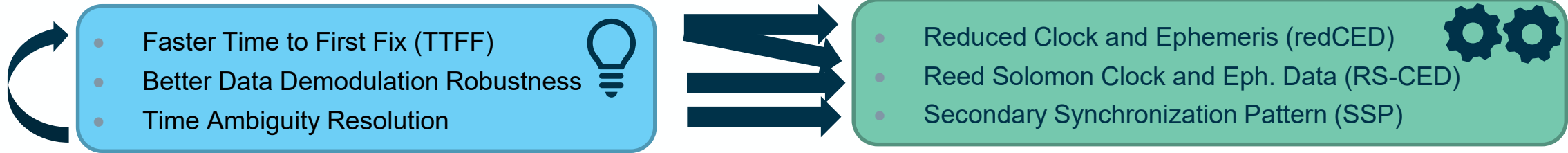
Issue 1.0, November 2021

Galileo is evolving!



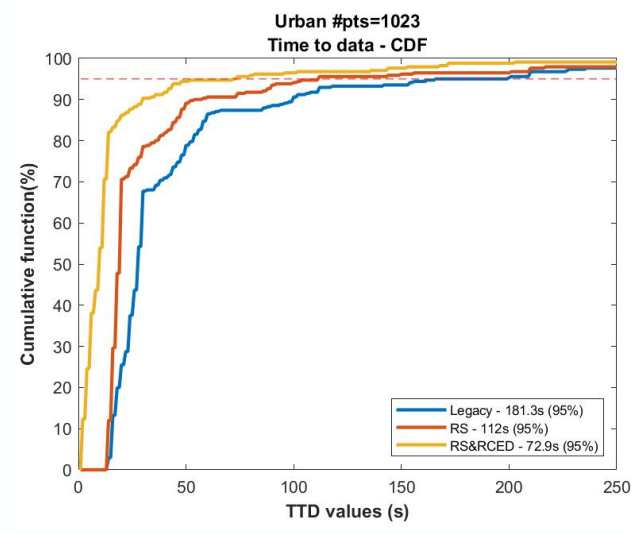
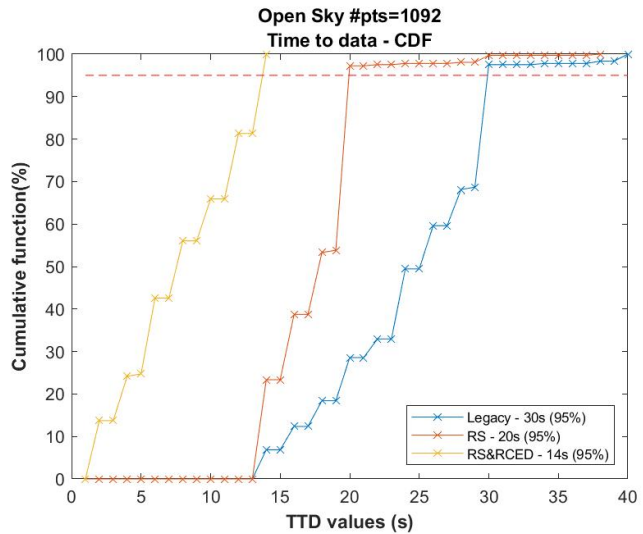
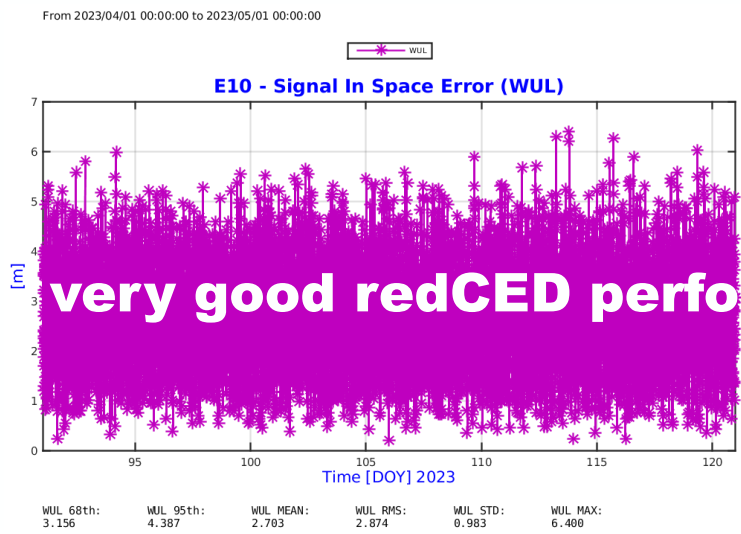
I/NAV Improvement	Allows faster Time to First Fix	
High Accuracy Service (HAS)	Allows sub-decimetre level positioning accuracy	
OS Authentication (OSNMA)	Data authentication function to ensure trusted source	
Commercial Service Authentication (CAS)	Provides controlled access and authentication function to users	
Safety of Life (SoL) – H-ARAIM	Integrity	
Emergency Warning Service (EWS)	Alerting population in case of an emergency	
Beacon Command Service (BCS)	Remote control of SAR beacons	

Galileo Evolutions - I/NAV Improvement for users



I/NAV Improvement provides 2-times faster First Fix with Galileo!

I/NAV Improvement provides 2-times faster access to Galileo system time for users that have coarse time information in Urban Environment!

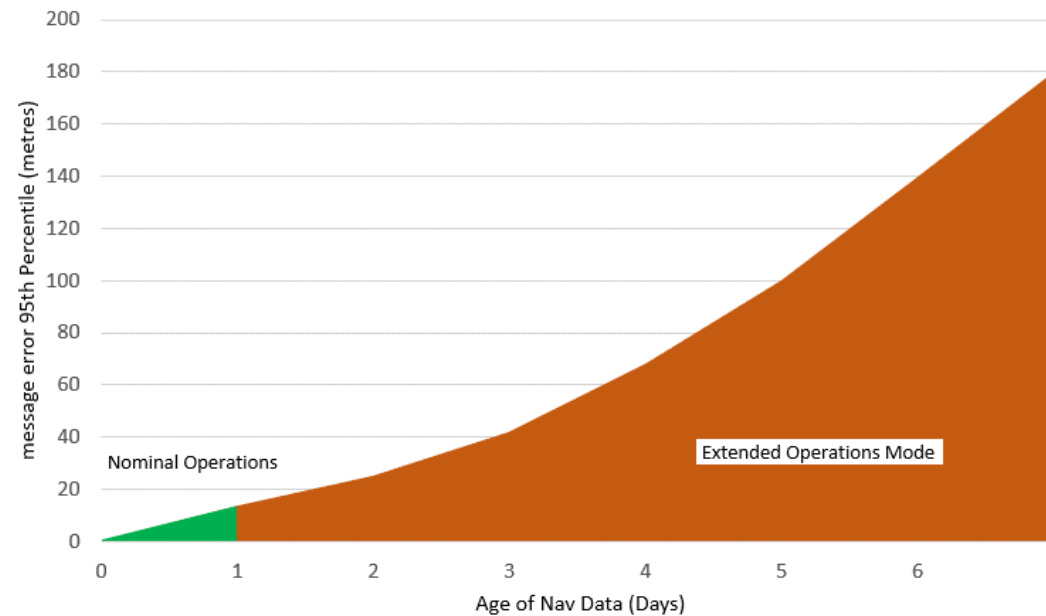


I/NAV Improvement now available from 17 satellites.
Full roll-out to Constellation by mid 2023



Galileo Evolutions – Extended Operations Mode

- Robustness improvement to allow continuous navigation message uplink even in case of Ground Segment failures
- The transition to and from Extended Operations Mode is seamless and transparent to the user.
- The Ranging Accuracy gradually degrades with respect to the nominal operating mode
- Specific MPL (Minimum Performance Level) to be included in next OS SDD update (to be published in 2023)

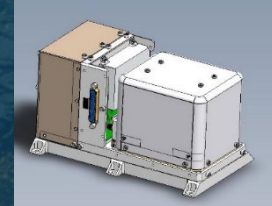
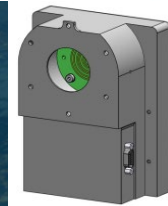


- | Service | Service Component |
|--|--------------------------------|
| Open Service (OS) | OS (Navigation Performance) |
| | Timing Service |
| | Quasi Pilot |
| High Accuracy Service (HAS) | GOSOL (incl ARAIM) |
| | Service Level 1 (global) |
| OS Authentication (OS-A) | Service Level 2 (regional) |
| | OS Nav Msg Authentication |
| Commercial/Signal Authentication (CAS/SAS) | OS Ranging Authentication |
| | Commercial/Signal Auth Service |
| Search & Rescue (SAR) | Forward Link |
| | Return link |
| | Remote Beacon Activation |
| | Two Way Communication |
| Emergency Warning Service (EWS) | Distress Position Sharing |
| | EWS-Return Link Message |
| | EWS-INA V |
| | |
| Ionospheric Prediction (CIP) | Ionosphere Prediction |

G2G Procurement Status



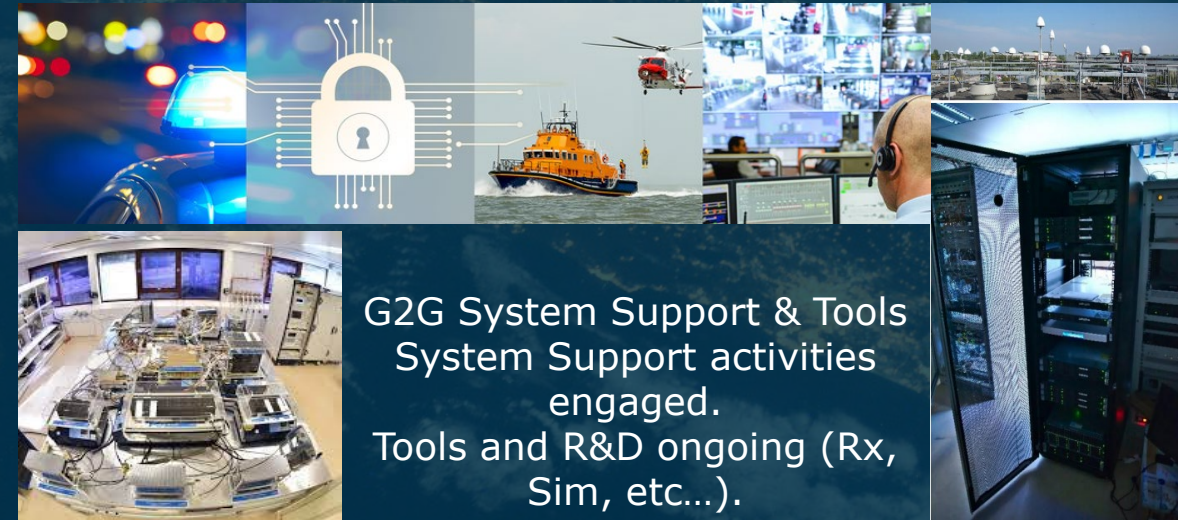
G2G B1 – ADS-DE Satellite
PDR passed. First HW available



G2G Satellite Clocks
2 Operational, 2 Evolutions, 5
Experimental clocks



G2G B1 – TAS-IT Satellite
PDR passed. First HW available



G2G System Support & Tools
System Support activities
engaged.
Tools and R&D ongoing (Rx,
Sim, etc...).

G2G Ground Segment & System Test Beds
7 IOV GSEG & Syst Test Beds procurements ongoing
G2G IOC GSEG reaching PDR

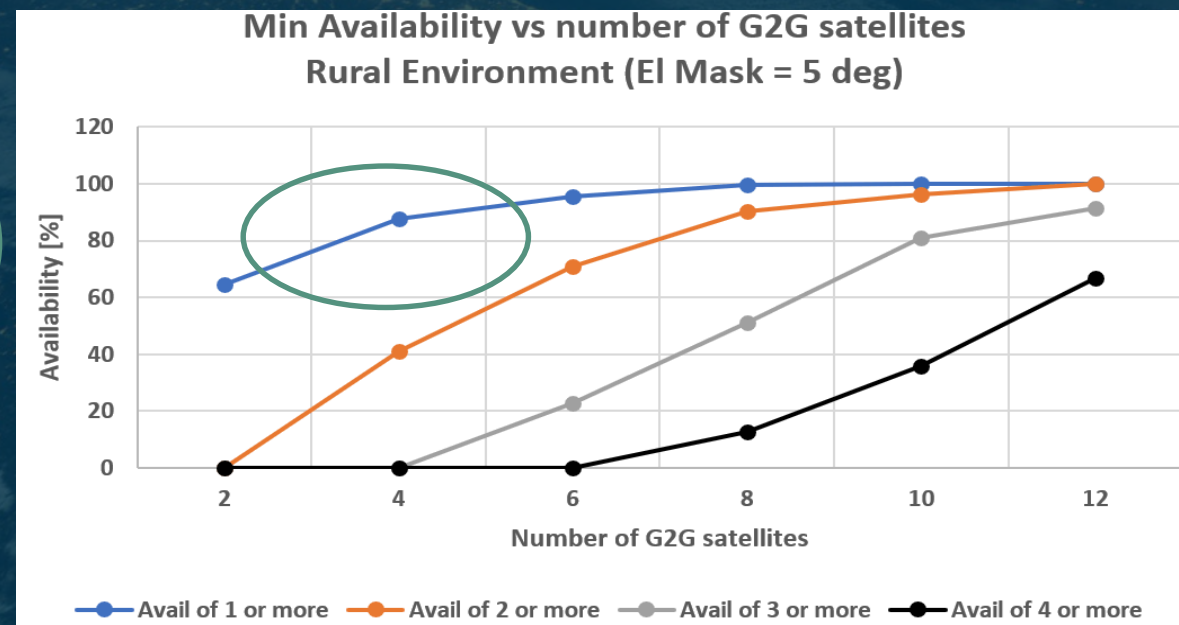
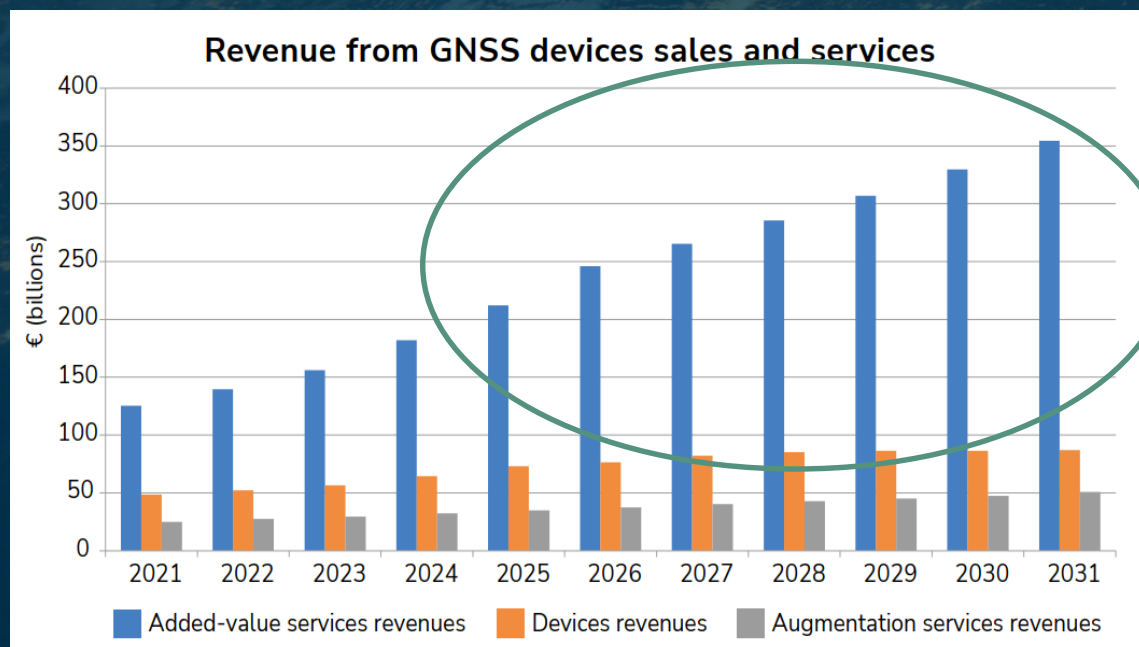
G2G Satellites: Designed for future generations

- New signal generation capabilities: increased number of signal components and configurability.
- Improved EIRP.
- Inter Satellite Links.
- On Board Authentication.
- Minimised in-orbit maintenance activities.
- Increased data rate in the Ground to Space communication.
- Improved Time Reference (number of atomic clocks and their relevant monitoring functions).
- Orbit Raising Capability – Dual Launch.
- 15 years lifetime.



G2G System Flexibility and Added Value Services focused

- ❑ G2G design at all levels is embedded with internal flexibility to ensure new service implementation without constellation re-deployment (from 15 years to 1 year Time To Market).
- ❑ G2 development and satellite validation approach is compatible with progressive improvement and deployment of services already working with one line-of-sight:
 - ❑ E.g. Fast Acquisition, OS Signal Authentication, OS TTFF, HAS, EWS, ARAIM, etc...
 - ❑ This is the fastest growing market sector.



Courtesy EUSPA EO & GNSS Market Report:

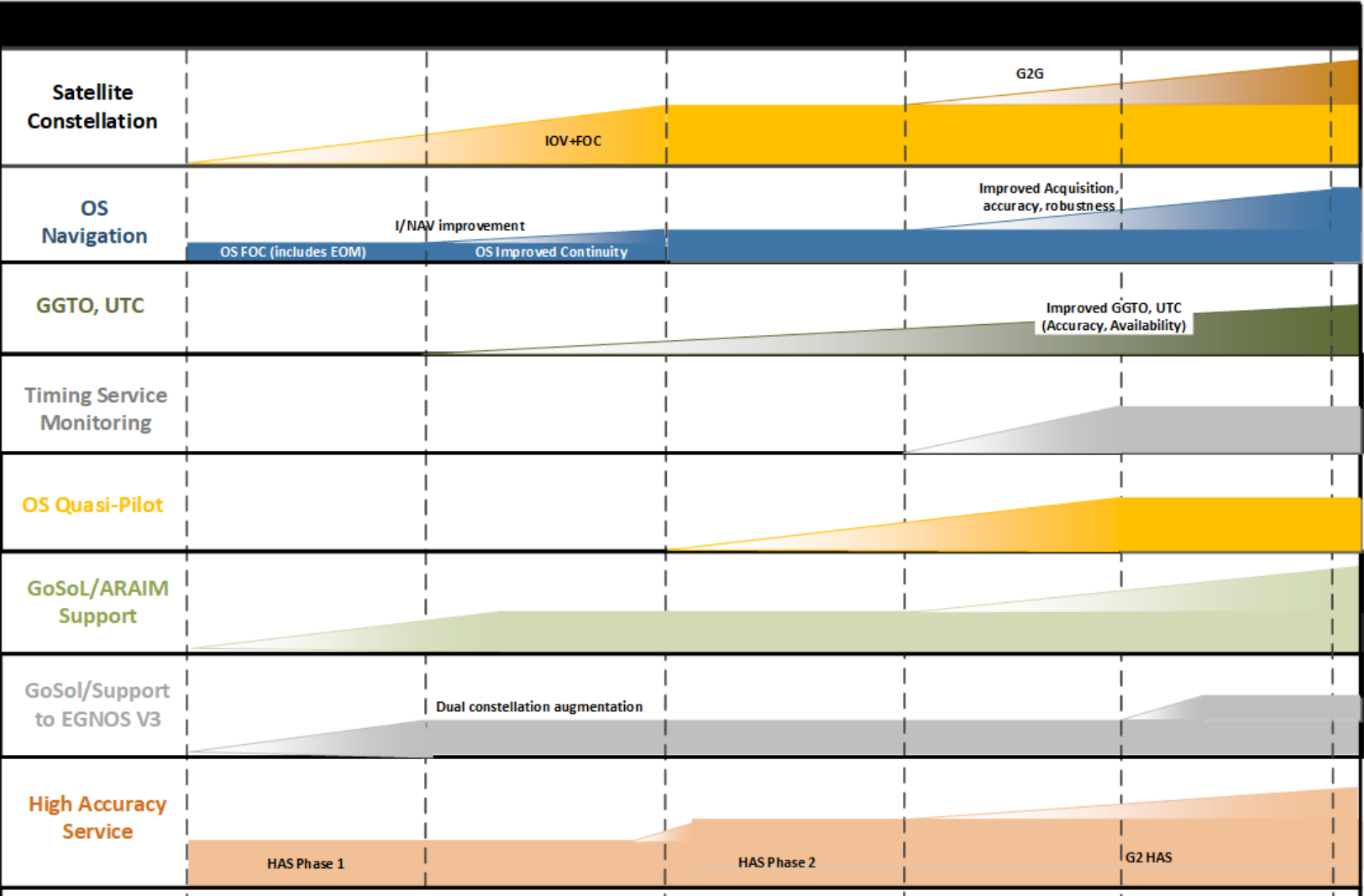
<https://www.esa.europa.eu/sites/default/files/impact-espa-market-report-2022.pdf>

Galileo Service Enhancements & New Services incremental build up (I)



G1 FOC G2 1st Launch G2 IOV G2 IOC

Service	Service Component
Open Service (OS)	OS (Navigation Performance)
	Timing Service
	Quasi Pilot
	GOSOL (incl ARAIM)
High Accuracy Service (HAS)	Service Level 1 (global)
	Service Level 2 (regional)
OS Authentication (OS-A)	OS Nav Msg Authentication
	OS Ranging Authentication
Commercial/Signal Authentication (CAS/SAS)	Commercial/Signal Auth Service
Search & Rescue (SAR)	Forward Link
	Return link
	Remote Beacon Activation
	Two Way Communication
Emergency Warning Service (EWS)	Distress Position Sharing
	EWS-Return Link Message
	EWS-INAV
Ionospheric Prediction (CIP)	Ionosphere Prediction



	2017	2020	2023	2026	2029
OS Authentication Service		OSNMA initial service			Signal Authentication
CAS/SAS			E6 authentication		
Emergency Warning			G1 EWS		G2 EWS
SAR (FLS & RLS)		SAR & RLM FOC			
SAR (BCS/RBA)					

Galileo System Status – Takeaways

- ✓ Galileo performances are outstanding.
- ✓ Galileo INAV available & roll-out on-going.
- ✓ High Accuracy Service declared in Service.
- ✓ OS-NMA Public Observation Phase on-going
- ✓ G2G development activities ongoing (Satellite, GSEG, Test Beds, Tools):
 - ✓ Will ensure Galileo Legacy services enhancement and early G2 Capabilities and Services.



Thanks for your attention