

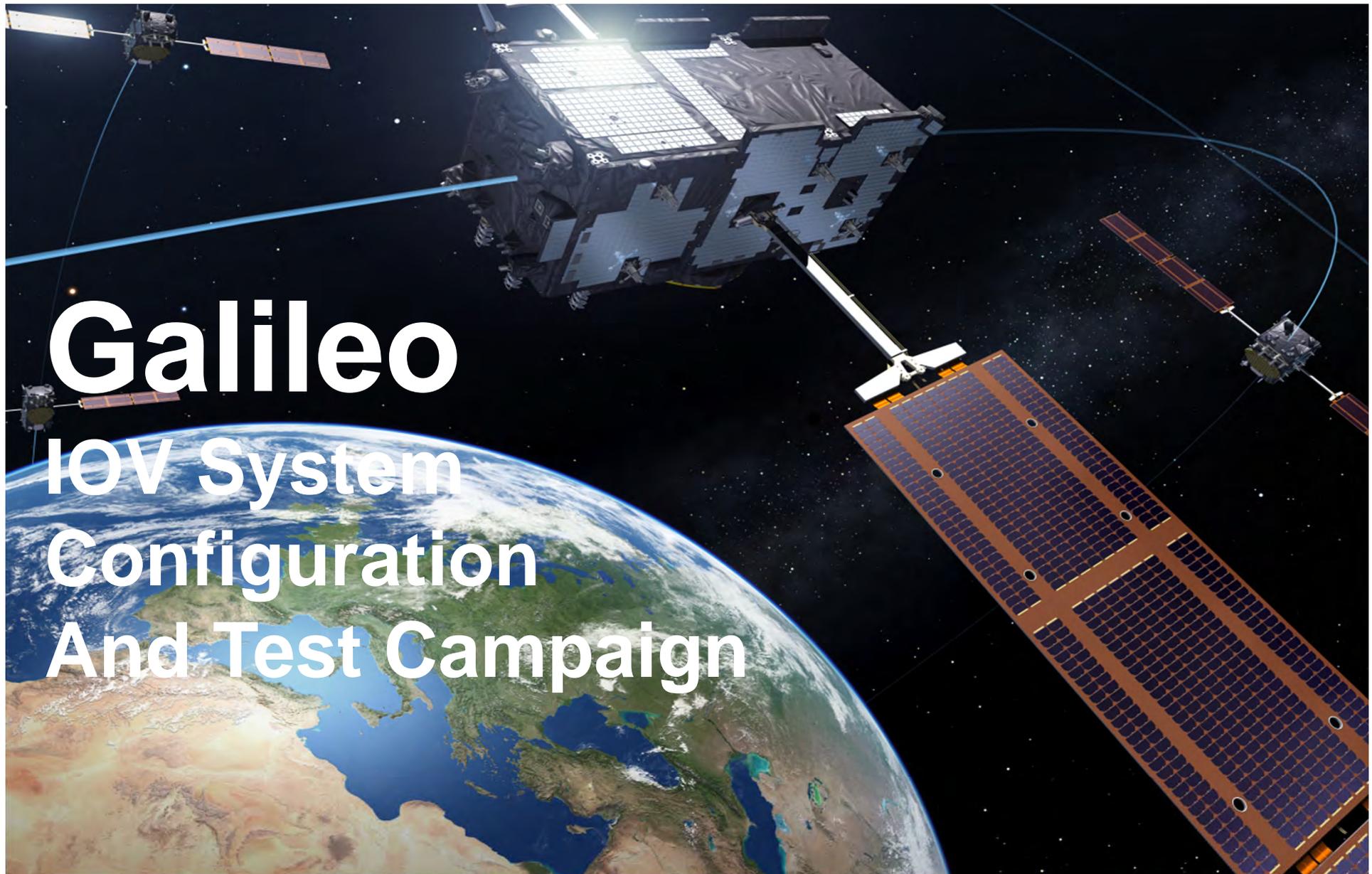
Galileo IOV Results

Galileo IOV results



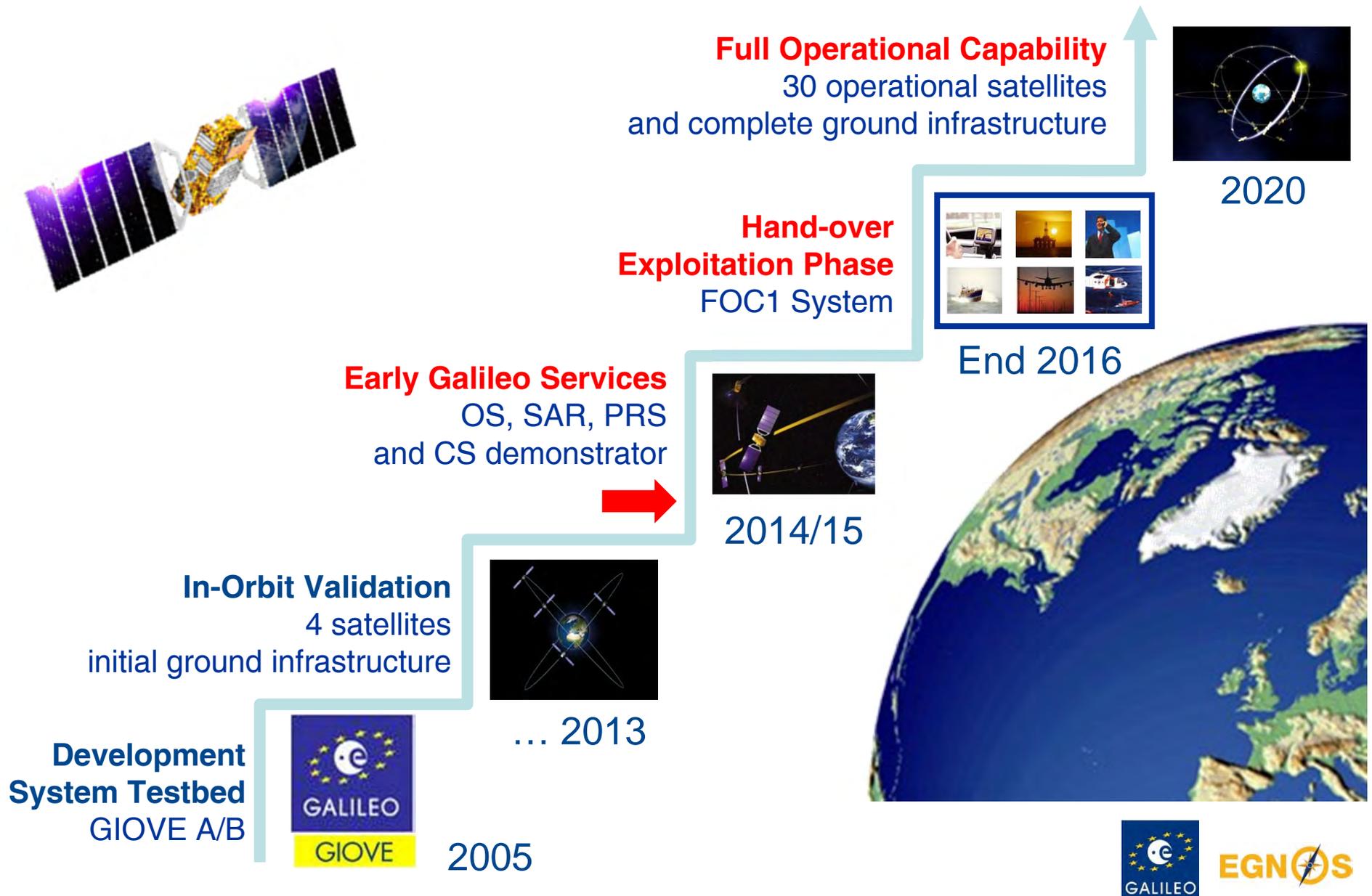
1. Galileo IOV System Configuration and IOV Test Campaign Objectives - E. Breeuwer (ESA)
2. Quality of the broadcast Galileo navigation message
 - a) Orbit and clock prediction, ionospheric and group delay parameters - A. Ballereau (ESA)
 - b) UTC-Galileo System Time offset and GPS-Galileo Time Offset - F. Gonzalez (ESA)
3. Galileo UERE and Position accuracy results - G. Lopez-Risueno (ESA)
4. Performance extrapolation to FOC & Outlook towards Galileo Early Services - D. Blonski (ESA)



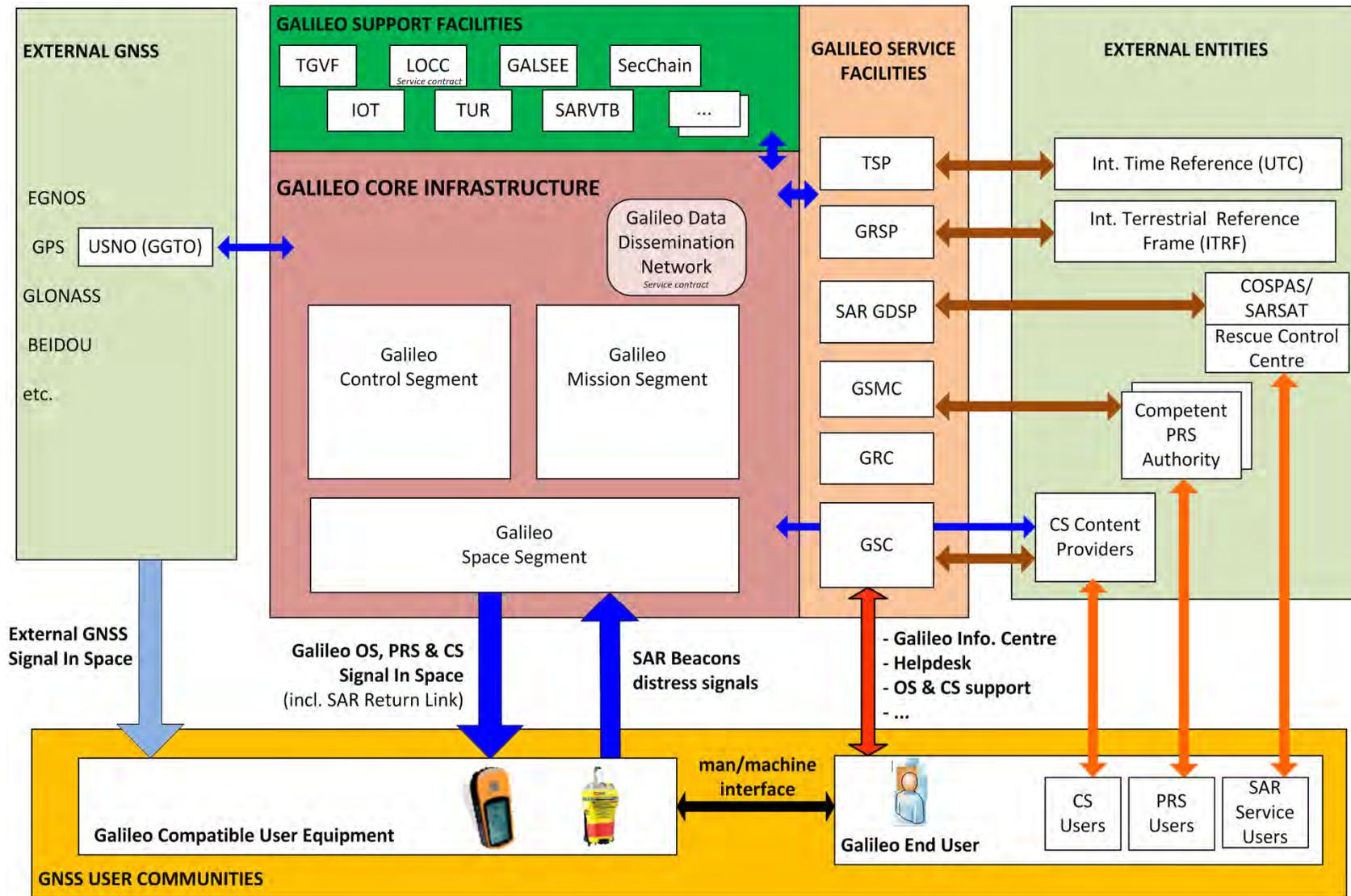


Galileo IOV System Configuration And Test Campaign

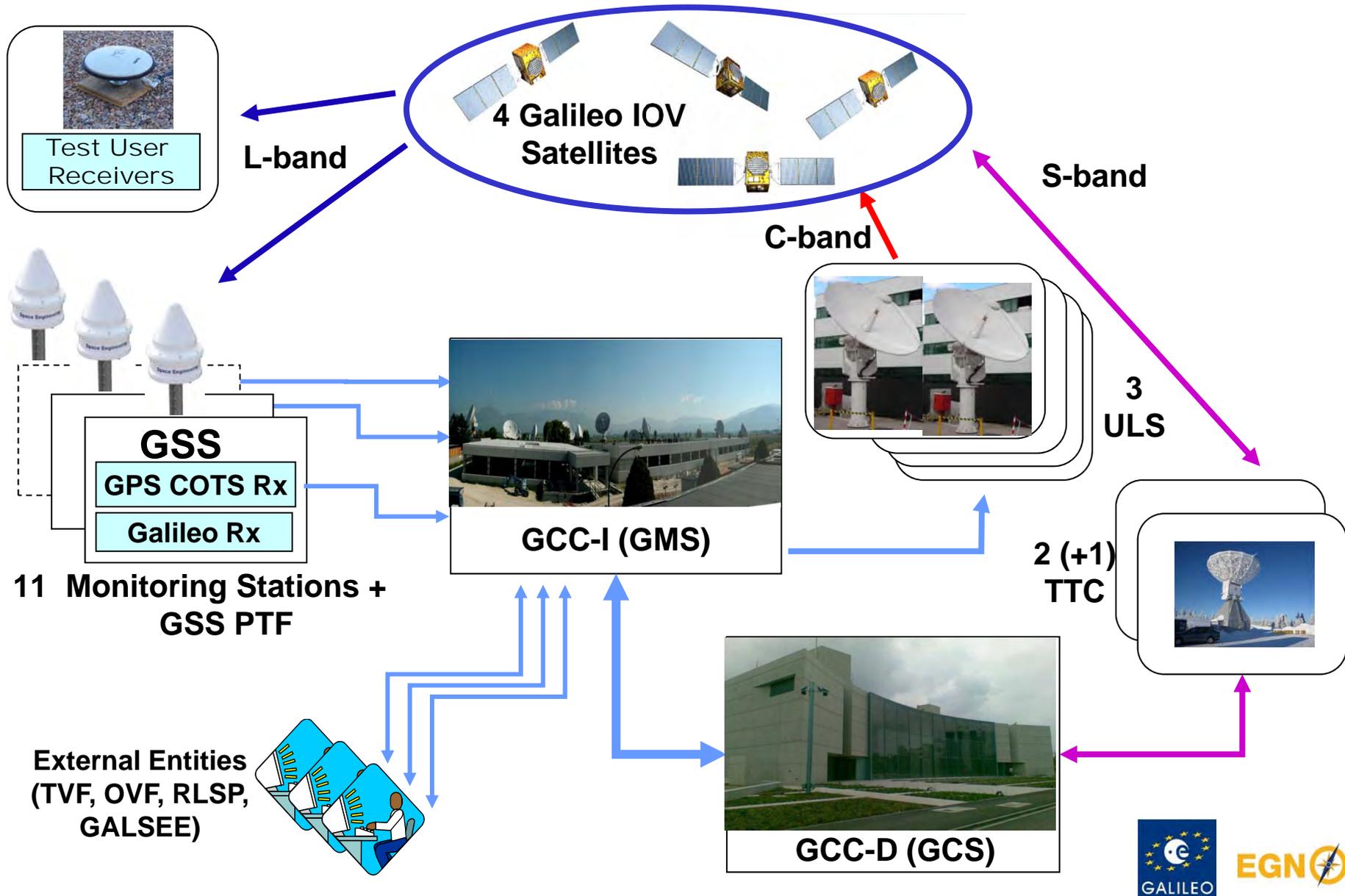
Deployment / Exploitation Plan



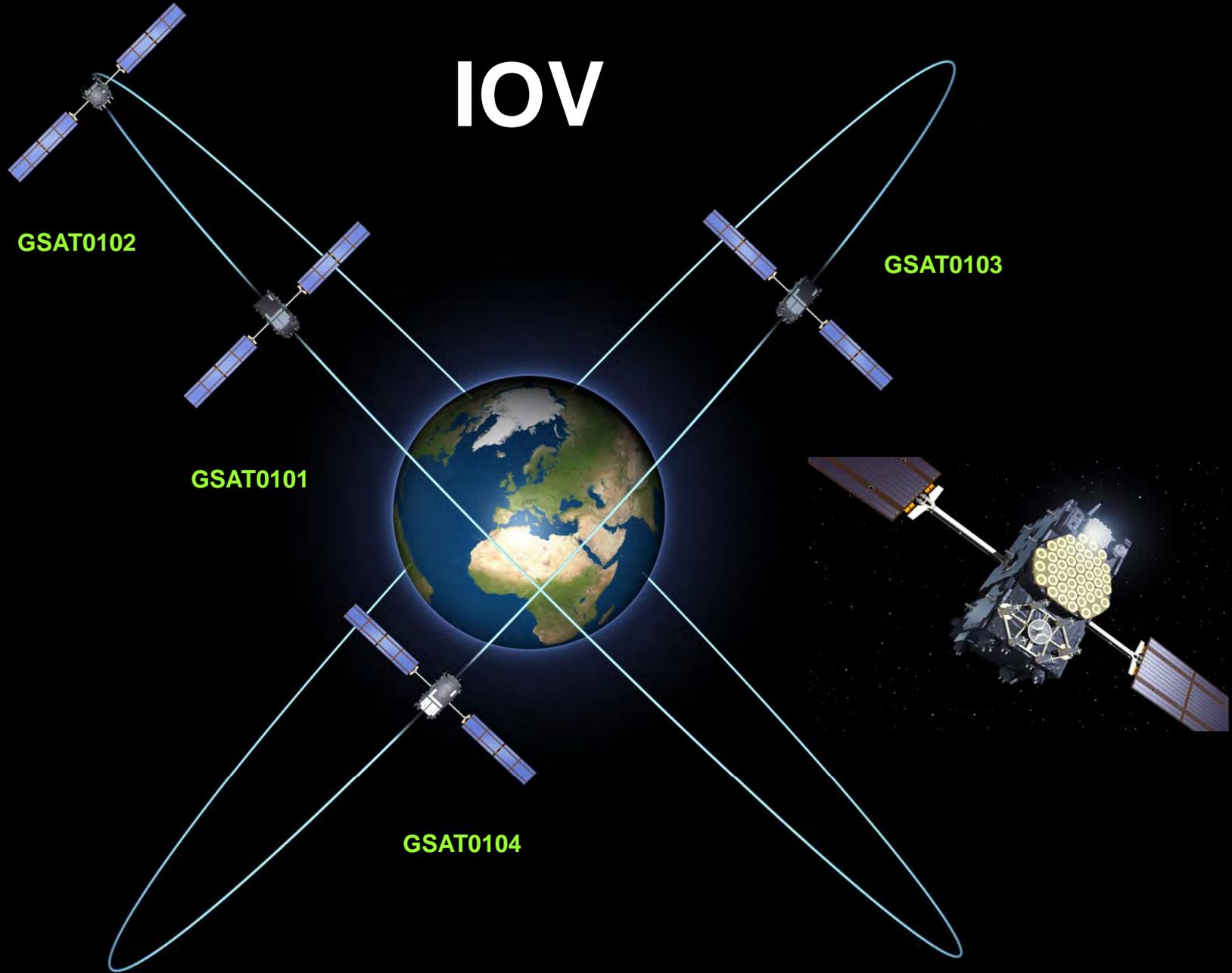
Galileo System



Galileo IOV Configuration



IOV



GSAT0102

GSAT0103

GSAT0101

GSAT0104

IOV FM3/FM4 Satellites

EADS Astrium GmbH
EADS Astrium Ltd
Thales Alenia Space – Italy

FM1/2 + FM3/4 differences

- SAR Transponder (not on FM 1/2)
- NSGU

SPACECRAFT Properties

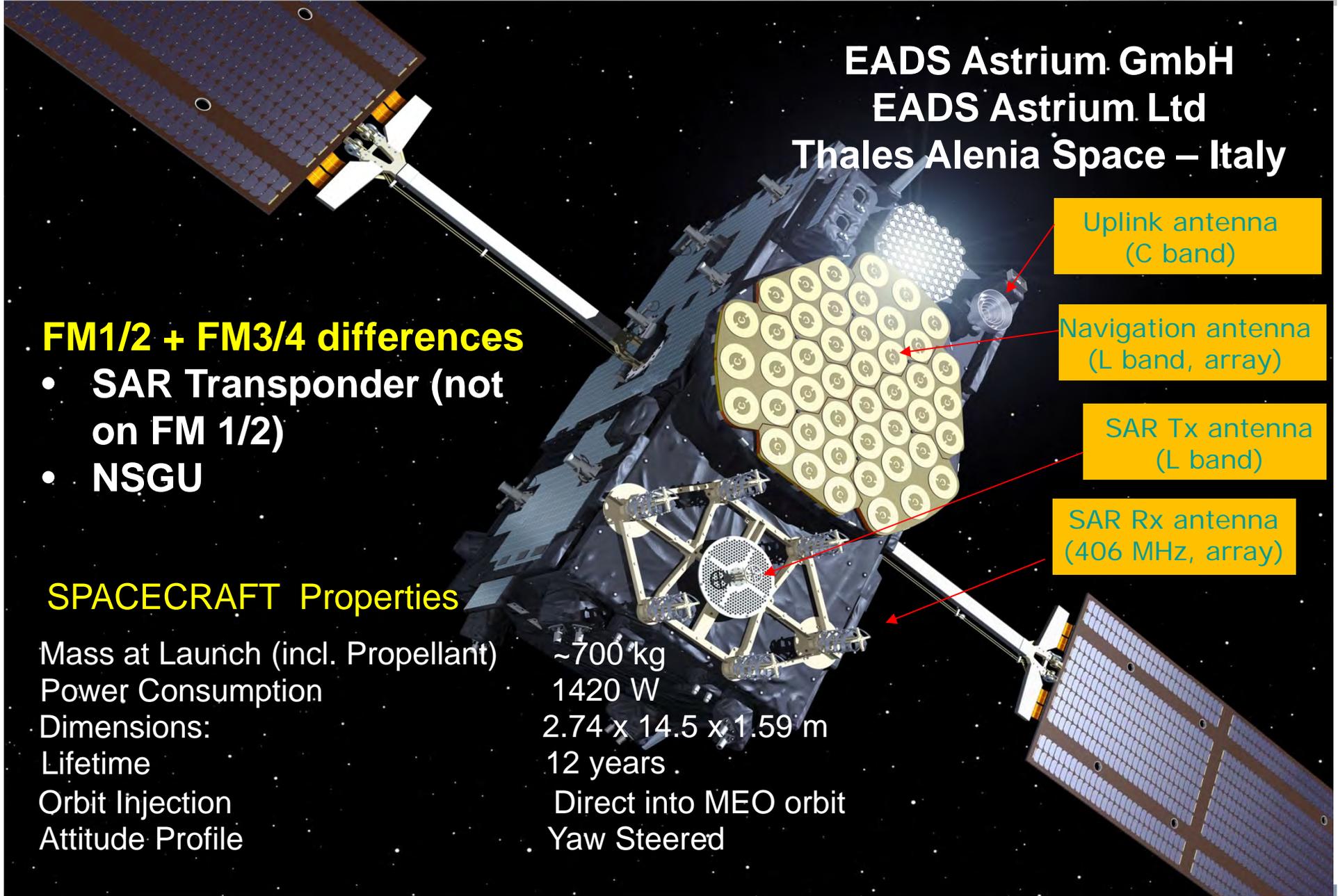
Mass at Launch (incl. Propellant)	~700 kg
Power Consumption	1420 W
Dimensions:	2.74 x 14.5 x 1.59 m
Lifetime	12 years
Orbit Injection	Direct into MEO orbit
Attitude Profile	Yaw Steered

Uplink antenna
(C band)

Navigation antenna
(L band, array)

SAR Tx antenna
(L band)

SAR Rx antenna
(406 MHz, array)





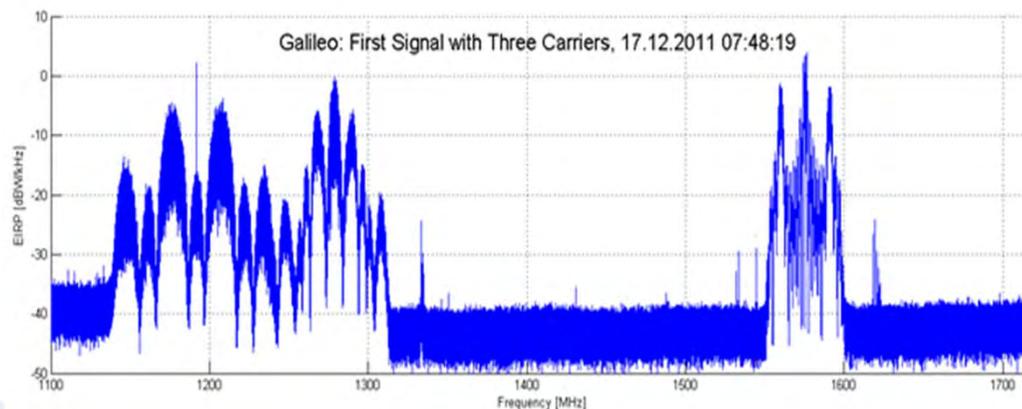


IOV-1 Launch: Soyuz from CSG «Maiden Flight»

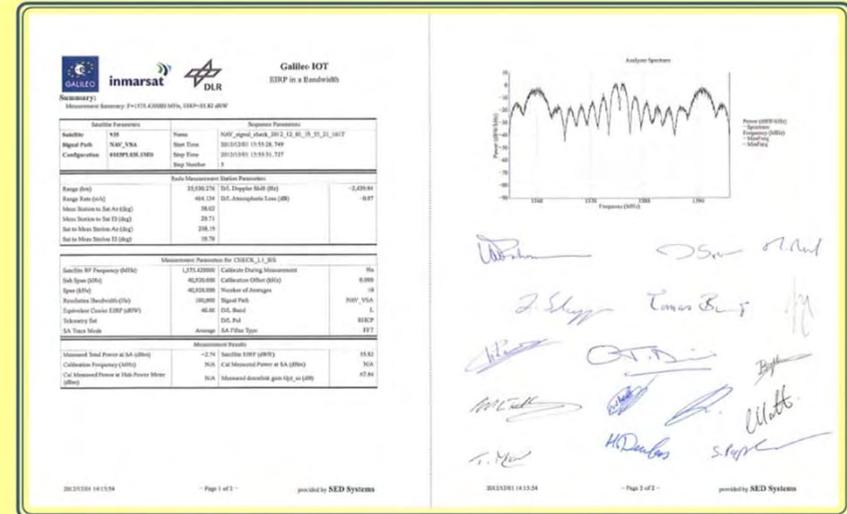
21 October 2011



First two IOV Satellites (PFM/FM2) launched from Guiana Space Center on 21 October 2011



IOV-2 Launch 12th of October 2012



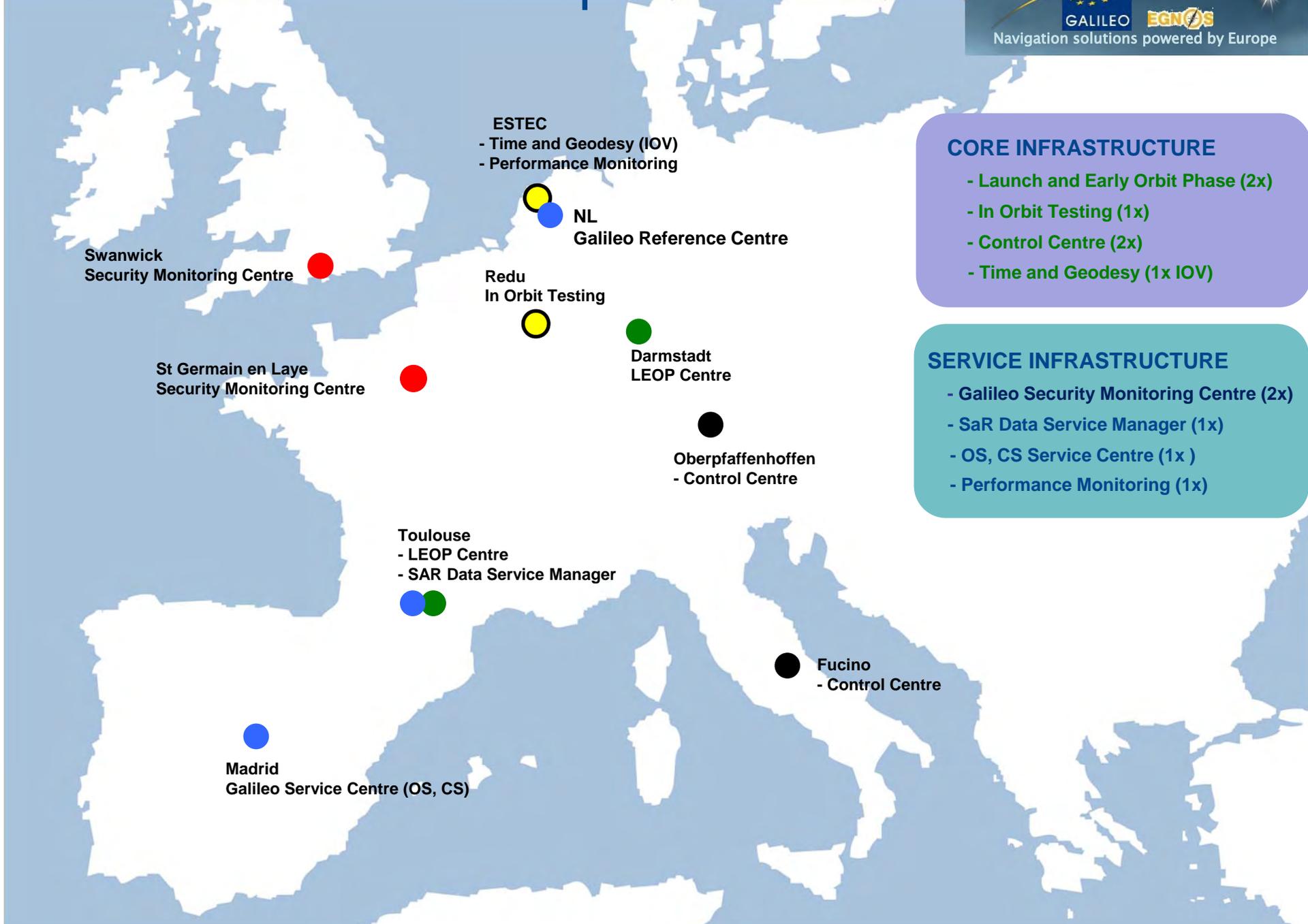
First Galileo IOV FM3 Signal Reception at IOT Station
 ESA REDU, 1st December 2012, 13:55:28 GST



Ground Stations Network (2013)



Galileo Sites in Europe



- CORE INFRASTRUCTURE**
- Launch and Early Orbit Phase (2x)
 - In Orbit Testing (1x)
 - Control Centre (2x)
 - Time and Geodesy (1x IOV)

- SERVICE INFRASTRUCTURE**
- Galileo Security Monitoring Centre (2x)
 - SaR Data Service Manager (1x)
 - OS, CS Service Centre (1x)
 - Performance Monitoring (1x)

Galileo Control Centre (D)



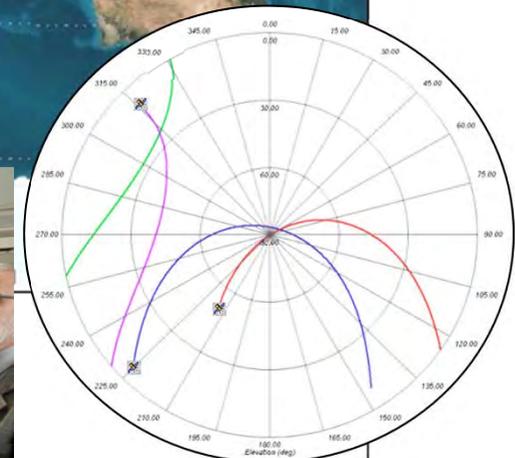
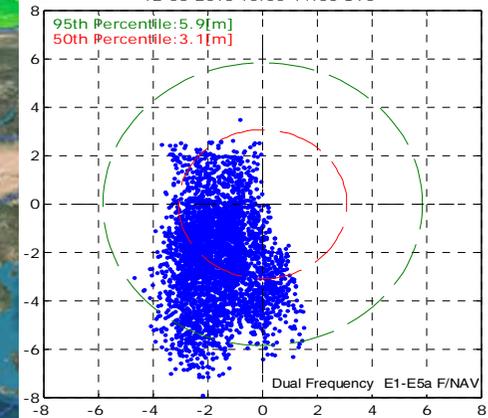
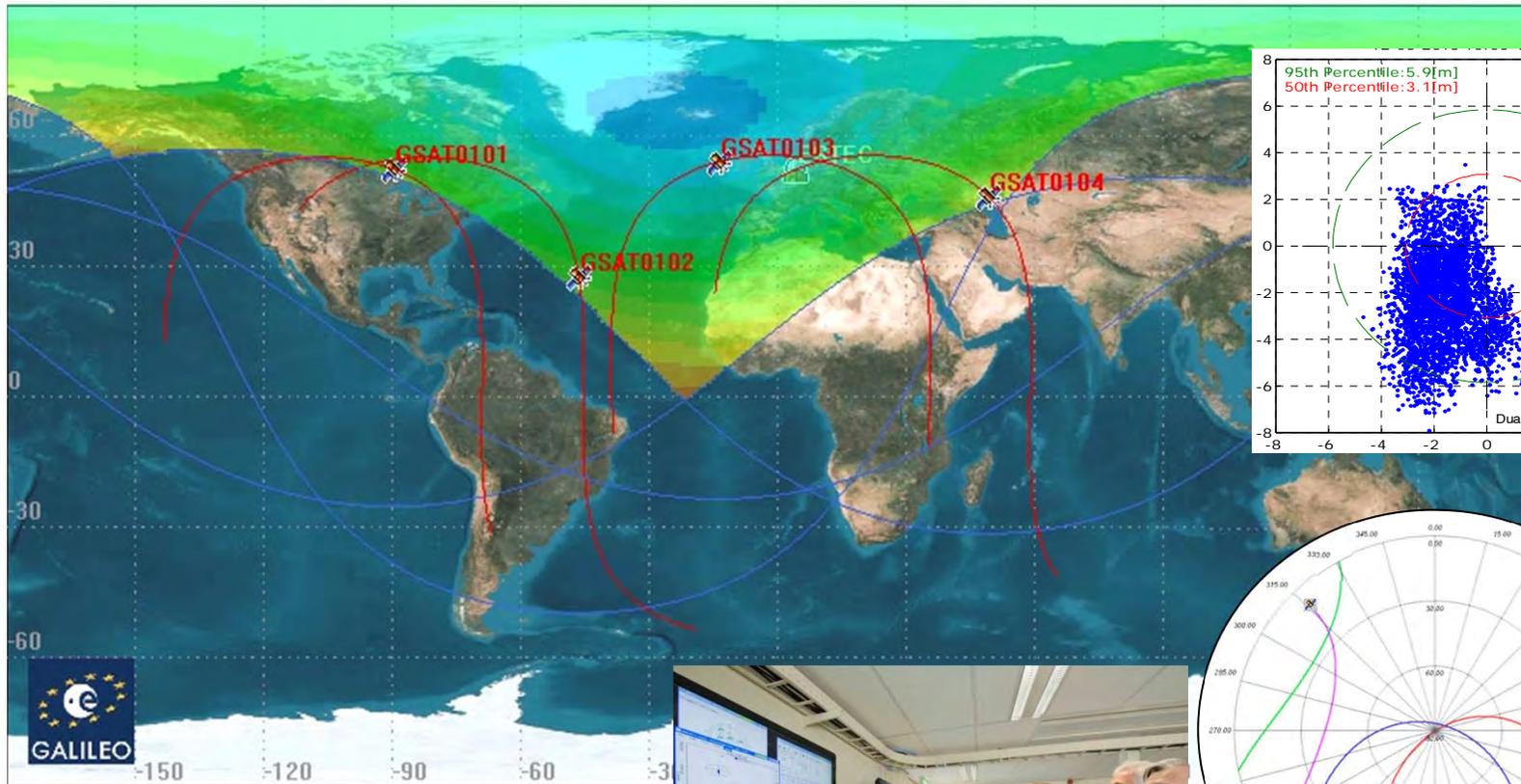
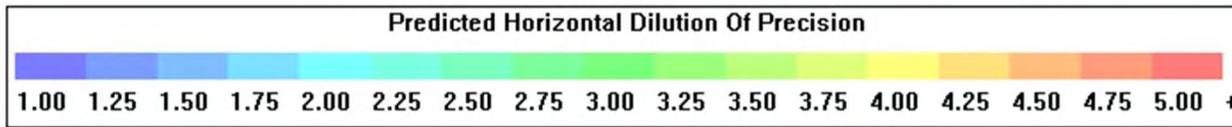
Galileo Control Centre (I)



IOV Main Objectives

1. Validation in flight of all space, ground and user components, including their interfaces, prior to full system deployment
2. Analysis of system performance with the view to refine the FOC system prior to full system deployment
3. Verification of the adequacy of the site requirements
4. Verification of Navigation Processing
5. User Equivalent Range Error budget characterization
6. Characterization of feared events
7. Verification of operational procedures
8. Deployment risk reduction

12 March 2013 – Galileo 1st Position Fix



12/03/2013
10:00 -11:00 UTC



Positive Feedbacks Around the World



[Galileo fixes Europe's position in history](#)

12 Mar 2013 - Galileo. This first position fix of longitude, latitude and altitude took place at the Navigation Laboratory at ESA's technical heart ESTEC, ...



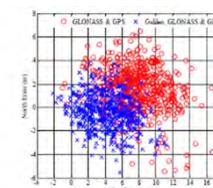
[NavSAS, Septentrio Report Galileo IOV Positioning Results, Turin](#)

13 Mar 2013 - Two European organizations announced successful positioning results yesterday (March 12, 2013) using signals from the four Galileo in-orbit ...



[PLAN Group Tracks Galileo Satellites for Positioning in Canada](#)

15 Mar 2013 - Within a day of their initial activation over central Europe on March 12, Galileo satellites were visible over North America. The PLAN Group of ...



[Four Galileo Birds Sighted over Asia](#)

27 Mar 2013 - Scientists in Hanoi, Vietnam, send word that on March 27 the four Galileo in-orbit validation satellites were visible at the same time in the sky over that Southeast Asian country



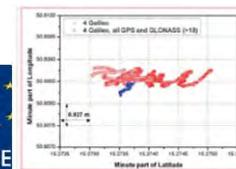
[Real-time PPP with Galileo is now a reality!](#)

25 Mar 2013 – Press Release indicates that the noise level of the position is better with Galileo alone than when GPS and GLONASS satellites are also used. This suggests a strong future for Fugro's Galileo PPP solution.



[GALILEO-only Position Fix from India](#)

9 Sep 2013 - First successful Galileo-only 3-dimensional position solution obtained from Burdwan, India on 03 July, 2013.



IOV test campaign Facts and Figures

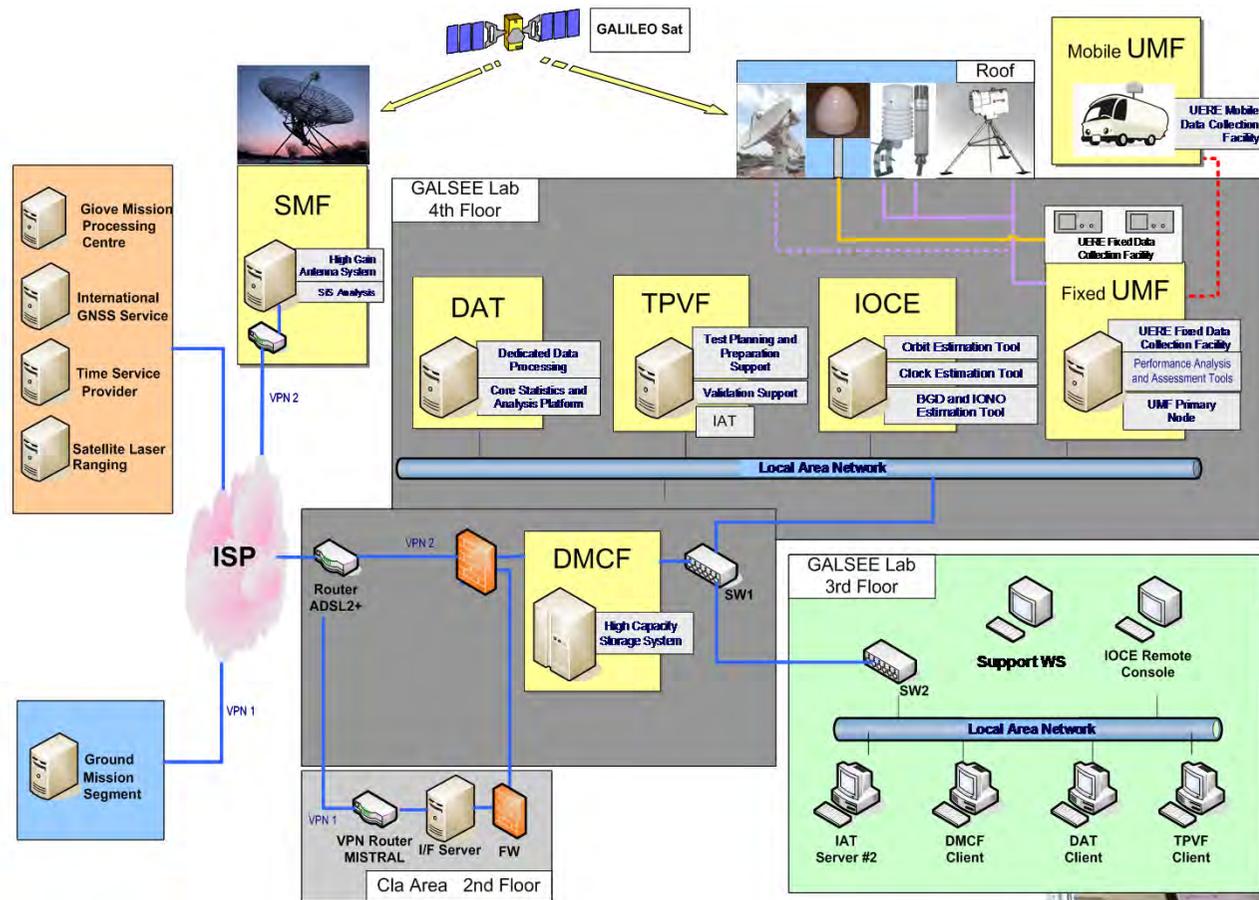
- ★ IOV Test Campaign started on 14th May up to 31st Oct 2013
- ★ More than 5 months of continuous navigation validation campaign conducted in Rome, Fucino and at ESTEC
- ★ 2 months of Search and Rescue validation campaign conducted in Toulouse, Maspalomas and ESTEC
- ★ 2 months of PRS access control campaign in Fucino, Rome and ESTEC
- ★ Test Activity conducted in Galileo GCCs, ESA, CNES and TASI Laboratories and facilities (both fixed and mobile)
- ★ Teams of up to 35 people for Industry and 25 for ESA continuously deployed
- ★ Tens of Terabites of data accumulated and processed during the campaign
- ★ Mobile Vans
 - ★ Open Service 8500Km and 250 hrs
 - ★ PRS 2000Km and 100 hrs



IOV Test campaign achievements

Date	Event
12 March	First Position Fix
16 April	First GST-UTC offset dissemination
22 April	First GGTO dissemination
27 May	First implementation of GTRF aligned to ITRF2008
25 June	First dissemination of Commercial Service data
9 July	First SAR localisations using Maspalomas MEOLUT
July	First PRS position fix by Member States (PPTI)
October	First dissemination of SAR Return Link
12 November	First aeronautical test (incl. PRS)
22 November	First Mobile PRS Access Control

GALSEE



- ★ Generates orbit&clock reference based on IOCE tool processing GSS data
- ★ Collects and compares orbit and clock data directly retrieved from GMS through dedicated interface



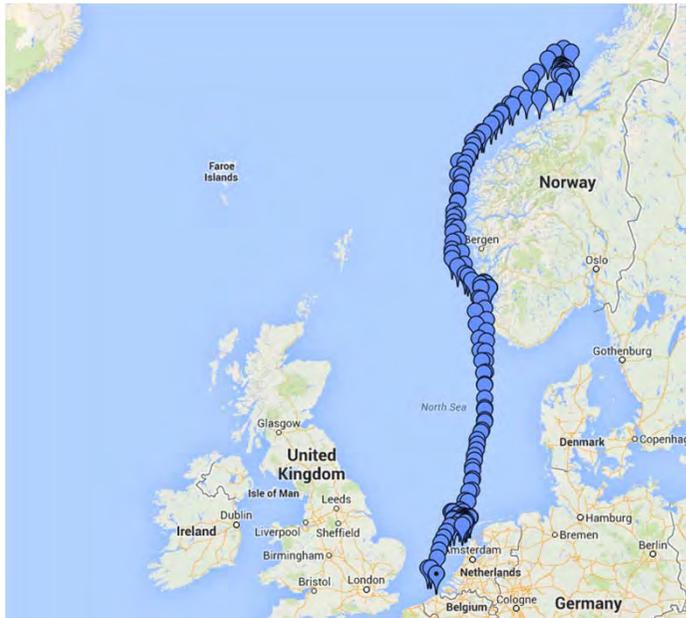
Test User Receivers



- ★ OS and PRS versions
- ★ Collect data for UERE analysis and run PRS access control tests
- ★ Fixed and Mobile set-ups (ESTEC and TAS-I/Rome).



First Road and Maritime and Trials



First Galileo Aeronautical Trials

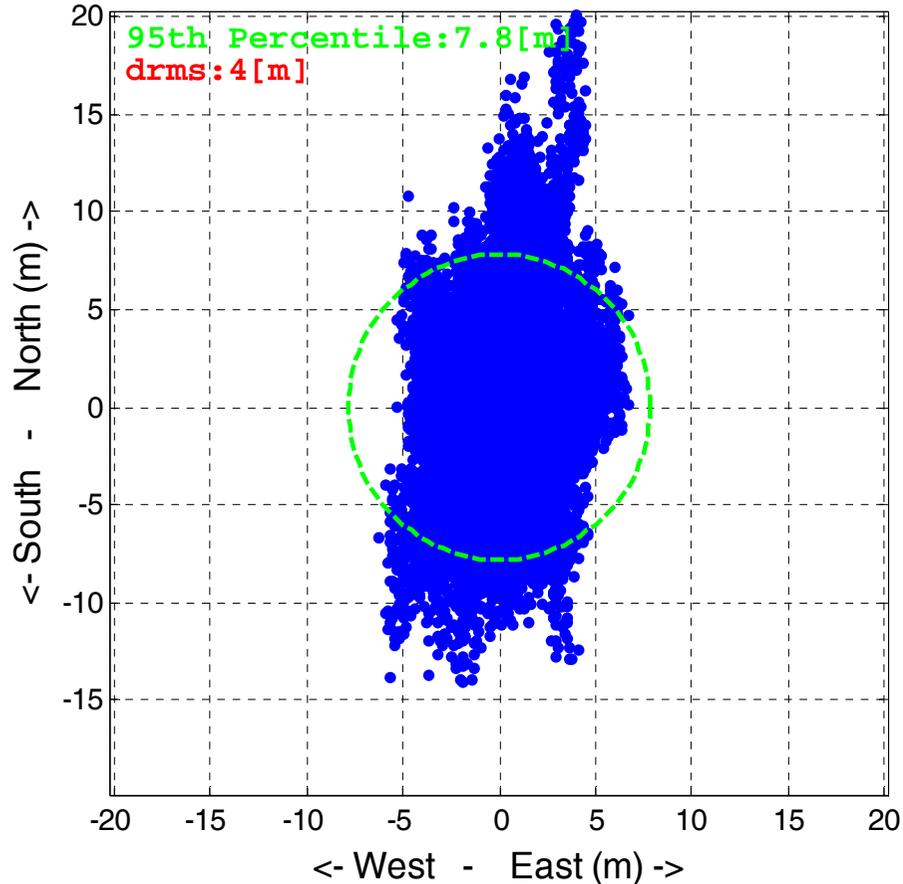


- 3 flights in November 2013 co-organized by ESA and NLR
- Done in Gilze-Rijen Air Force Base using the NLR Metro-2 aircraft.

Galileo Positioning works well



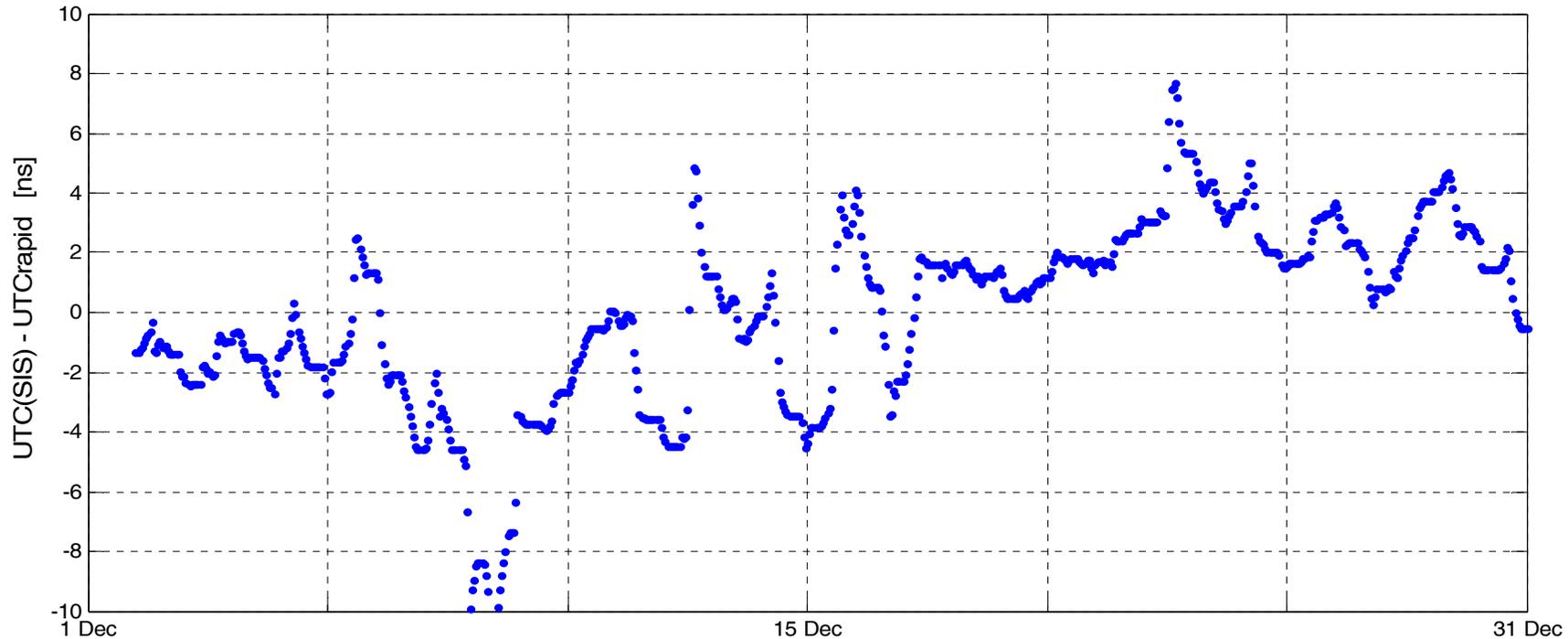
GUSN 23rd August - 3rd September 2013, GDOP<10 [mean GDOP = 4.5]



Dual Frequency
Positioning Accuracy
(PDOP ≤ 5):

- Horizontal (95%)
8 m in average
- Vertical (95%)
9 m in average

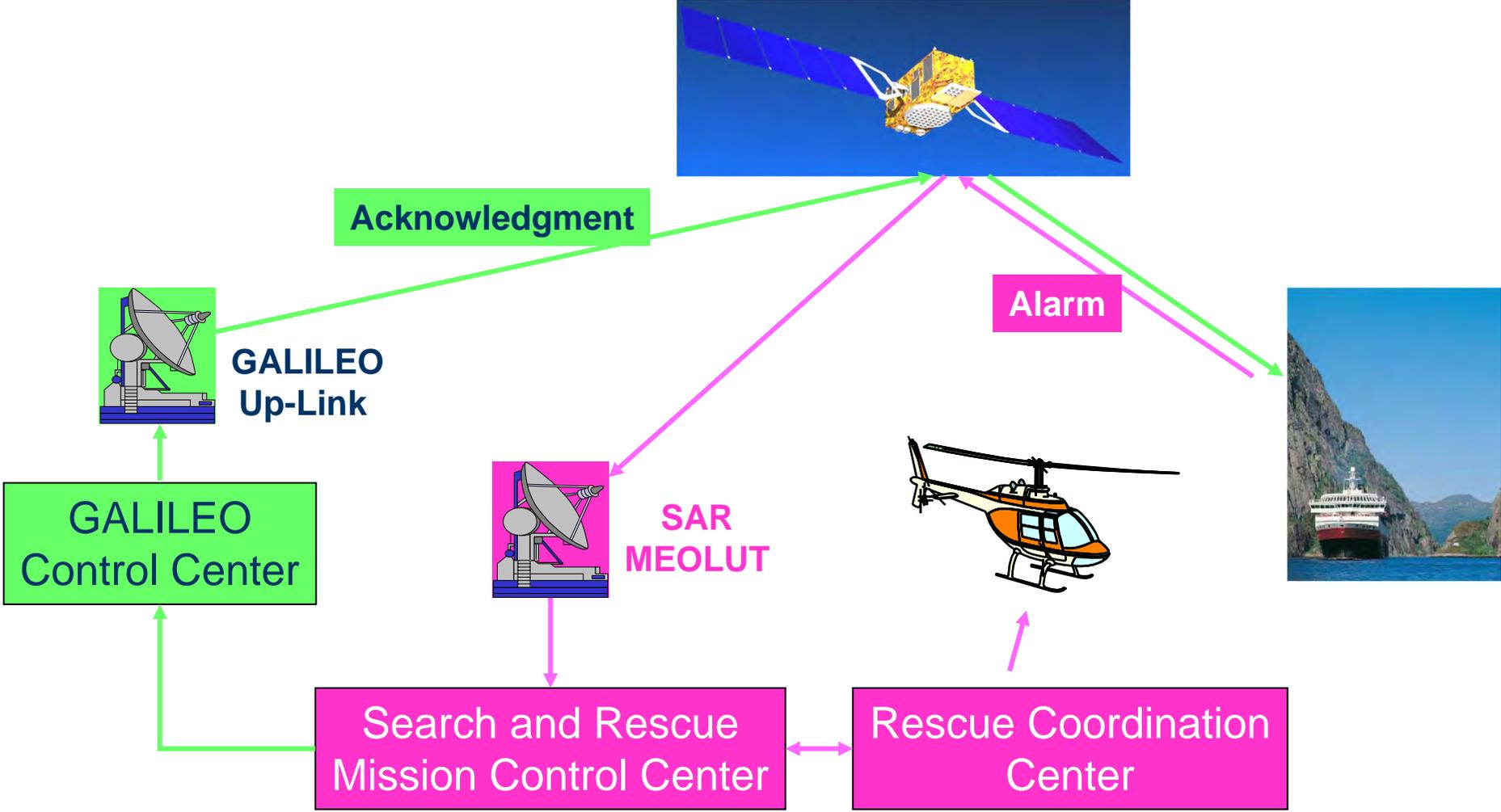
Galileo Timing works well



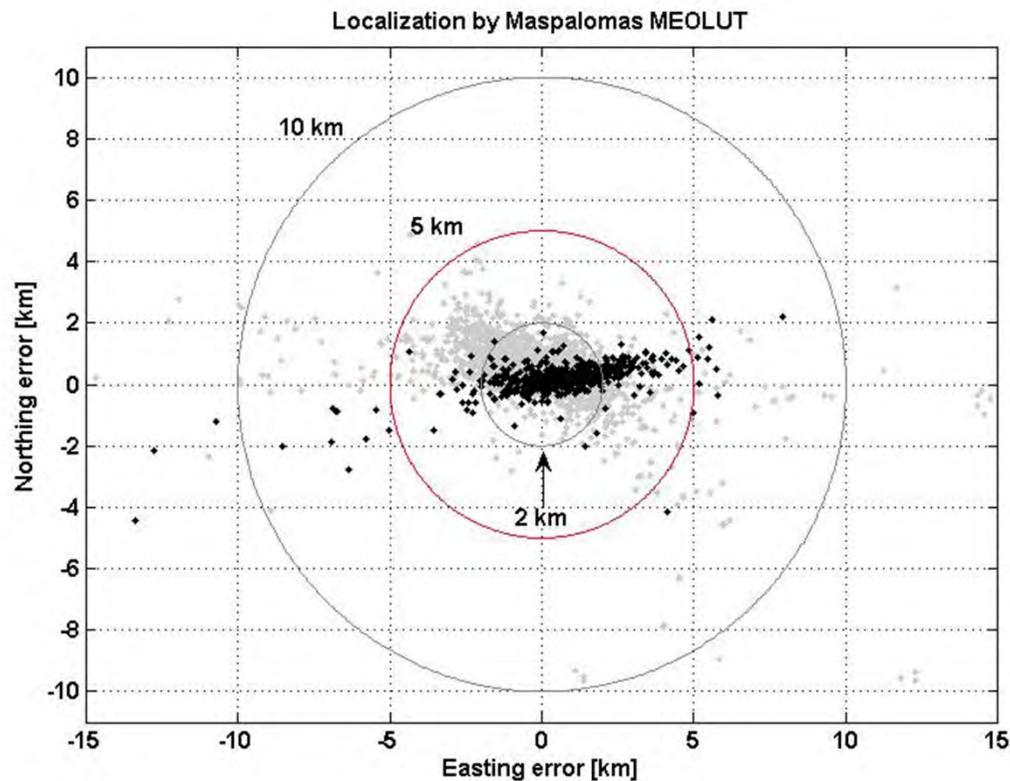
Timing Accuracy: **10 nsec in avg**

- 67% availability with 4 IOV S/C
- 96% availability after 1st FOC launch (6 S/C)

Search And Rescue/Galileo



Galileo Search and Rescue works well



Grey = 3 s/c
Black = 4 s/c

SAR Beacons Localisation Accuracy:

- **Within 2 km**
(77% localisations)
- **Within 5 km**
(95% localisations)

IOV Industry Team

- ★ WP1 SETA Industrial Team:
 - ★ TASI as Prime Contractor
 - ★ Astrium-D (now Airbus!) for Signal, Performance and External Interfaces
 - ★ TCS for Security
- ★ WP6 Operations Industrial Team:
 - ★ SpaceOpal as Prime Contractor
 - ★ DLR Lead for Spacecraft Operations and GCS Ground Operations
 - ★ Telespazio Lead for GMS Ground Operations and PLSU M&C

ThalesAlenia
A Thales / Finmeccanica Company Space

 **ASTRIUM**
AN EADS COMPANY

THALES

 spaceopal
a DLR GfR and Telespazio company

DLR Gesellschaft für Raumfahrtanwendungen (GfR)

Ein Unternehmen des
 **DLR** Deutsches Zentrum
für Luft- und Raumfahrt e.V.

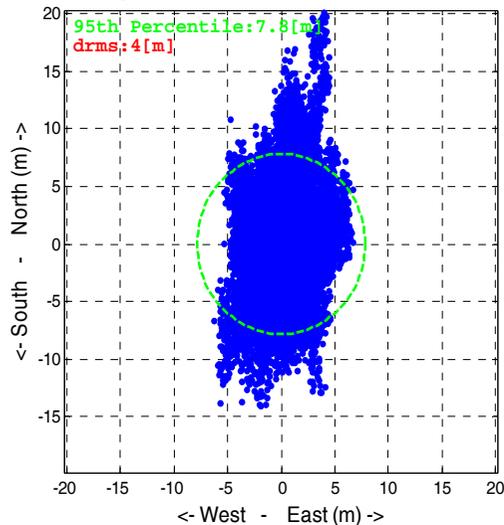
 **TELESPAZIO**
A Finmeccanica / Thales Company



Galileo works very well!!

Positioning

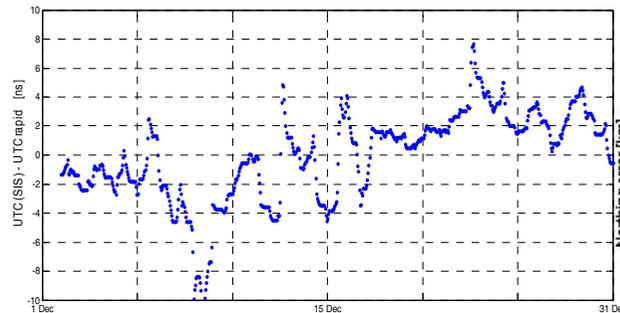
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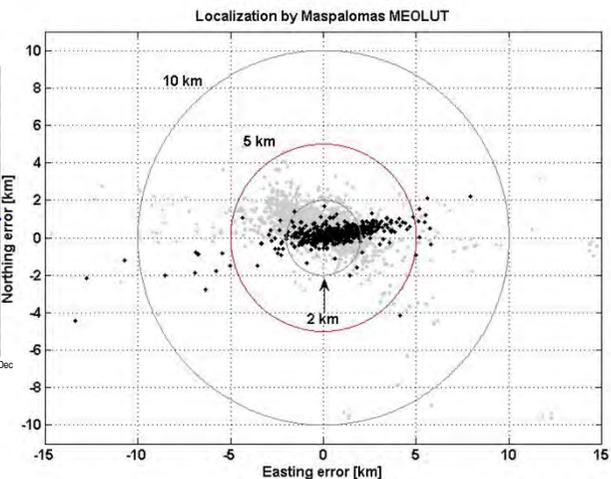
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Thank You



http://www.esa.int/Our_Activities/Galileo

<http://www.gsc-europa.eu>

