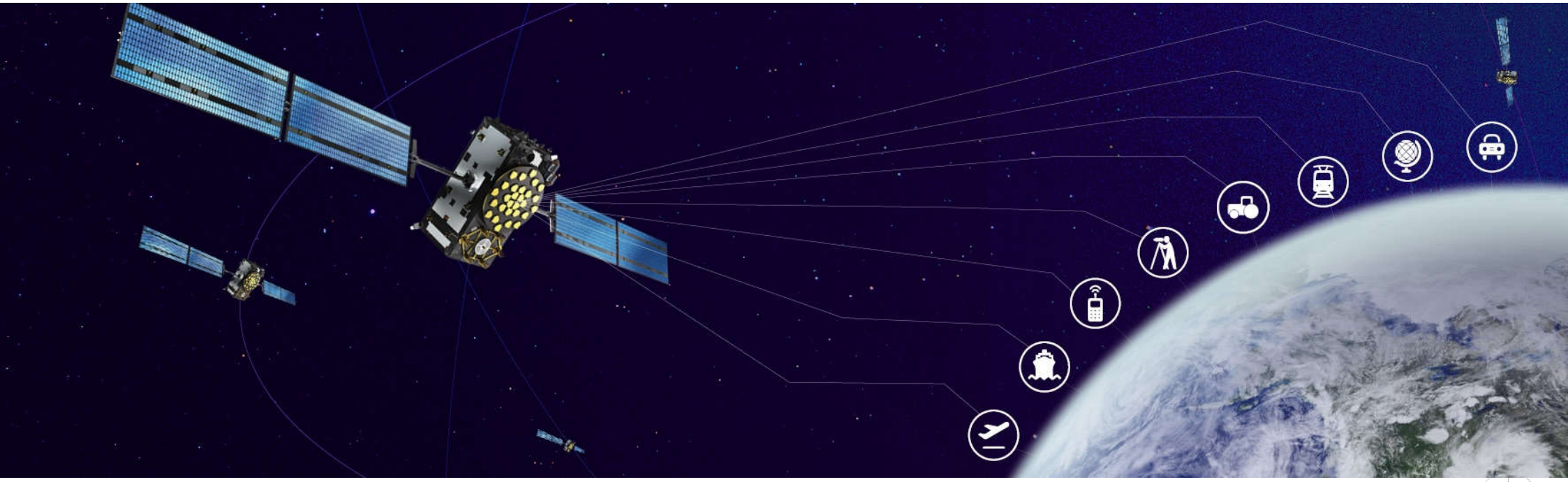


European
Global Navigation
Satellite Systems
Agency

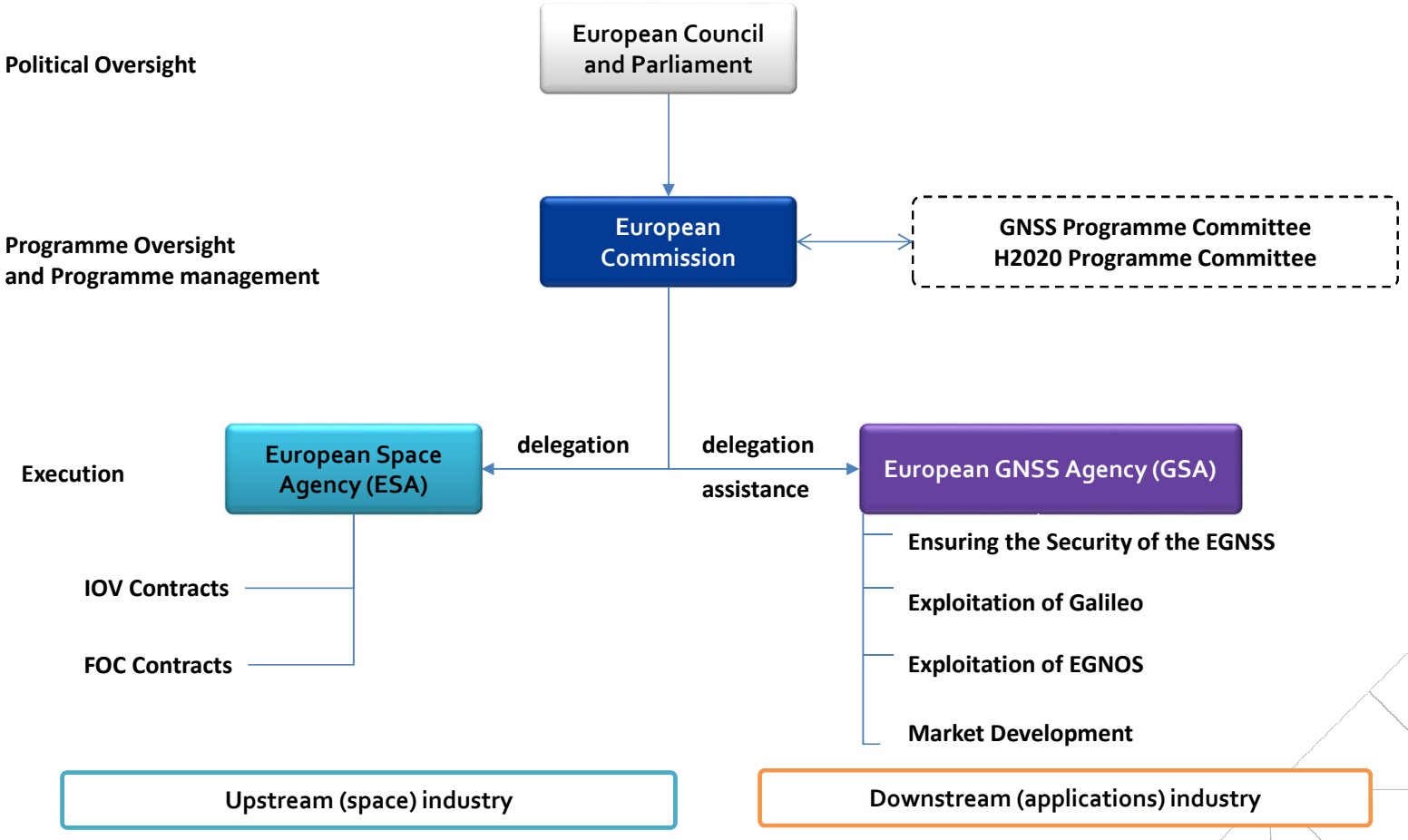
GALILEO EGNOS
NAVIGATION SOLUTIONS
POWERED BY EUROPE

Galileo Reference Centre

Peter BUIST (GSA), Alvaro Mozo (GSA), Hillar Tork (EC)

EUREF SYMPOSIUM 2018, May 30th, Amsterdam

EU GNSS programmes



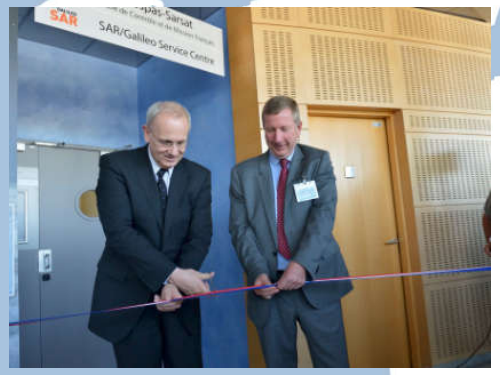
European GNSS Agency (GSA)

- An Agency of the European Union
- Designing, enabling and **providing** GNSS Services
- Engaging market stakeholders
- Security of GNSS Services

As of July 1 2017 the GSA is responsable for Galileo Service Provision

GALILEO – SERVICE INFRASTRUCTURE

Galileo Reference Centre
Noordwijk (NL)



Galileo SAR Centre
Toulouse (F)

Galileo Integrated Logistics Centre
Transinnes (BE)

Galileo Service Centre
Madrid (SP)

1st Galileo User Assembly

1ST GALILEO USER ASSEMBLY

28-29 NOVEMBER 2017 MADRID

USEGALILEO.EU

FIND A GALILEO-ENABLED DEVICE TO USE TODAY

Galileo is Europe's Global Satellite Navigation System (GNSS), providing users with improved positioning and timing information.

Click on the icons to find Galileo-enabled devices.

GALILEO SERVICE PROVISION

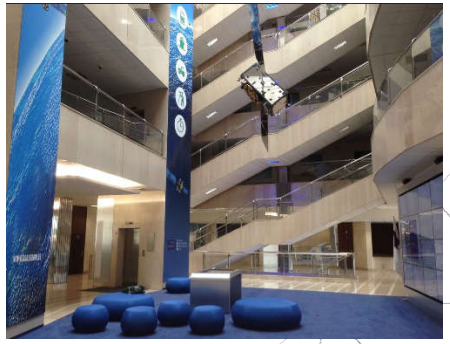
- The key focus is now on Service Provision
  - Initial Services declared in Dec 2016
  - Implies service quality commitments by the Programme

- Service Delivery handed over to the European GNSS Agency (GSA)

- Operations contract with GSOp signed in Dec 2016
  - Spaceopal
  - 10-year service contract

- Successful handover mid 2017

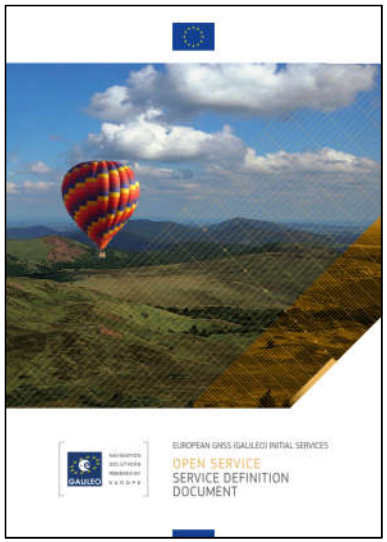
spaceopal
a DLR GfR and Telespazio company



Galileo Service Definition

–Public Programme Reference Documents concerning OS:

Signal In Space Interface Control Document (OS SIS ICD)



Service Definition Document (OS-SDD)

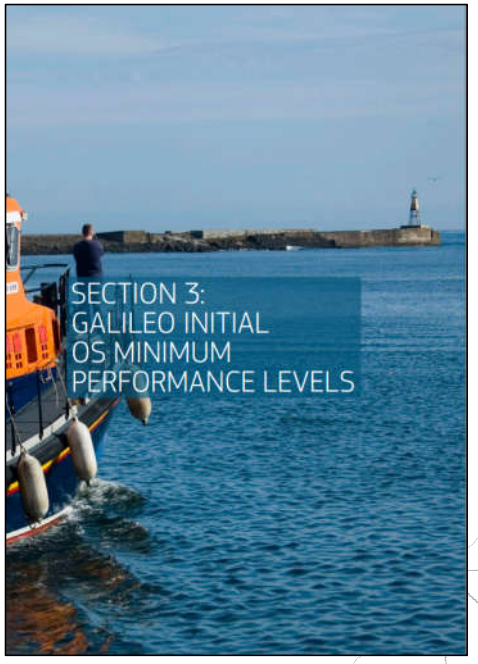
Ionospheric Correction Algorithm for Galileo Single Frequency Users

OS SIS ICD

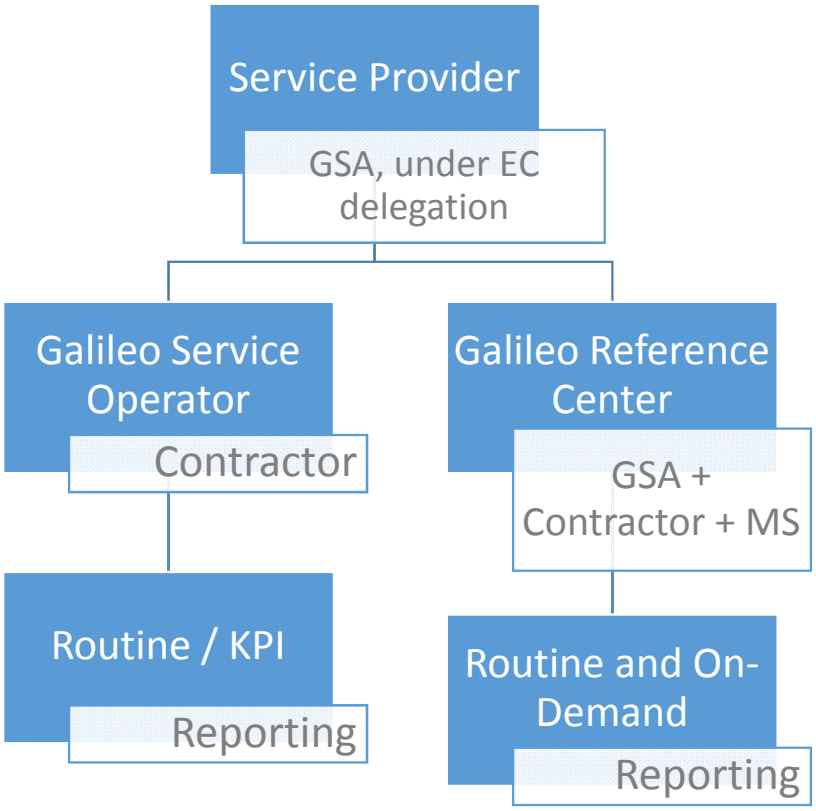
- Contains the publicly available information on the Galileo Signal-in-Space
  - Intended for use by the Galileo user community
  - specifies the interface between the Galileo Space Segment, and the Galileo user Segment
  - Enabling receiver manufactures to build receivers capable of receiving Galileo SiS, specifying RF aspects, modulation, coding etc.

OS-SDD

- Published at Declaration of the Galileo Initial Services on 15 December 2016
- Based on the GNSS OS Performance Standards Template elaborated in the framework of the ICG
- Has three main sections:



Galileo Service performance monitoring



GRC Mission

- Perform **independent monitoring** and assessment of service provision
- When feasible, assess the compatibility and **interoperability** between Galileo and other GNSS
- Provide service **performance expertise** to Programme
- Support **investigations** of service **performance** and service degradations
- Archive service performance data over nominal operational lifetime of system
- Integrate **data and products** from EU **Member States**, Norway and Switzerland (MS)

GRC Architecture and Operational Concept

Core Facility

- Situated in the Netherlands
- Stand-alone capabilities

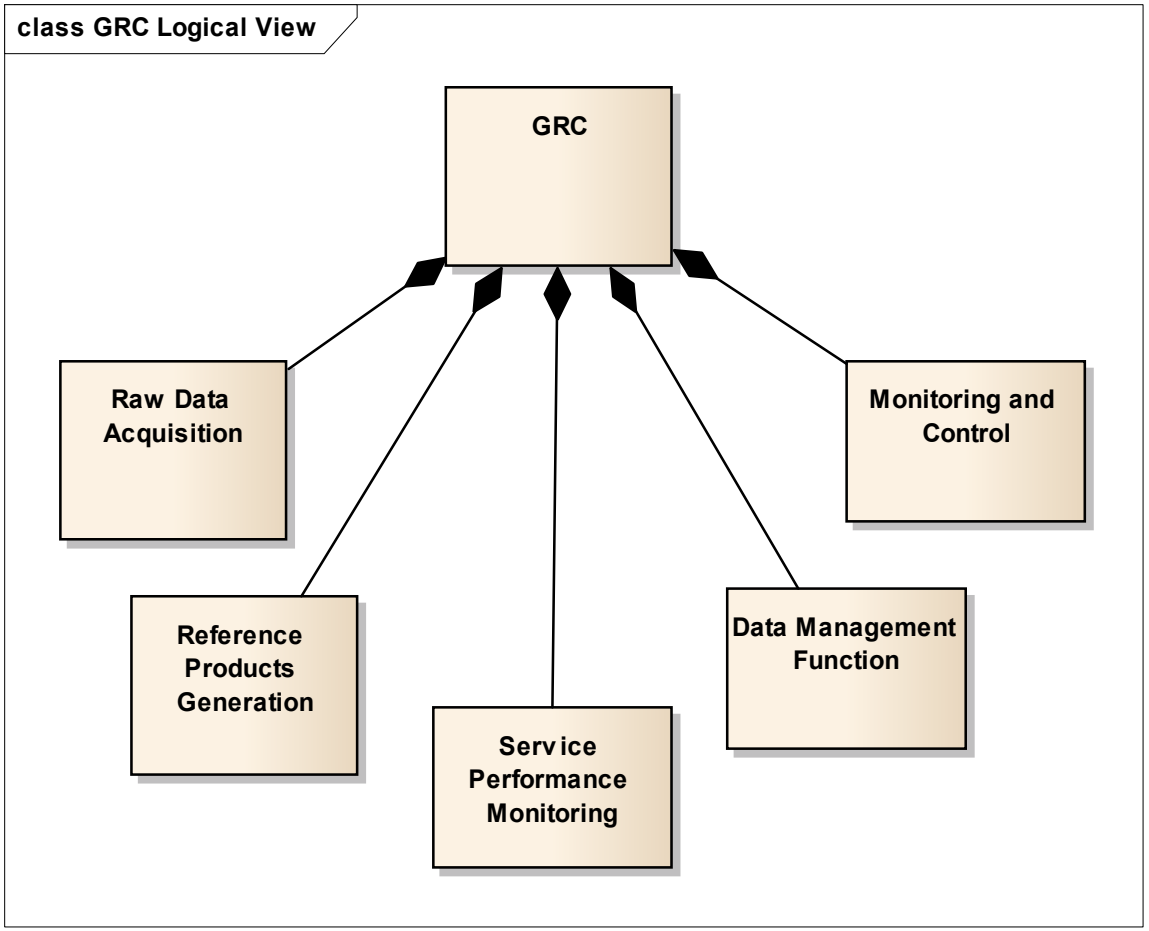
MS Contributions

- Data
- Products
- Expertise

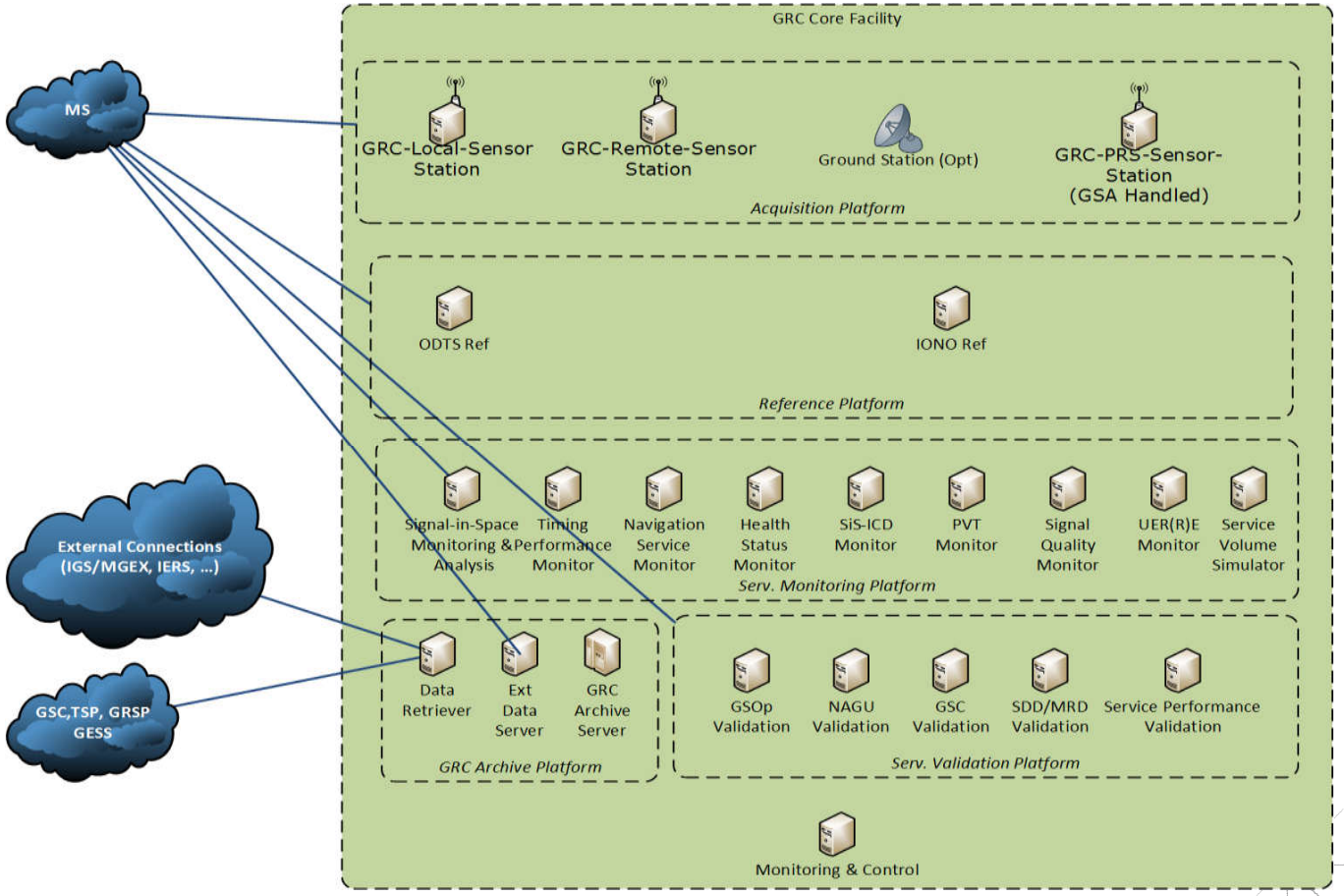
GRC Architecture and Operational Concept

- Fully independent of the system and of the Galileo Service Operator (GSOp)
  - both technical solution and operations
- Automatic processes for continuous monitoring and data processing
  - each Galileo service shall be monitored against Key Performance Indicators (KPIs) and Figures of Merit
  - KPIs are derived from SDDs and Galileo Service Operator KPIs
- Evaluate basic monitoring parameters for Galileo signals against values specified in Galileo SiS ICD
- Perform dedicated campaign-based analyses
  - Also taking advantage of data, products, facilities and expertise contributed by MS

GRC Architecture and Operational Concept



GRC Architecture and Operational Concept



Service definition documents

- OS SDD
  - It defines the minimum performance levels of the Galileo Open service to be provided during the Galileo Initial Services Provision Phase
- KPI Definition document
  - Generated in the scope of Galileo Services Operator (GSOp)
  - It defines the Galileo KPIs and metrics to monitor Galileo performance at user level

Monthly Report-1

European Global Navigation Satellite Systems Agency

GALILEO REFERENCE CENTRE
MONTHLY REPORT
MARCH 2018
GRC

UNCLASSIFIED

	NAME	COMPANY	SIGNATURE
Prepared by:	GRC Operations Team	GMV	
Approved by:	Guillermo TOBIAS	GMV	
Authorised by:	Cristina GARCIA	GMV	
Customer Approval:	Peter BUIST	GSA	

Code:	GAL-RPT-GMV-GRC-2029
Version:	1.1
Date:	03/05/2018
Internal code:	GMV 21430/18 V2/18

EC Proprietary information. Unauthorized distribution, dissemination or disclosure not allowed

- For internal Programme use
- PDF format
- Delivered monthly
- Covering Galileo performances for 1 month

Monthly Report-2

European Global Navigation Satellite Systems Agency

GALILEO REFERENCE CENTRE
MONTHLY REPORT
MARCH 2018
GRC

UNCLASSIFIED

	NAME	COMPANY	SIGNATURE
Prepared by:	GRC Operations Team	GMV	
Approved by:	Guillermo TOBIAS	GMV	
Authorised by:	Cristina GARCIA	GMV	
Customer Approval:	Peter BUIST	GSA	

Code:	GAL-RPT-GMV-GRC-2029
Version:	1.1
Date:	03/05/2018
Internal code:	GMV 21430/18 V2/18

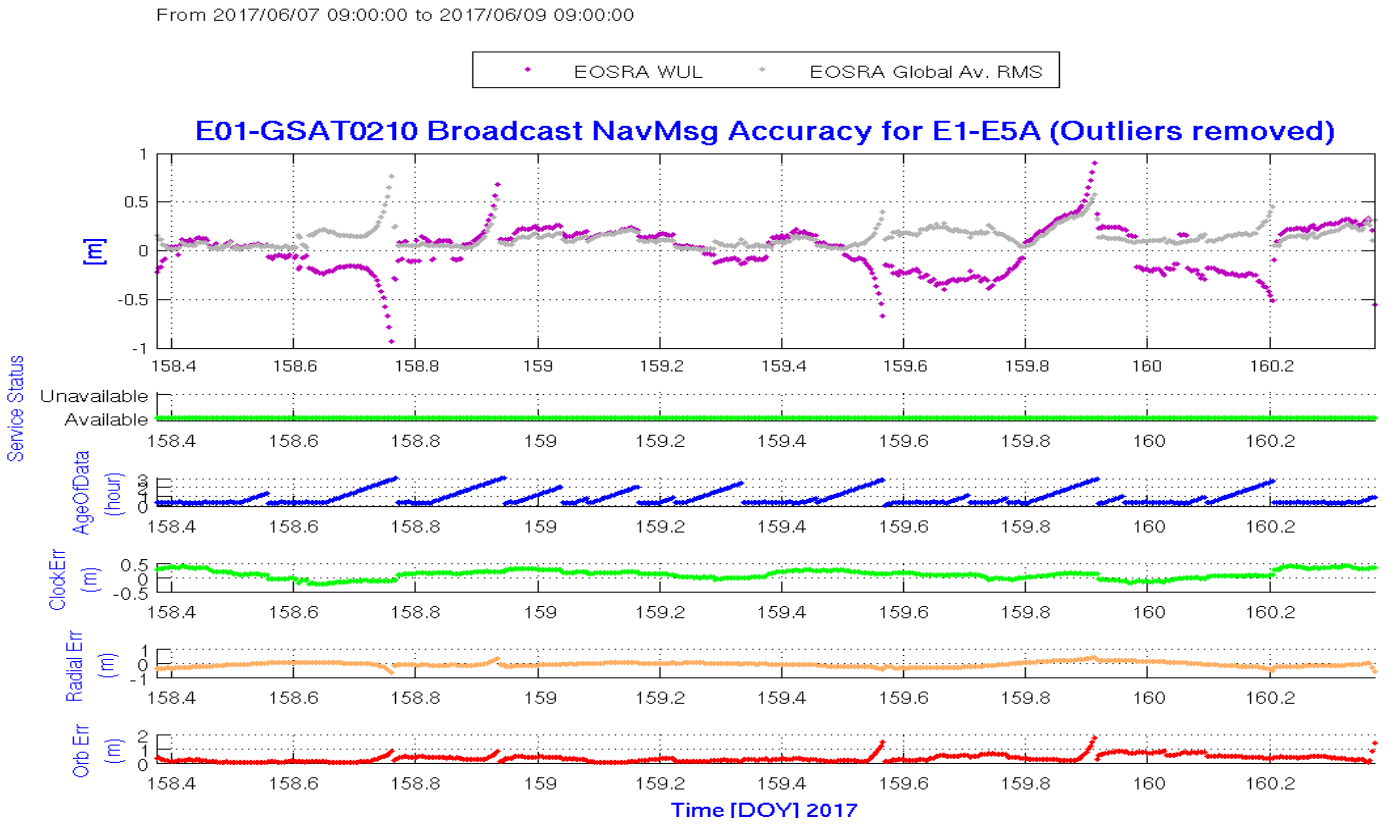
EC Propietary information. Unauthorized distribution, dissemination or disclosure not allowed

- Latency of 3 weeks
  - Time needed to obtain final orbit, clock and bias products
- KPIs reported:
  - Ranging accuracy: Difference between the true satellite position and the one broadcast by the navigation message
  - Ranging availability: Percentage of time that a satellite is transmitting a healthy signal, and percentage of time that a user is receiving at least one healthy signal
  - UTC-GST, GGTO dissemination availability
  - UTC-GST, GGTO offset/frequency accuracy
- List of stations used to compute KPIs:
  - GESS network

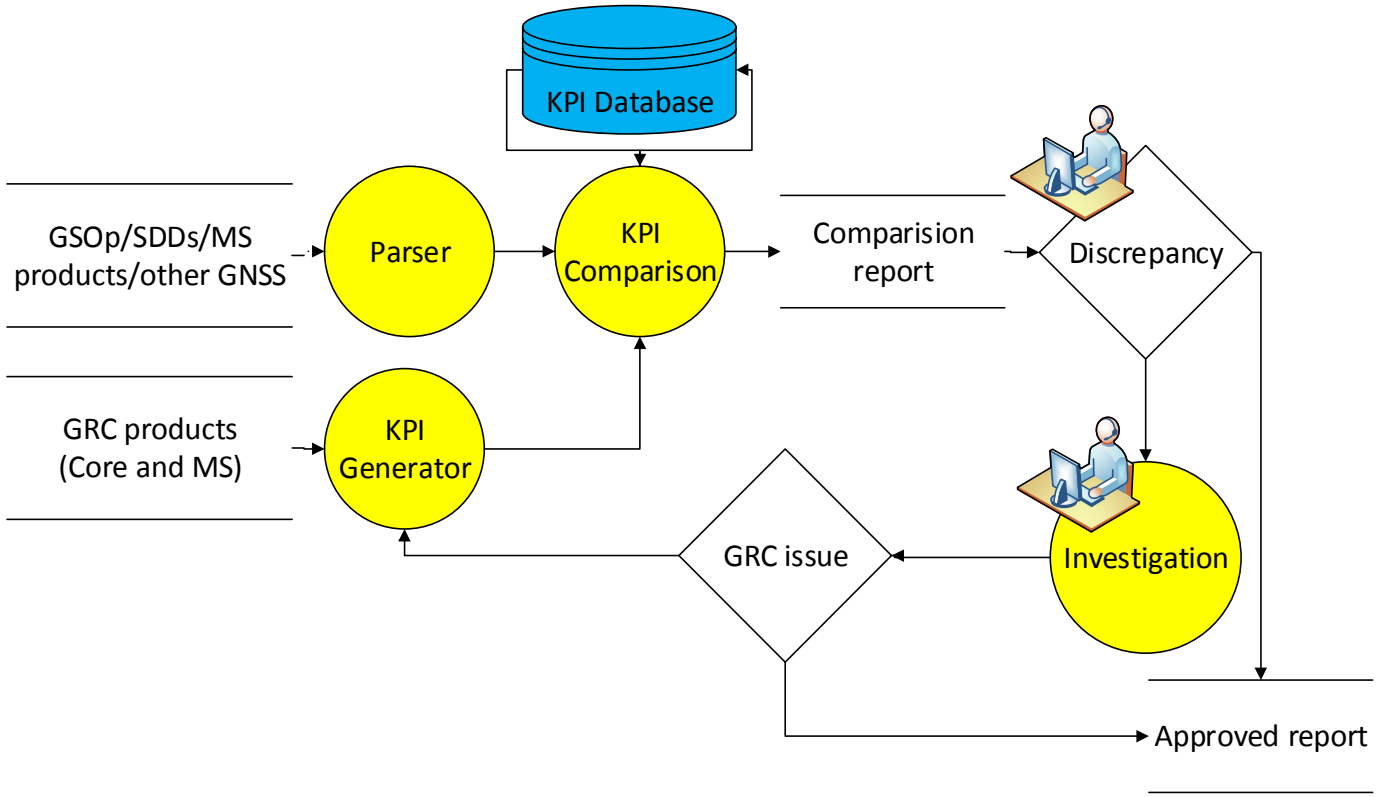
Other Reports

- Daily monitoring capabilities that are of use for service delivery and reaction in case of failure.

Signal in Space Ranging Error per satellite and signal/ signal combination



Monthly KPI Report cross-check

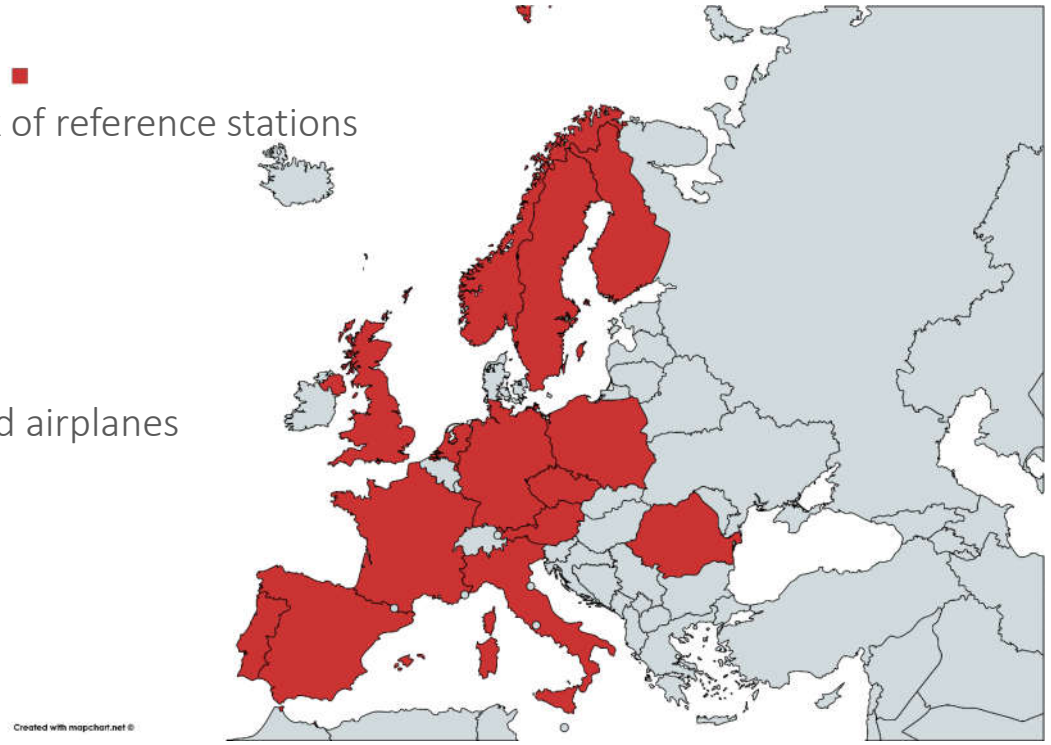


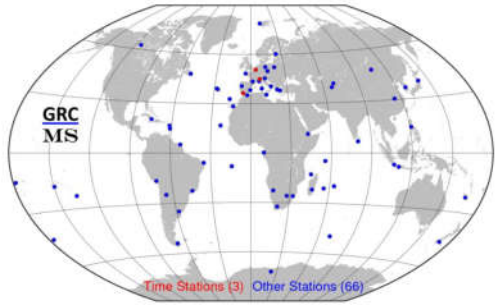
Member States' Contributions

- To establish long-term relationships to provide access to a range of facilities and expertise for Galileo service performance monitoring in order to enhance the performance of the GRC
- The GRC should benefit from but also contribute to maintaining the long term competences and expertise at the level of Member States;

Member States' Contributions

- 23 organisations from 14 countries
- Including
  - Worldwide network of reference stations
  - Reference products
  - Timing labs
  - Radio telescopes
  - Laser ranging
  - Vehicles, vessels and airplanes





Building Construction

November 2016

December 2016

June 2016

May 2017

Building design and realisation

Building internals

Official Opening 16 May 2018

Implementation Approach (1/2)

GRC V0

- Existing assets
- 2017 Q2+ (from 04-2018 in GRC building)

GRC V1

- Core Facility
- MS Contributions
- 2018 Q2

Implementation Approach (2/2)

- Capability to monitor other core GNSS constellations (v1.1)
- Expending the number of KPIs for Enhanced Services
- Flexibility to address additional KPI monitoring

Contribution to International GNSS Monitoring

- Authoritative international GNSS monitoring and assessment system to benchmark the performance of available GNSSs (GPS, Glonass, Beidou, Galileo)
- Organized through the International GNSS Monitoring and Assessment Task Force of the United Nations Office of Outer Space Affairs, International Committee on GNSS
- Nominated Monitoring Analysis Centre for Galileo is the GRC.
  - European participation was confirmed by letter during ICG in Sochi 2016

EUROPEAN COMMISSION
Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs

EU satellites navigation programmes
Director

Brussels, 08. 11. 2016
GROW/J1/HT/kp/ARES(2016)6757470

NOTE TO THE IGMA TASK FORCE CO-CHAIRS

Dear co-chairs,

With reference to the Call for Participation for the international IGMA-IGS Joint Trial Project I am pleased to confirm our intention to participate.

The nominated Monitoring Analysis Centre (MAC) for Galileo will be the Galileo Reference Centre (GRC) of the European GNSS Agency (GSA). When fully operational, the GRC will carry out the independent monitoring of Galileo performance, based on observation and analysis of the Galileo signals in space. Monitoring of other GNSS is also foreseen. As the GRC core facility is currently under development, initial contributions to the trial project will be coordinated by the GSA under the umbrella of a

IGMA-IGS Joint Trial Project-2

2-day Workshop 2018 before the official GRC opening

Generation of products for initial Phase of IGMA-IGS Trial Project

- Monitor broadcast ephemeris (Orbits and Clocks) accuracy
- Monitor SIS User Range Error
- Monitor SIS UTC Offset Error
- Determine PDOP for some defined and agreed sites

Conclusions 1

- The Galileo Reference Centre is monitoring the Galileo service performance
  - With V0 at ESTEC from Q2 2017, moved to GRC building on 4 April 2018
  - V1 is expected in coming weeks.
- The GRC is the main source of input for the KPIs reporting since January 2018.
- The GRC has a stand-alone Core Facility and also benefits from expertise and assets from Member states

Conclusions 2

- The GRC plays a pivotal role in Galileo's service provision, providing GSA with an independent system to evaluate the performance of the quality of the signals in space and the Galileo Service Operator
- The GRC helps ensure that Galileo users are provided with very high-quality signals for use by an array of new navigation applications
- The European Commission has nominated the GRC as the European Monitoring and Analysis Centre for Galileo, part of a joint project of the United Nations that includes contributions from the United States (GPS), Russia (Glonass) and China (Beidou)
  - Successful two day workshop prior to opening event

Thank you
for your attention

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