

# Galileo & Copernicus

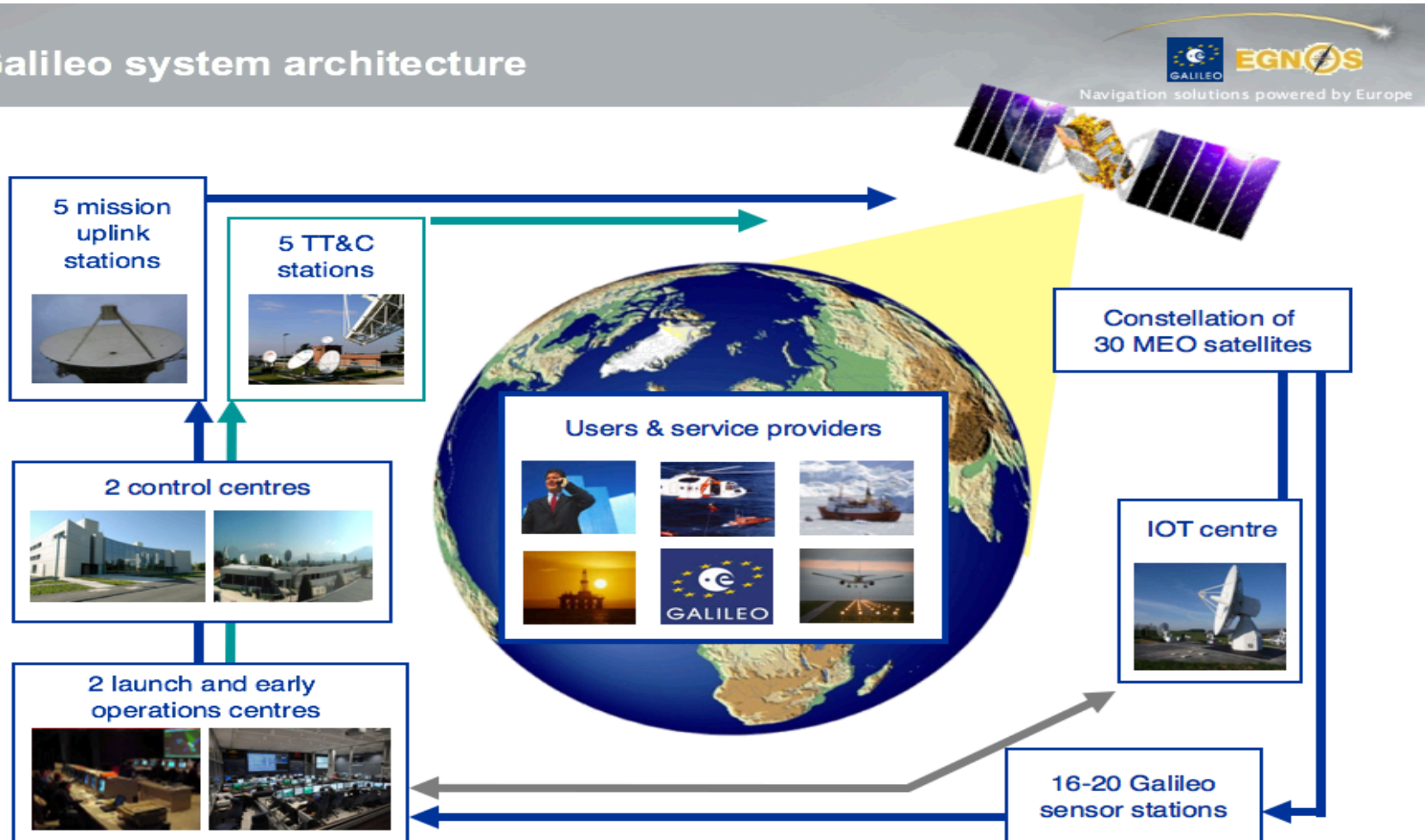
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Head of Navigation Support Office  
*ESA/ESOC*

1. Galileo Update
2. GNSS Performance
3. Copernicus

# Galileo Update - Architektur

## Galileo system architecture



MEO: Medium Earth Orbit






TT&C: Telemetry, Tracking and Command

IOT: In-Orbit Testing

# Galileo Update – Dienste

## The Galileo Services



<b>Open Service (OS)</b>	Freely accessible service for positioning, navigation and timing	
<b>Public Regulated Service (PRS)</b>	Encrypted service designed for greater robustness in challenging environments	
<b>Search and Rescue Service (SAR)</b>	Locates distress beacons and confirms that message is received	
<b>Commercial Service (CS)</b>	Delivers authentication and high accuracy services for commercial applications	
<b>Integrity Monitoring Service</b>	Provides vital integrity information for life-critical applications	

The former "Safety-of-Life" service is being re-profiled

# Galileo Update – Zeitplan



## Galileo Implementation Plan



### Galileo is implemented in a step-wise approach

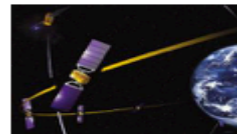
#### By 2020 Galileo will be:

- ★ fully deployed and recognised
- ★ adopted by the widest user communities
- ★ a civilian infrastructure delivering robust positioning and timing services with high degree of performances

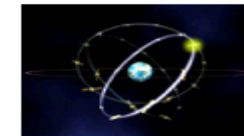
**Galileo System Testbed v1**  
Validation of critical algorithms  
**2003**



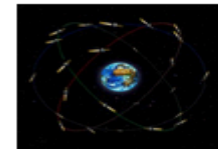
**GIOVE A/B**  
2 test satellites  
**2005/2008**



**In-Orbit Validation**  
4 operational satellites and ground segment  
**2013**



**Initial Services Provision**  
Initial services for OS, SAR, PRS, and demonstrator for CS  
**2016**



**Full Operational Capability**  
Full services, 30 satellites  
**2020**



## 1. Galileo Service Operator

- Ausschreibung für Galileo Betreiber ist im Gange
- Auftragsvolumen, ca. 1 Mrd. €

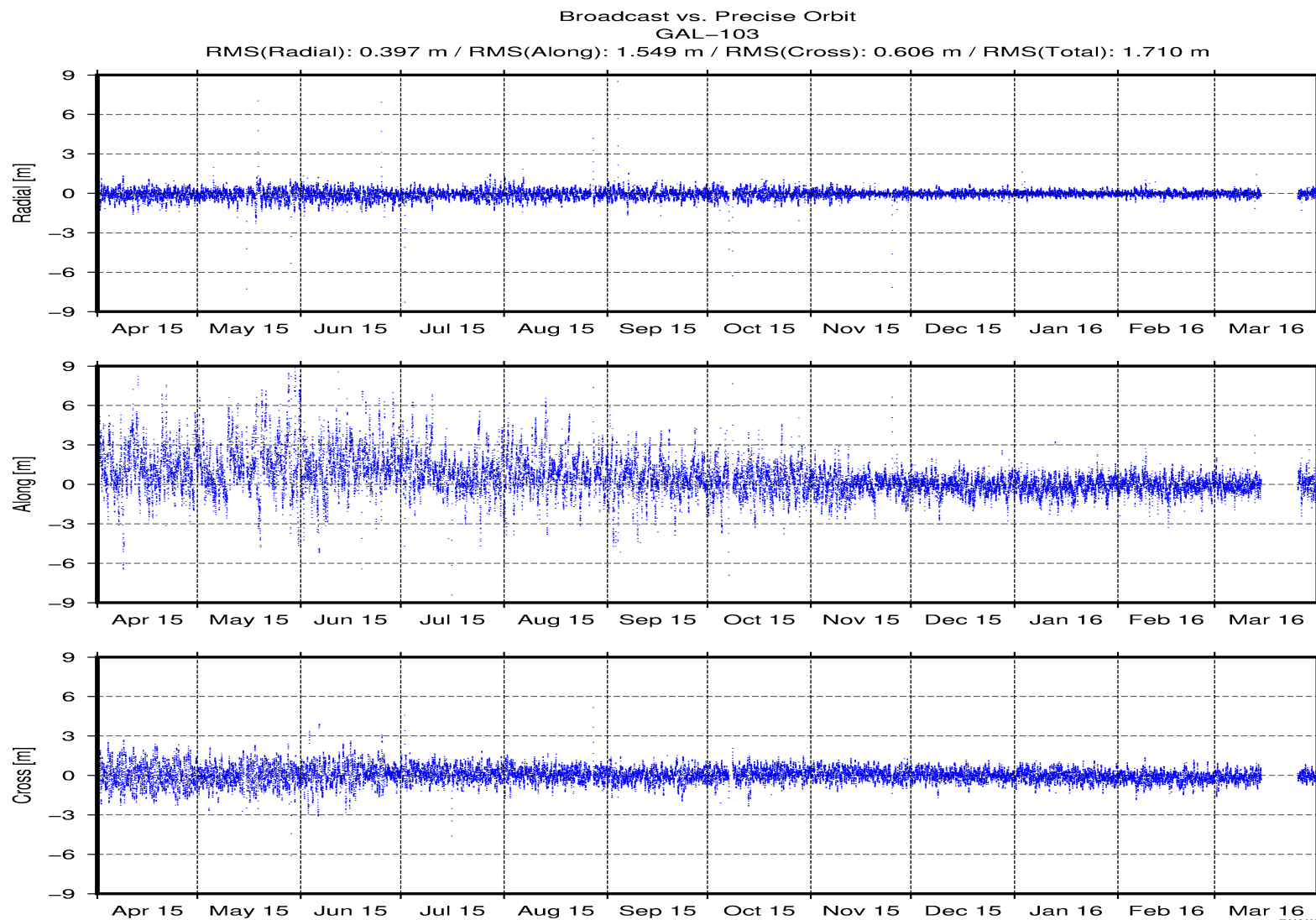
## 2. Satellitenstarts

- Mai 2016, 2 Satelliten (13 und 14)
- Okt/Nov 2016, 4 Satelliten mit Ariane 5 (15 - 18)

## 3. Services

- Initial Services geplant für 2016
- Full Galileo Services geplant für 2020

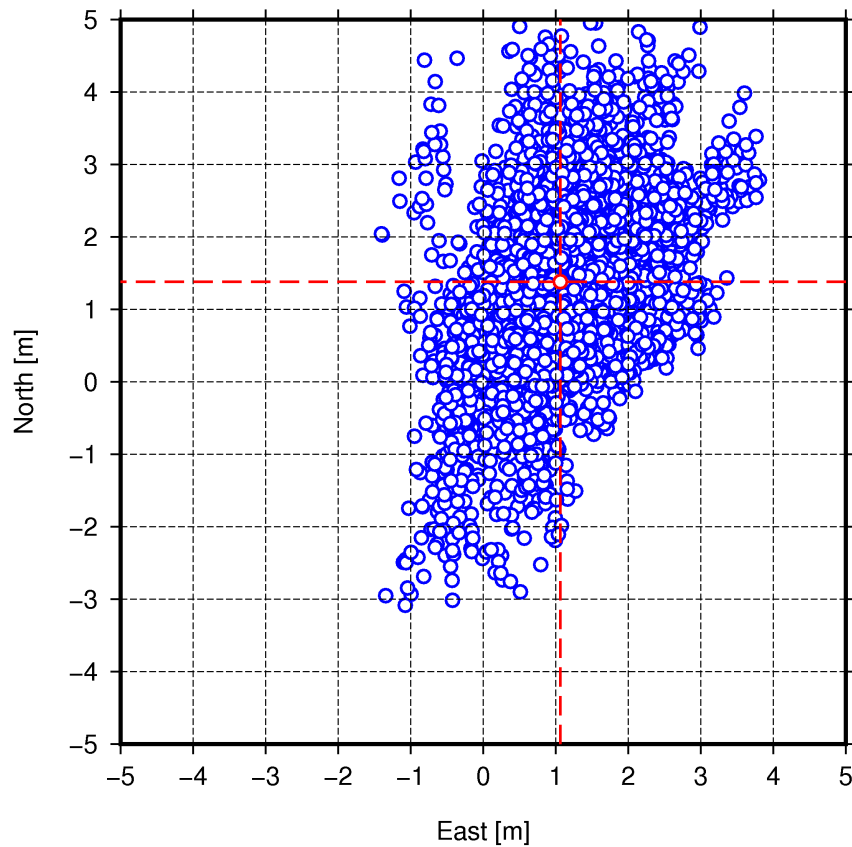
# GNSS Performance – Galileo Broadcast Orbits



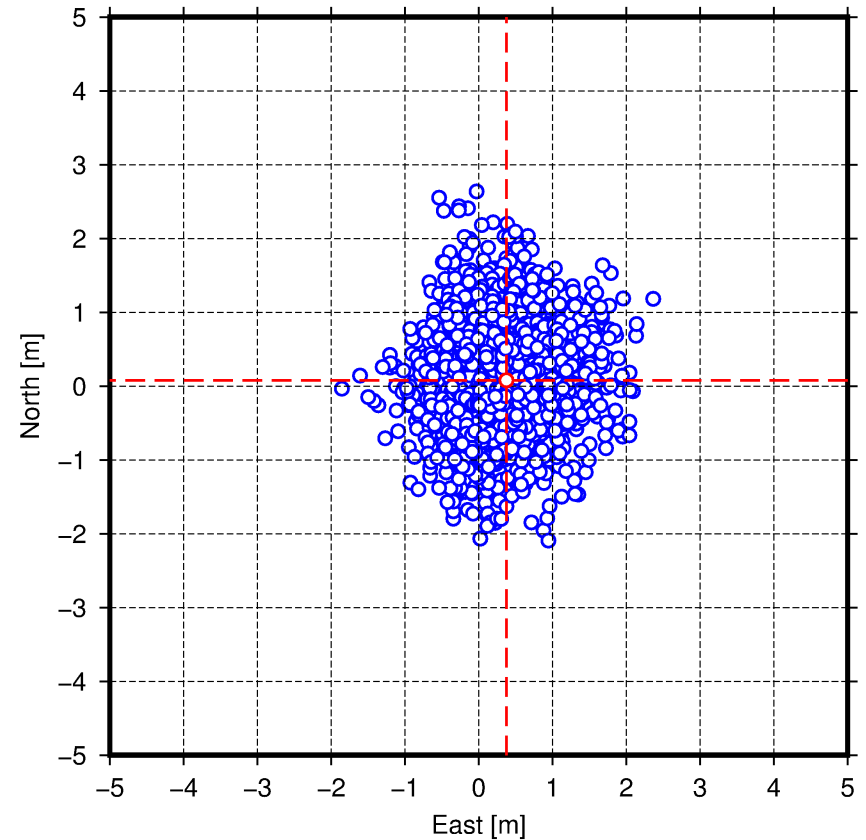
# GNSS Performance – Galileo OS (2 Frequenzen)



GAL E1–E5a  
Broadcast Orbits / Code / 4–4 SV  
MAS1 / 31–01–2014 / 07:00–08:00 UTC  
RMS(2D): 2.394 m / STD(2D): 1.642 m



GAL E1–E5a  
Broadcast Orbits / Code / 4–4 SV  
MAS1 / 08–04–2016 / 15:00–15:45 UTC  
RMS(2D): 0.953 m / STD(2D): 0.872 m



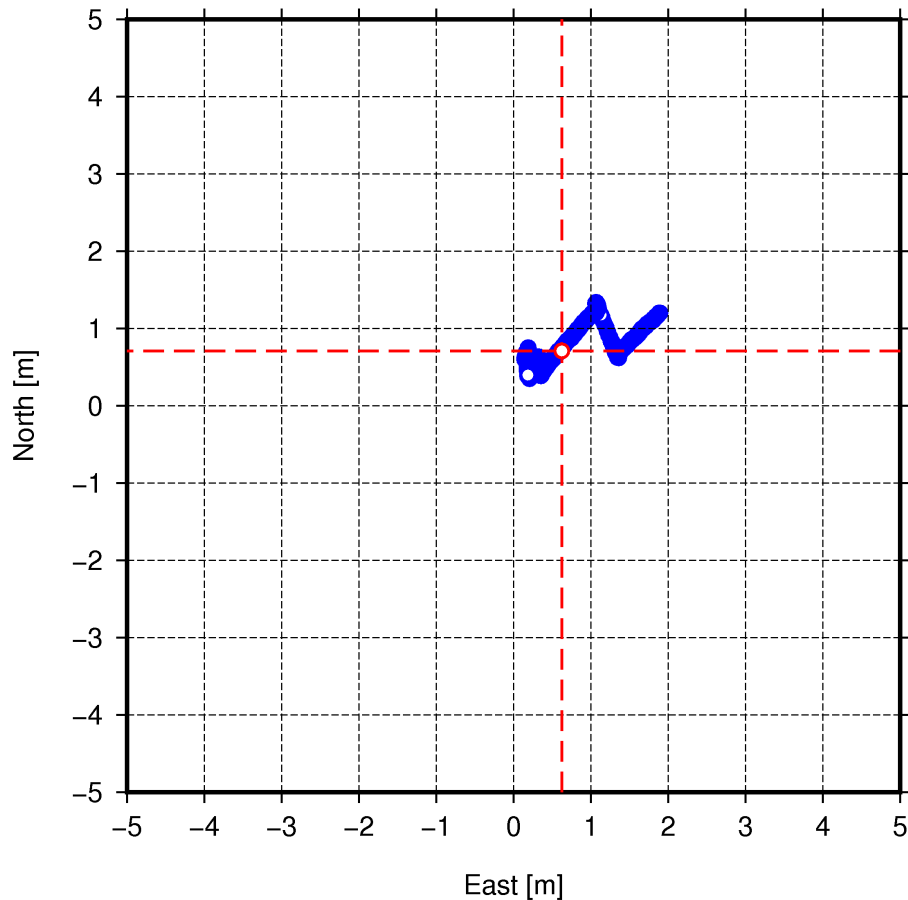


# GNSS Performance – Galileo OS (2 Frequenzen)



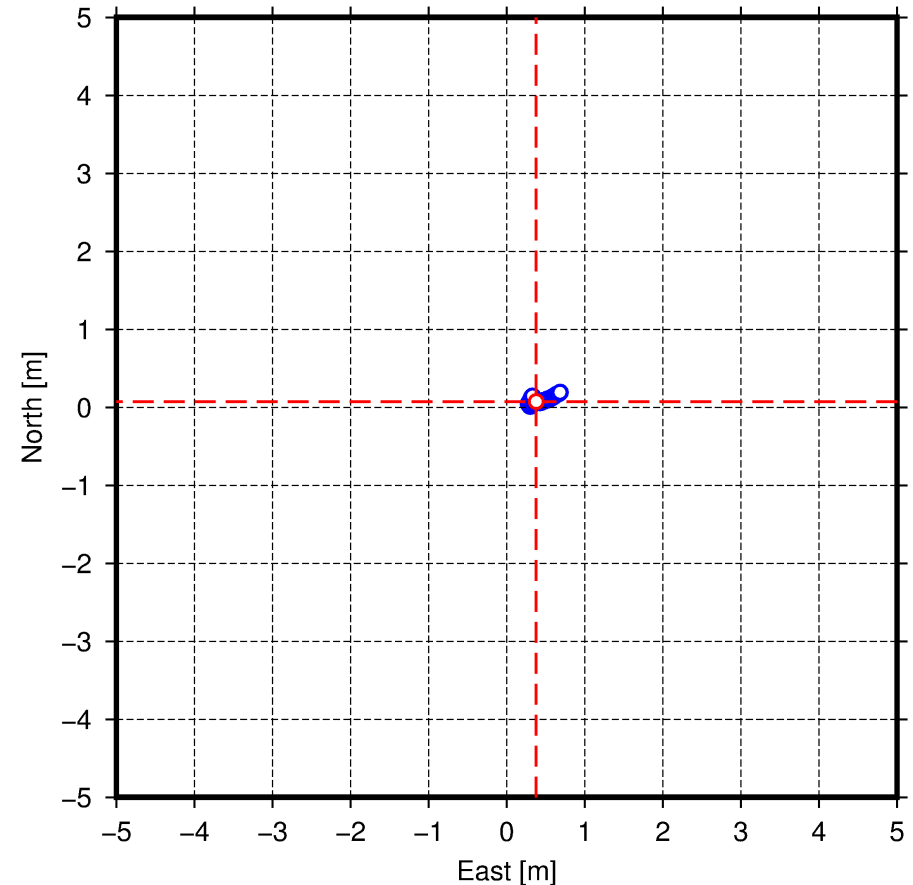
GAL E1–E5a

Broadcast Orbits / Code+Phase / 4–4 SV  
MAS1 / 31–01–2014 / 07:00–08:00 UTC  
RMS(2D): 1.099 m / STD(2D): 0.597 m



GAL E1–E5a

Broadcast Orbits / Code+Phase / 4–4 SV  
MAS1 / 08–04–2016 / 15:00–15:45 UTC  
RMS(2D): 0.404 m / STD(2D): 0.118 m

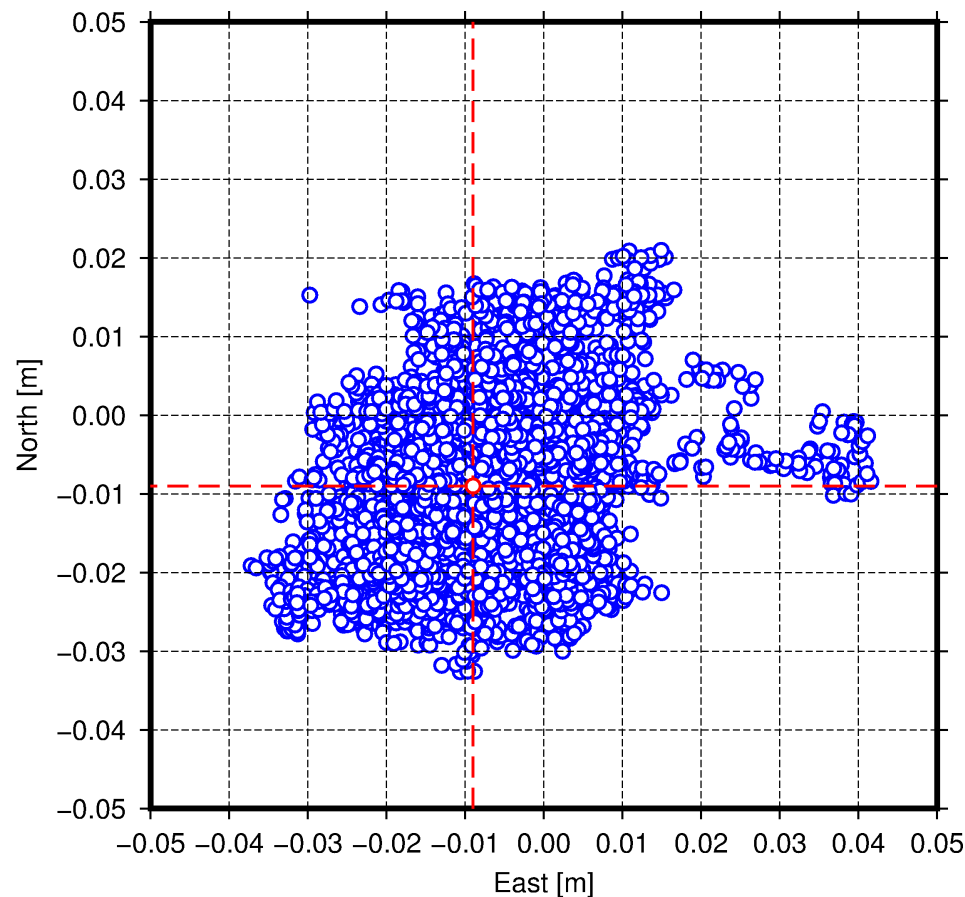
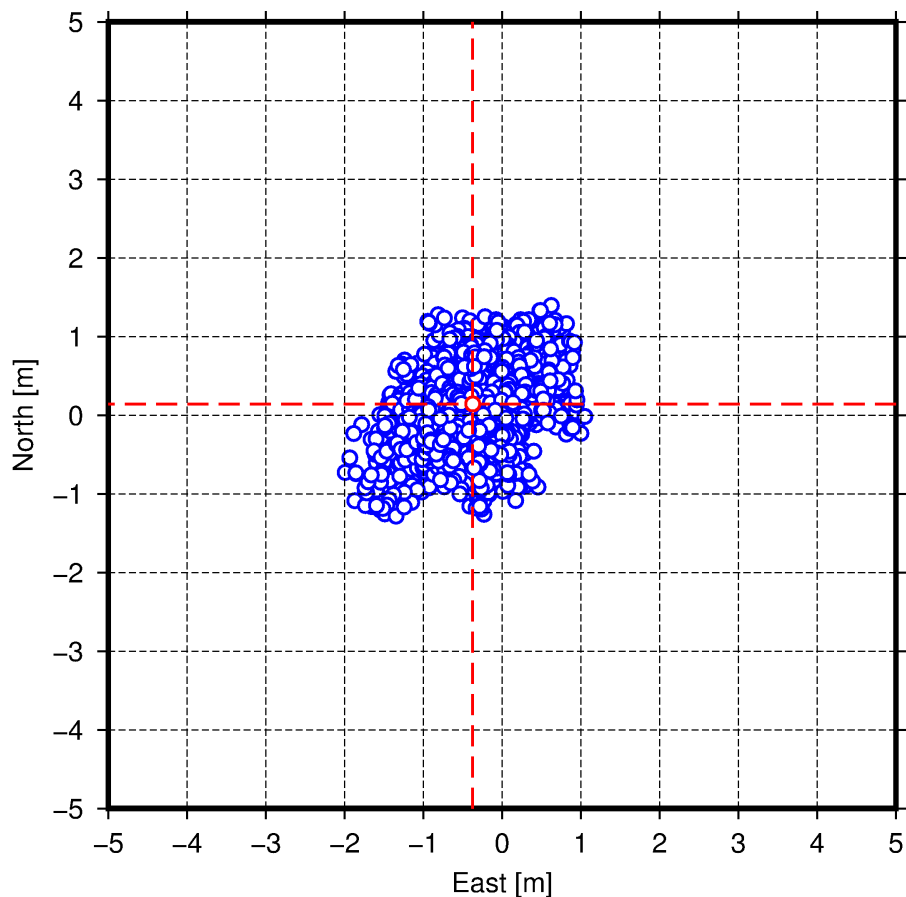


# GNSS Performance – Galileo 2 Frequenzen, Precise Orbits



GPS L1-L2 / GAL E1-E5a  
Broadcast Orbits / Code / 11-13 SV  
NNOR / 31-03-2016 / 04:30-06:00 UTC  
RMS(2D): 0.717 m / STD(2D): 0.596 m

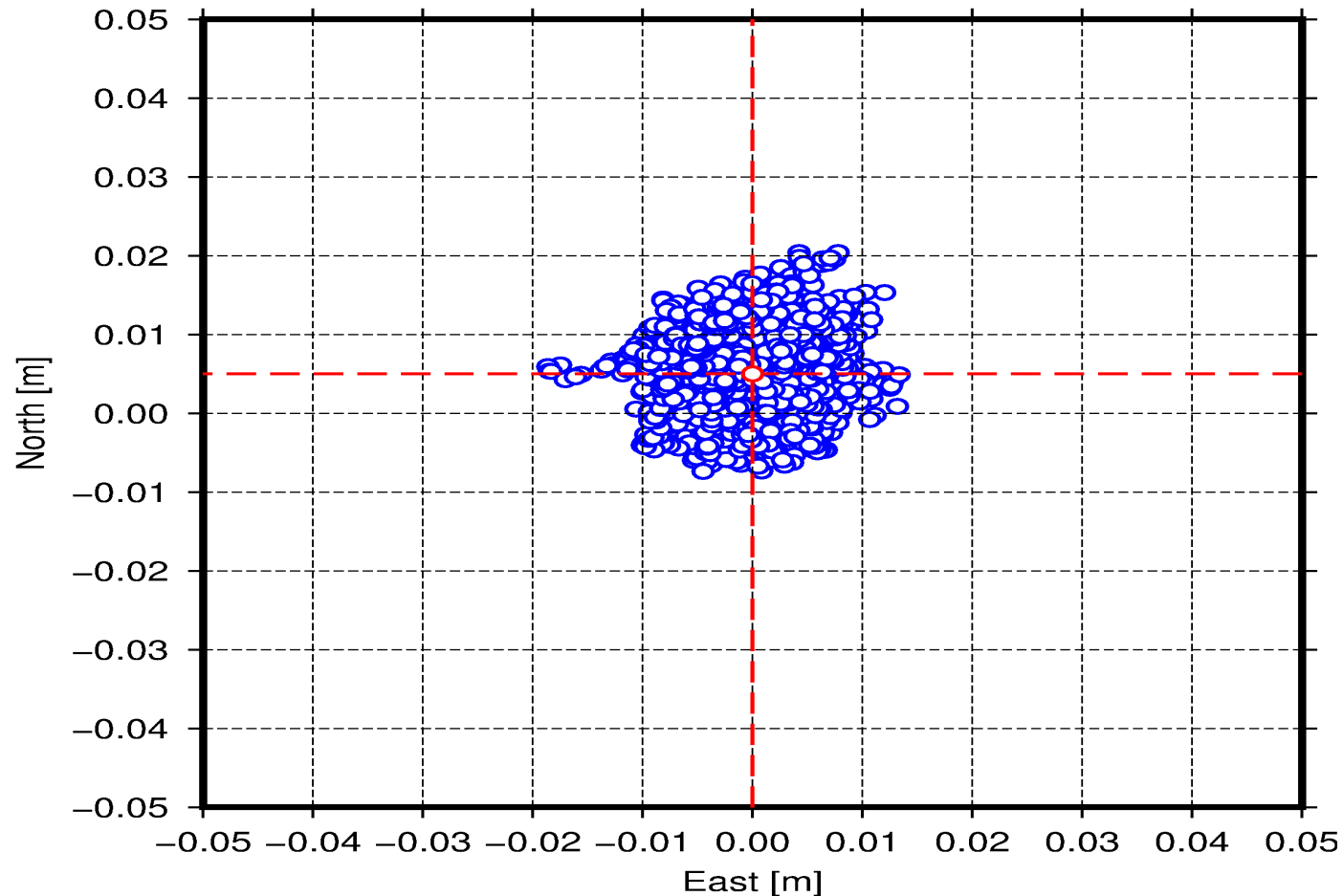
GPS L1-L2 / GAL E1-E5a  
Precise Orbits / Code+Phase / 12-14 SV  
NNOR / 31-03-2016 / 04:30-06:00 UTC  
RMS(2D): 0.019 m / STD(2D): 0.015 m



# GNSS Performance – Multi GNSS, Precise Orbits



GPS L1–L2 / GLO G1–G2 / GAL E1–E5a / BEI B1–B2  
Precise Orbits / Code+Phase / 17–20 SV  
MAS1 / 08–04–2016 / 15:00–15:45 UTC  
RMS(2D): 0.008 m / STD(2D): 0.006 m

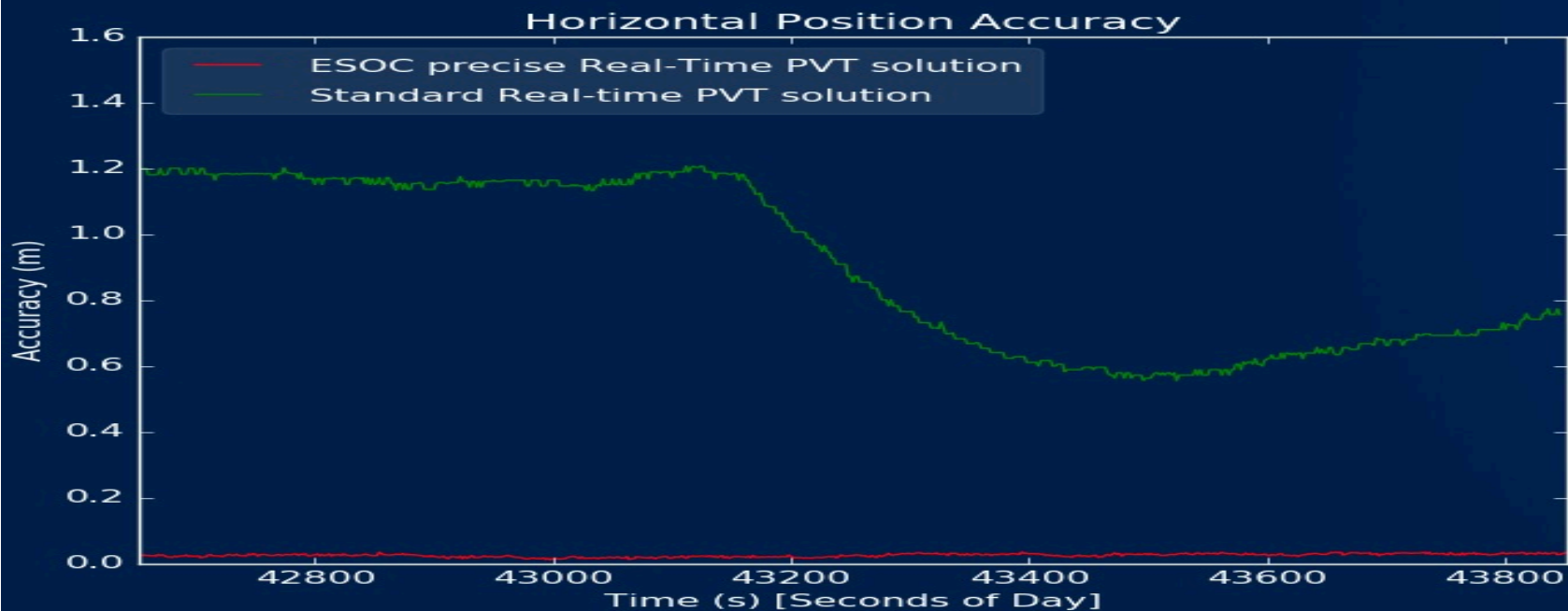


# GNSS Performance – ESOC Real Time Lösung



European Space Agency

Mo 25 Apr 2016



# Copernicus



# Was ist Copernicus?

Copernicus ist ein  
Europäisches System  
zur Erdbeobachtung

- Dienste und Produkte werden generiert für Umwelt- und sicherheitsrelevante Aspekte durch
- Prozessierung von Satelliten-Daten und In Situ Sensor-Daten
- Operationelle Perspektive bis 2030



# Copernicus



# GMES/Copernicus Key Milestones



2014+

First Sentinel satellites launched

2014

EU-ESA Copernicus Agreement for 2014-2020

2014

Revision of the ESA GSC Declaration

2014

EU Regulation of the Copernicus programme

2013

EU Delegated Regulation for Copernicus data access

2010

Commission proposal for a Regulation on GMES initial operations (2011-2013)

2008

ESA Ministerial Council in The Hague provided next major funding contribution by ESA Member States; Signature of EU-ESA Delegation Agreement on GMES

2005

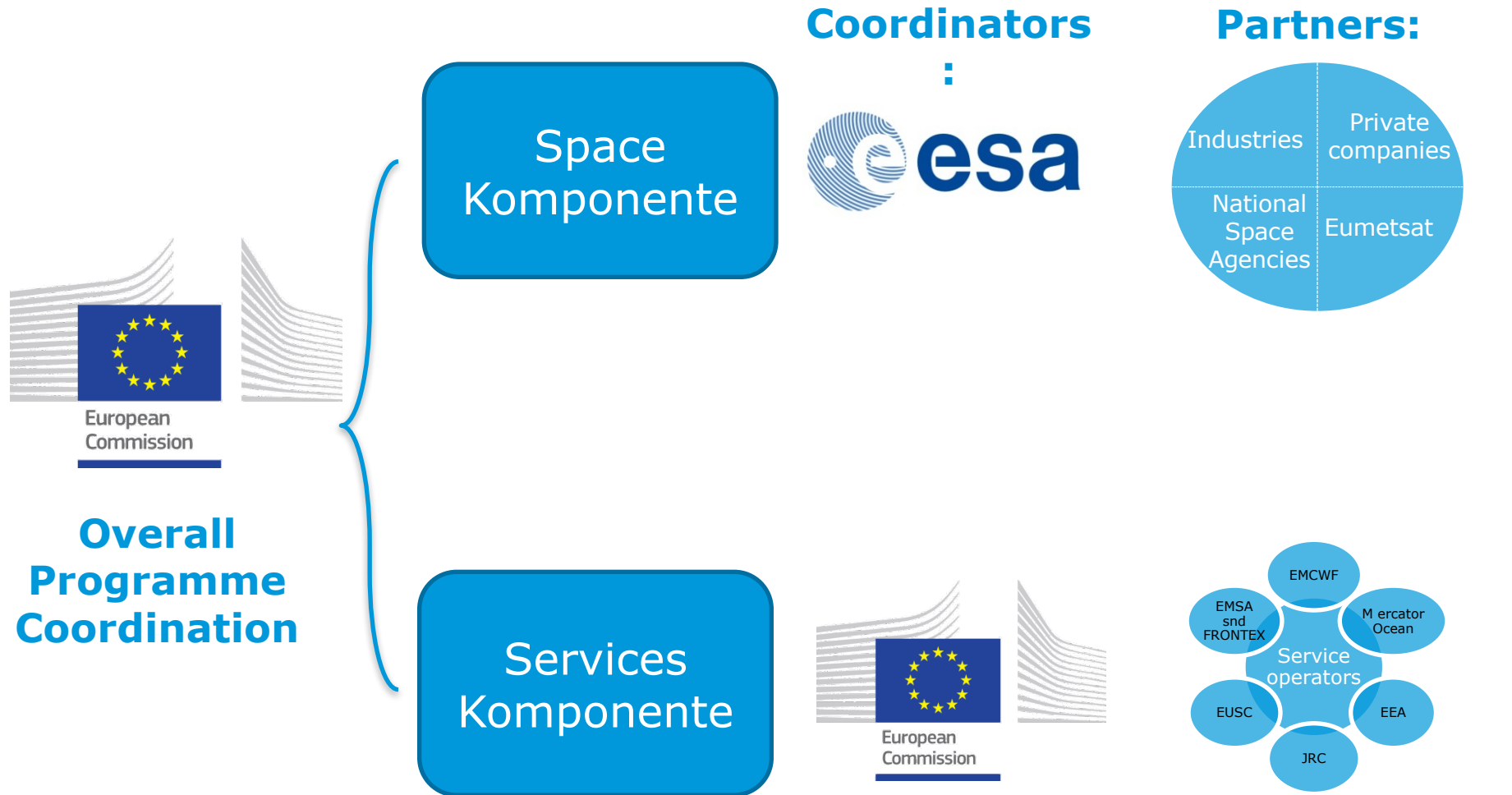
ESA Ministerial Council in Berlin: first funds committed to the Copernicus Space Component

2001

ESA Ministerial Council in Edinburgh: first Copernicus services funded

1998

Initiation of Copernicus: 'Baveno Manifesto'



## In-situ Daten unterstützen die Space und Service Komponenten



# Copernicus Space Komponente: die einzelnen Sentinels ...



**S1A/B:** Radar Mission

3 Apr 2014/22 Apr 2016



**S2A/B:** High Resolution Optical Mission

23 June 2015/2017



**S3A/B:** Medium Resolution Imaging and Altimetry Mission 16 Feb 2016/2017



**S4A/B:** Geostationary Atmospheric Chemistry Mission

2021/2027



**S5P:** Low Earth Orbit Atmospheric Chemistry Mission

2016



**S5A/B/C:** Low Earth Orbit Atmospheric Chemistry Mission

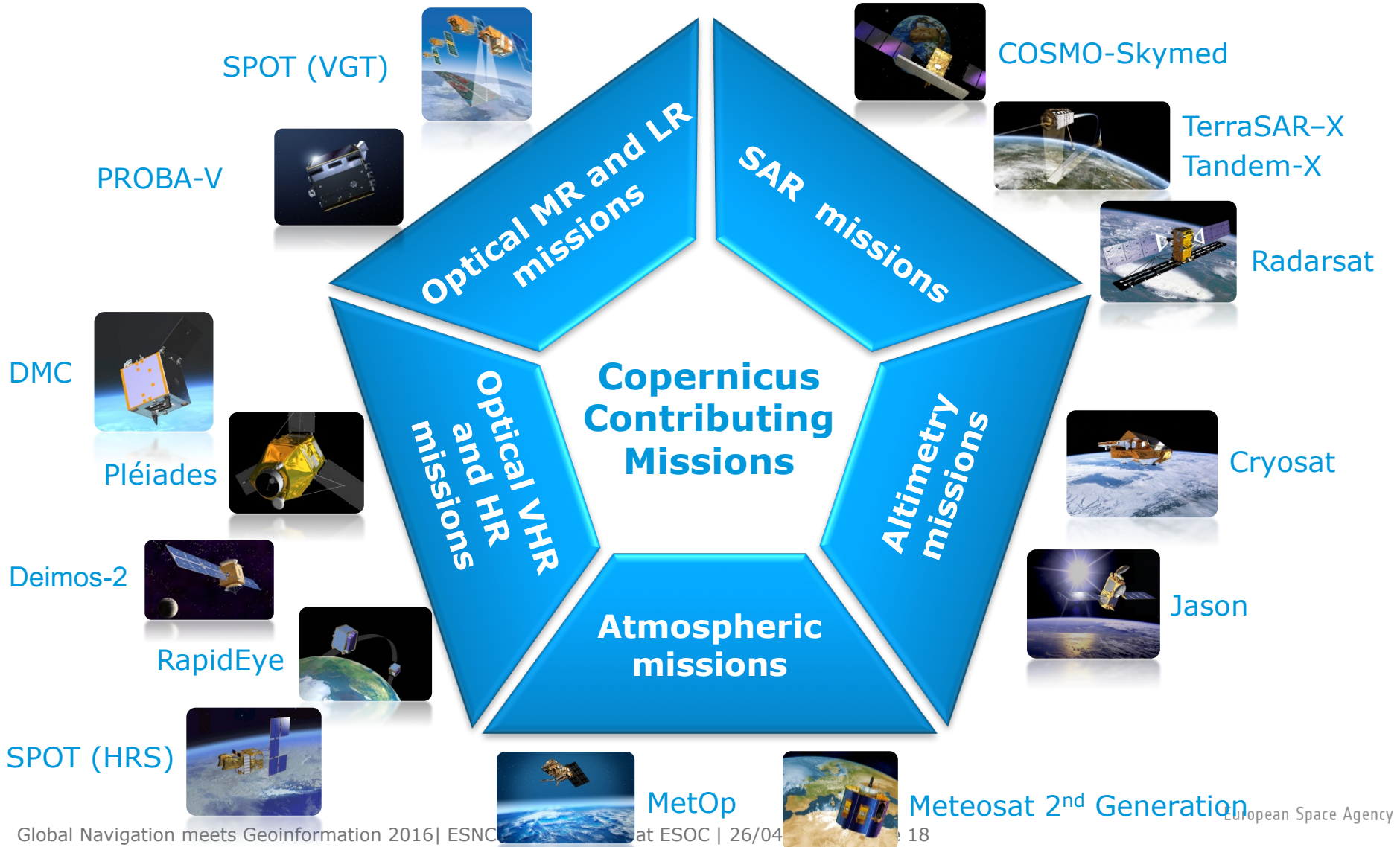
2021/2027



**S6A/B:** Altimetry Mission

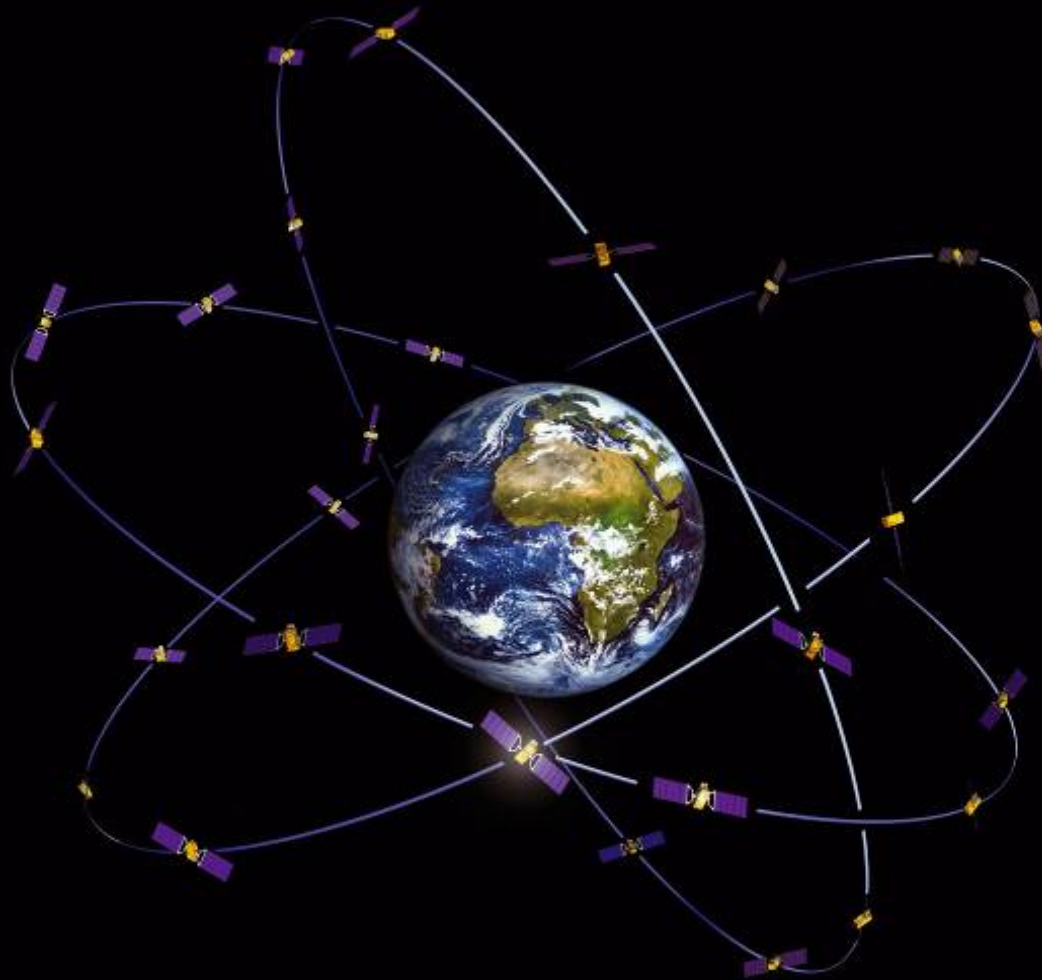
2020/2025

# Copernicus – Missionen, die Daten für Copernicus zur Verfügung stellen



## Sentinel Data Policy = **FREE and OPEN access**

- Joint COM/ESA Sentinel Data Policy Principles have been prepared in 2009 - adopted by ESA MSs in Sep 2009
- EU Delegated Act on Copernicus Data and Information Policy has been published on 12 July 2013 (C(2013)4311, final)
- Main principles of Sentinel data policy:
  - Open access to Sentinel data by anybody and for any use
  - Free of charge data licenses
  - Restrictions possible due to technical limitations or security constraints
- Info über Datenzugriff: Sentinel Online portal ([sentinels.copernicus.eu](http://sentinels.copernicus.eu))



Danke für Ihre Aufmerksamkeit