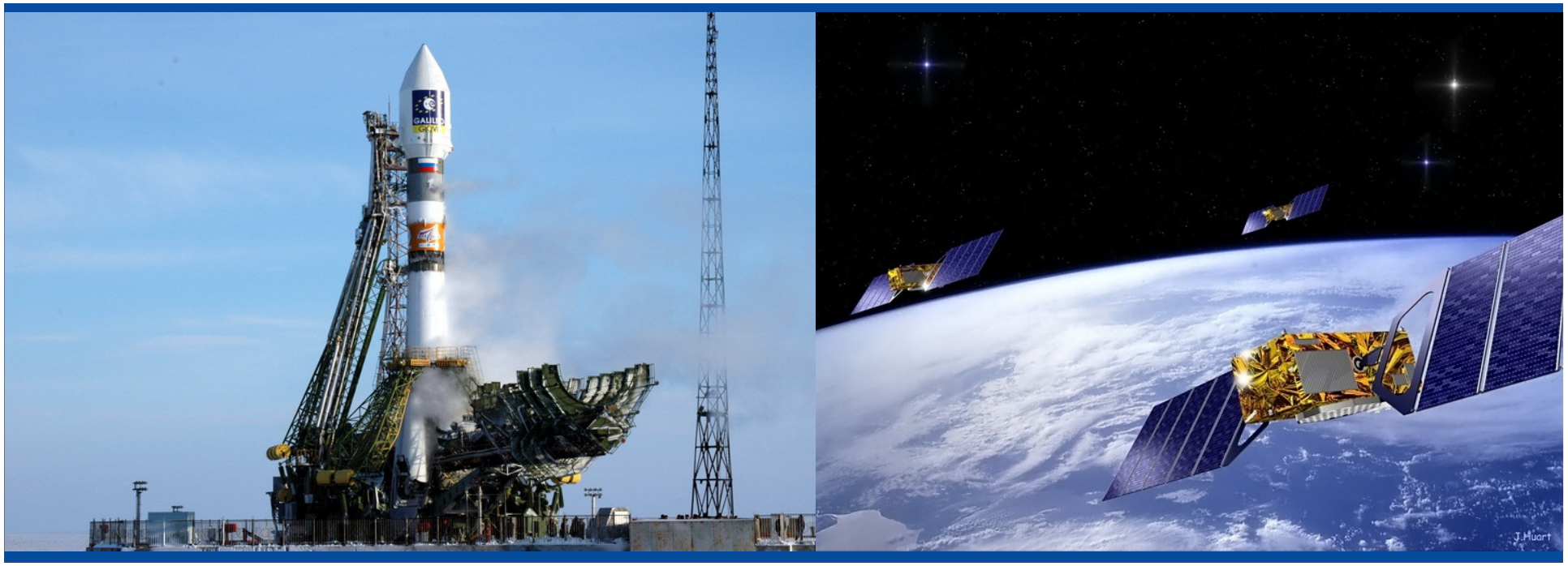

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EUROPEAN COMMISSION

European GNSS Programmes Galileo and EGNOS

UN/Azerbaijan/US/ESA Workshop on the Applications of GNSS
Baku, Azerbaijan, 11 May 2009

Helmut Spitzl, European Commission

GALILEO

esa EGNOS
European Geostationary Navigation Overlay Service

EGNOS

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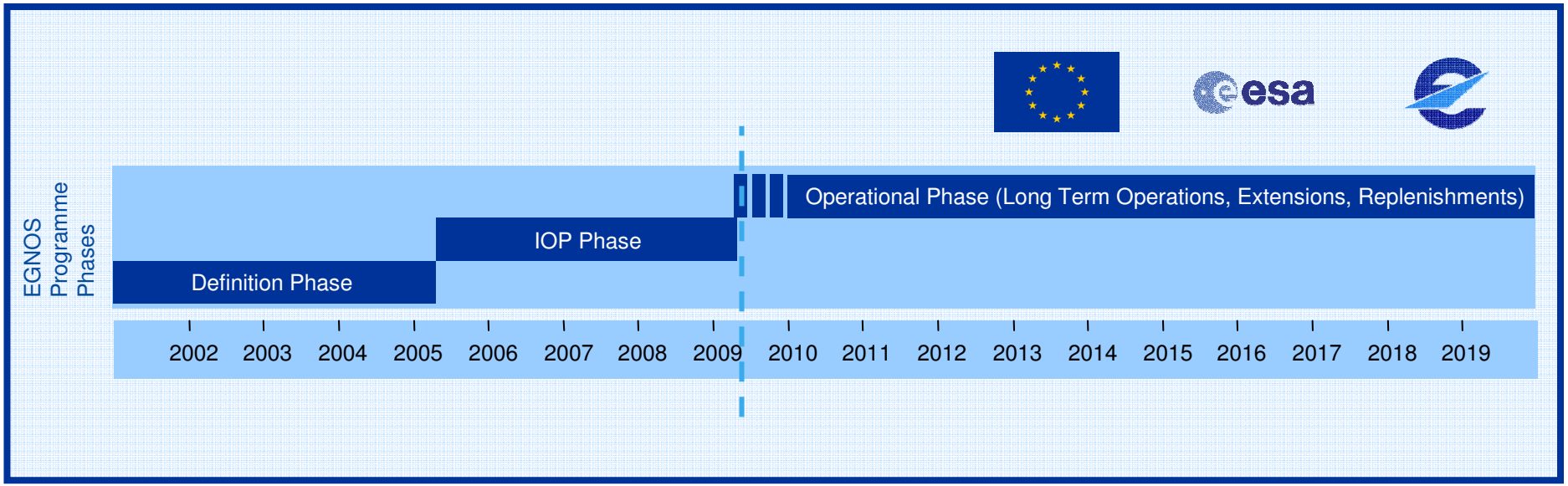
EGNOS Timeline

Regional Infrastructure & Services



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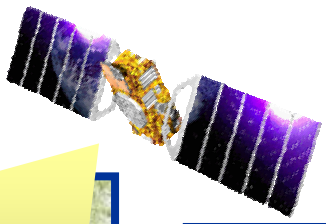
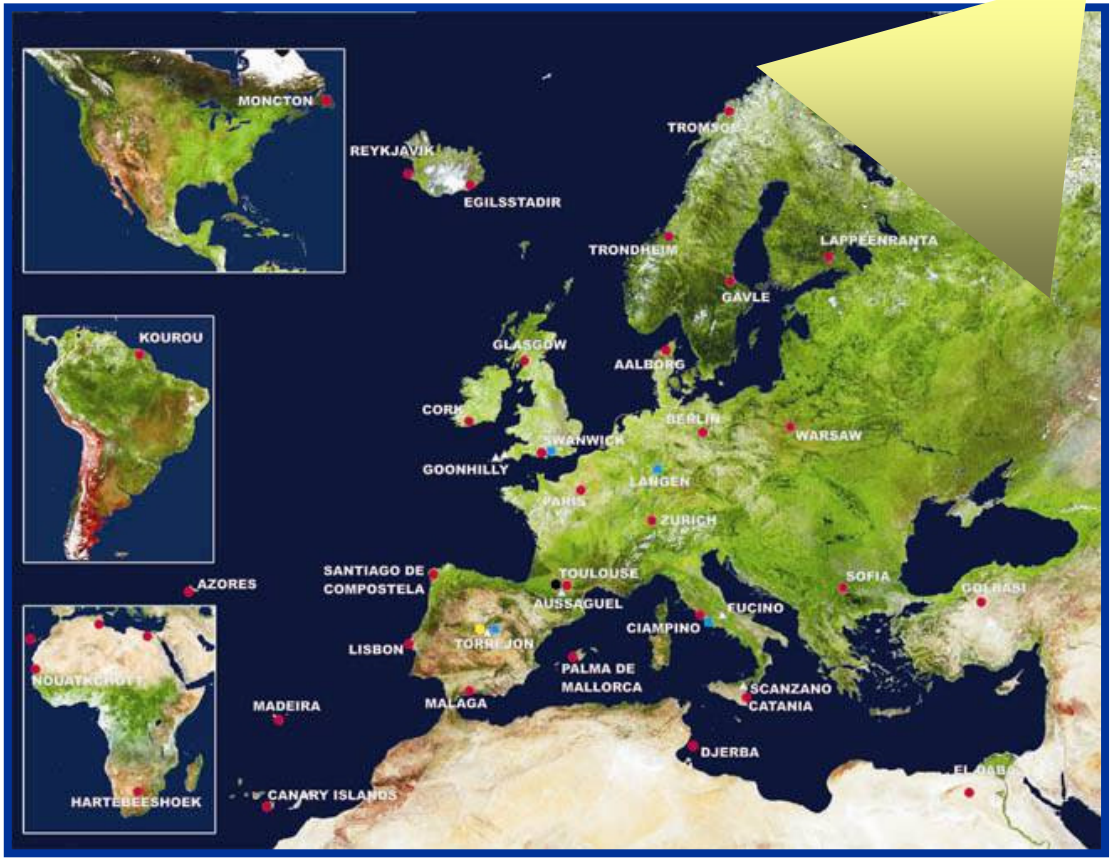
IOP … Initial Operations

EGNOS System Architecture



3 GEO Satellites



Users & Service Providers

6 Navigation Land Earth Stations △

2 Support Facilities ●●

4 Mission Control Centres

34 Ranging & Integrity Monitoring Stations (RIMS) ●

GPS & GLONASS

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EGNOS Services

Service	Transmission Means	Typical User Communities	Guarantee of Service
Open Service	L1 frequency	Pedestrian, in-car navigation	None
Safety of Life Service	L1 frequency	Aviation, maritime, railway	Compliance to ICAO standards (certification)
EGNOS Data Access Server (EDAS)	Ground network	Pedestrian, in-car navigation, research (e.g. atmospheric, tectonics), high-accuracy	Compliance to SLA when commercialisation will start

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SLA … Service Level Agreement, EDAS … EGNOS Data Access Server

EGNOS Services – Current Status

Service	Accuracy	Service Status	Expected Lifetime
Open Service	Typical vertical and horizontal positioning accuracy in the centre of Europe around 1m (spec: 3m horizontal, 4m vertical)	SIS available, declaration of "entry into service" planned for late 2009	20 years
Safety of Life Service	Same accuracy as Open Service. SoL service levels compliant to ICAO SARPS definition for APV1	Test SIS available, declaration of "entry into service" planned for mid-2010	20 years
EGNOS Data Access Server (EDAS)	Corrections provided by terrestrial network allow for sub-meter accuracy locally or regionally through additional processing	Experimental service available since 2008	20 years

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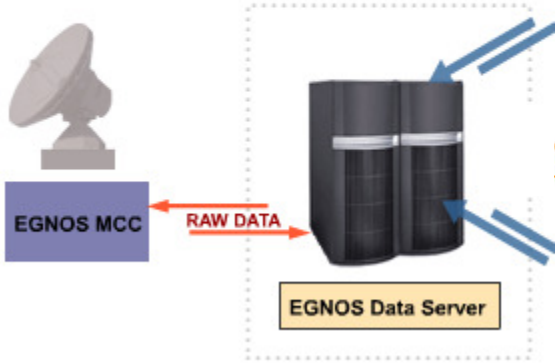
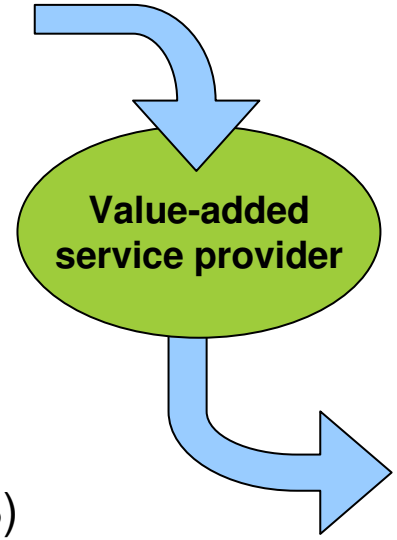
SIS … Signal in Space, SARPS … Standards and Recommended Practices, SoL … Safety of Life

EGNOS Data Access Service (EDAS)

EGNOS data (real-time):

- *RIMS raw observations*
- *SBAS messages*





End users

User-specific information

Phased approach:

- **Phase 1**: prototyping (2008)
  - » EDAS data free-of-charge
  - » No guarantee/liability
  - » 12 months duration minimum
- **Phase 2**: commercial exploitation (from 2009)

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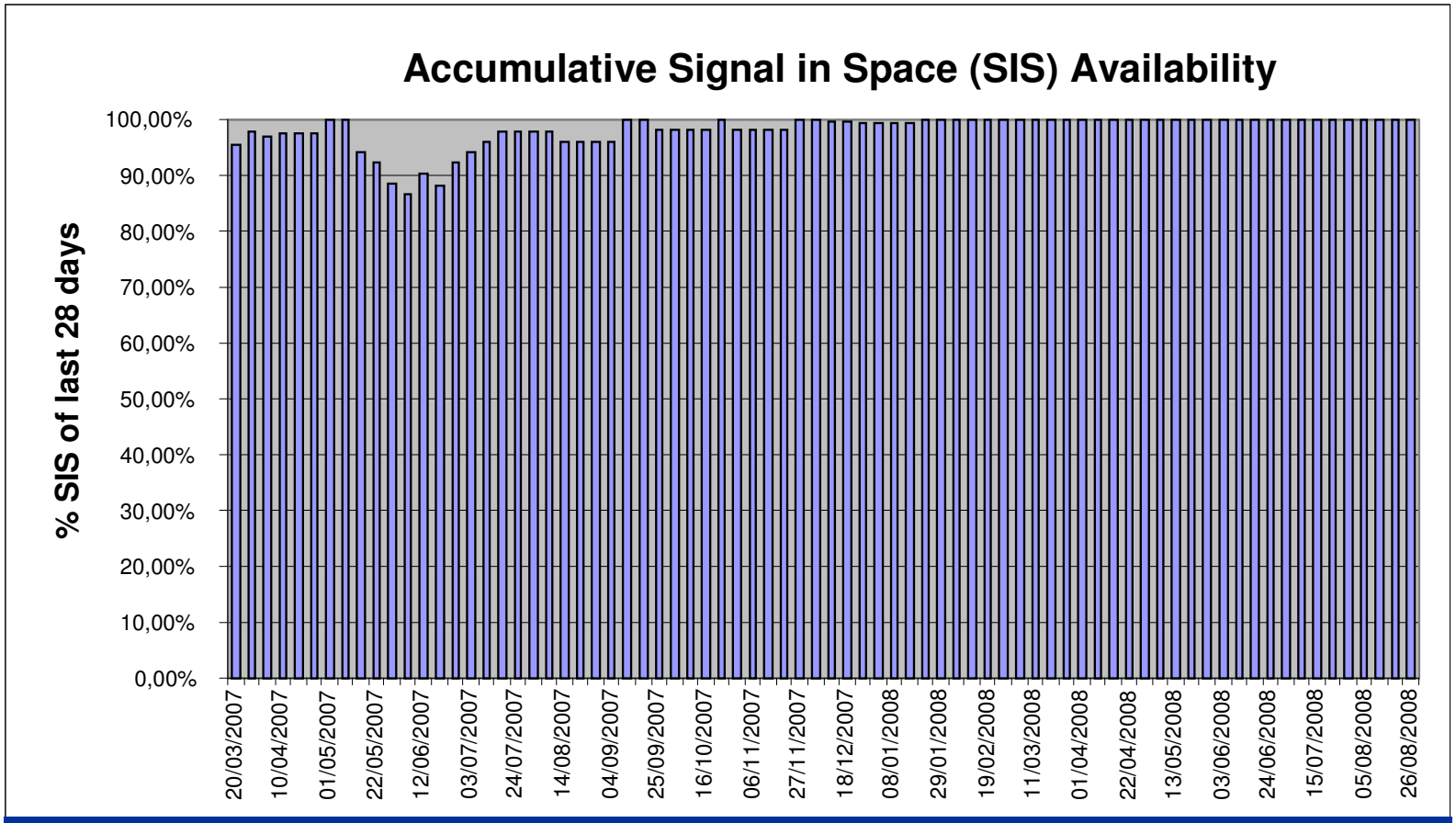
EGNOS Performance (March 2007 – August 2008)



EGNOS is already broadcasting signals of excellent quality.
Signal in Space availability has been continuous since January 2008*.

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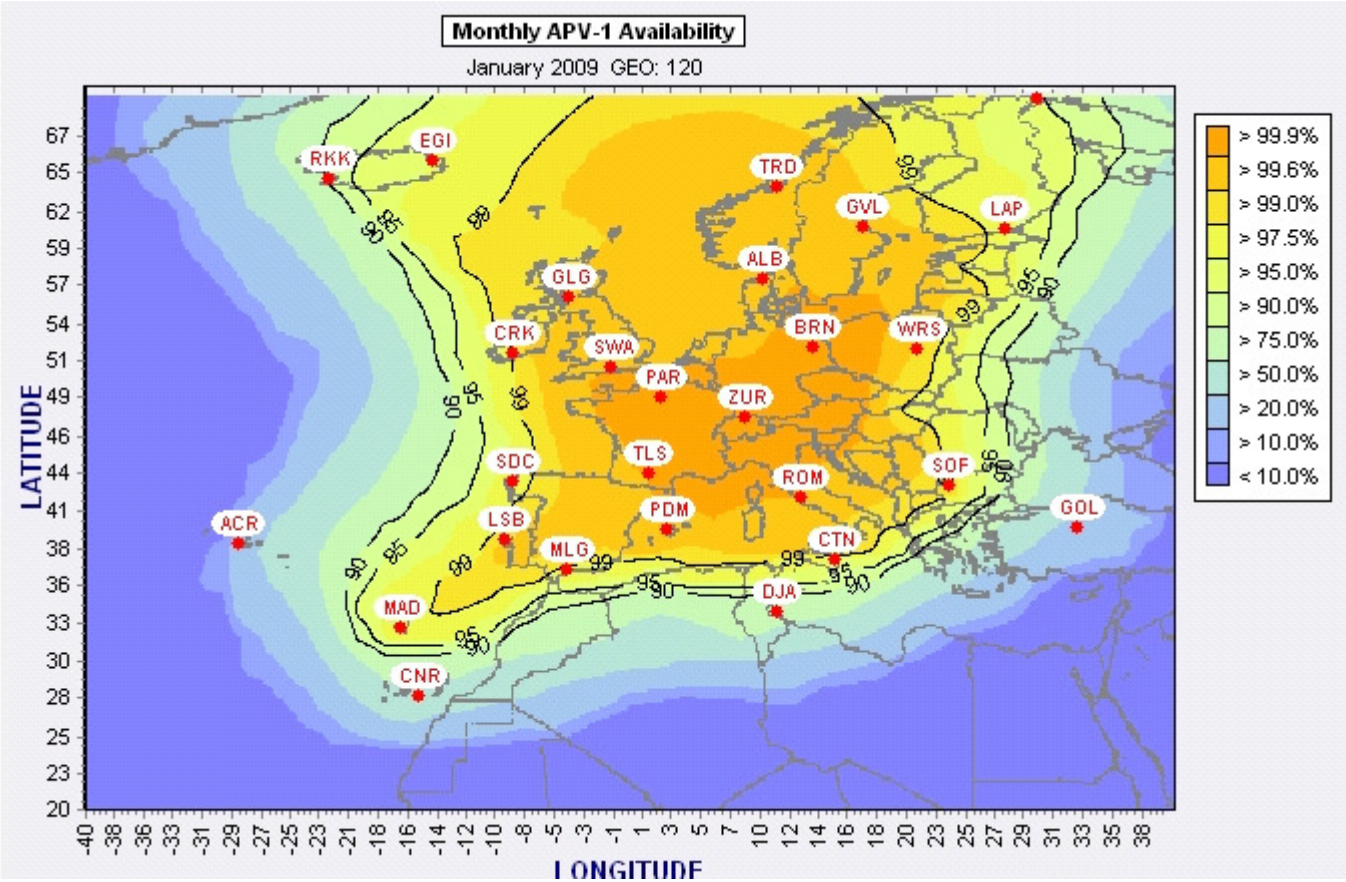
* with exception of 28 December 2008

EGNOS Performance (January 2009)

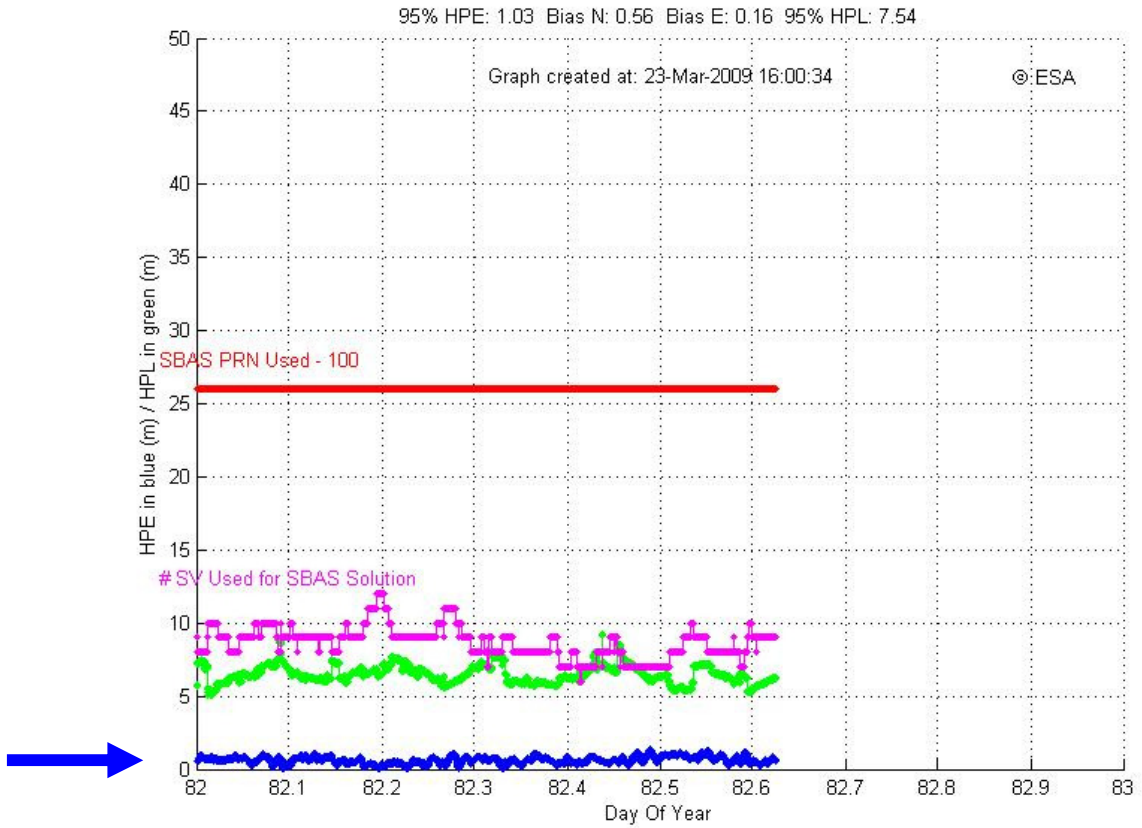


Source: Service Management Report ESSP for January 2009

The deployment of additional RIMS in Northern Europe, Southern Europe, and Northern Africa will increase the coverage area of APV-1 Availability.

APV … Approach with vertical guidance

EGNOS Performance (23 March 2009, Toulouse)



Source: http://www.egnos-pro.esa.int/IMAGEtech/perfect/real_time/view_all/toulouse.html

With around 1 m (blue line), the Horizontal Precision Error for the centre of Europe is consistently better than the requirements.

HPE … Horizontal Precision Error, HPL … Horizontal Protection Level

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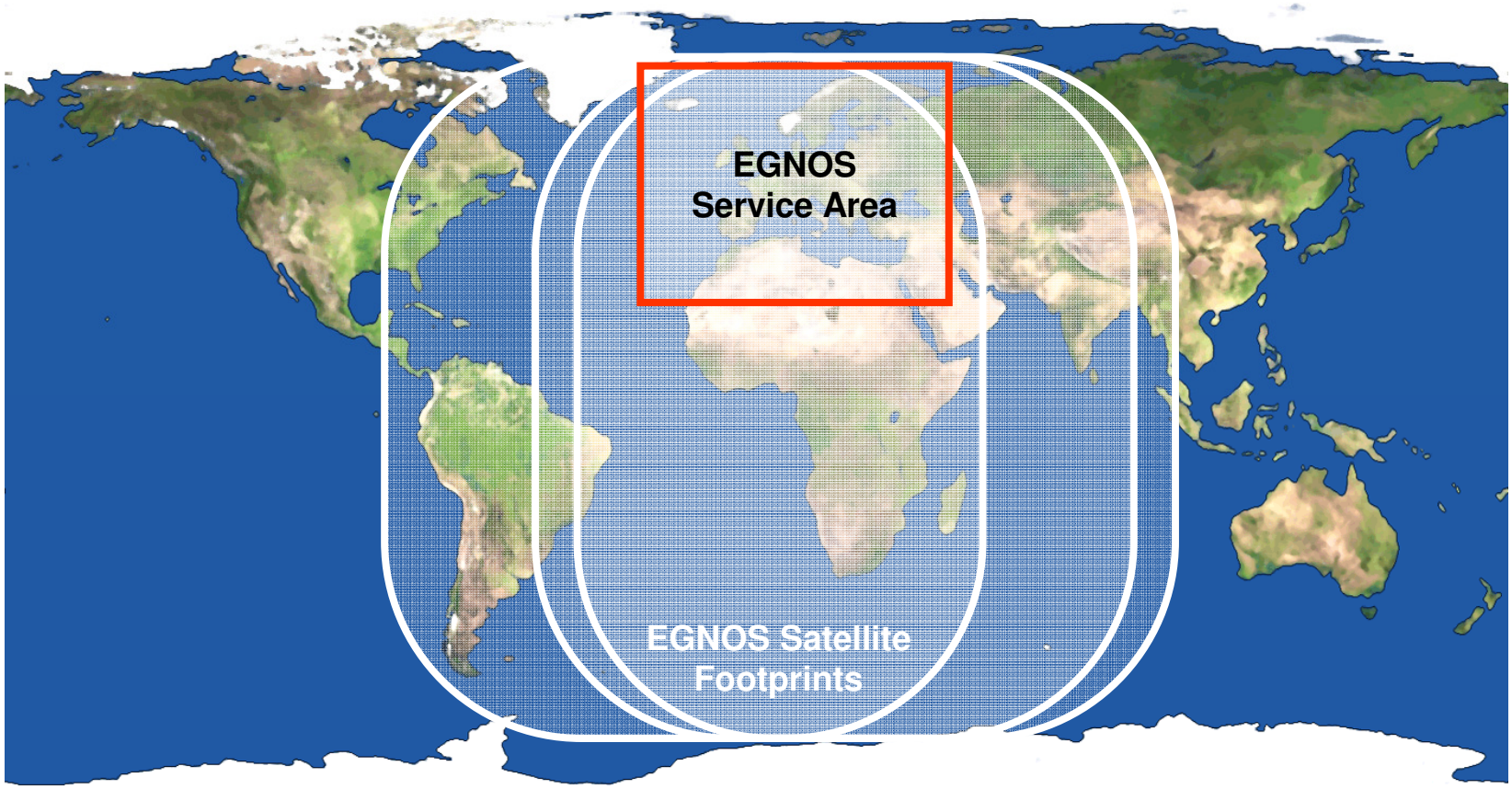
EGNOS Service Area



INMARSAT AOR-E (15.5°W), ARTEMIS (21.3°E), INMARSAT IOR-W (25°E)

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EGNOS Programme Status

- EGNOS is already broadcasting signals of excellent quality
- 2009:
  - Assets have been transferred from ESA to the European Community in April 2009
  - **First EGNOS operator** contract as of 1st April 2009
  - **OS declaration** of "entry into service" planned for late 2009
  - EC has finalized the procurement and lease of an EGNOS transponder to replace ARTEMIS as of 2011
  - Procurement action ongoing for replacement of 2nd EGNOS transponder
  - Geographical service extension is under study
- 2010:
  - **SOL declaration** of "entry into service" planned for mid-2010 (after certification milestone)

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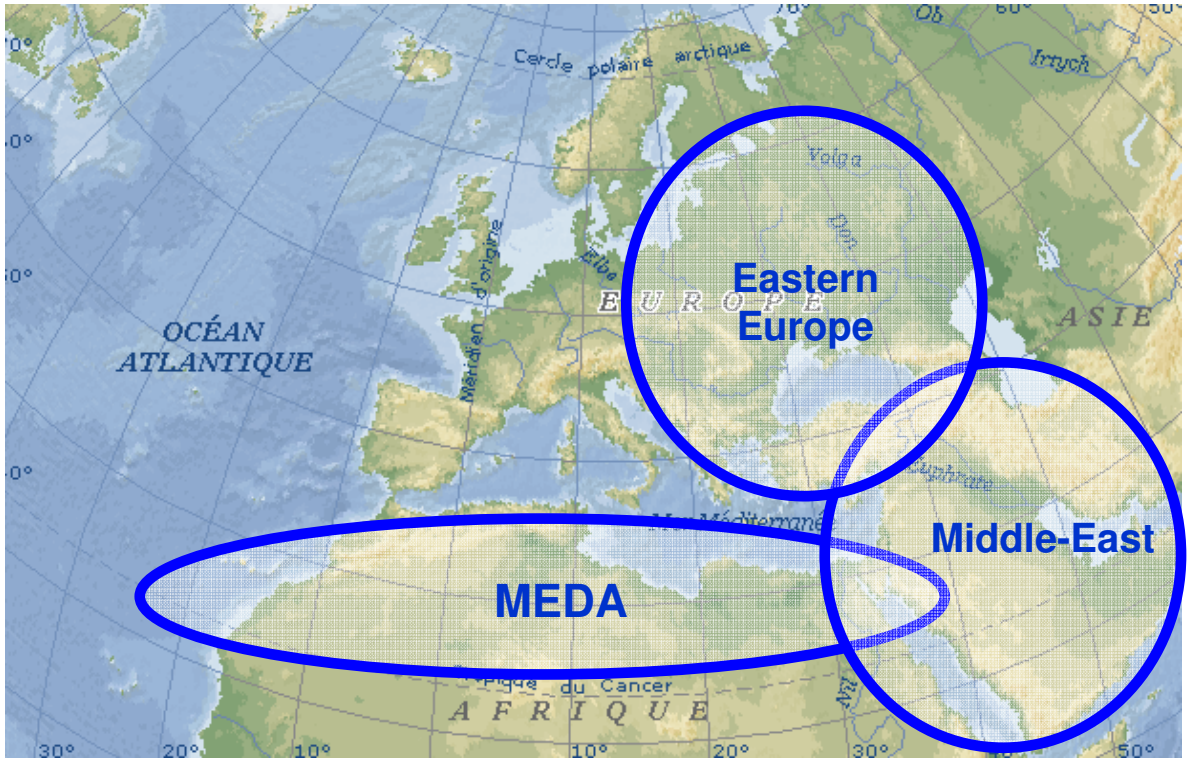
EGNOS Extensions



Depending on the extension area, technical implementation may vary from:

- Homogeneous extension with deployment of **additional RIMS**
- **Regional infrastructure** including additional processing capabilities

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EGNOS Service Evolutions

- Service Provision Improvements ▶short/medium term
- Coverage Evolution
  - » Eastern Europe, MEDA, Middle East/ACAC ▶medium term
  - » Africa ▶medium/long term
- Frequency Evolution
  - » Extension to the E5a/E5b frequency decided on ARTEMIS replacement
- Evolution of Standards ▶long term
  - » Standardisation of E5a and E5b, L1 CBOC on-going
  - » Augmentation of new GNSS
- Additional Services
  - » LPV200 service level ▶medium term (2011)
    EGNOS capability to meet this service level currently under technical evaluation
  - » EGNOS time service ▶medium term
  - » Possible critical communication message (ALIVE concept)

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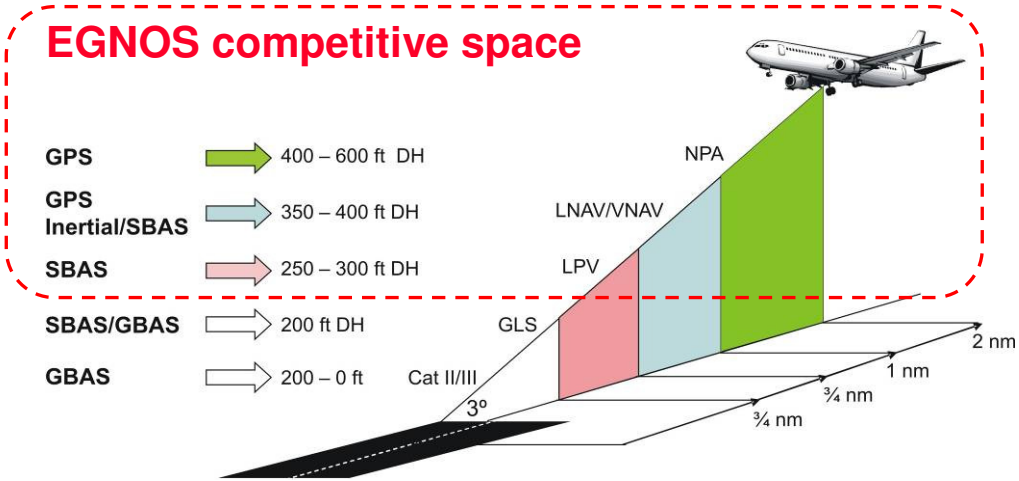
Aviation was first to recognise EGNOS benefits (mostly GA and smaller airports)

- EGNOS enables a reduction in the decision height
- General operational benefits
  - Reduction in angle of approach (direct and curved)
  - Better lateral guidance



- Allows for IFR-like operation in non ILS-equipped airports
- Increase in airports capacity
- Increase in safety
- Increase in flight capability (e.g. helicopters)
- Expensive land based navaids can be avoided
- Enables their long term decommissioning => lower terminal charges

} Long-term

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Galileo

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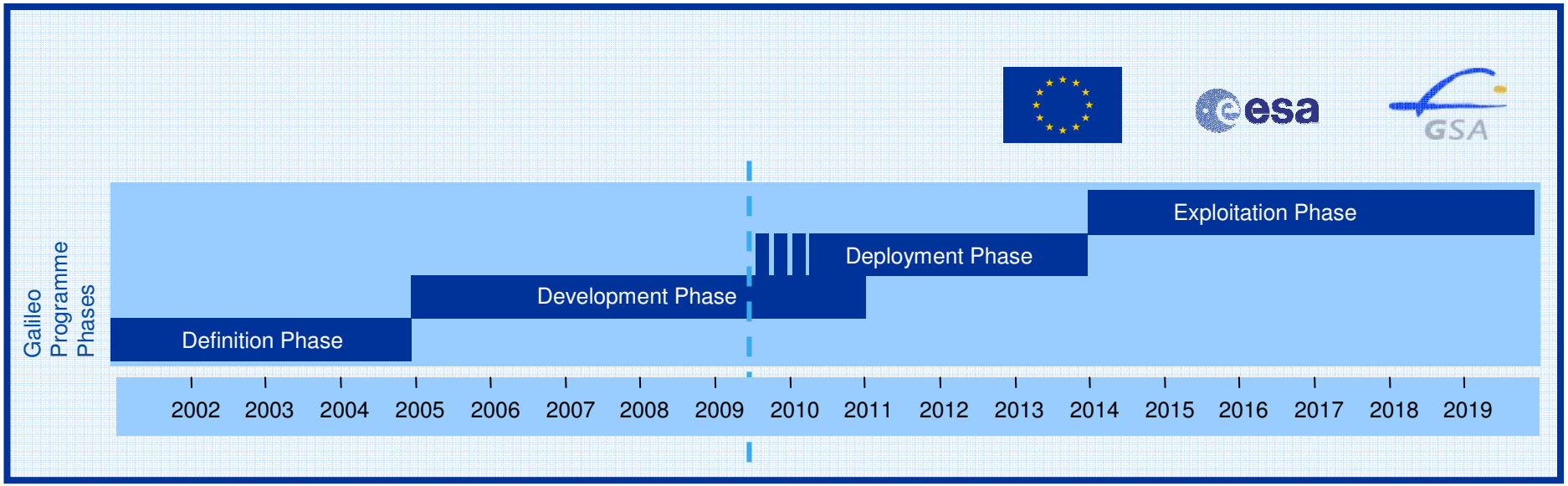
Galileo Timeline

Global Infrastructure & Services



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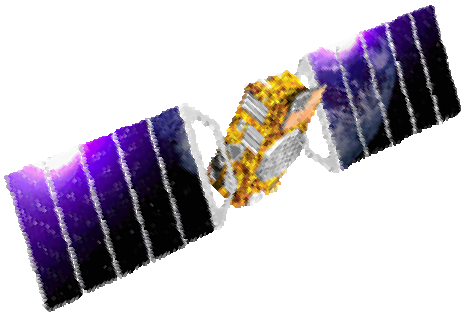
Galileo Implementation Plan



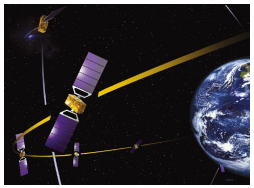
Galileo System Testbed v1
Validation of critical algorithms
2003

GALILEO
GSTB-V1

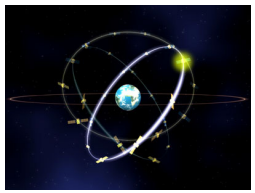
Galileo System Testbed v2
2 initial test satellites
2005

GALILEO
GIOVE

In-Orbit Validation
4 IOV satellites plus ground segment
2010



Full Operational Capability
27 (+3) Galileo satellites
2013



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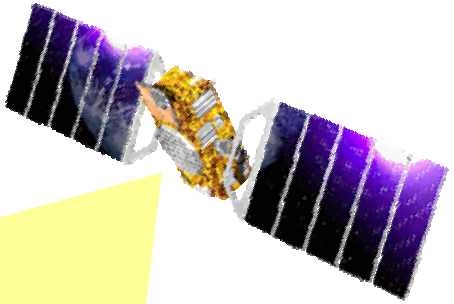
Galileo – An infrastructure



9 Mission Uplink Stations

5 TT&C Stations

Constellation of 30 MEO Satellites

Users & Service Providers

3 Control Centres

30-40 Galileo Sensor Stations

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Galileo – 5 Services

Open Service	Free to air; Mass market; Simple positioning	
Commercial Service	Encrypted; High accuracy; Guaranteed service	
Safety of Life Service	Open Service + Integrity and Authentication of signal	
Public Regulated Service	Encrypted; Integrity; Continuous availability	
Search and Rescue Service	Near real-time; Precise; Return link feasible	

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Galileo Performance Standards (Dual Frequency)

Service	Horizontal Accuracy (95%) (incl. system margins)	Vertical Accuracy (95%) (incl. system margins)	Availability*	Integrity
Open Service	4 m	8 m	> 99.5%	NO
Commercial Service	Detailed performance requirements under elaboration			
Safety of Life Service	4 m	8 m	> 99.5%	YES (LPV200)
Public Regulated Service	4 m	8 m	> 99.5%	YES

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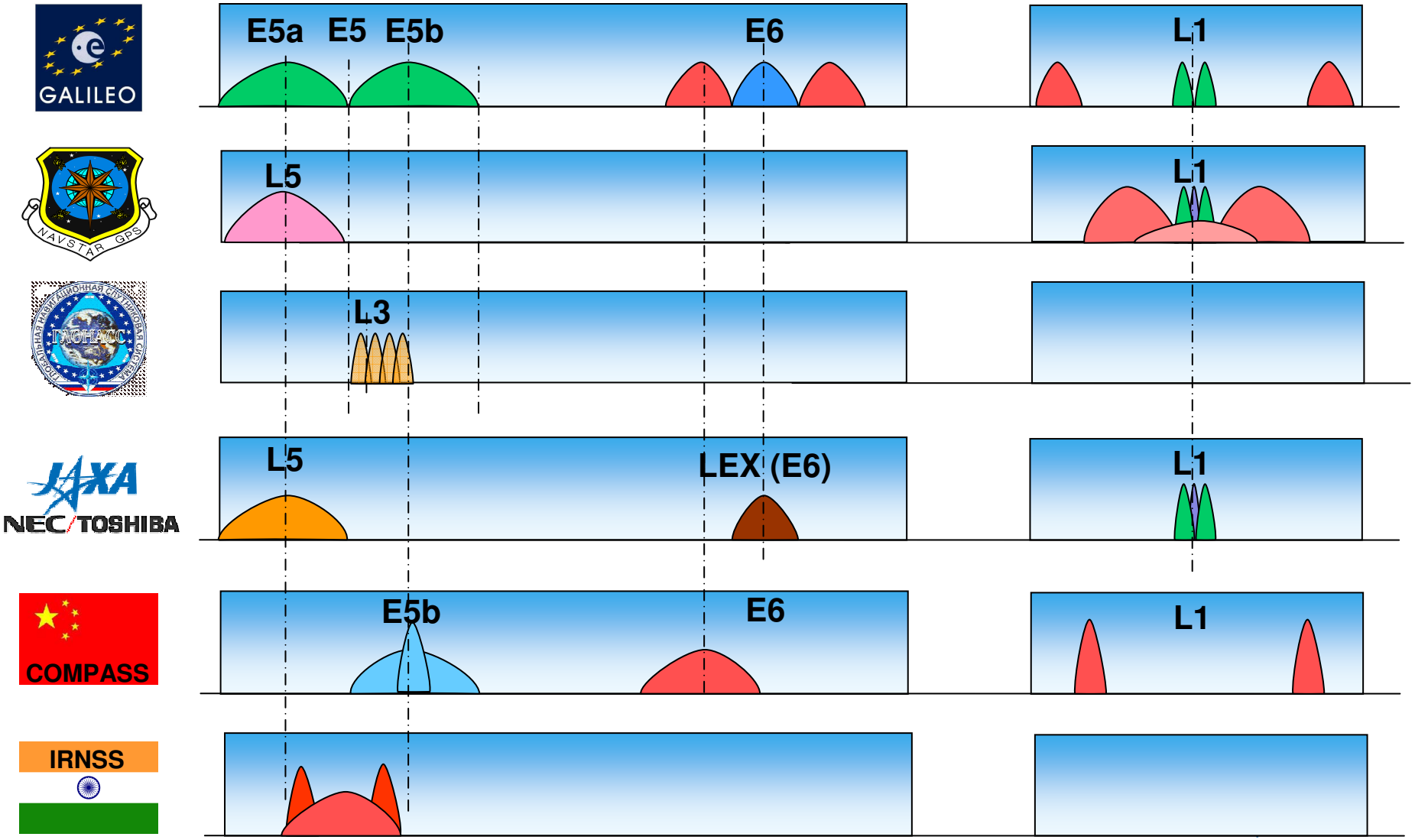
* Availability figures for global average

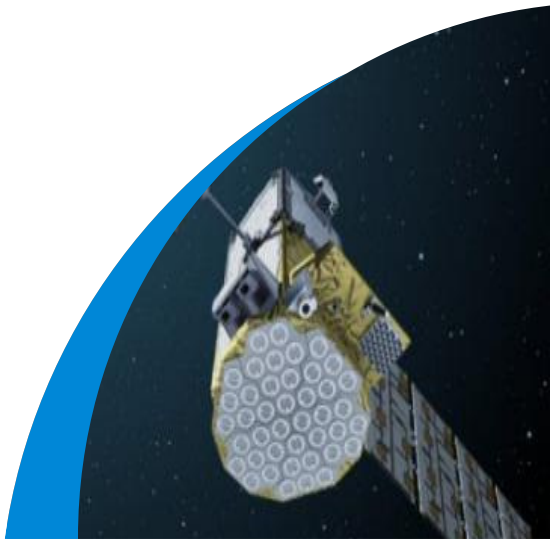
GNSS Compatibility & Interoperability



Galileo Test Satellites

- Giove-A launched on 28 December 2005
  - » Securing of Galileo frequencies
  - » Still operating

- Giove-B launched on 27 April 2008
  - » First Passive Hydrogen Maser atomic clock ever flown
  - » Implementation of CBOC signal
  - » Working as expected



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Galileo IOV vs FOC

	Component	IOV Phase	FOC Phase
	Satellites	4	27(+3)
	Control Centres	1	3
	Mission Uplink Stations	5	9
	TT&C Stations	2	5
	Sensor Stations	20	30-40

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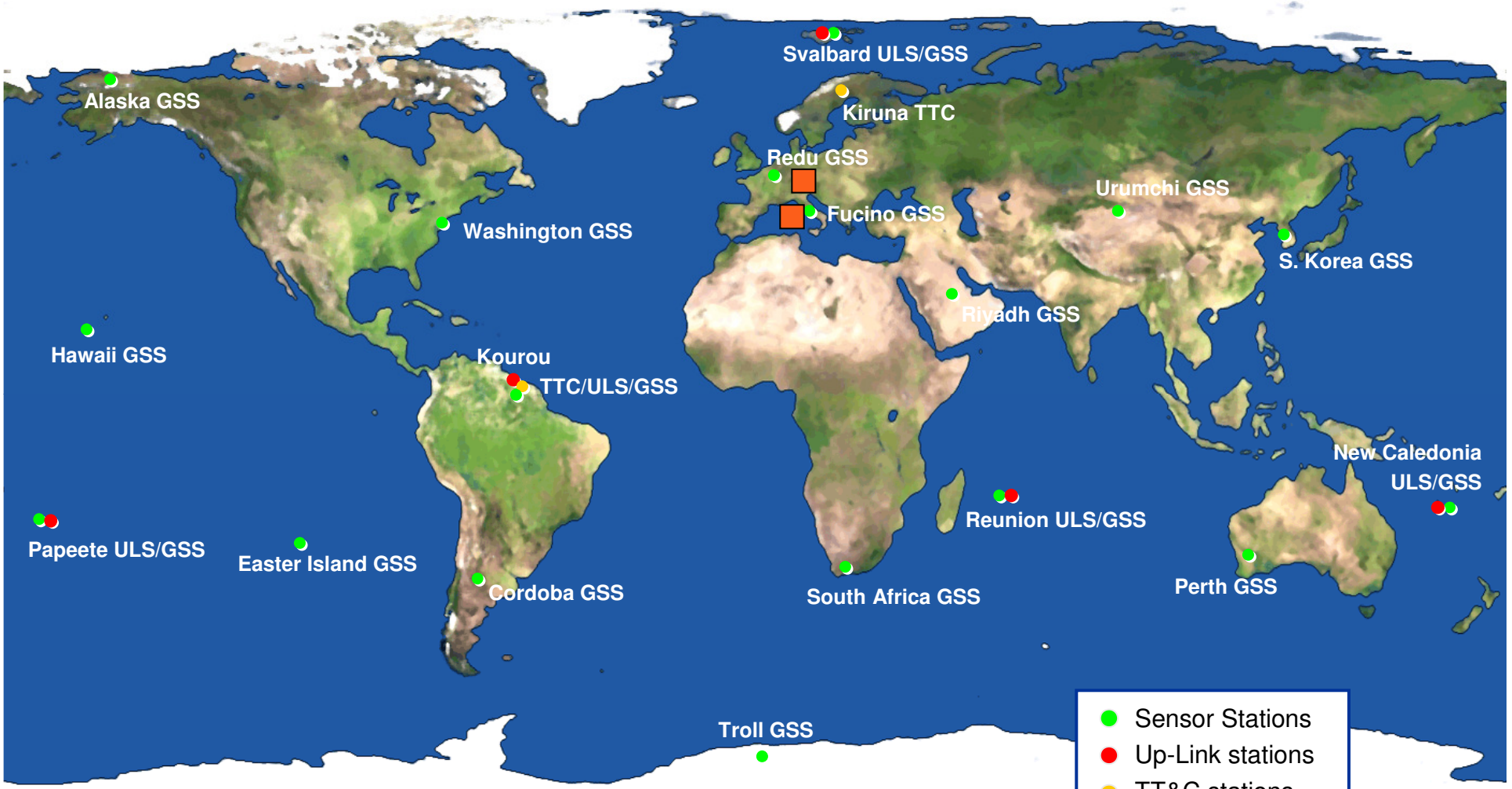
IOV (In Orbit Validation), FOC (Full Operational Capability)

IOV Ground Segment Sites



Galileo IOV Control Centres

Fucino (IT)

Oberpfaffenhofen (DE)

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Credits: ESA

Galileo IOV Ground Segment Sites

Kiruna Galileo TTC Site Completed (Nov 2007)

Svalbard Galileo ULS/GSS Site Completed (May 2008)

Credits: ESA

Galileo Programme Status

- 2008:
  - Full Operational Procurement contract notice: 1 July 2008
- 2009:
  - Infrastructure procurement ongoing in 6 work packages
  - Individual contract awards expected in 2009 and early 2010
- 2010:
  - Launch of 4 In-Orbit-Validation (IOV) satellites
- 2013:
  - Incremental deployment to reach Full Operational Capabilitiy (FOC)

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Galileo FOC Procurement

Retained Candidates

Work Package	Retained Candidates
1. System Support	• ThalesAleniaSpace (IT) • Logica (NL)
2. Ground Mission Segment	• ThalesAleniaSpace (FR) • Logica (UK)
3. Ground Control Segment	• Astrium (UK) • G-Nav grouping represented by Lockheed Martin IS&S (UK)
4. Space Segment	• Astrium (DE) • OHB System (DE)
5. Launch Services	• Arianespace (FR)
6. Operations	• Nav-up grouping represented by Inmarsat (UK) • DLR (DE) and Telespazio (IT)

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Galileo – International Activities

- Agreements with:

  P.R. of China, USA, Israel, South Korea, Ukraine, Morocco

- Multilateral:

  Founding member of UN International Committee on GNSS & Providers Forum, candidate to host ICG in 2010

- Cooperation *inter alia* on:
  - Compatibility
  - Interoperability
  - Standardisation
  - Development activities
  - Galileo applications
  - Research
  - Trade matters

- Regional training centers:
  - Asia, Africa, Latin America

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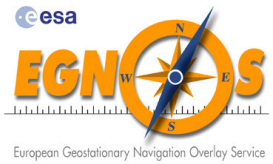
Conclusions



EGNOS will soon enter into its operational phase

- EGNOS Open Service in 2009
- EGNOS Safety of Life Service in 2010

Galileo is at the handover between the development (IOV) and deployment (FOC) phases

- GIOVE-A, GIOVE-B missions on-going
- FOC procurement started in July 2008
- 4 IOV satellites in 2010
- Full Operational Capability in 2013

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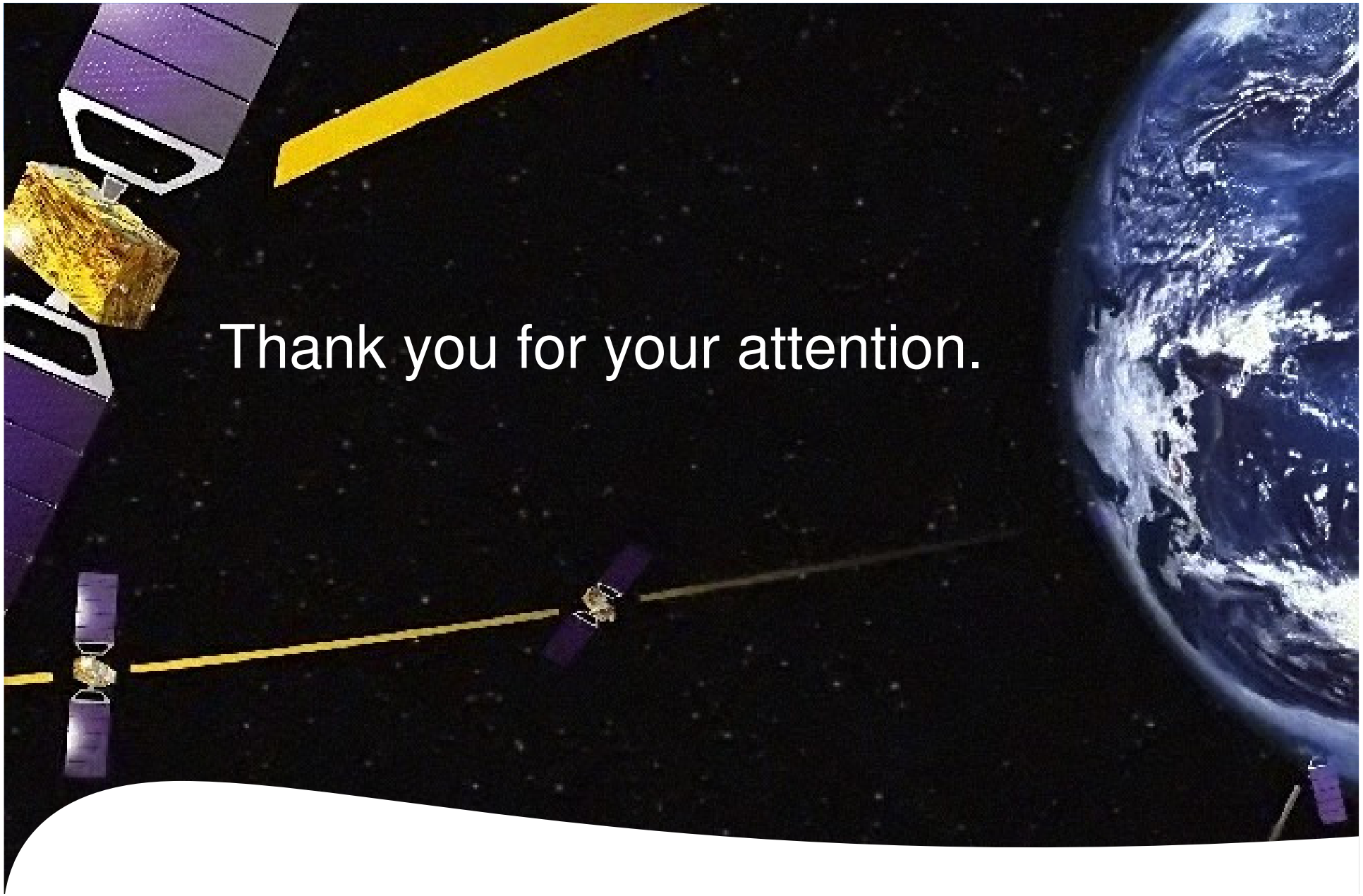
International coordination is an important feature

- Ensure compatibility as a minimum
- Achieve interoperability when desired


Thank you for your attention.