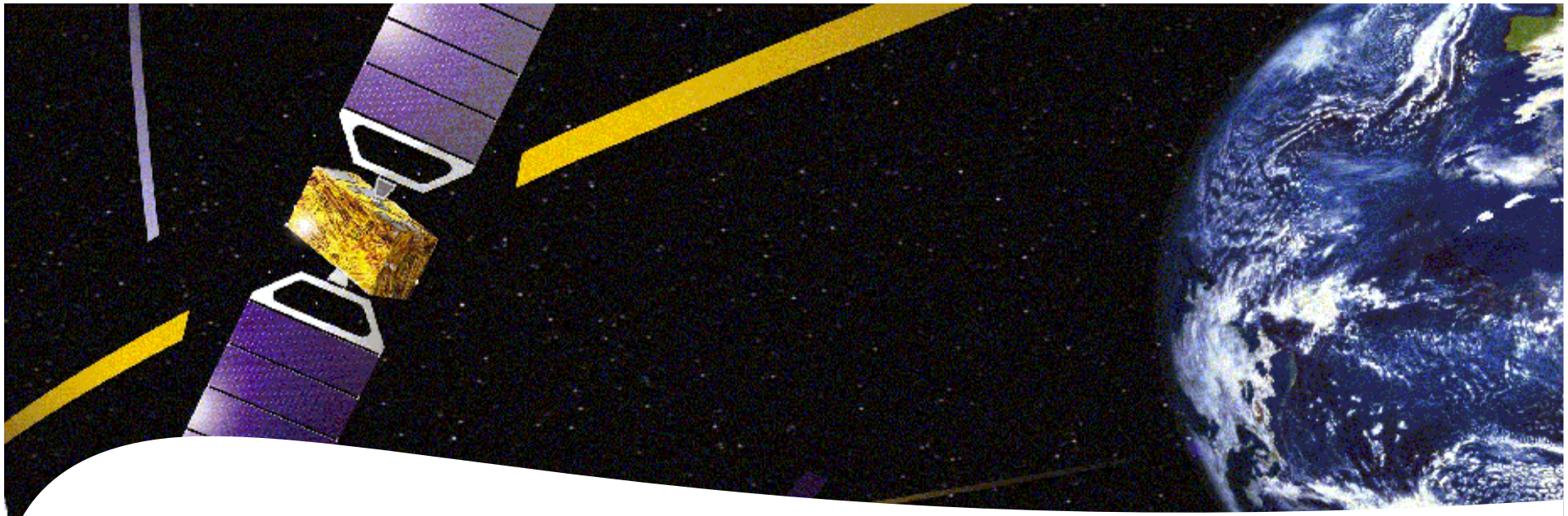

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EUROPEAN COMMISSION

Status and Prospects of European GNSS Systems

Prof. Dr.-Ing. Werner Enderle

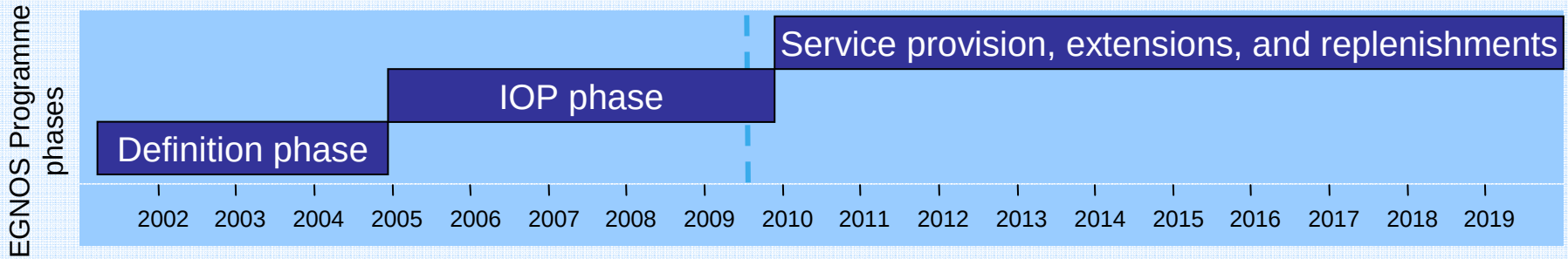
TREN-G3

17/06/2009, The Swiss Institute of Navigation – Navigare‘09

Galileo & EGNOS Schedule

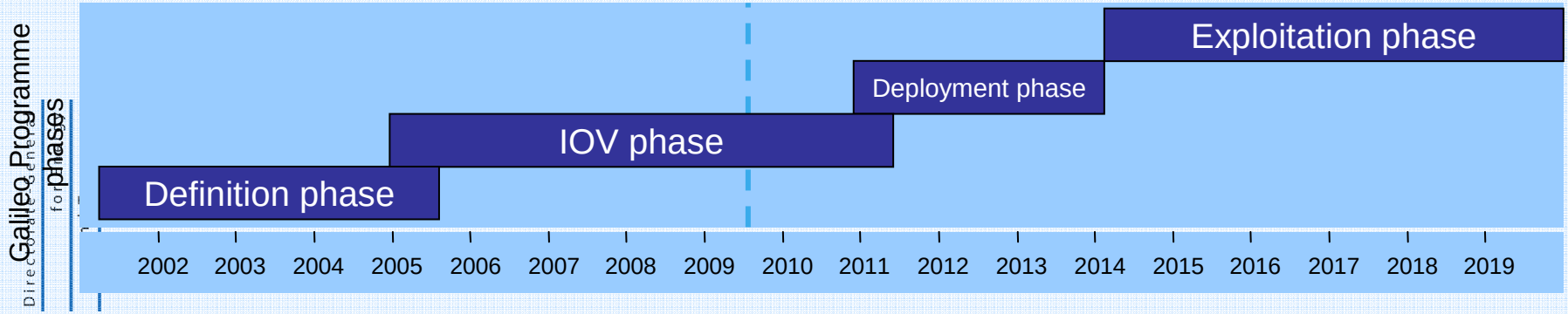
1) EGNOS

Regional Infrastructure & Services



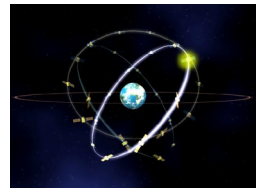
2) Galileo

Global Infrastructure & Services

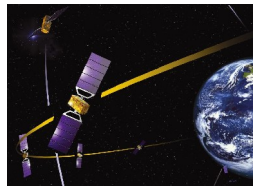


Galileo – Implementation Plan

Full Operational Capability
27 (+3) Galileo Satellites
2013



In-Orbit Validation
4 satellites plus
ground segment
2011



Galileo System Testbed v2
Initial Test Satellites
2005

GALILEO
GIOVE

Galileo System Testbed v1
Validate critical algorithms
2003

GALILEO
GSTB-V1

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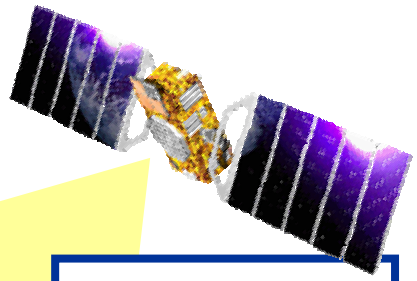
Galileo – System Architecture



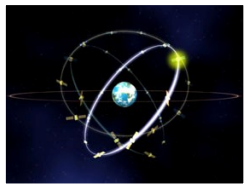
30
MEO satellites

Users & Service Providers




30-40 Galileo
Sensor Stations

30 satellite
Constellation



5 TT&C Stations

10 mission
Uplink stations

3 Control Centres

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Galileo – System Architecture

	Component	IOV Phase	FOC Phase
	Satellites	4	27 (+3 spares)
	Control Centres	2	3
	Mission Uplinks	5	10
	TT&C	2	5
	Sensor Stations	18-20	30-40

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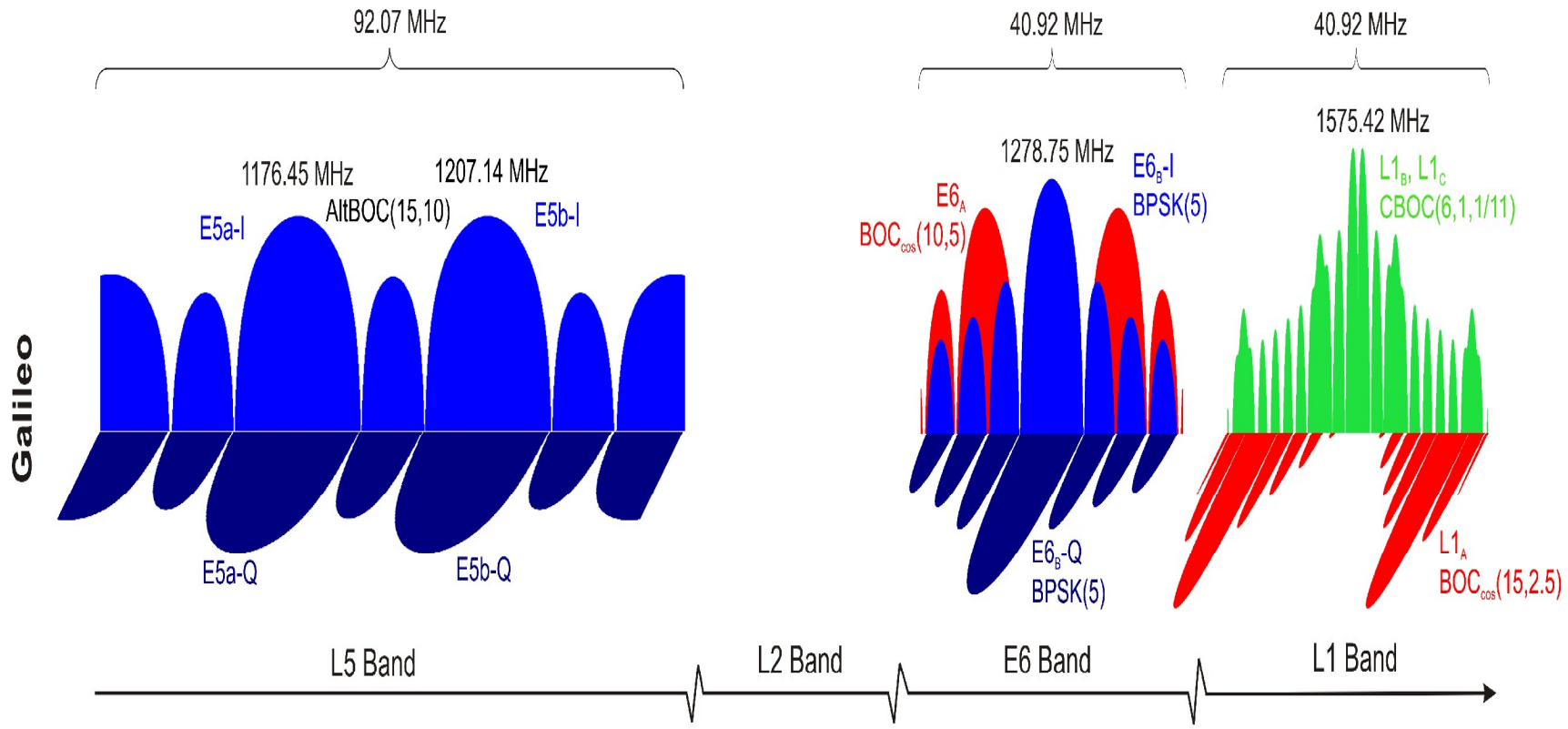
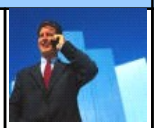
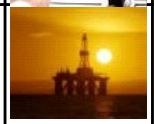
Galileo – Signals and Frequencies



Band	E5a	E5b	E6	E1
Service	OS/SoL/CS	OS/SoL	PRS CS	PRS OS/SoL/CS

Galileo - Services

Service			Receiver	Benefits	Target user groups	Availability
Open Service	OS		**Single frequency**	• **Additional satellites for better multi-system coverage (e.g., deep urban)** • **Coding and modulation advances for increased sensitivity and multi-path mitigation** • **Pilot signal for fast acquisition**	• **Low end mass market (e.g., LBS, outdoor)**	**Open**
			**Double frequency**	• **As above + increased accuracy with 2nd frequency**	• **High end mass market (e.g., car navigation, maritime)**	**Open**
Commercial Service	CS		**Double frequency**	• **Increased accuracy using additional frequencies and signals** • **Additional features under investigation (e.g., data rate capacity)**	• **Professional markets (e.g., surveying, precision agriculture)**	**Commercial basis**
Safety of Life Service	SoL		**Single frequency (Level B)**	• **As OS +** • **Integrity and authentication of signal** • **Continuity and service guaranty**	• **Aviation (en route)**	**Certified receivers**
			**Double frequency (Level A and C)**	• **As above at higher performance levels suitable for stringent dynamic conditions**	• **Aviation (A)** • **Maritime (C)** • **Road, Train (A)**	**Certified receivers**
Public Regulated Service	PRS		**Dual frequency**	• **As OS +** • **High Continuity (in times of crisis)** • **Improved Robustness (vs jamming, spoofing)**	• **Law enforcement** • **Strategic infrastructure**	**Regulated**
Search and rescue	SAR		**Single frequency**	• **Almost instantaneous reception of emergency calls** • **Exact positioning of emergency beacon**	• **Emergencies**	**Certified & registered beacons**

Galileo - Services

Galileo Service	Horizontal Accuracy (95%)	Vertical Accuracy (95%)	Availability	Integrity
Open Service	4 m	8 m	> 99.8%	NO
Safety of Life	4 m	8 m	> 99.8%	YES
Commercial Service	Detailed performance requirements under elaboration			
Public Regulated Service	6.5 m	12 m	> 99.8%	YES

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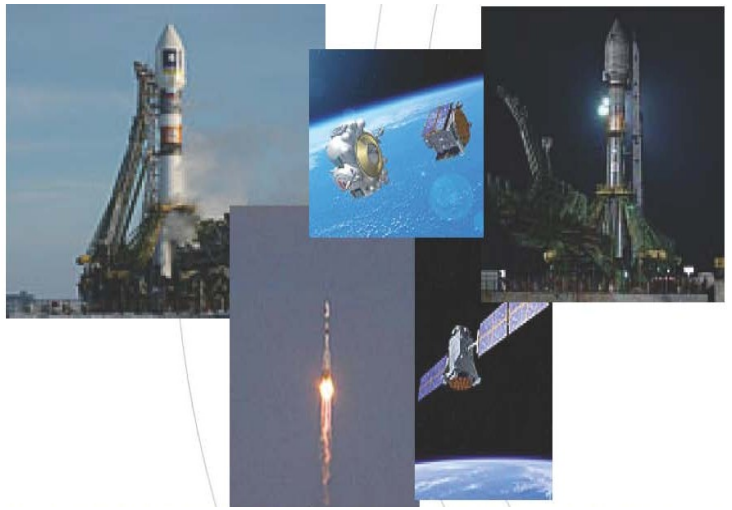
Galileo Test Satellites

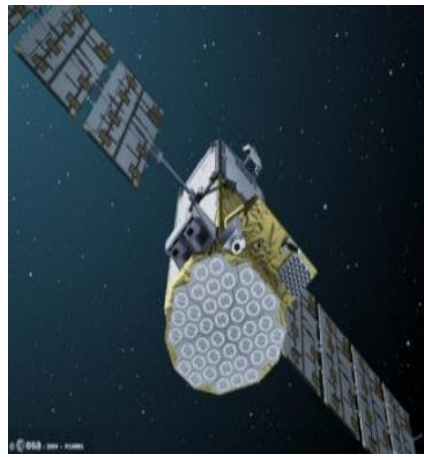


Giove-A

- Launch date: 28 December 2005
- Still operating

Giove-B

- Launch date: 27 April 2008
- Works as expected
- First maser atomic clock ever flown
- MBOC signal (first time)



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Galileo Re-structuring

- Year 2007: re-structuring
  - PPP: private sector limitations
    - Does not bear market risks
    - Does not bear technical risks
    - No (or expensive) money
  - Implementation funding secured: 3.4 billion €
  - European Commission
    - Fully in charge of Programme
    - Owner

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Galileo - FOC Procurement

- Contract notice: 1 July 2008
- EC procurement rules (subject to WTO agreements on trade)
- Infrastructure in 6 work packages
  - Candidates selected for each work package with good level of competition
  - Competitive Dialogue phase (ongoing)
  - Contracts in 2009
  - Full Operational Capability in 2013

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Galileo International Activities

Perspectives

- Hosting of worldwide infrastructure
- Regional & Local components
- Research & technology
- Compatibility, interoperability
- Applications and Trade
- Standards and certification

Galileo Centres

- China
- Egypt
- Brazil

Agreement EU-MS and..	Signed / Initialed
U.S.A.	✓
China	✓
Israel	✓
India	✓
Morocco	✓
South Korea	✓
Ukraine	✓

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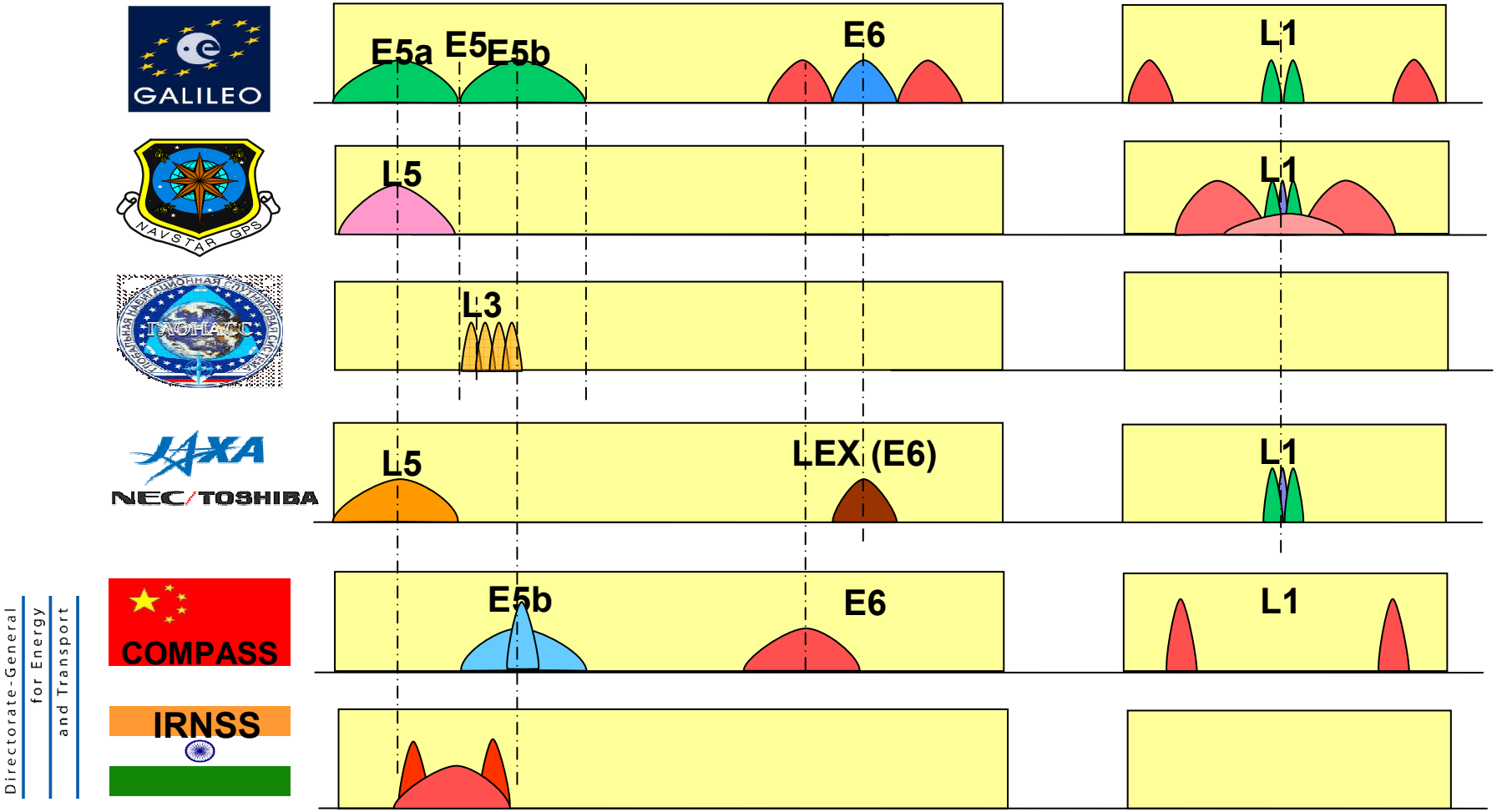
Galileo – Compatibility/Interoperability



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Galileo - Interoperability

- ***Compatibility*** refers to the ability of space-based positioning, navigation, and timing services to be used separately or together without interfering with each individual service or signal, and without adversely affecting national security.

- ***Interoperability*** refers to the ability of civil space-based positioning, navigation, and timing services to be used together to provide better capabilities at the user level than would be achieved by relying solely on one service or signal.

  • Geodetic reference frame
  • Time reference
  • Center frequency and signal design

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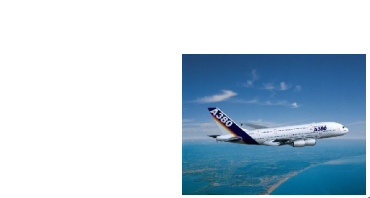
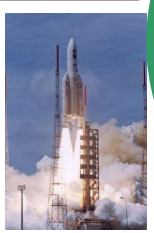
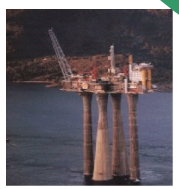
Galileo Security Doctrine






Accidental or deliberate attack on Galileo

③ Prevention of misuse of services

- ***Control of service denial***
- ***Control of legitimate use***


Subversive and hostile use of Galileo services

Illegitimate use

① Protection of Galileo infrastructure and

② Protection of all services

- ***Ensure availability***
- ***Ensure integrity***
- ***Ensure confidentiality***

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EGNOS System Overview

- EGNOS (**E**uropean **G**eostationary **N**avigation **O**verlay **S**ervice)
  - Space based Augmentation System for US GPS
  - Provision of
    - Improved accuracy (correction information)
    - System Integrity information for Safety-of-Life application (Civil Aviation)
- Position Accuracy
  - 1-2 m (95%) horizontal
  - 2-4 m (95%) vertical
- Official operations will start by end of 2009
- Certification of system in 2010

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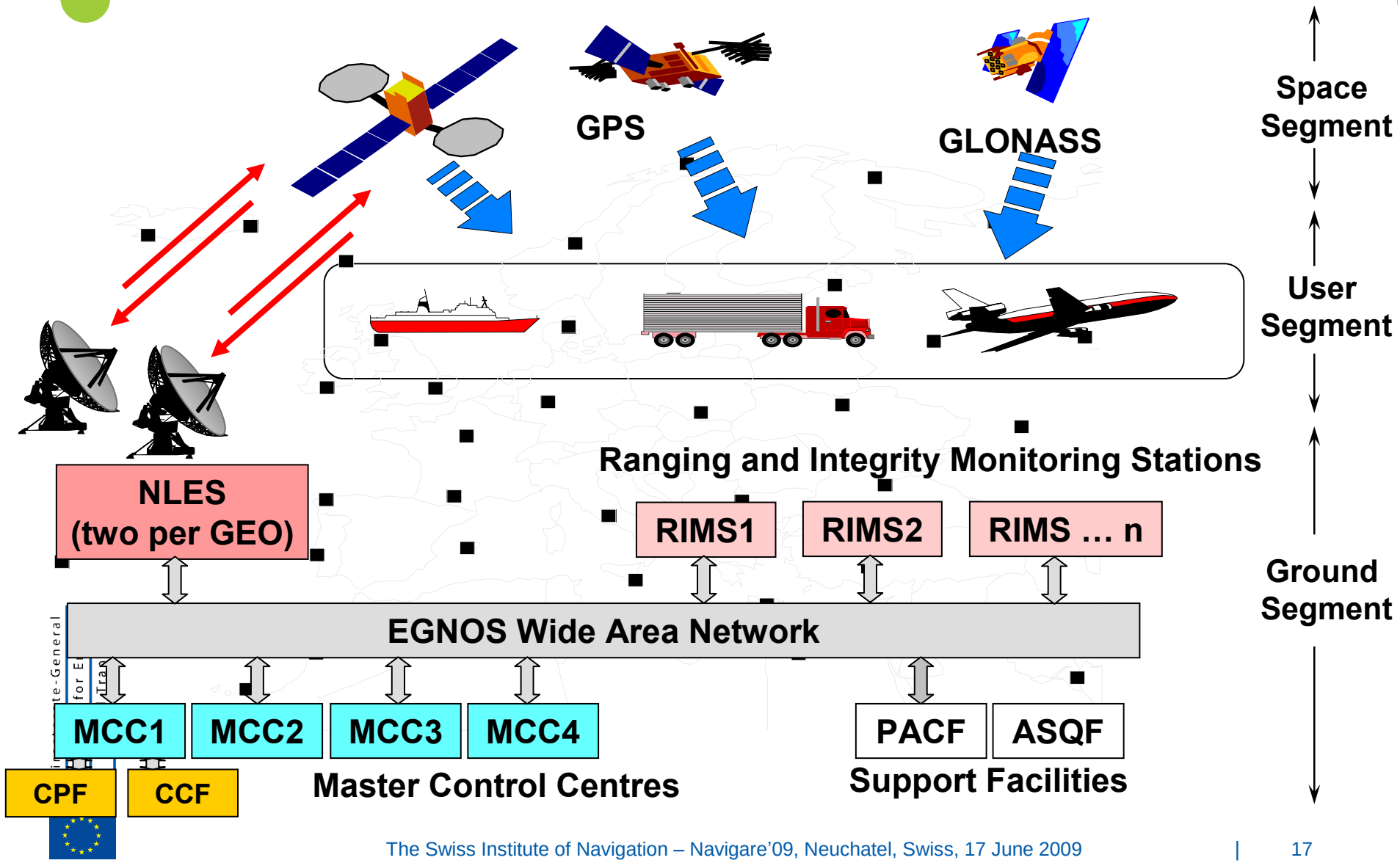
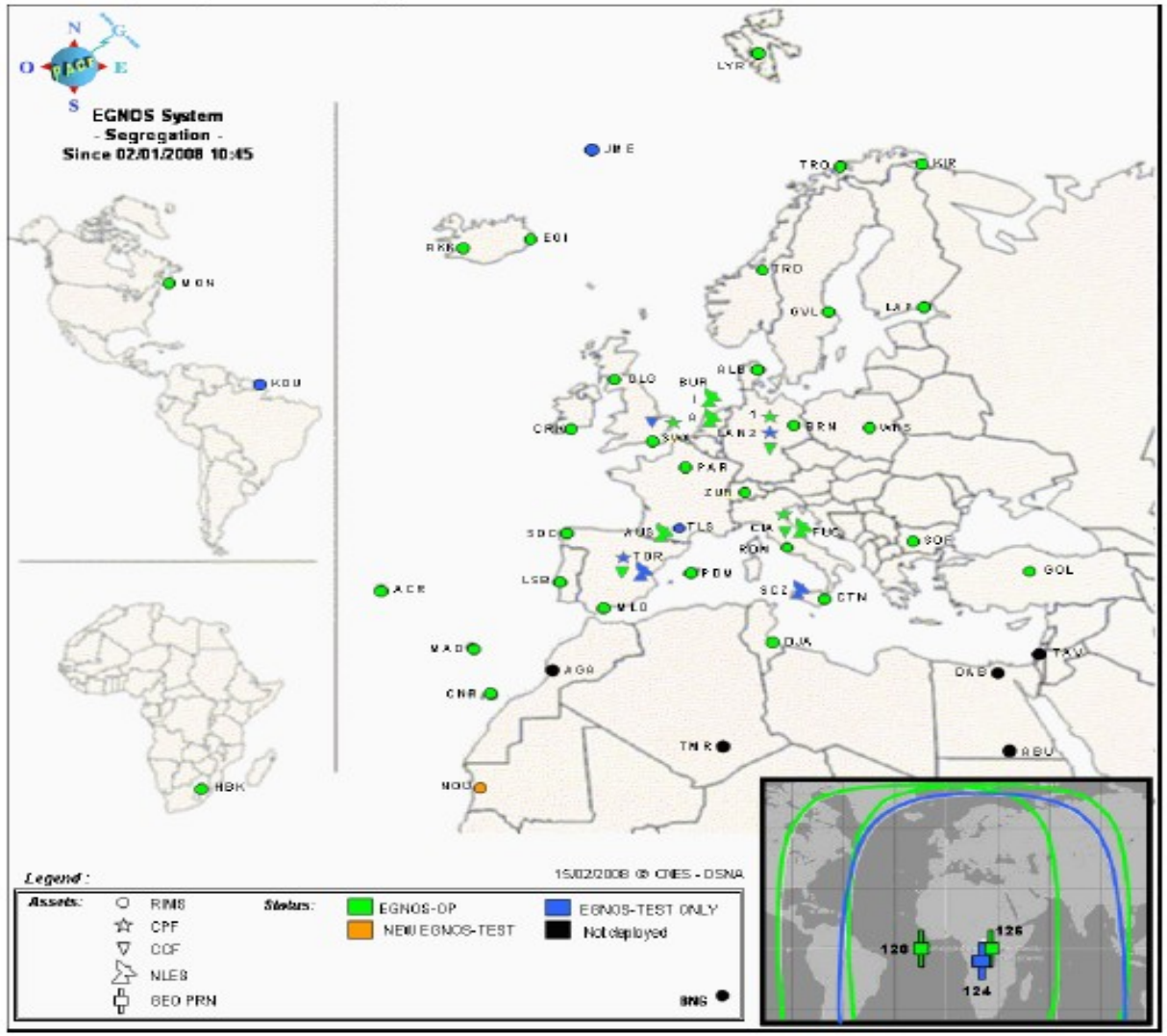
EGNOS System Architecture



EGNOS – Deployed Configuration



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EGNOS - System Status

- System release V2.2 is qualified since July 08 (34 ref stations, 4/4 MCCs, three GEOs)
- Operational qualification is achieved since March 09
- V2.2 is the release supporting certification

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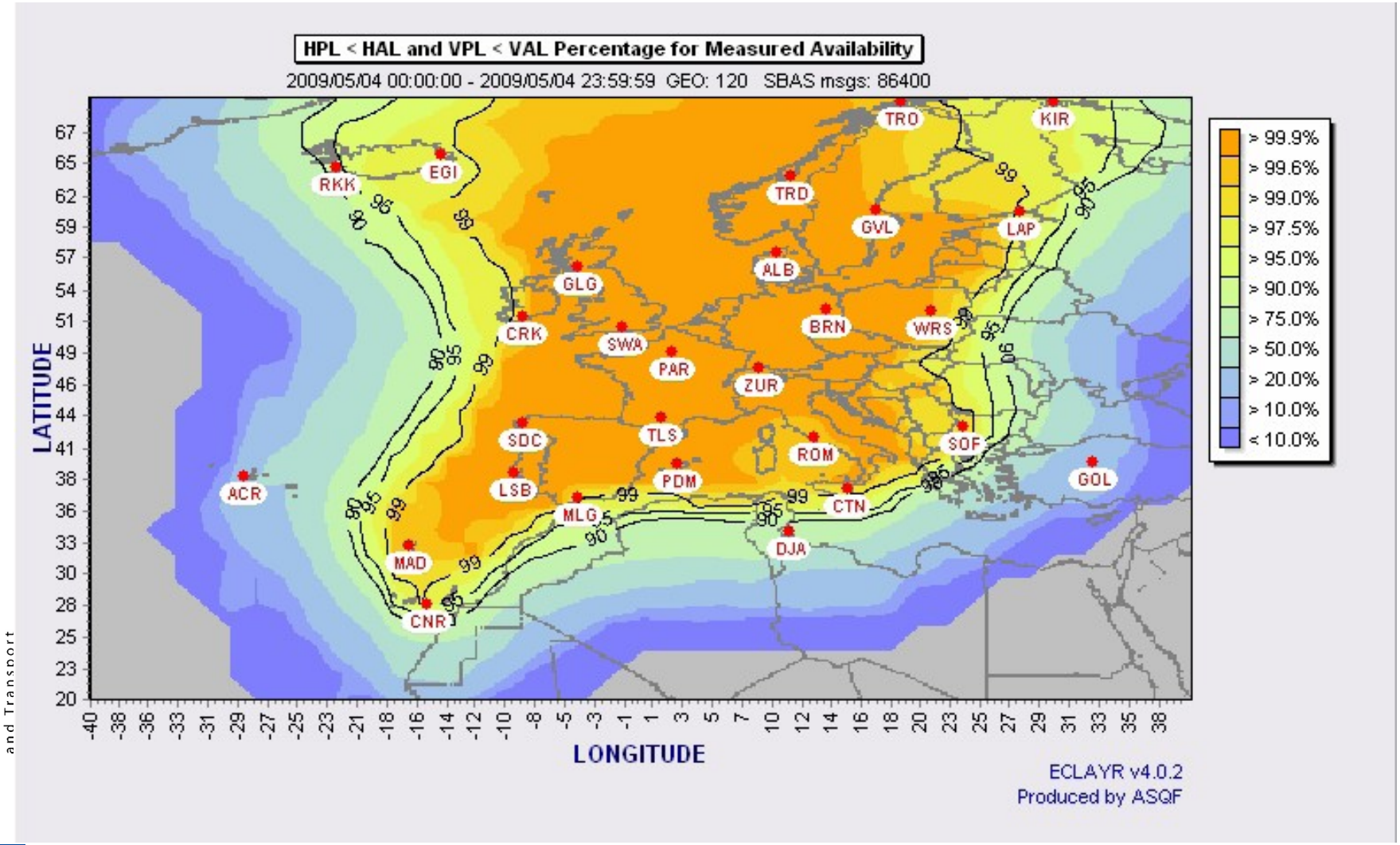
EGNOS – System Performance



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EGNOS Services

	Open Service	Safety Of Life	CDDS
Transmission means	RF signal (L1 frequency)	RF signal (L1 frequency)	Ground network
Reference	EGNOS MRD	EGNOS MRD	EGNOS MRD
Guarantee of service	None	Guarantee of compliance to ICAO standards (certification)	Guarantee of compliance to SLA
Definition of the service	Free-to-air SIS only	SIS + Guarantee of compliance to ICAO standards (certification)	EGNOS data + Guarantee of compliance to SLA
Typical user communities	Pedestrian, in-car navigation	Aviation, Maritime, railway, road (tolling), emergency services	A-GNSS applications, high-precision GNSS, Research (e.g. atmospheric, tectonics)

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EGNOS Services – Current Status

Mission description	Technical Implementation status	Service Status	Expected mission lifetime
Open Service	SIS available	Declaration of "entry into service" planned for end 2009	20 years (till 2029)
Safety-Of-Life (NPA, APV-1)	Test SIS available, operations under qualification	Declaration of "entry into service" planned for 2010	20 years (till 2030)
EGNOS Commercial Data Distribution Service	Data access available	Service prototyping phase – testing since 2008	20 years (till 2028)

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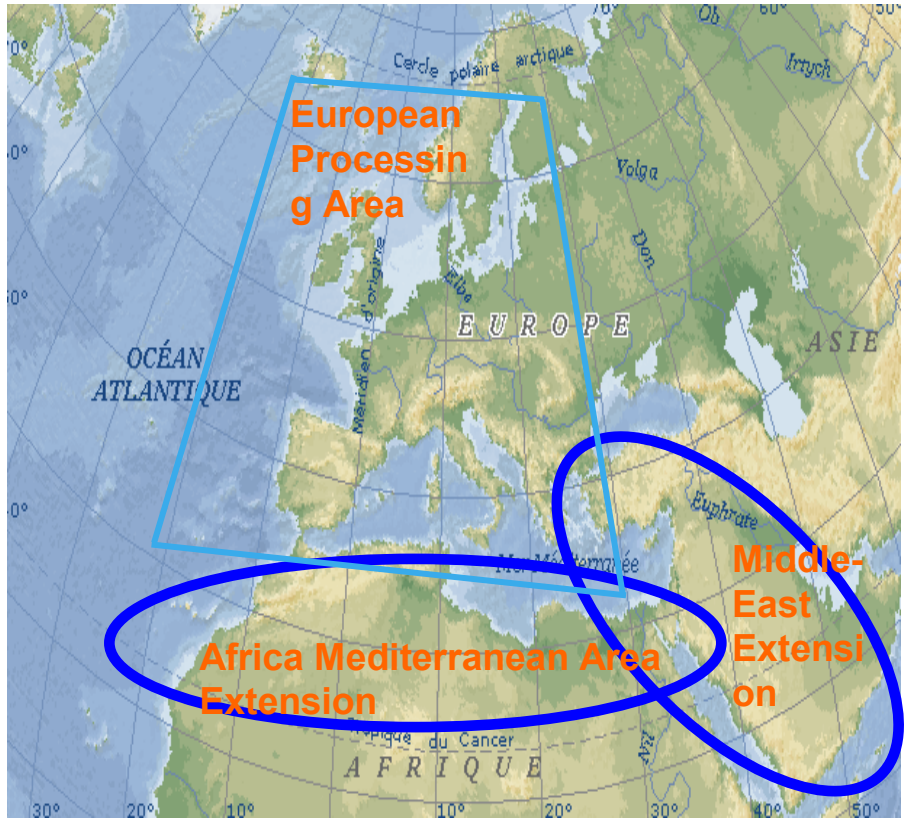
EGNOS Extension

- Extension of EGNOS to Africa Mediterranean Area (MEDA)
  - Implementation of EGNOS network extension is on-going
- Extension of EGNOS to Middle East (ACAC) under investigation



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EGNOS – Next Steps

- "LPV200" service level ►**short term**
  - EGNOS capability to meet this service level currently under technical evaluation
- Service provision improvements►**short/medium term**
- Extension of coverage ►**short/medium term**
  - Eastern Europe
  - North Africa ("MEDA" countries)
- Next generation SBAS ►**medium/long term**
  - Under definition
  - EGNOS L1/L5/E5 (TBC)
  - Multi-constellation Regional Service concept (under investigation)

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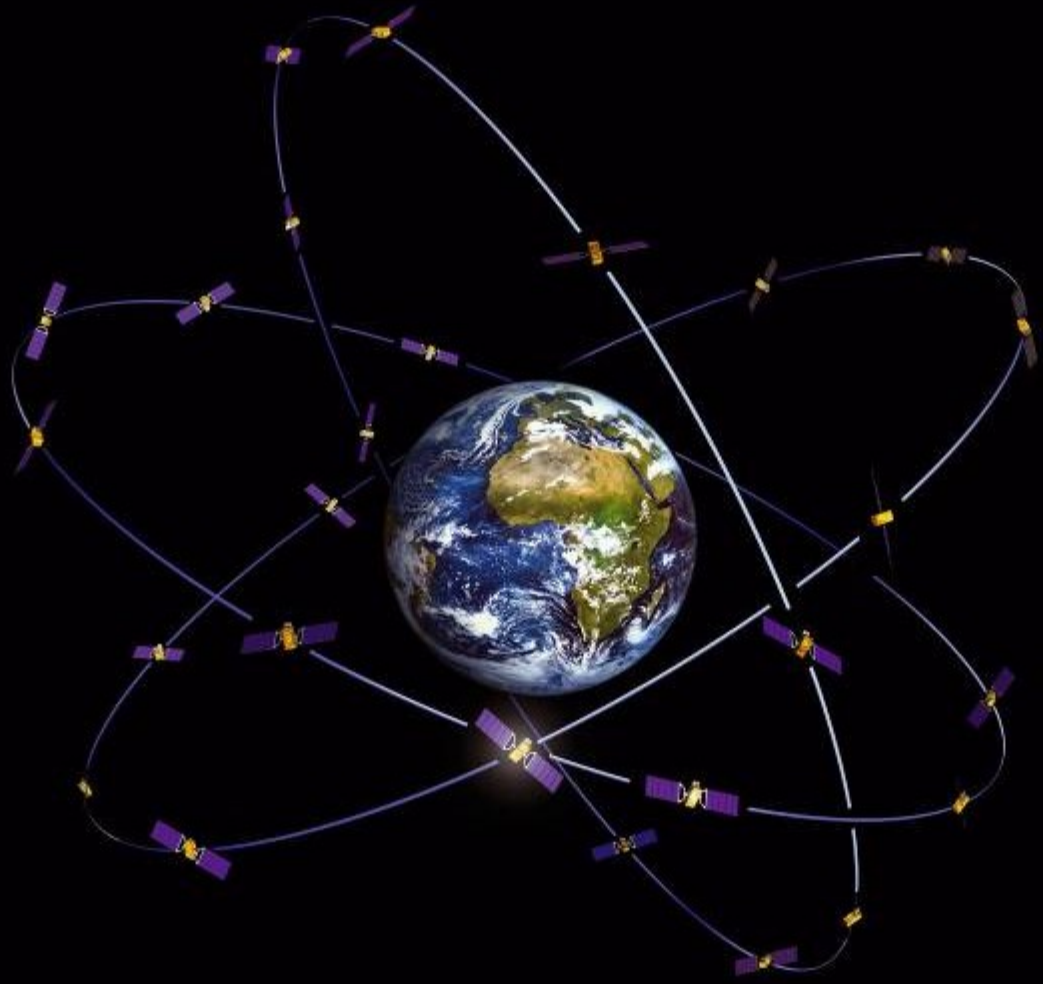

Thank you very much for your attention