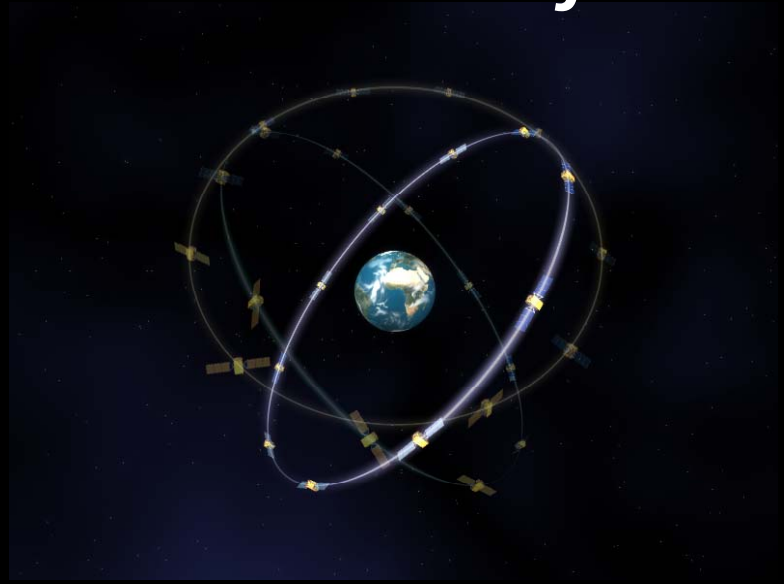
Status of EGNOS and Galileo Projects



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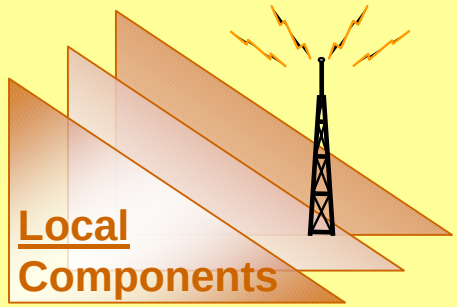
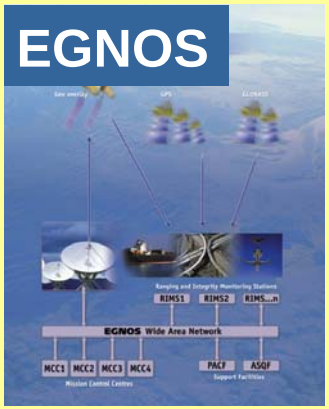
GALILEO Architecture

Regional Components

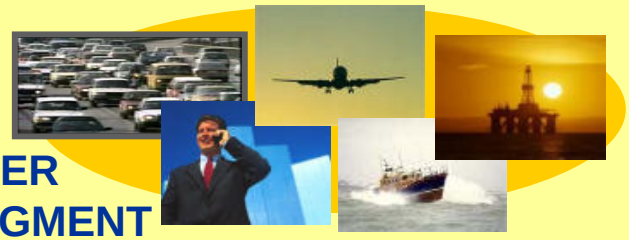
GALILEO: **Satellite constellation and ground mission and control segments**



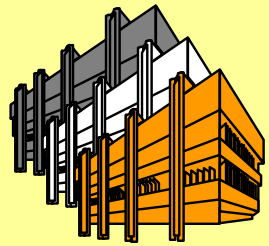
Local Components



SAR



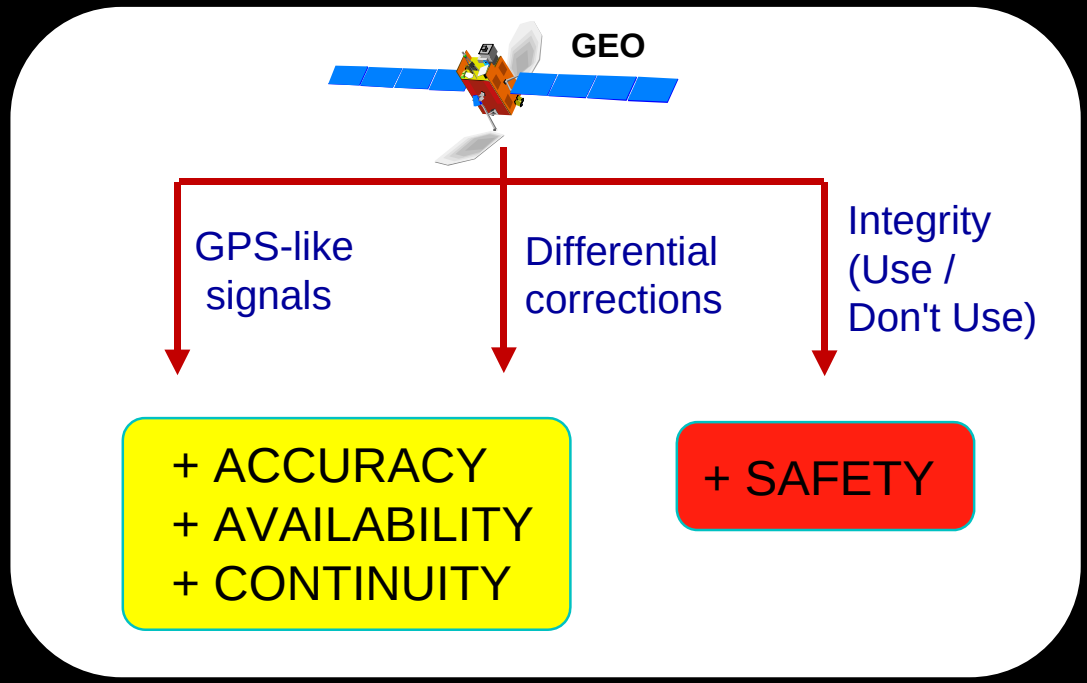
USER SEGMENT



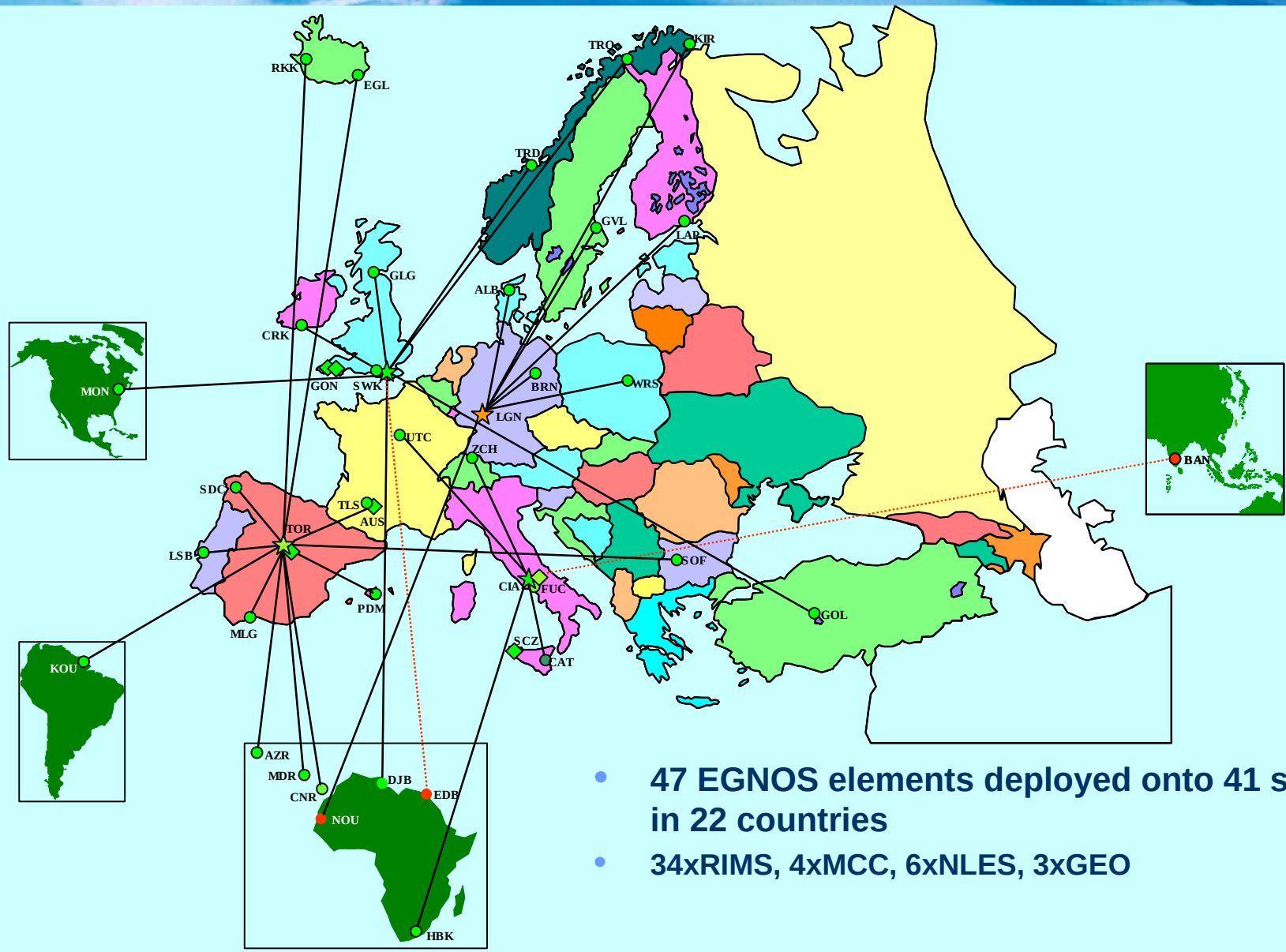
SERVICE CENTERS

EGNOS

- The first step of the European GNSS Strategy leading to Galileo.
- EGNOS is the first component of the European SatNav infrastructure.
- EGNOS provides early benefits to users and it is a precursor of Galileo services (e.g. integrity).

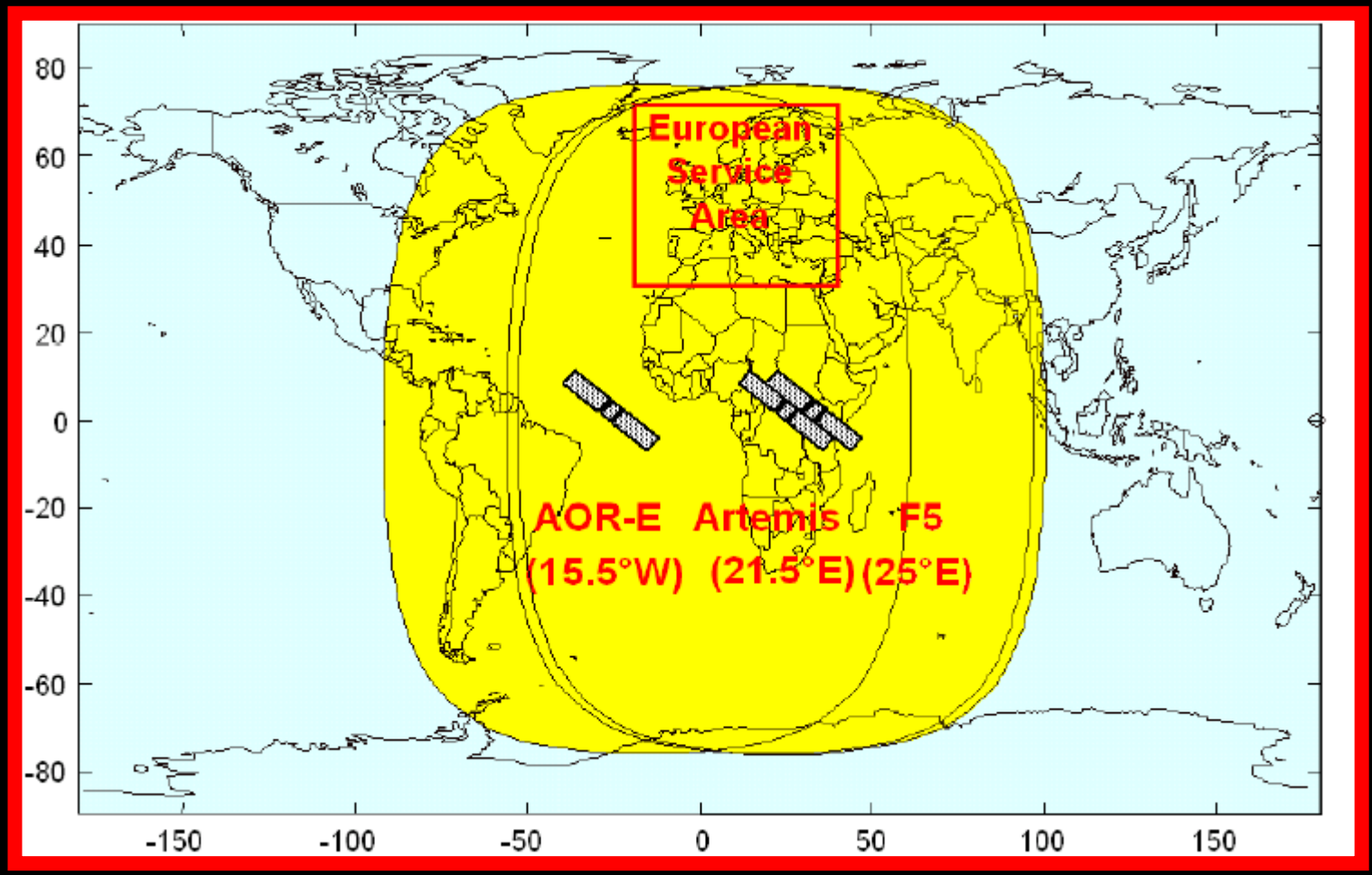


EGNOS Sites



- **47 EGNOS elements deployed onto 41 sites in 22 countries**
- **34xRIMS, 4xMCC, 6xNLES, 3xGEO**

EGNOS GEO Satellites



Triple coverage over Mediterranean and Africa

EGNOS Status

- Deployment practically completed
  - 4 MCCs, 6 NLES, 30 out of 34 RIMS;
  - All 3 EGNOS Geostationary satellites are transmitting successfully: AOR-E, IOR-W and ARTEMIS
- EGNOS test transmissions since July 2004.
- Signals available for non-safety of life users in early 2005.
- Signals available for safety-of-life users in 2006.
- Gradual introduction of EGNOS evolutions (e.g. extension of coverage area) to be initiated in 2005.

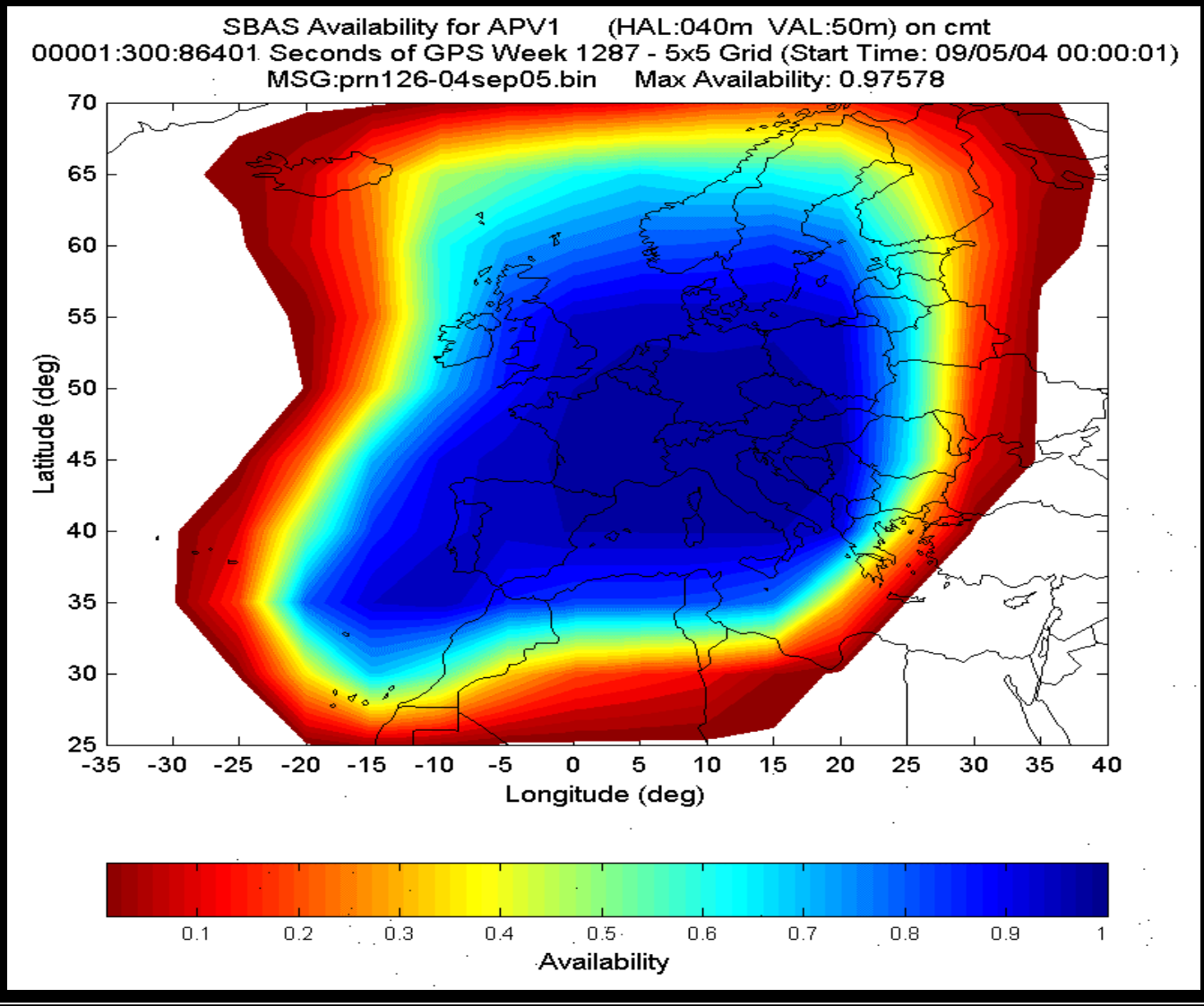
EGNOS Measured Accuracies

- *Less than 1 m horizontal accuracies recorded in EGNOS quite often;*
- *Excellent vertical accuracies 1-2m (well below the 7.6 m specification)*

	Lisbon	Toulouse	Rome	Brussels	Paris
HNSE 95%	1.2 m	**0.9 m**	1.1 m	**0.8 m**	1.0 m
VNSE 95%	1.7 m	1.4 m	**1.2 m**	1.7 m	**1.3m**

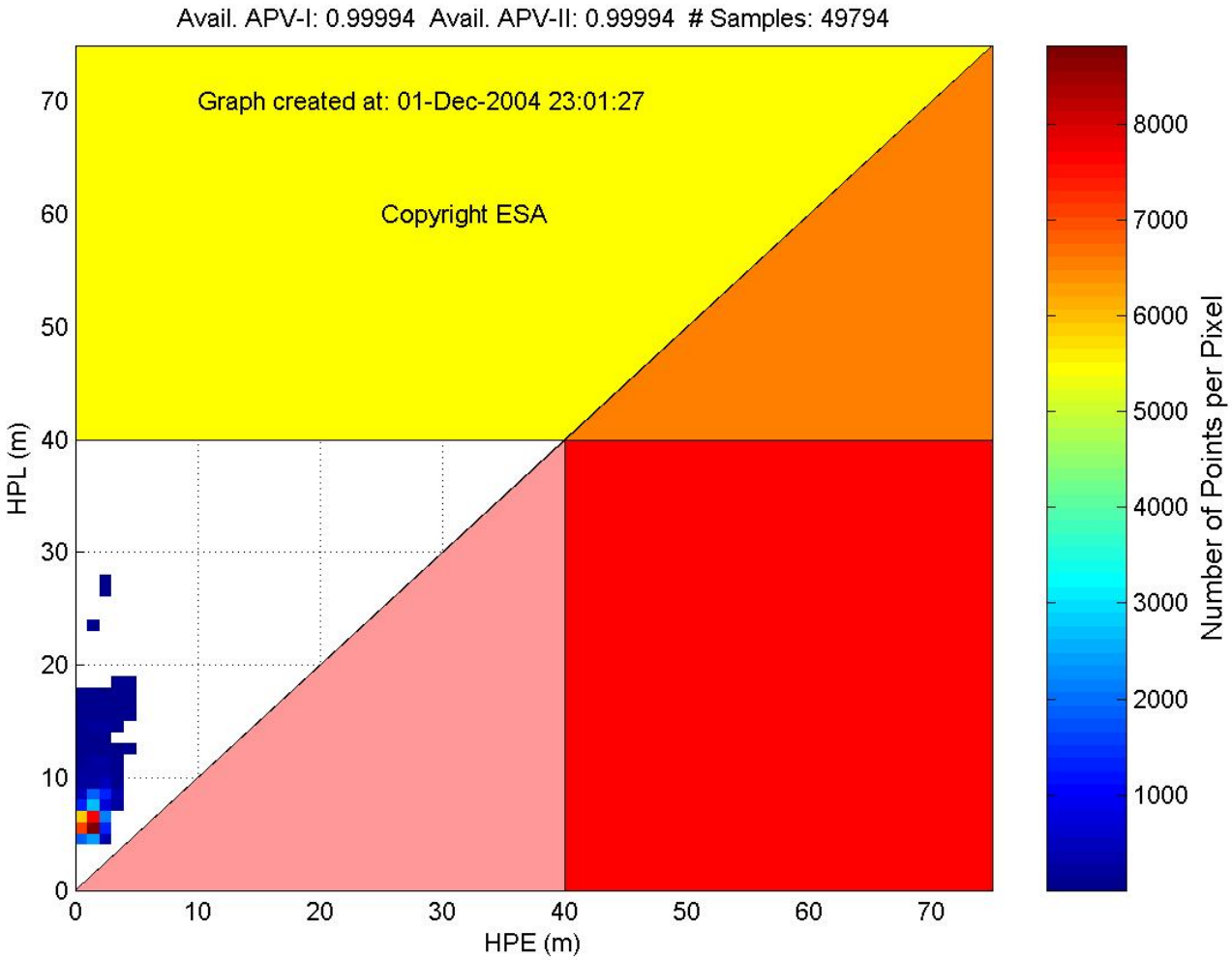
Sep 5, 2004

Service Coverage



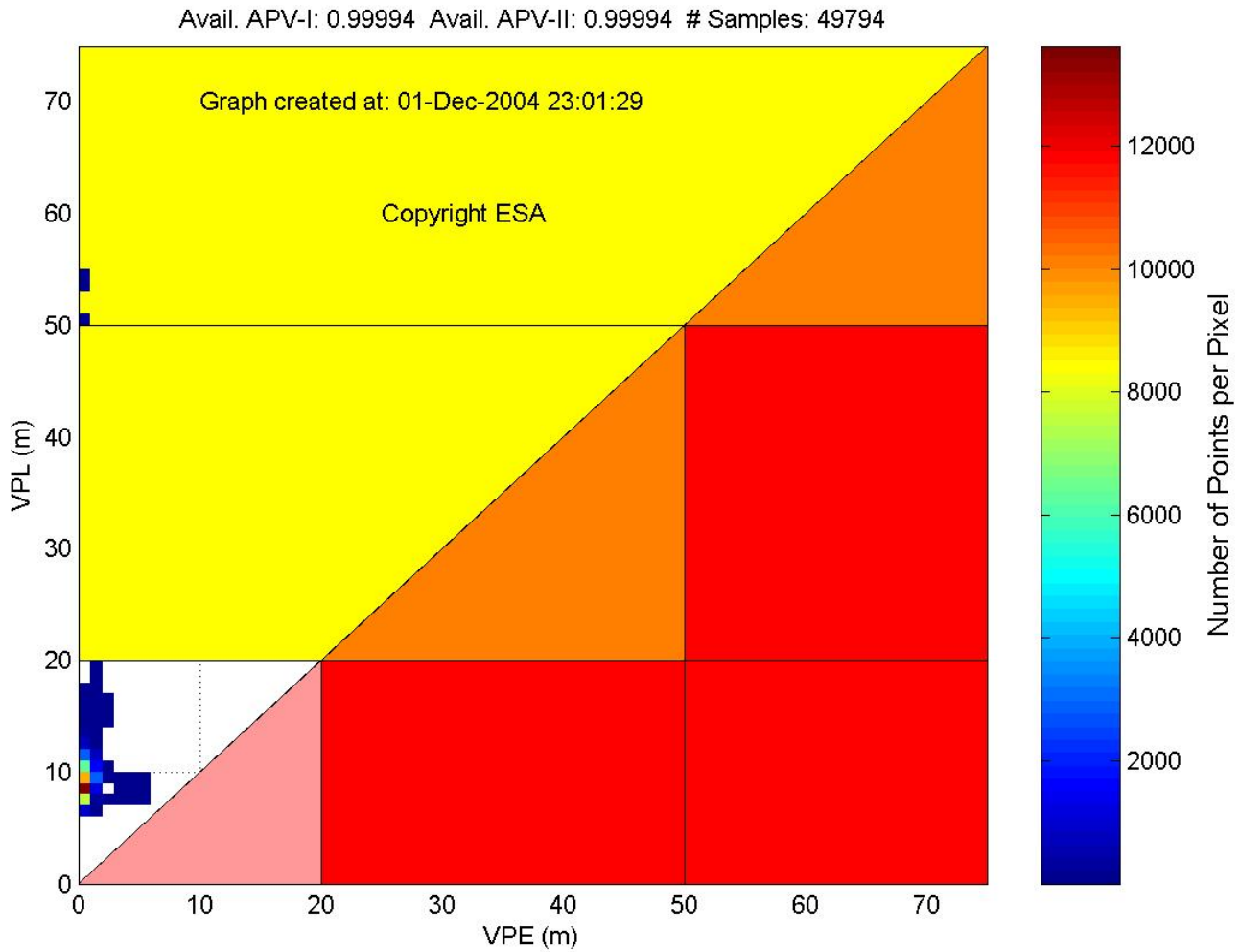
Sep 5, 2004 (24 h)
26 RIMS out of 34

Service Availability
Horizontal



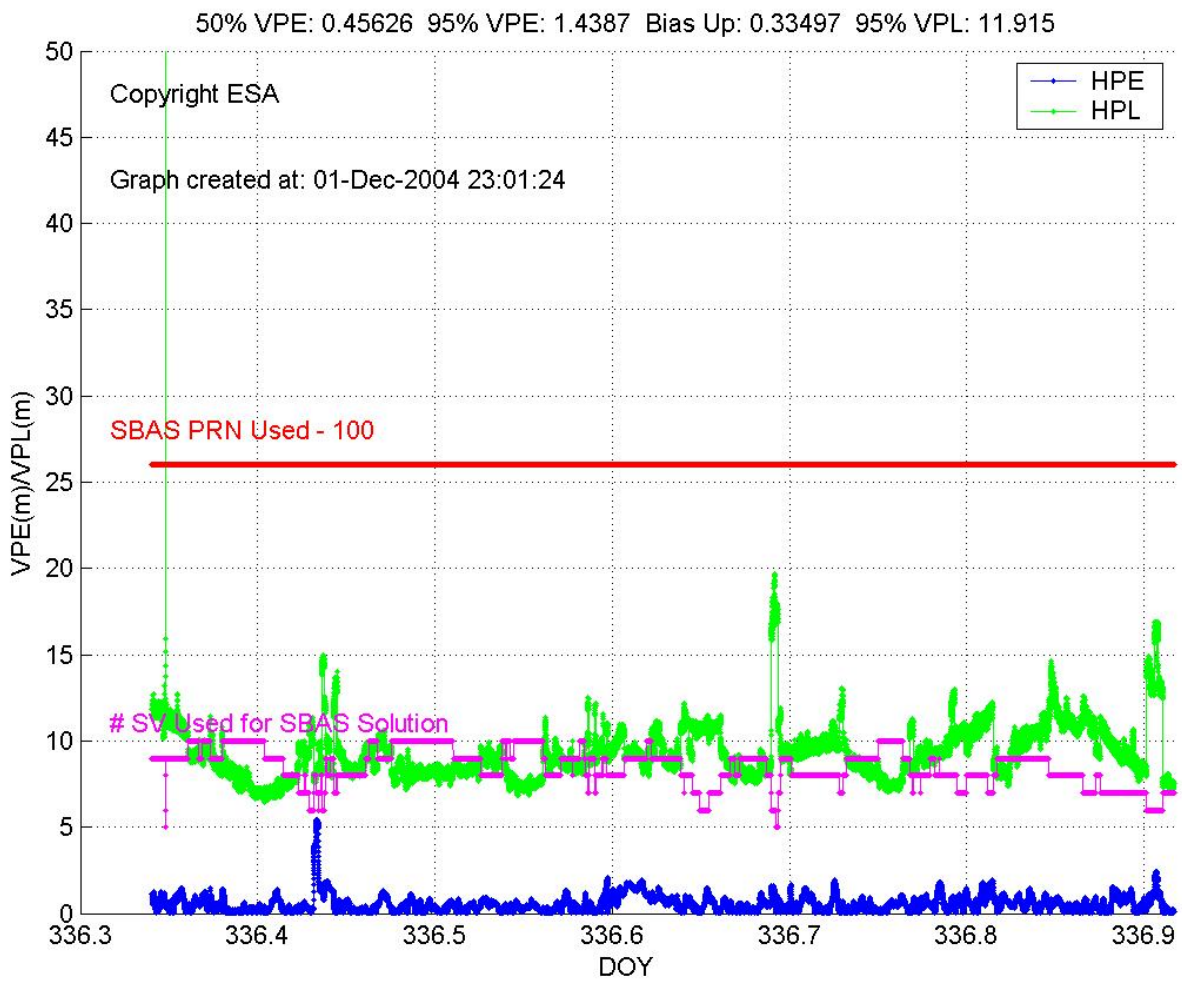
ESA/ESTEC (NL)
Dec 1, 2004
30 out of 34 RIMS

Service Availability
Vertical



ESA/ESTEC (NL)
Dec 1, 2004
30 out of 34 RIMS

Vertical Position Error and Protection Level vs Time



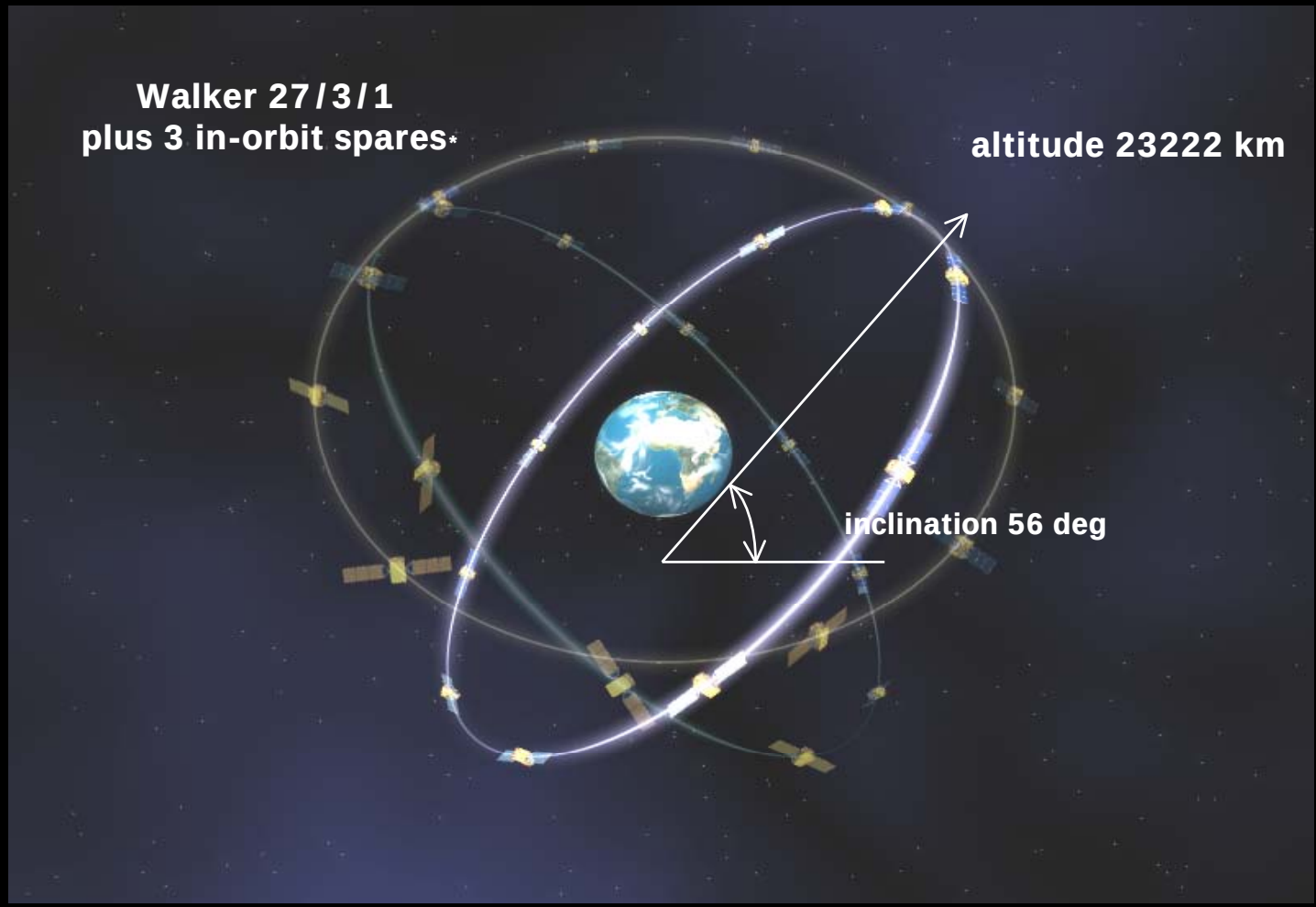
ESA/ESTEC (NL)
Dec 1, 2004
30 out of 34 RIMS

EGNOS Evolution

- No disruption of operational service
- Step-wise Implementation.
- Step 1 (2006):
  - EGNOS GEO data for dissemination over non-GEO links.
  - Extension of coverage area: South of Mediterranean area and East Europe.
- Step 2 (2007-2008)*:
  - Extension in Africa
  - L5 capabilities
  - Search and Rescue Return Link

*) to be confirmed in 2005

GALILEO Constellation



*) passive spares

Galileo Architecture

Constellation

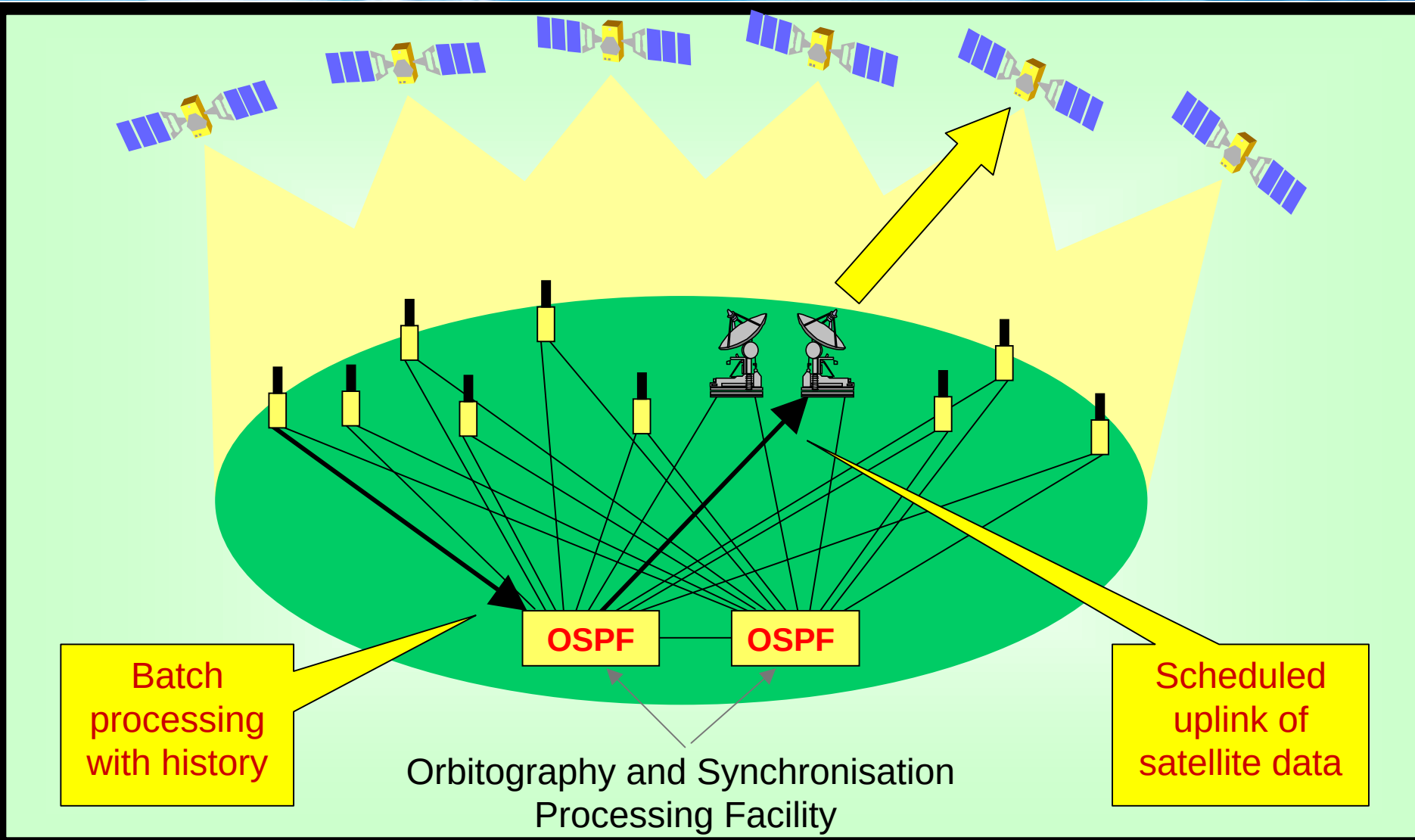
Control Data

Orbits, Clocks Integrity, …

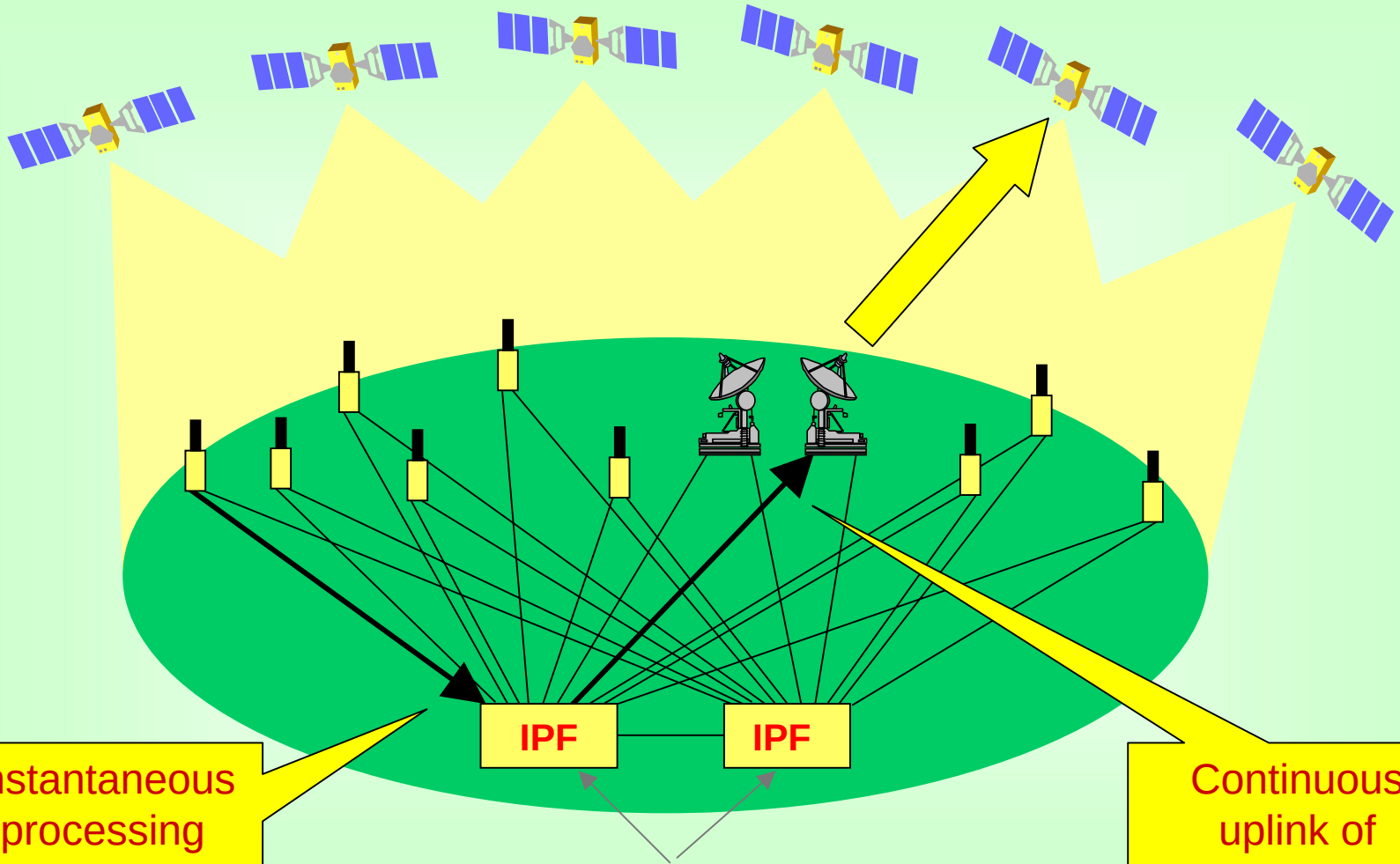
Up-Link Stations

Control Centers

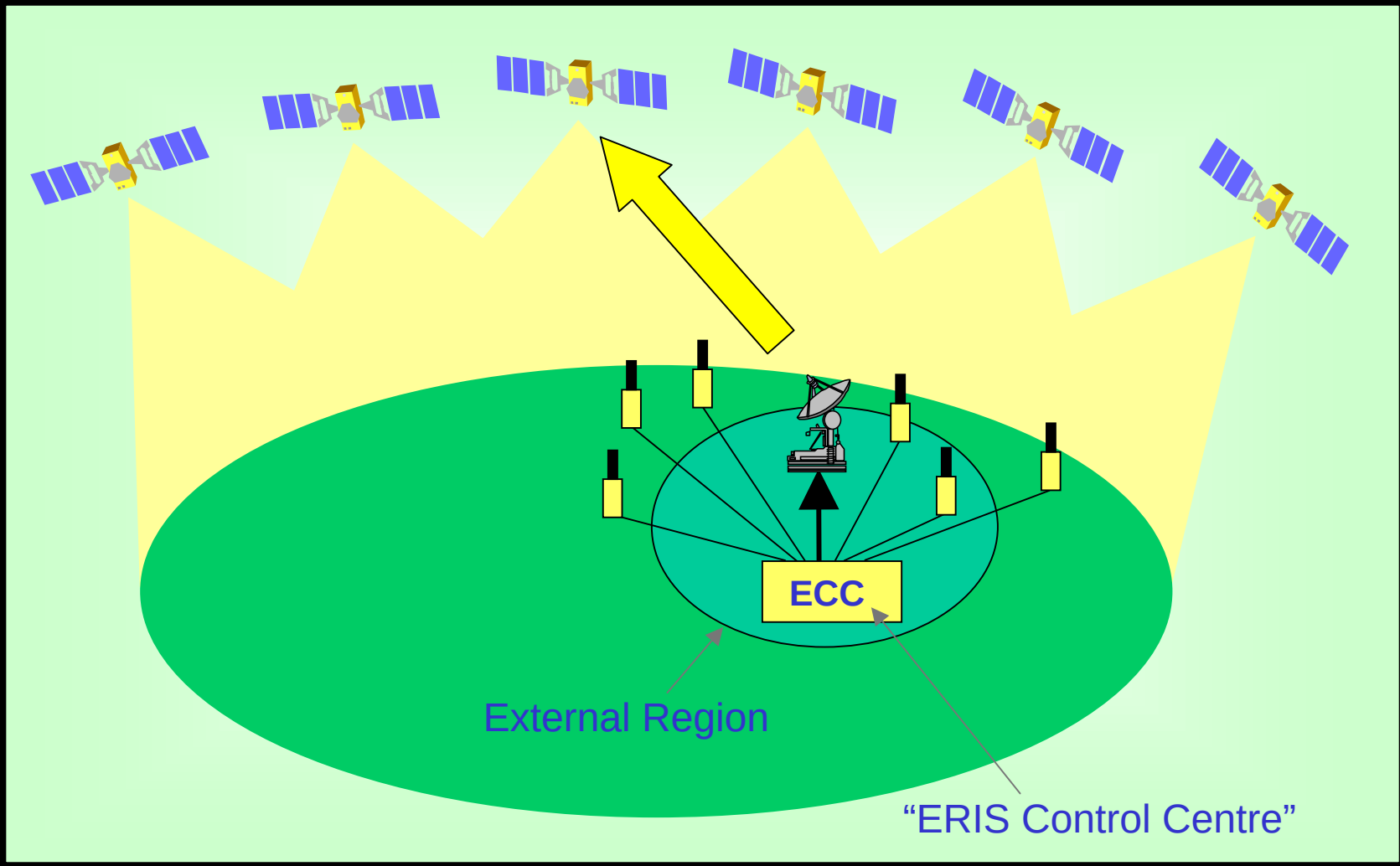
Orbit Determination & Time Synchronisation



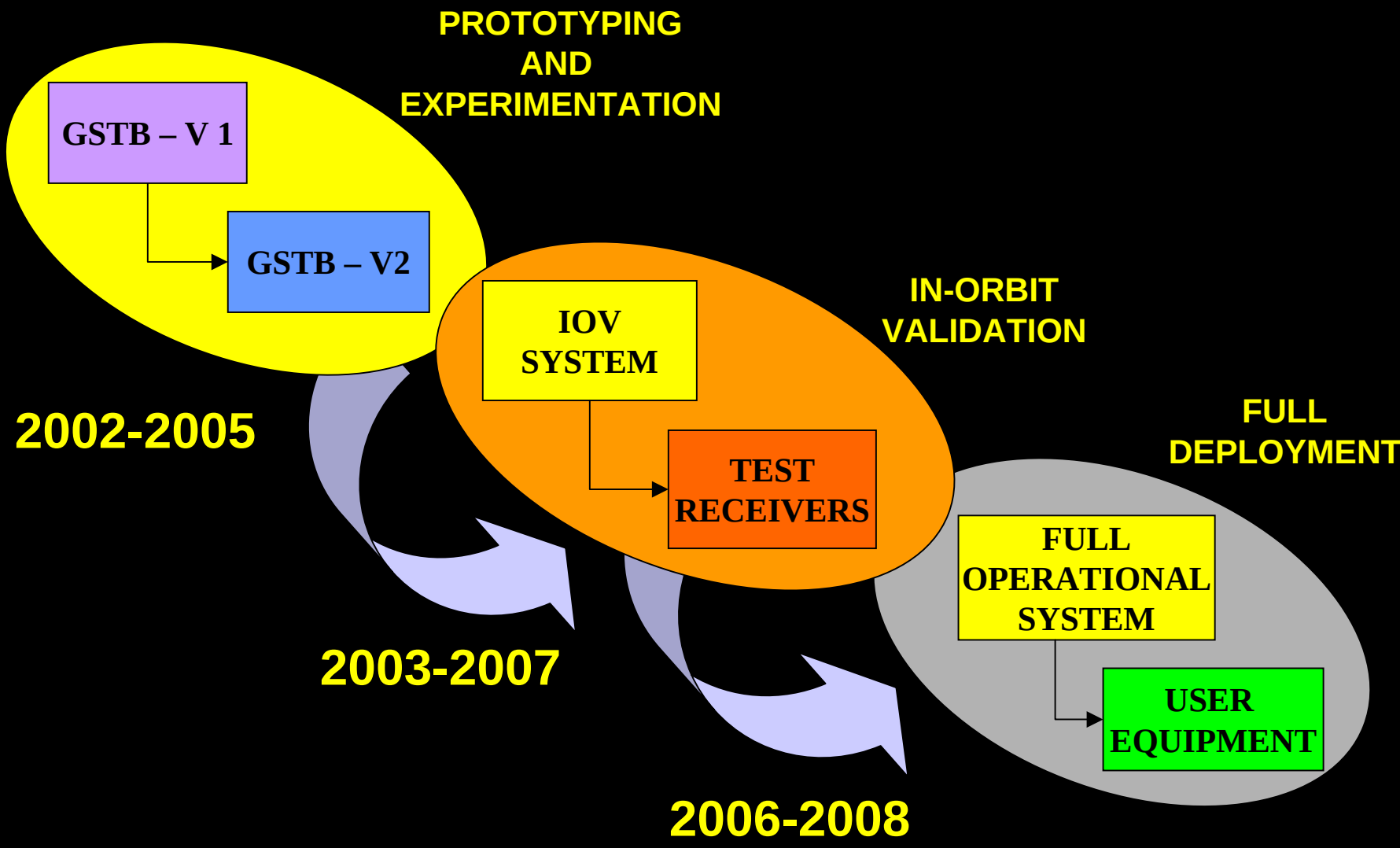
Integrity Determination



External Region Integrity Service



GALILEO Implementation Steps



Galileo Project Status

- **Critical technology developments completed*:***
  (i.e clocks Rubidium, H-Maser (1ns in 100min), Satellite Navigation Antenna, GSS Antennas, GSS Receiver PreDev, …)

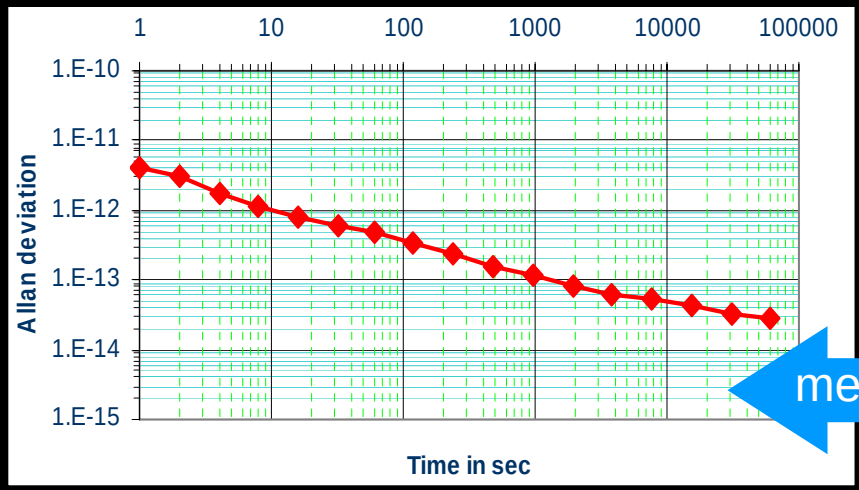
- **Galileo System Test-Bed (GSTB-V1) developed to experiment with Galileo-like processing algorithms based on GPS Observables. Six months of results.**

- **The GSTB-V2 development was Kicked-off in July 03**
  - Two experimental satellites under development.
  - First experimental satellite to be launched by end 2005.
  - The GSTB-V2 is planned to be operated for a period of two years after launch (2006 & 2007)

- **In-Orbit Validation Phase on-going.**

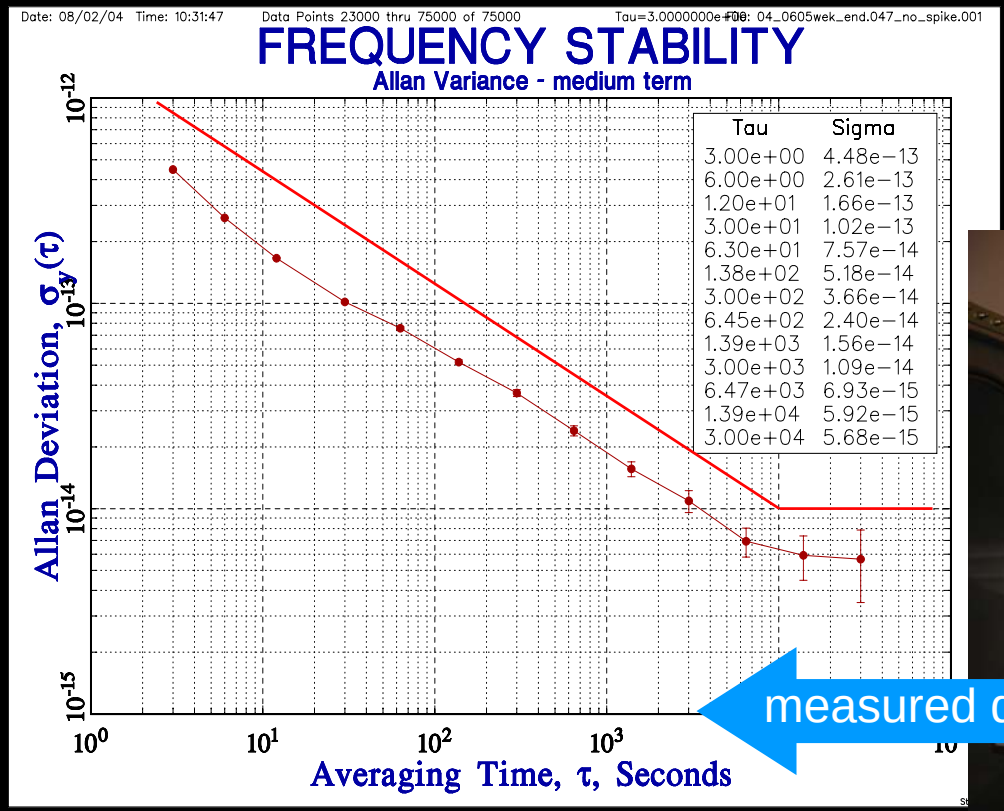
Rubidium Atomic Clock

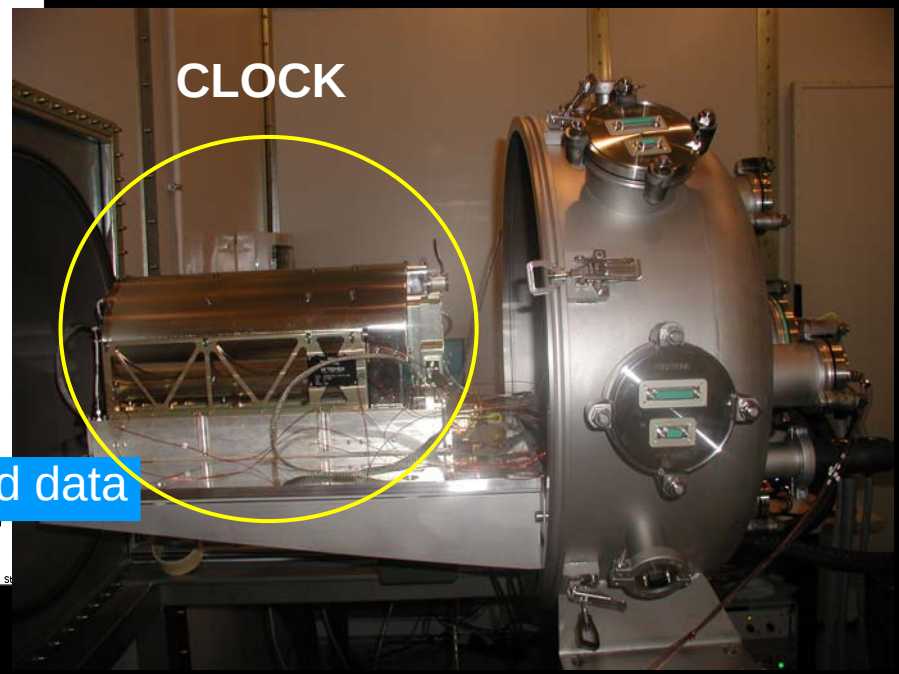
- weight and volume: 3.3 Kgs and 2.4 l.
- time stability: better than 10 nsec per day



measured data

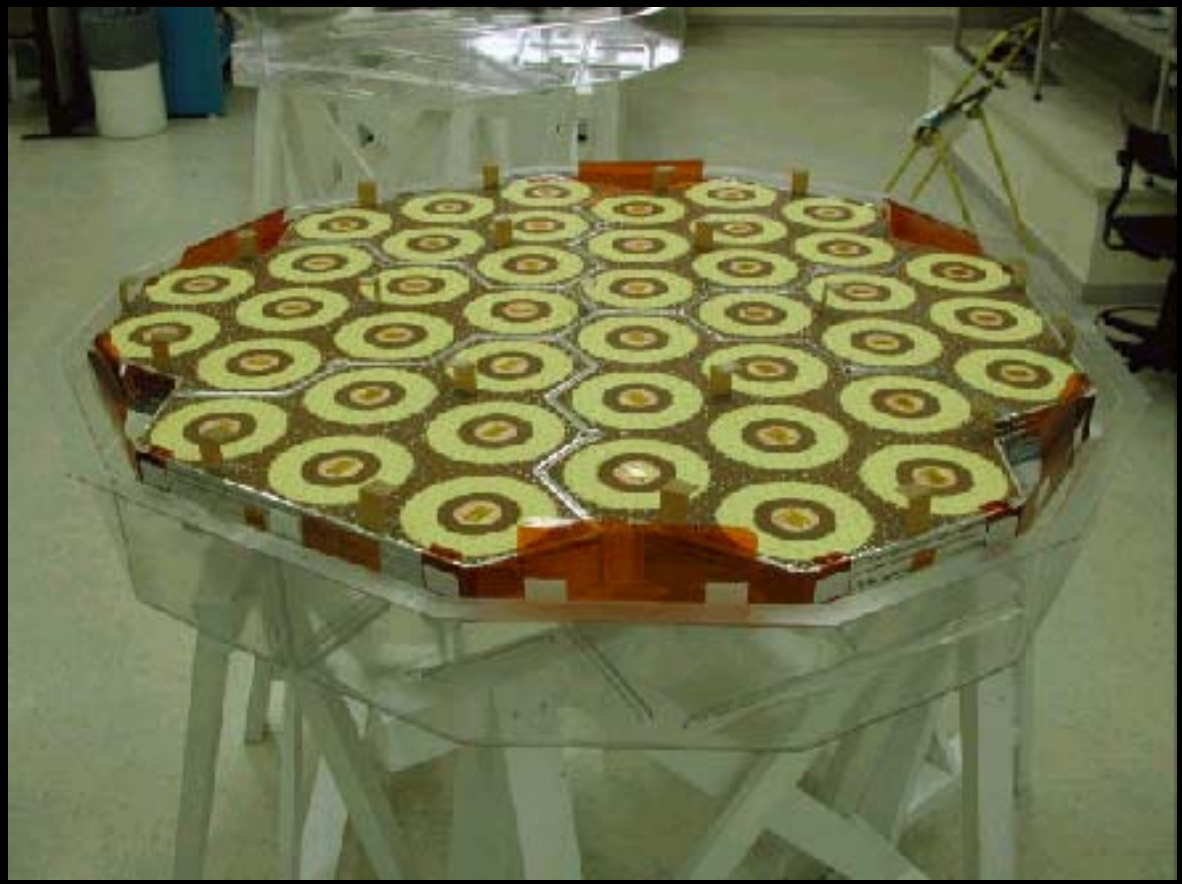
H-maser Atomic Clock





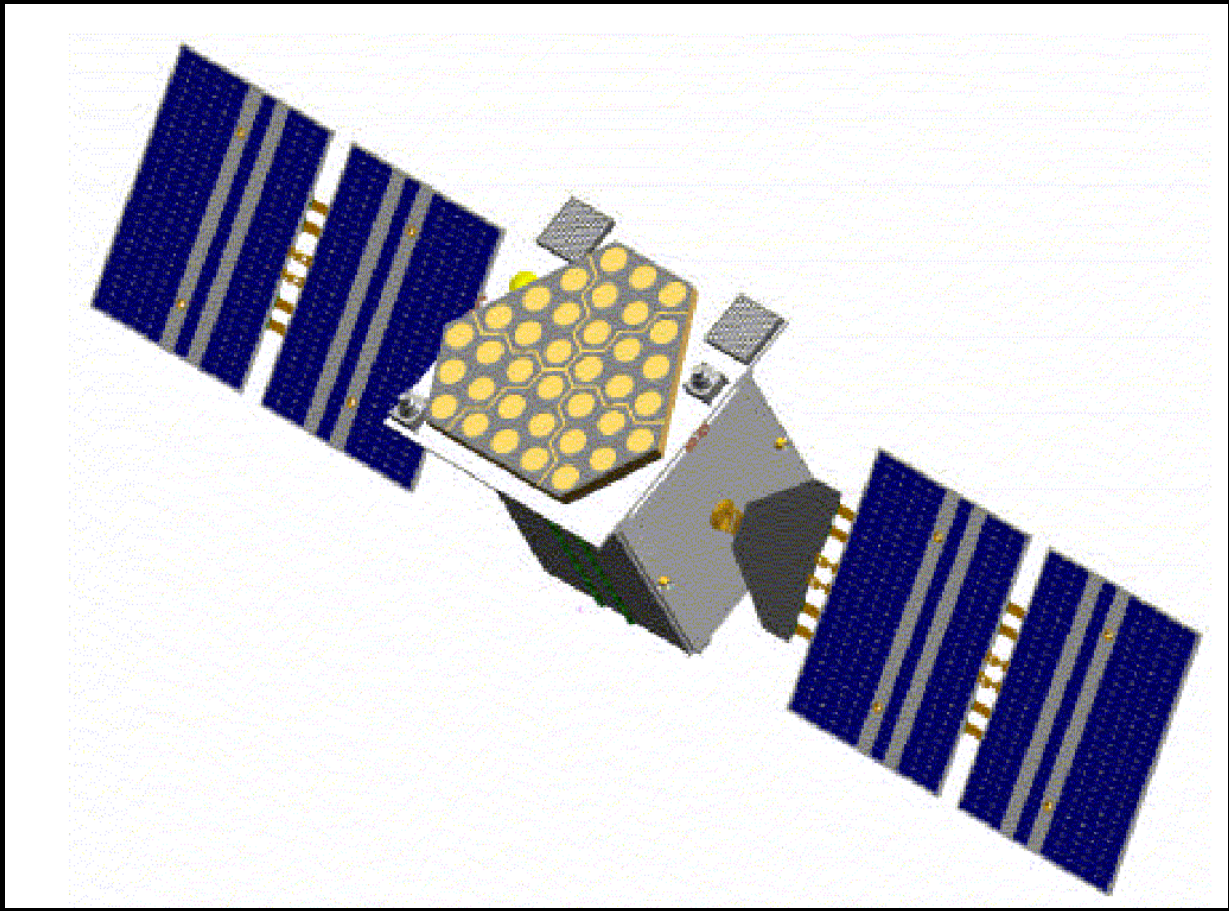
- weight and volume: 18 Kg and 45 l.
- time stability: better than 1 nsec per day.

Satellite Navigation Antenna



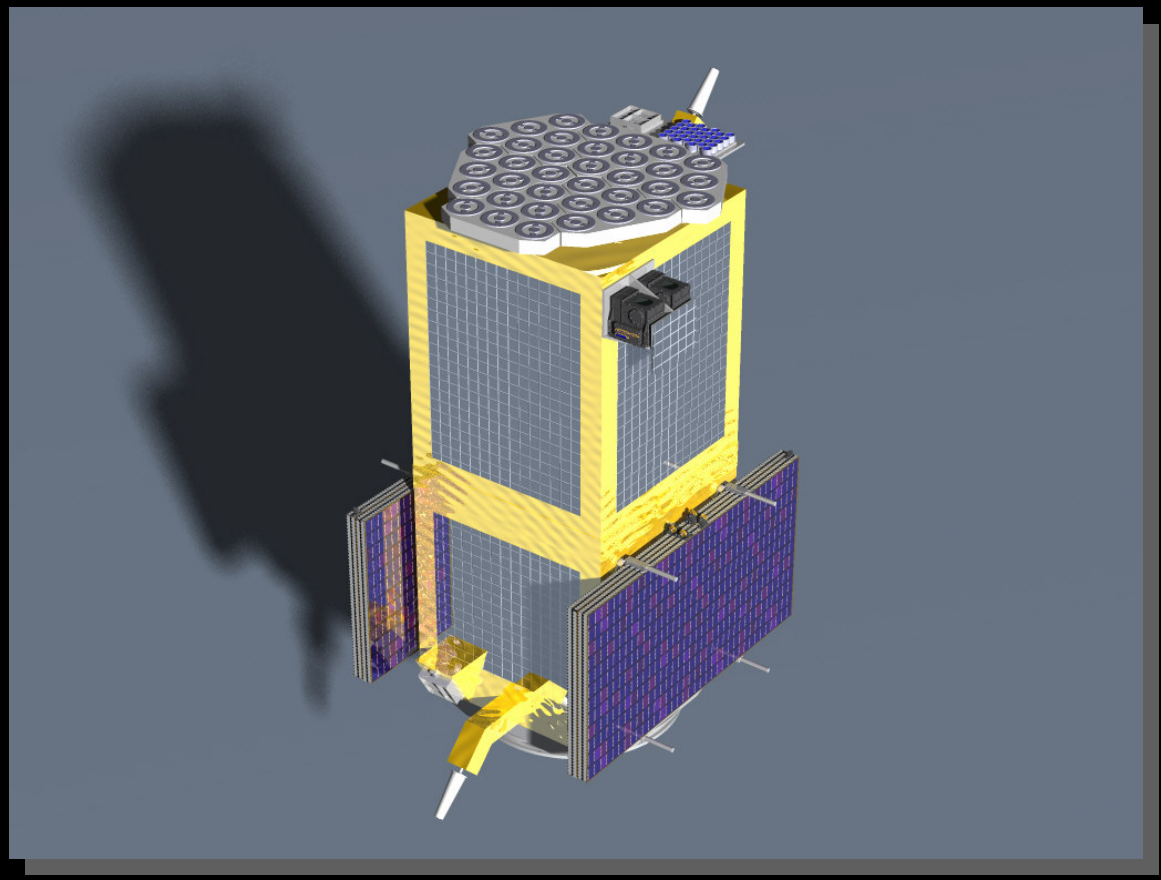
- Phase array.
- Isoflux pattern to equalize received power level on ground.
- Broadband frequency response to cover all the Galileo frequency bands with high performance

GSTB-v2 A Satellite (Surrey Satellite Technology Ltd)



- Lift-off mass 450 kg
- Power demand 660 W
- Stowed Dimensions 1.3 m x 1.74 m x 1.4 m

GSTB-v2 B Satellite (Galileo Industries)



- Lift-off mass 523 kg
- Power demand 943 W
- Stowed Dimensions: 0.955 m x 0.955 m x 2.4 m

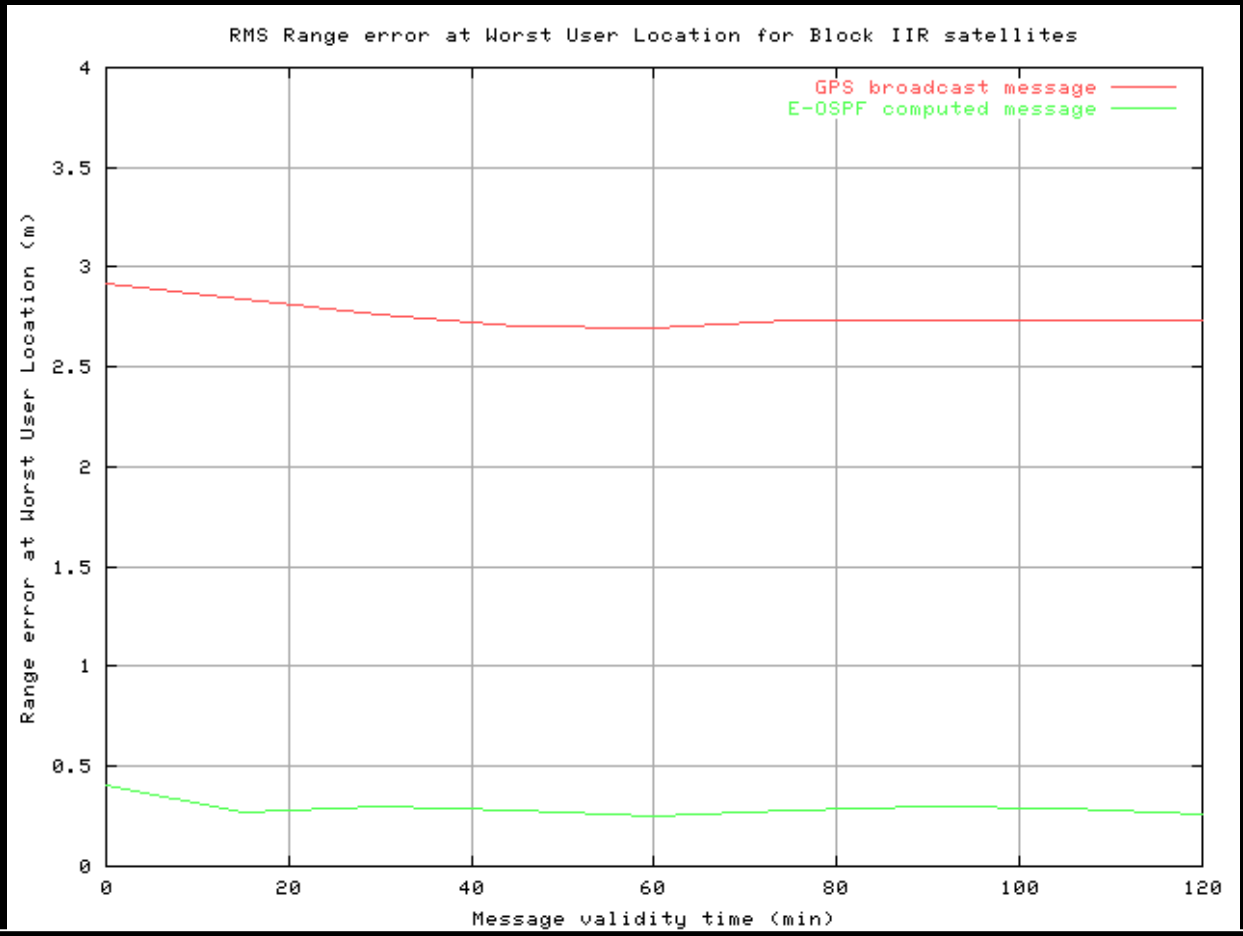
Experimental GroundSegment (GSTB-v1)

- **Galileo demanding performance require:**
  - Very precise satellite orbit prediction capability (65 cm).
  - Very precise satellite clock synchronization (1.5 nsec over 100 minutes)
  - Low integrity risk in detecting system failures (satellite or ground).
  - Overall high availability of service (99.5%)
- **Requires advanced ground segment processing algorithms.**
- **Algorithms being experimented today with GSTB-v1 using GPS signals and a dedicated network of GPS ground stations.**

GSTB-V1 Sensor Stations Network

The GALILEO network of reference stations will also be global.

GSTB-v1 Results: GPS Orbit and Clock Synchronization



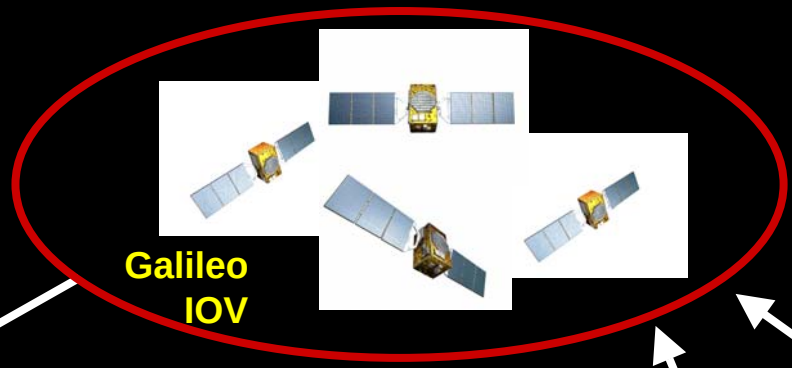
- **Contribution to range error due to orbit and clock erros.**
- **Comparison of the broadcasted GPS navigation msg with the E-OSPF computed one.**
- **Validity Time (2 hrs).**
- **Feasibility of meeting the GALILEO requirement (65 cm) proven.**

IOV Scope

- **IOV to address in full Galileo design and development (FOC technical requirements)**
  - GOAL:
    - qualification of space, ground and user segment through extensive test
    - Analysis of system performance with the view to refine the system prior to full system deployment
    - Verification of operational procedures
    - Deployment risk reduction
  - Based on manufacturing and deployment of a limited In-Orbit-Validation (IOV) System Configuration:
    - 1 experimental satellite (GSTB-V2) (early version of operational IOV Sat.)
    - 3-4 operation satellites (considered minimum number required)
    - Associated ground (20 GSS, 5 ULS, 2 TTC, 1 GCC) and test user segment

- **IOV Transition to FOC**
  - by recurring manufacturing / deployment / integration of IOV system components

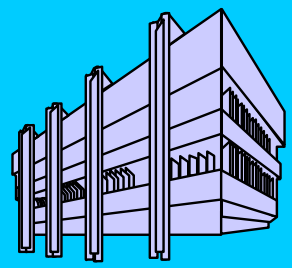
IOV System Configuration



3 to 4 SV's

Galileo Sensor Stations Global Coveragea

18 to 20 Galileo Sensor Stations (worldwide



Control Centre (1 site)

3 ULS Global

2 ULS/TTC Global

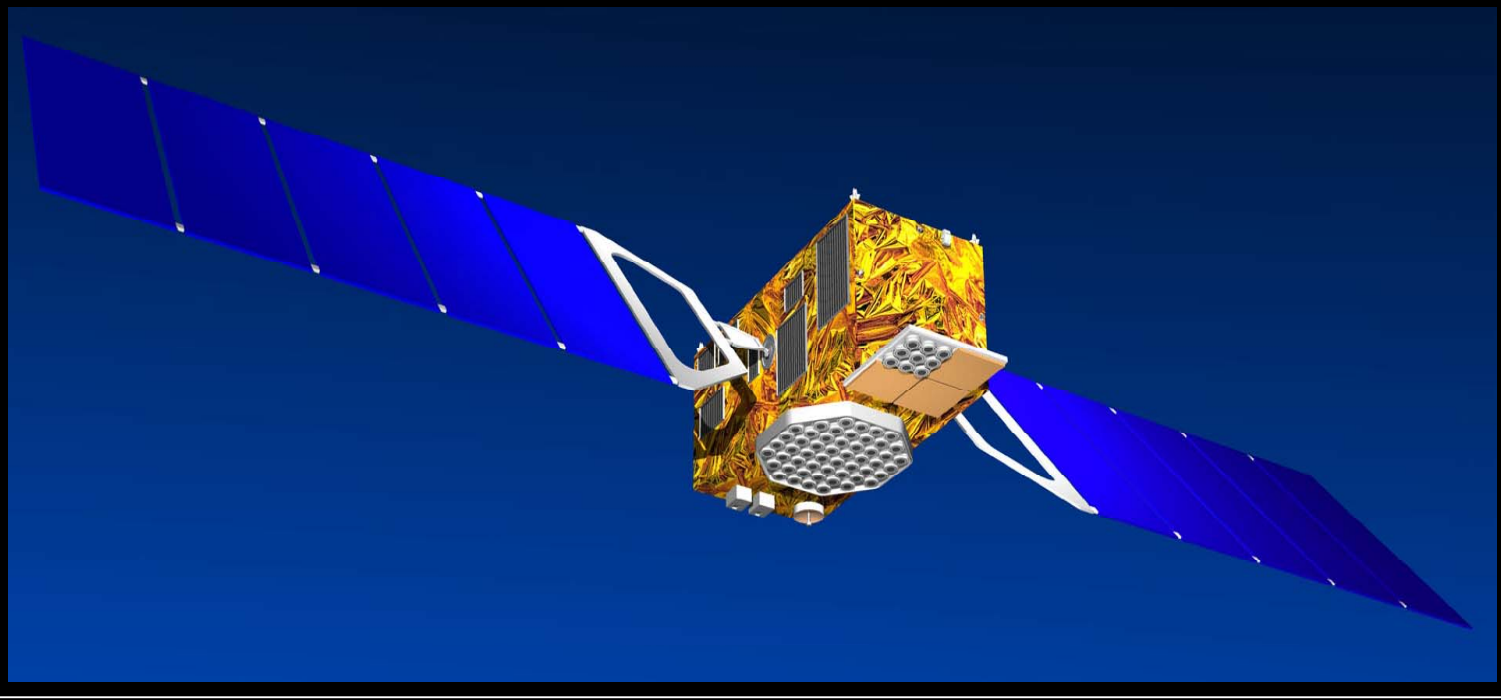
(collocated ULS/TTC at the same sites)

Galileo IOV Spacecraft

- Overall Spacecraft: 680 Kg / 1.6 kW class
- Launcher Options: Ariane, Proton, Soyuz, Zenit

- Navigation payload: 115 Kg / 780 W
- SAR transponder: appr. 20 kg / 100 W

- Dimensions: 2.7 x 1.2 x 1.1 m3



Further information

- Further information is available on the following websites:

  http://europa.eu.int/comm/dgs/energy_transport/galileo

  http://www.esa.int/export/esaSA/navigation.html

- Further information on the Joint Undertaking:

  http://www.galileoju.com