



European Geostationary Navigation Overlay Service

The European EGNOS System:

Status, performances, information to users and Evolution Plans

*Presented by: Dr J. Ventura-Traveset
Head of EGNOS Mission and System Evolution Section
European Space Agency (ESA), EGNOS Project Office*

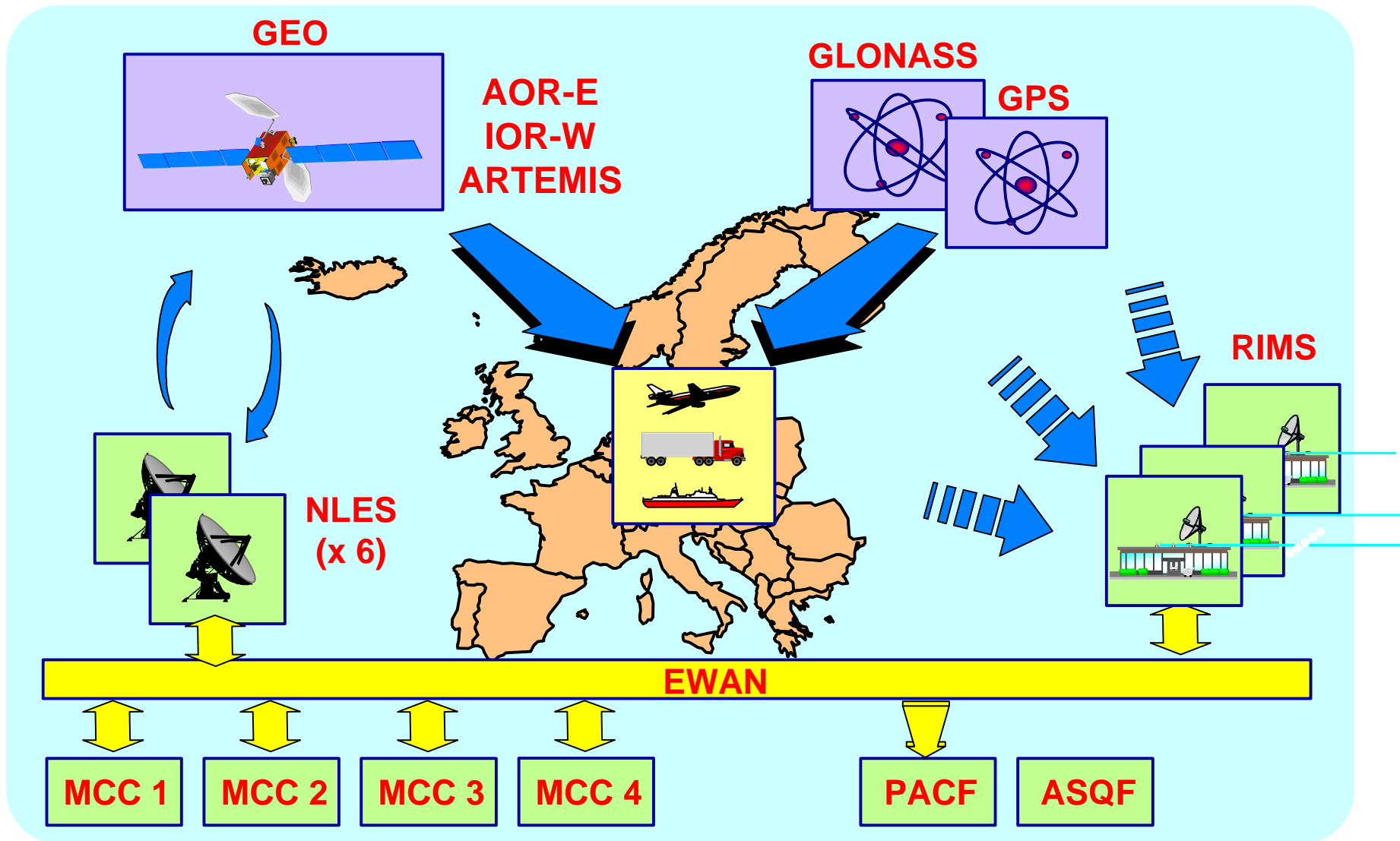


European Space Agency

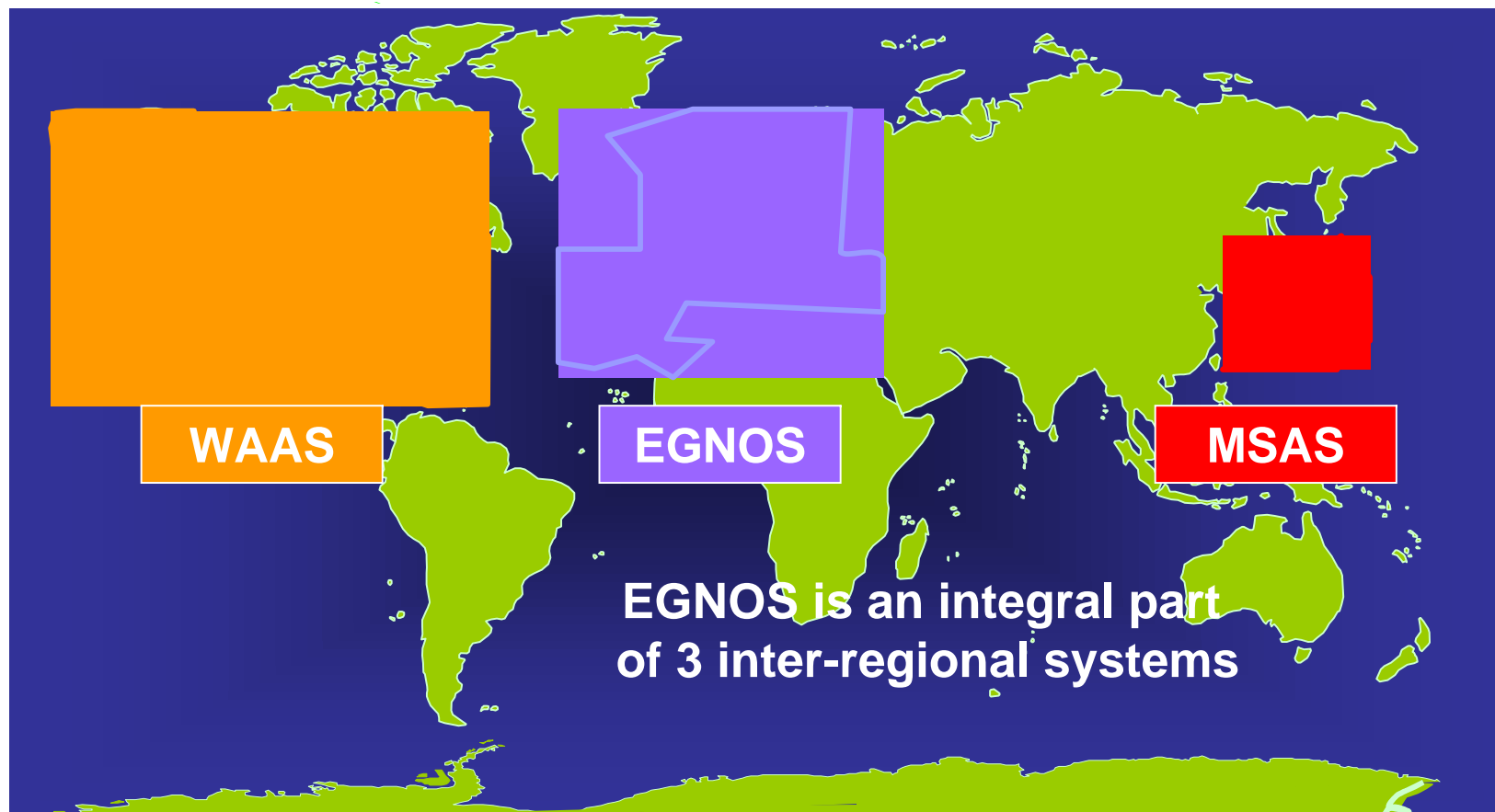
Outline

- EGNOS Status and performance Summary
- Technical Information to Users
- EGNOS Evolution Plans
- Information on EGNOS Test bed Status
- Issues for assessment with Receiver Manufacturers

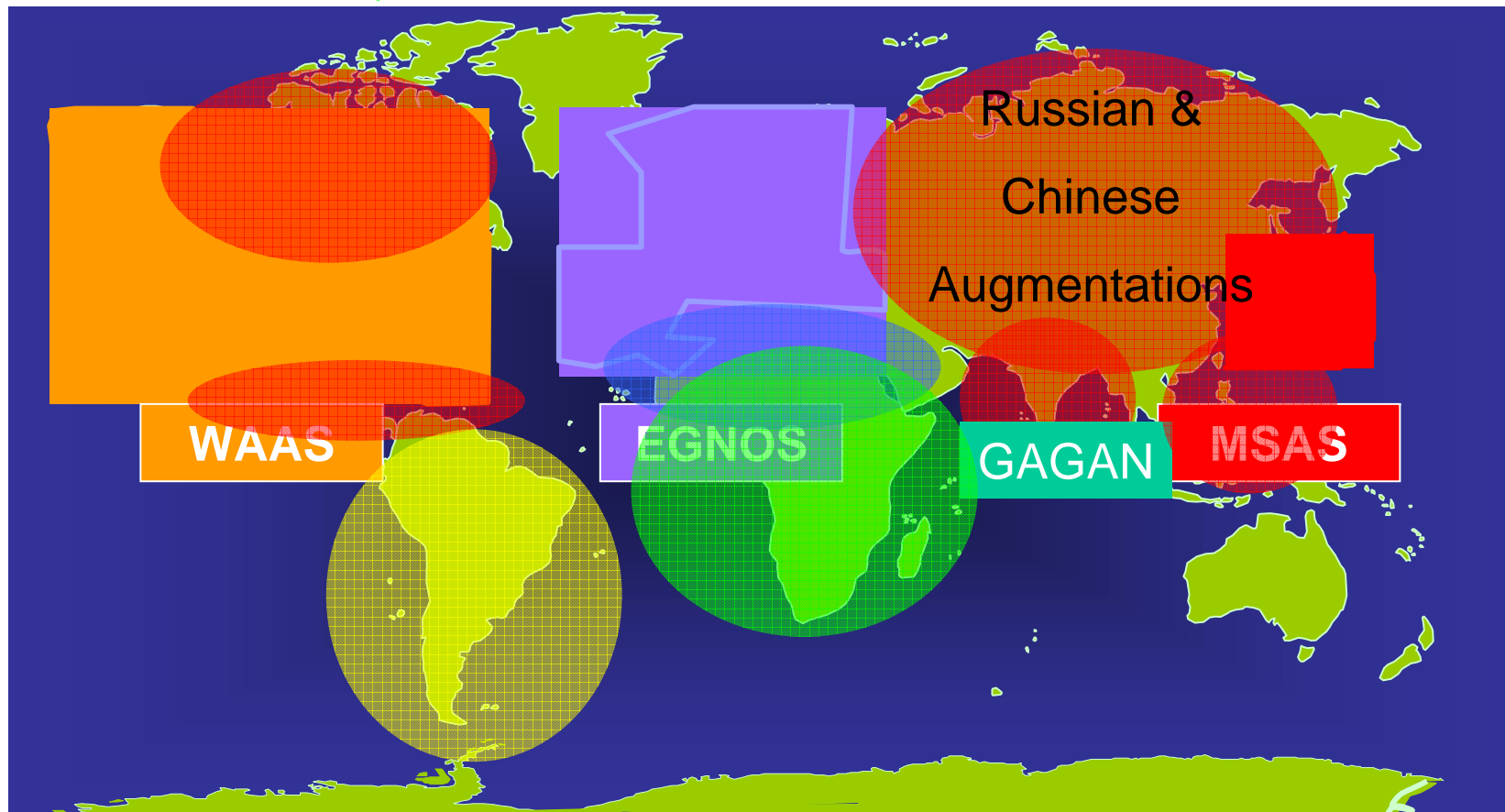
EGNOS: The European SBAS



SBAS: A worldwide Initiative Today and ...



... in the mid-term future .



EGNOS Technical Qualification and EGNOS Initial operations

- All Sub-systems deployed and under initial operations.
- The EGNOS formal qualification process (ORR) was held May/June 2005. A thorough review with more than 60 peers, including external Civil Aviation experts, GJU and Eurocontrol reviewers. A **formal Board** held on 16 June 2005 concluding:

- **EGNOS Technical qualification is successful, subject to the completion of review actions and recommendations**
- **EGNOS AOC requirements have been verified and are largely met**
- **the system is ready to enter into Initial Operations as EGNOS V1.0**

EGNOS NEWS
Volume 4, Issue 1, 2004

Editorial

Welcome to our new look EGNOS News heralding the transition from EGNOS System Test Bed to EGNOS. These are exciting times for all of us as we are approaching the end of the EGNOS development phase. In "Countdown to EGNOS" we are giving you an important update on the deployment status and initial performance, as well as giving you a feel for the plans for Operational Readiness Review and operations. One of ESA's great successes has been bringing the Artemis satellite on-line following its launch malfunction. Even better news for us, however, are the results of the first performance tests that we have been conducting for EGNOS. EGNOS promises to deliver real operational benefits for users.

In this issue we are also bringing you news of two interesting EGNOS applications. The first, Active Road Management Assisted by Satellites (ARMAAS) aims to improve safety, increase traffic management and provide an electronic fee collection mechanism. It is currently being tested in Lisbon. The second, Common Agriculture Policy (CAP) fraud monitoring is using EGNOS to measure field areas.

We are looking forward to hearing what you are planning to do with EGNOS at the GNSS2004 conference. Please contact us at the EGNOS helpline - we are always interested to see how we can improve the service.

Contents

- Countdown to EGNOS
- Artemis - a success story for EGNOS
- News from Brussels
- Road management in Lisbon
- Monitoring CAP fraud
- Frequently asked questions
- Forthcoming events

Countdown to EGNOS

The countdown to EGNOS is progressing well. In this article we present the deployment status, give you early performance results, talk about the route to the Operational Readiness Review (ORR) and conclude by looking ahead to EGNOS operations.

Deployment Status

The deployment of the EGNOS infrastructure is moving swiftly. At the time of writing:

- all the Master Control Centres (MCC) have been deployed;
- five of the six Navigation Land Earth Stations (NLES) have been deployed with Torrejón due for completion shortly;
- 30 of the 34 RIMS have been deployed with only Golbaei, El Daba, Nouakchott and Bangalore pending and
- both support facilities have been deployed.

Finally, all three EGNOS Geostationary satellite links' transmissions (Inmarsat, IOR-W, ACR-E, and ESA's Artemis satellite) have been tested successfully during this period. This remarkable effort will allow EGNOS to deliver its SIS-2 performance in June/July - a major final step before the Operational Readiness Review (ORR).

Performance

Our first EGNOS performance results based on SIS-1 (16 RIMS, 1 MCC, 1 NLES and 1 GEO) are very encouraging.

Together with our IMAGE (Independent Monitoring Assessment of GNSS signal-in-space Emission) partners, we have measured accuracies of 1-2m (95%) horizontal, and 1-2 m (95%) vertical. These are far better than the 7.7 m (95%) specified and are a testament to all who have been involved in the EGNOS development.

With this limited SIS-1 RIMS configuration, we have also measured APV performance in the centre of Europe, already very similar to those obtained with the operational US Wide Area Augmentation System (WAAS).

Most recently (April 23, 2004) we have also measured EGNOS performance with up to 28 RIMS. The results are excellent with accuracies better than 1m in several sites and APV availabilities of the order of 100%, while at the same time we measured very comfortable safety margins.

Our next step in June/July 2004 is to assess long-term performance using the complete SIS-2 configuration. We are expecting to consolidate and improve on the current encouraging results and to realise the final performance that we are expecting from the operational EGNOS system.

Deployed Infrastructure - April 2004

EGNOS Initial Operations

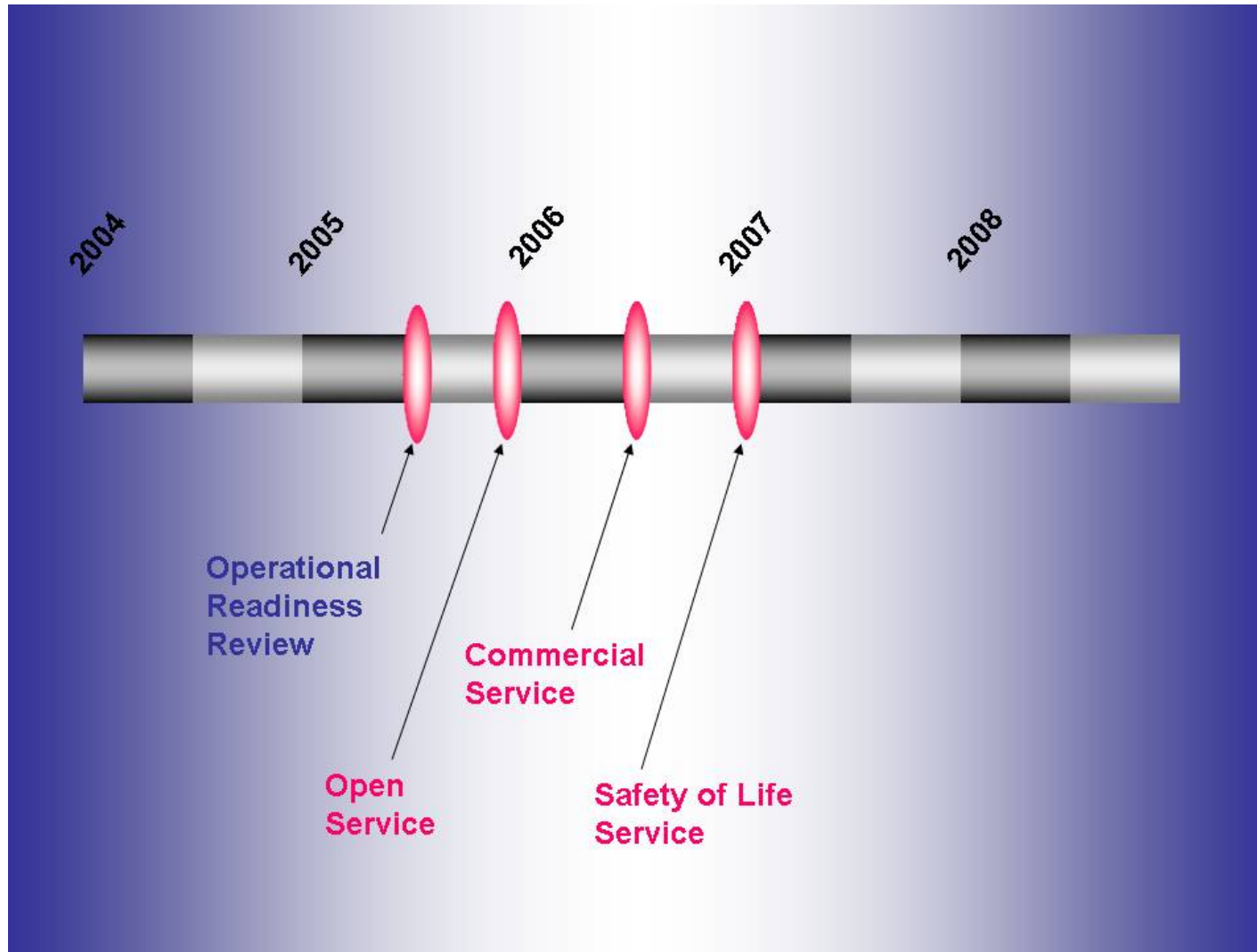
- *EGNOS Initial operations kicked-off under Contract with ESSP on July 2005. EGNOS shall reach Initial operational stabilisation in January 2006.*

- *EGNOS GEO Transmissions today:*
 - **PRN 124:** *EGNOS initial operations (ESSP Contractor)*
 - **PRN 126** *EGNOS Industry Contractor: implementing some post-ORR complementary tests*
 - **PRN 120:** *EGNOS Test bed transmission maintained until EGNOS operations are stabilised (6 months). Under ESA direct control.*

EGNOS Disclaimer

- ❖ At this moment the EGNOS SIS is currently provided without any warranties. The use of the EGNOS SIS is at the user's own risk. The EGNOS SIS is provided for test purposes without any warranties regarding availability, continuity, accuracy, reliability, fitness for a particular purpose or meeting the users' requirements.

EGNOS Planned Services



Precise dates to be decided by the European Commission with GJU/GSA

EGNOS Accuracy measured performances during the EGNOS qualification campaign

Example: Accuracy (in meters) measured on 22 February at 9 locations (*)

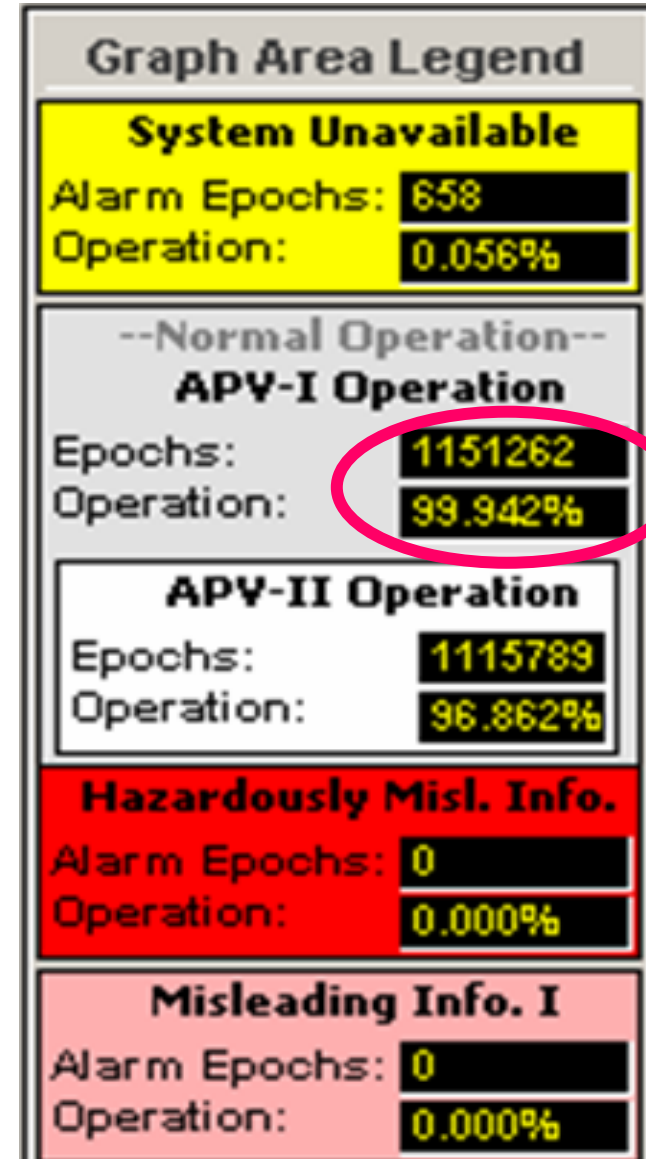
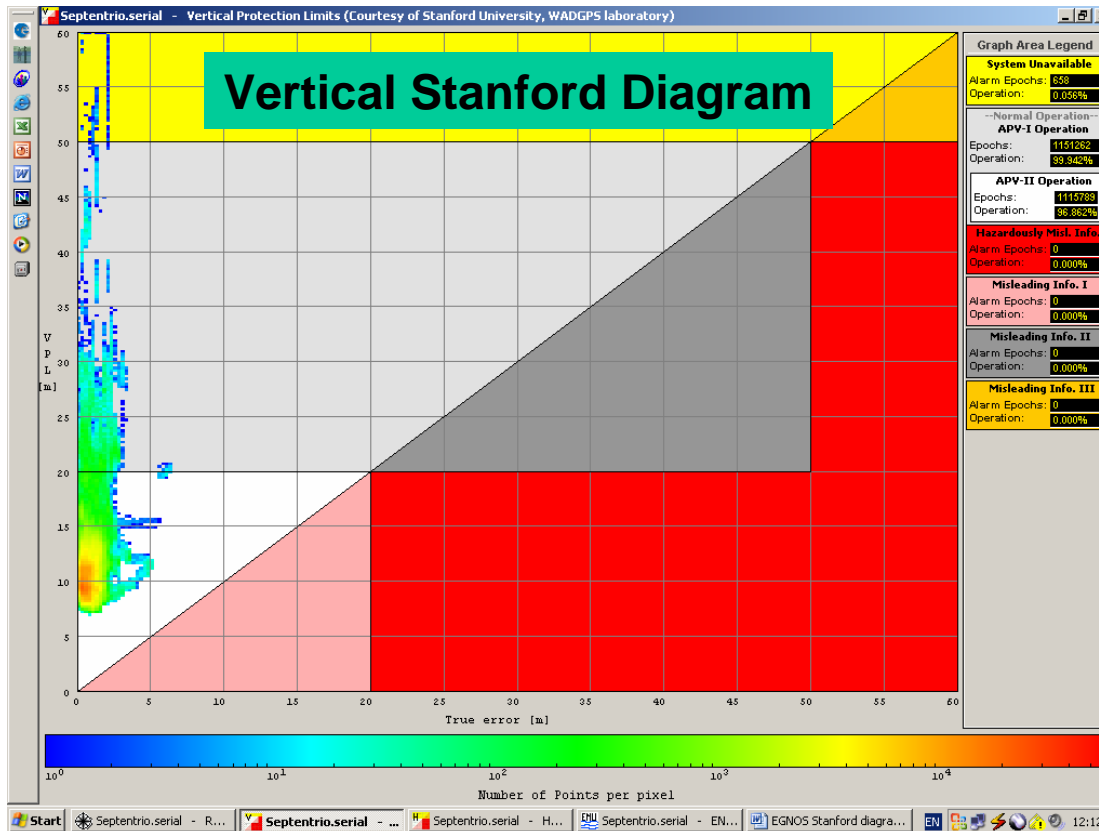
Place	Paris	Toulouse	Madrid	Brussels	Geneve	Palma de Mallorca	Lisbon	Cork	Berlin
HNSE (95%)	1.0	1.0	1.1	0.8	0.9	1.1	1.1	1.3	1.1
VNSE (95%)	1.3	1.6	1.4	1.6	1.5	1.5	1.7	1.9	1.6

HNSE (95%) 0.8-1.5 m (where within 1-3 meters expected)
 VNSE (95%) around 1.3-2.0 m (well within 2-4 meters expected)

(*) inputs provided during ESA IMAGE Workshop by different partners

Cumulative SIS-2 perf. measured at ESA/EPO In Toulouse

ESA – Toulouse: more than one million samples recorded from the 11th to the 25th February 2005

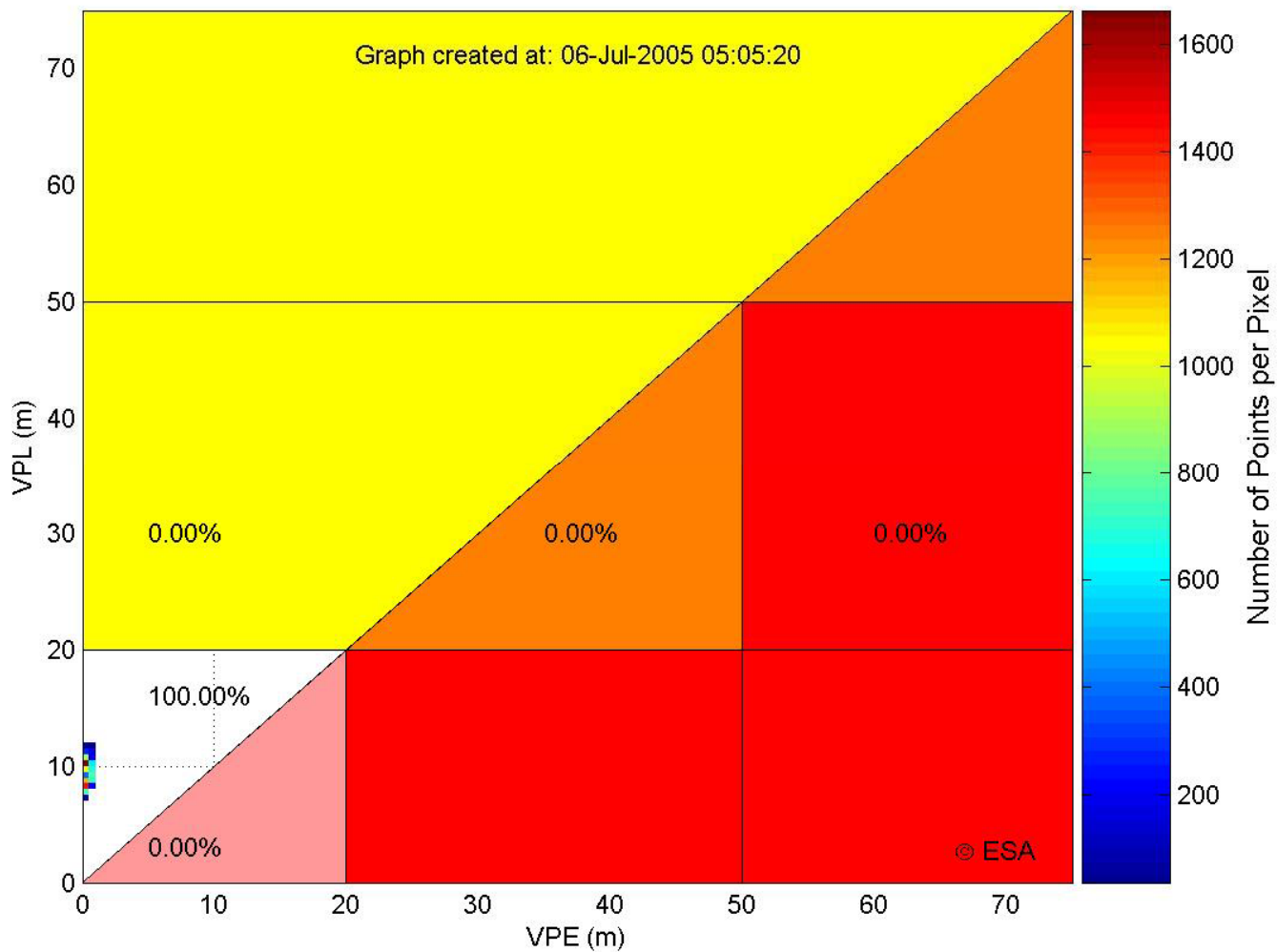


Integrity

- No single MI event in user domain at any location in Europe (over 20.000.0000 samples analysed)
- Comfortable safety margins;
- No pseudorange underbound events;
- Results of deployed system in line to factory results at user and pseudorange level.
- **Note:** Complementary performance analysis performed for October 2003 storm (“worst” day of last IONO solar cycle) showing excellent results (dedicated presentation).

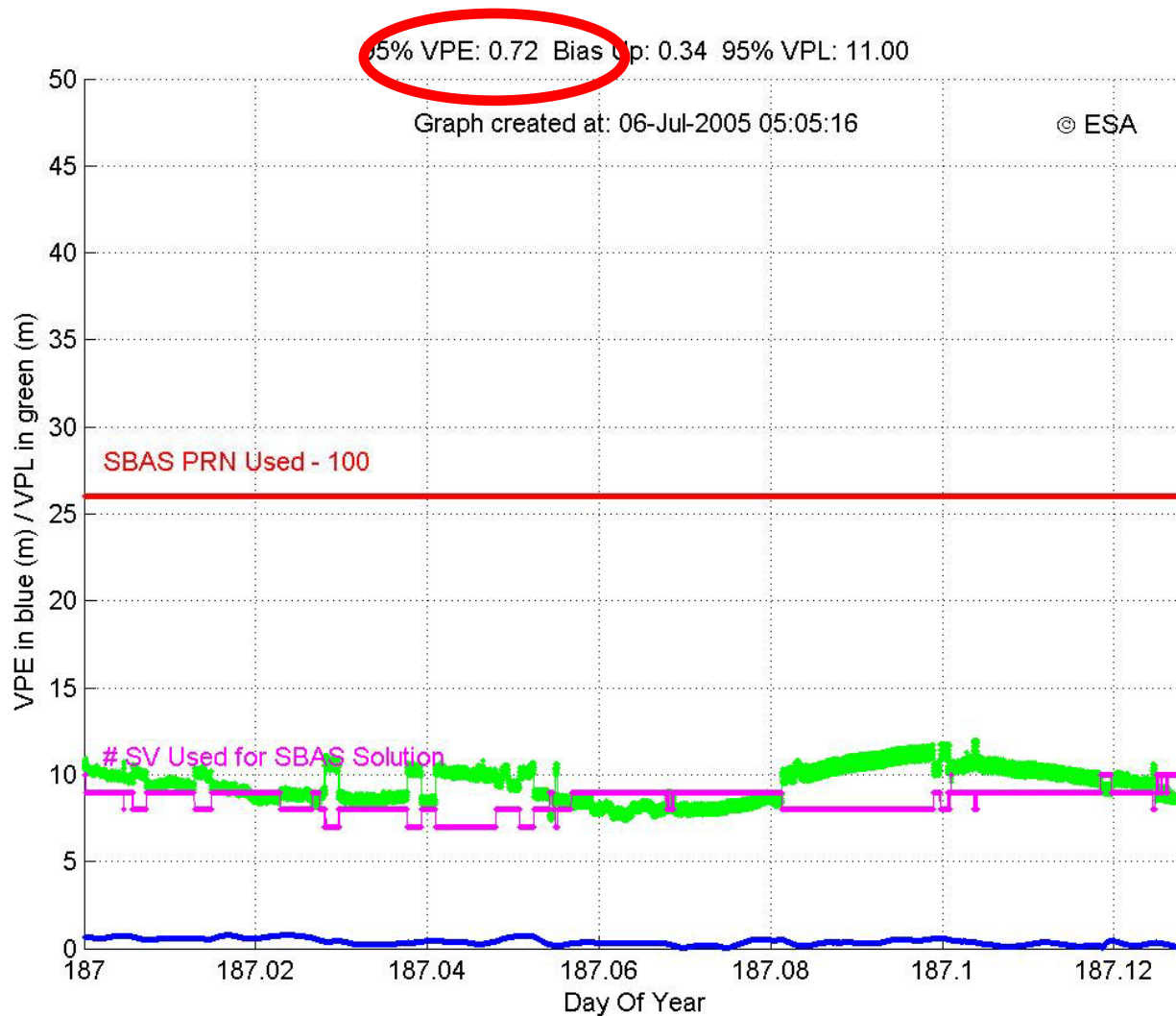
Performance measured July 6, 2005, PRN 126, ESA/ESTEC The Netherlands

Avail. APV-I: 1.000 Avail. APV-II: 1.000 # Samples: 11037





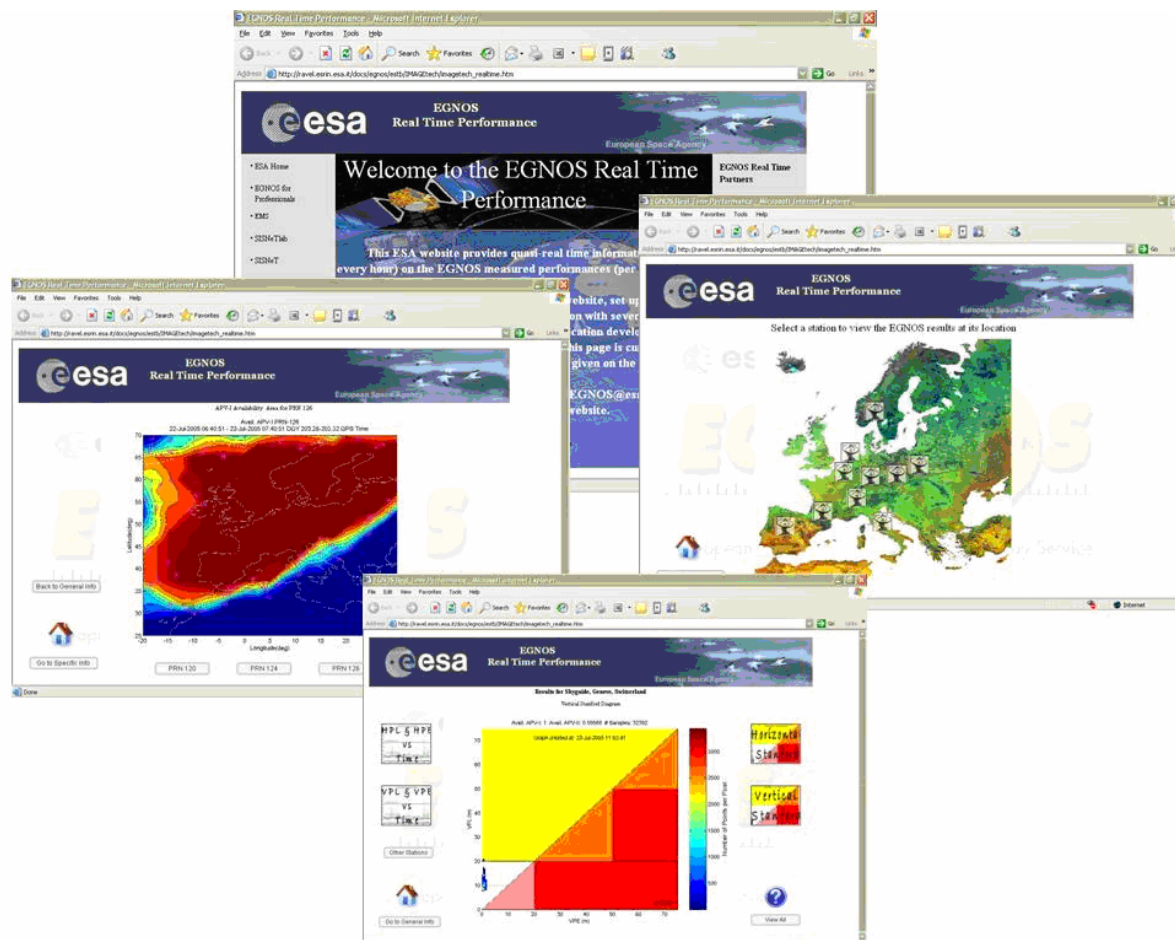
Performance measured July 6, 2005, PRN 126, ESA/ESTEC The Netherlands



Outline

- EGNOS Status and performance Summary
- Technical Information to Users
- EGNOS Evolution Plans
- Information on EGNOS Test bed Status
- Issues for assessment with Receiver Manufacturers

Experimental ESA Real time performance website



- Aiming at supporting applications ESA has created an EGNOS Real Time Performance website www.esa.int/navigation/egnos-pro

The EGNOS Technical User Interface Document

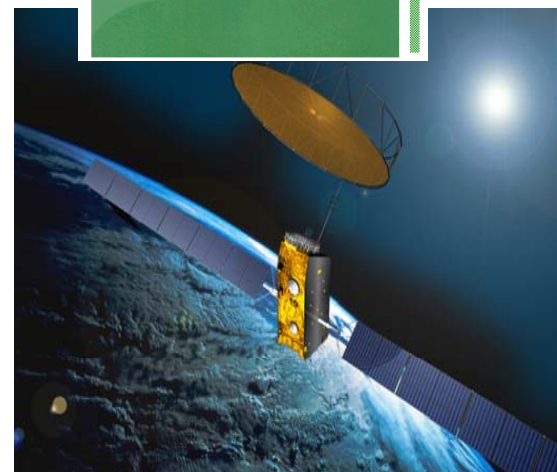
EGNOS UID

Outline

- EGNOS Status and performance Summary
- Technical Information to Users
- EGNOS Evolution Plans
- Information on EGNOS Test bed Status
- Issues for assessment with Receiver Manufacturers

In parallel to the start of EGNOS operations, EGNOS needs to respond positively to the dynamic GNSS environment

- GNSS environment has changed significantly:
 1. Galileo programme (EGNOS integration concept)
 2. GPS Modernisation program (IIR-M, IIF)
 3. Glonass modernisation programme
 4. New L1/L5 GEOs
 5. Export opportunities for SBAS technology
 6. GPS/SBAS L5 standardisation work
 7. WAAS Modernisation program launched
- EGNOS provides the best SBAS performances worldwide today. This European excellence needs to be maintained.
- It is key to modernise EGNOS without disturbing nominal operations and service provision which need to proceed (similar to WAAS Approach).
- EGNOS V2 and V3 concepts. Definition study launched by ESA in June 7, 2005 with EGNOS Industry consortium.

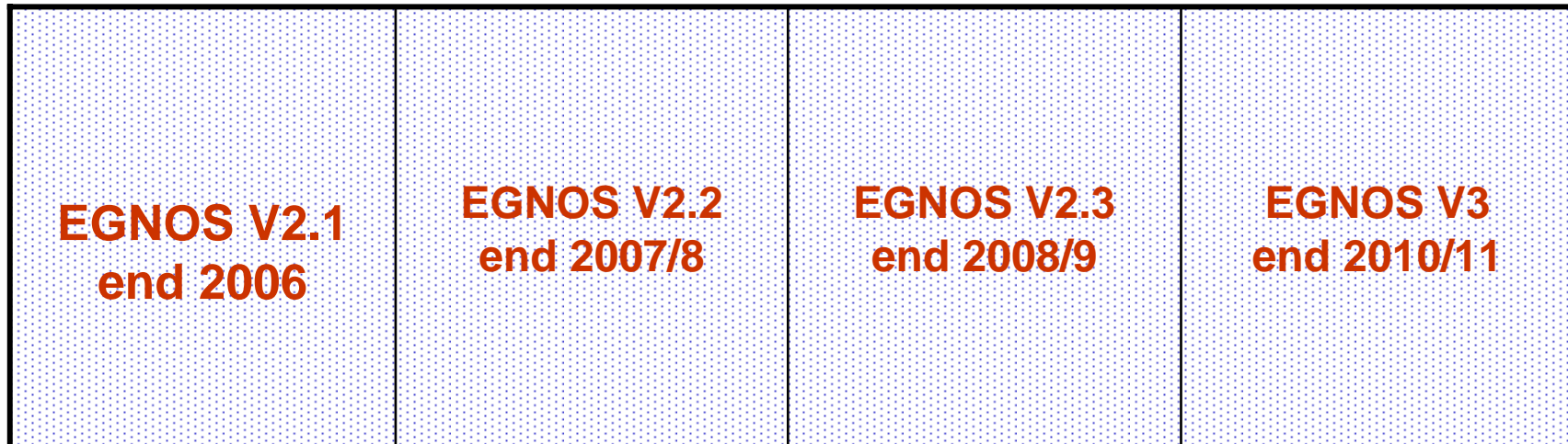




EGNOS V2 and V3 versions conceived in 2006-2010

STEP 1

STEP 2 : EGNOS Evolution Programme



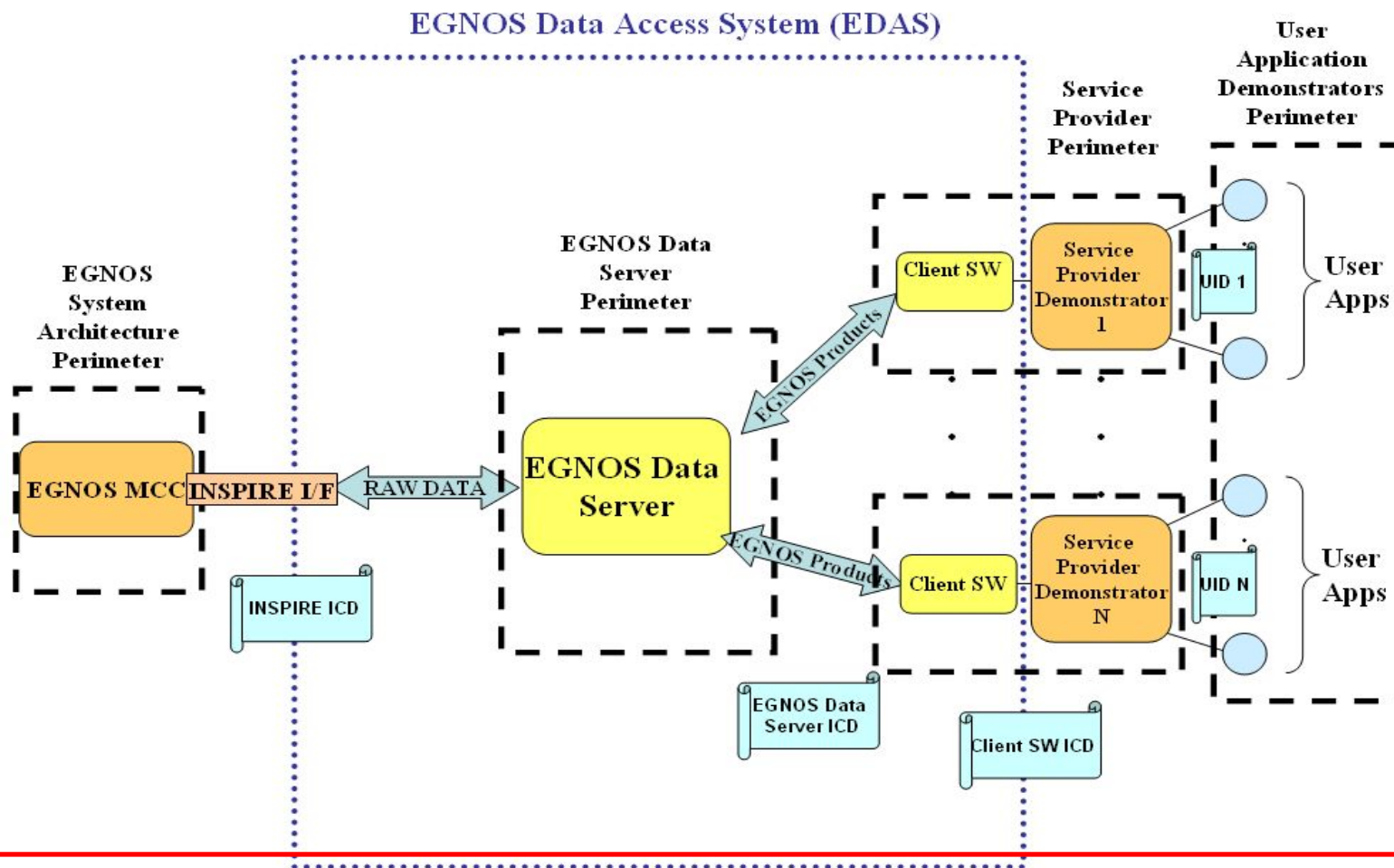
Proposed EGNOS core Infrastructure Evolution Plan focuses on user-beneficial functional evolutions

STEP 1

STEP 2: EGNOS Evolution Programme

EGNOS V2.1 in 2006	EGNOS V2.2 in 2007/8	EGNOS V2.3 in 2008/9	EGNOS V3 in 2010/11
<p>EGNOS Data Server</p> <p>Extension to MEDA Region</p> <p>Critical technologies assessment</p> <p>Consolidation of EGNOS Infrastructure Evolution Plan</p>	<p>Regional Extension Module (REM) concept</p> <p>Extension in Africa</p> <p>ESA ALIVE concept</p>	<p>L5 Message standards and initial L5 GEO broadcast</p> <p>GPSL1/L5/Galileo /Glonass enhanced RIMS receivers</p>	<p>MRS Concept (Multi-constellation Regional System)</p> <ul style="list-style-type: none"> ➤ GPS L5 augmentation Service ➤ Galileo Augmentation (TBC) ➤ Glonass modernisation augmentation (TBC)

EGNOS Data Server Concept

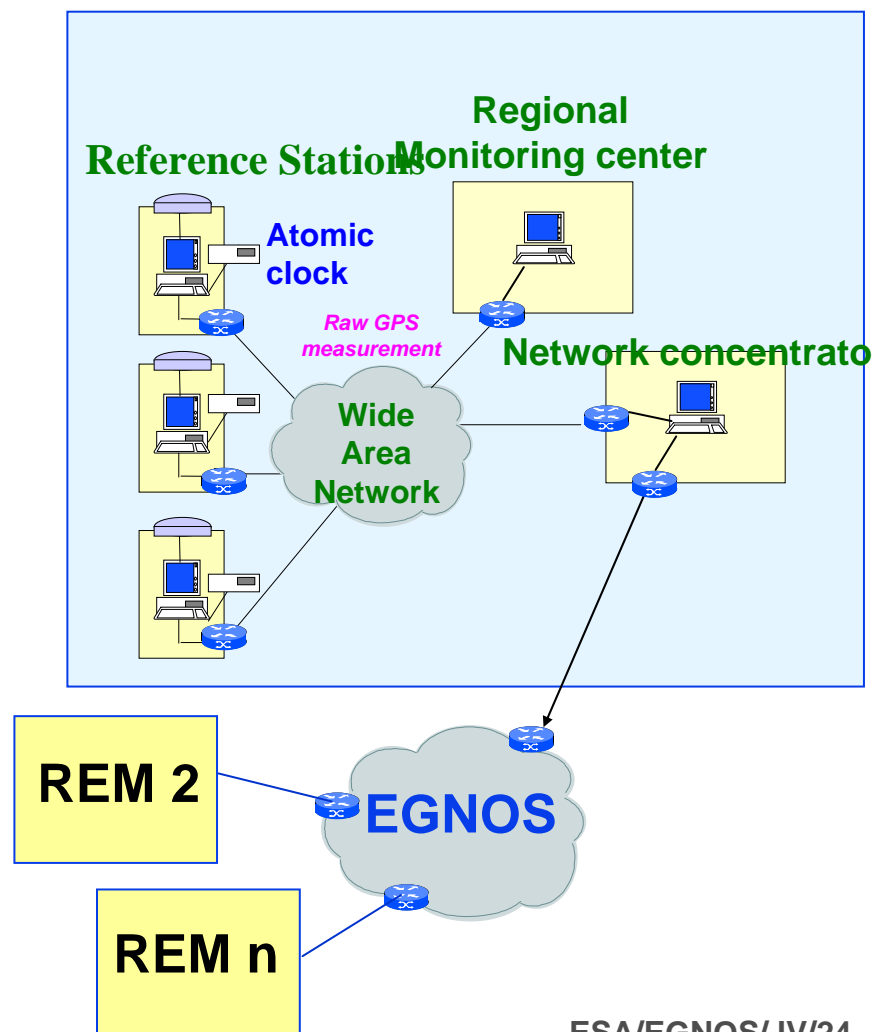


Access to EGNOS RIMS and EGNOS Message data in Real time.
 Highly enhances EGNOS Multi-modal capabilities: EGNOS broadcast through Internet (SISNET), RTCM, RDS, DAB, WARTK, etc

EGNOS V2.2: Regional Extension Module Concept

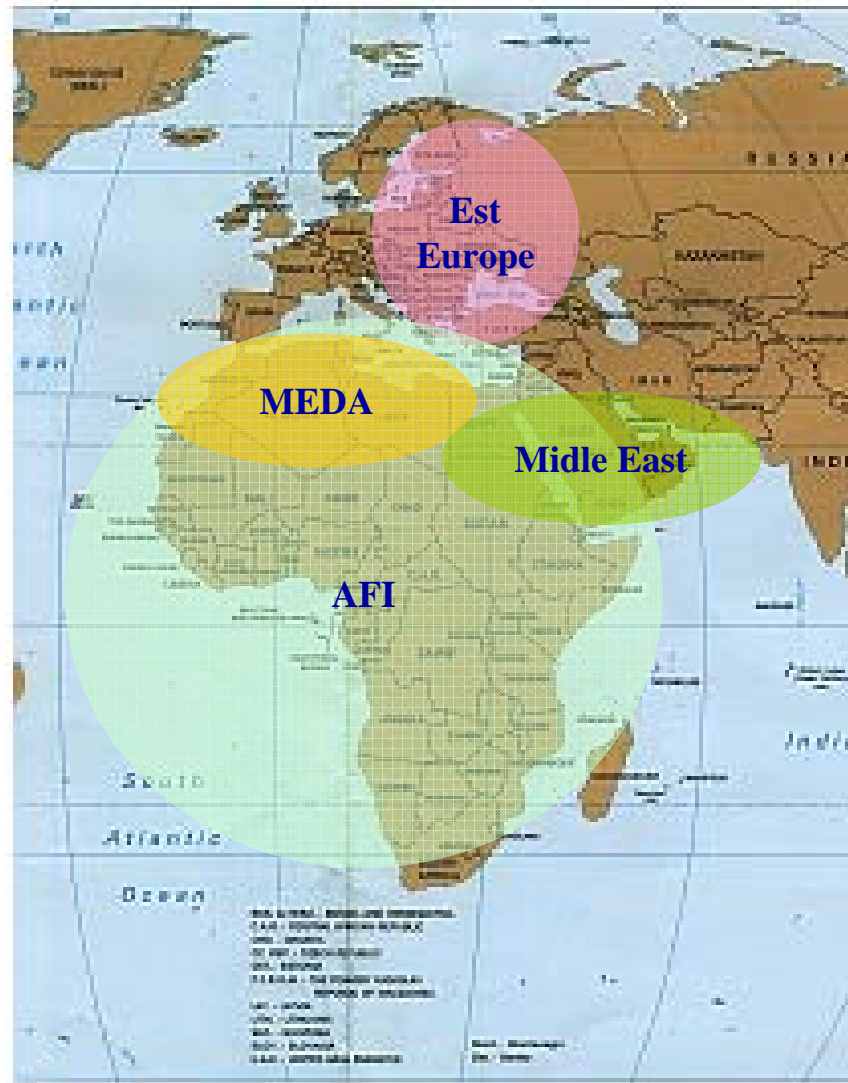
- **Regional Extension Module concept should allow:**
 - EGNOS extensions to be based as much as possible on **recurrent** extension design concept
 - **Extension in steps** through connection of several REM unit: controlled system scalability
 - Provide **operational autonomy** to the extended region
 - **Clean & simple interfaces** with EGNOS Core system for extended region
 - **No degradation in EGNOS ECAC** in case REM remote problem
- **Concept currently assessed as part of EGNOS Definition Phase.**
- **First instantiation: Africa extension (3 to 4 REM modules)**

Regional Extension Module





Potential EGNOS Extension areas



EGNOS V2.2: ESA ALIVE concept: provision of Disaster Alert messages through SBAS services (1/3)

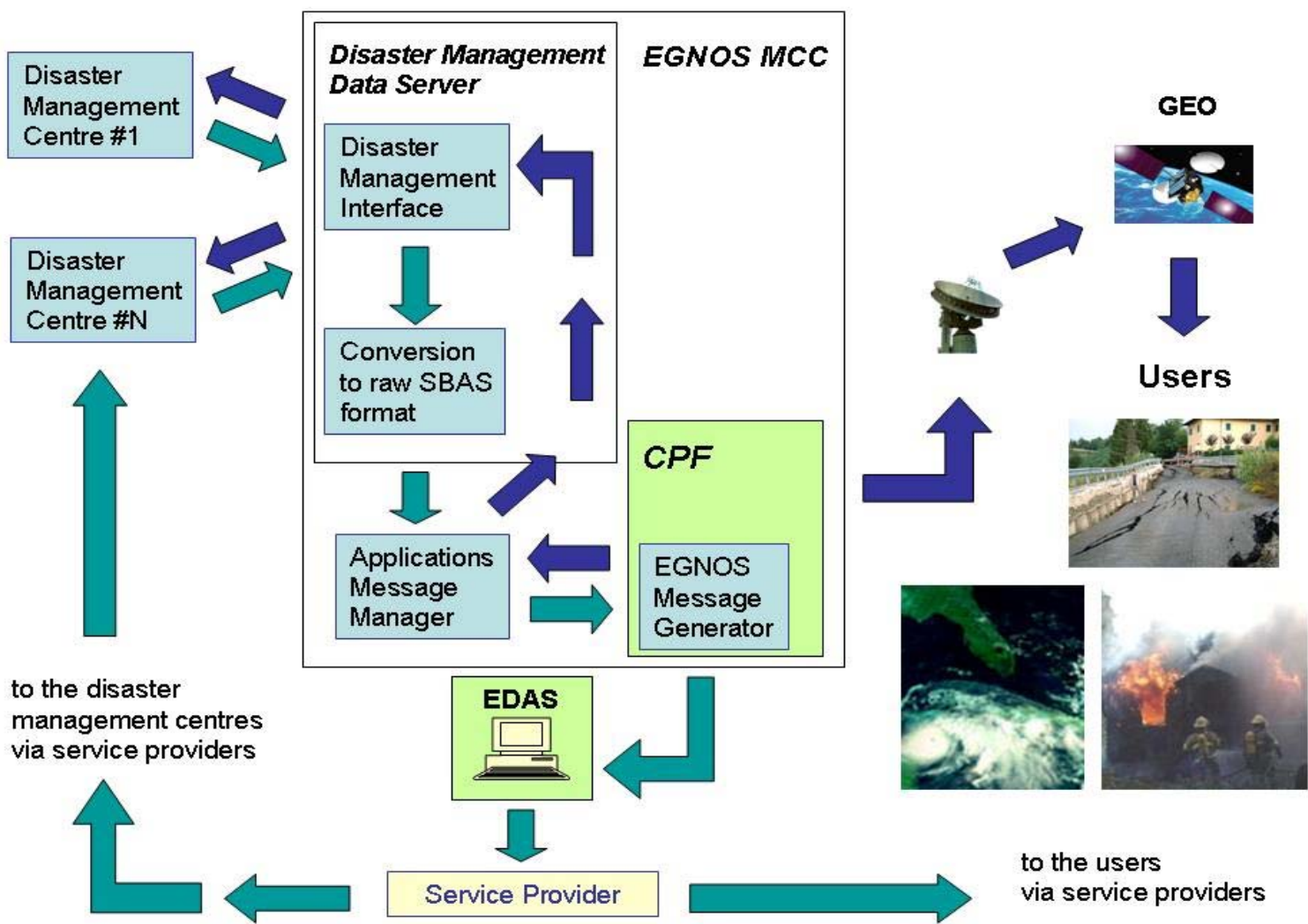
- **Disaster prevention, mitigation and preparedness are better than disaster response.** The possibility to use Satellite Based Augmentation Systems (SBAS) message broadcast capability as a means for disaster announcements has been assessed internally at ESA:

ESA ALIVE concept (Alert Interface Via EGNOS)

- The SBAS Systems have a number of inherent characteristics which make the **SBAS solution very attractive** (discussed later)
- ESA EGNOS P.O consider the ESA ALIVE concept as a **meaningful and viable concept**, which may be implemented in a reasonable short time frame, contributing to save lives in the event of disasters.
- Together with ALIVE, EGNOS could also provide **other critical communication messages** (SAR Return link, Information to Avionic users, etc).
- **This proposal is to be consolidated and discussed (on-going) at relevant European and United Nations agencies, relevant Non-Governmental Organisations (NGO) and the European Commission**



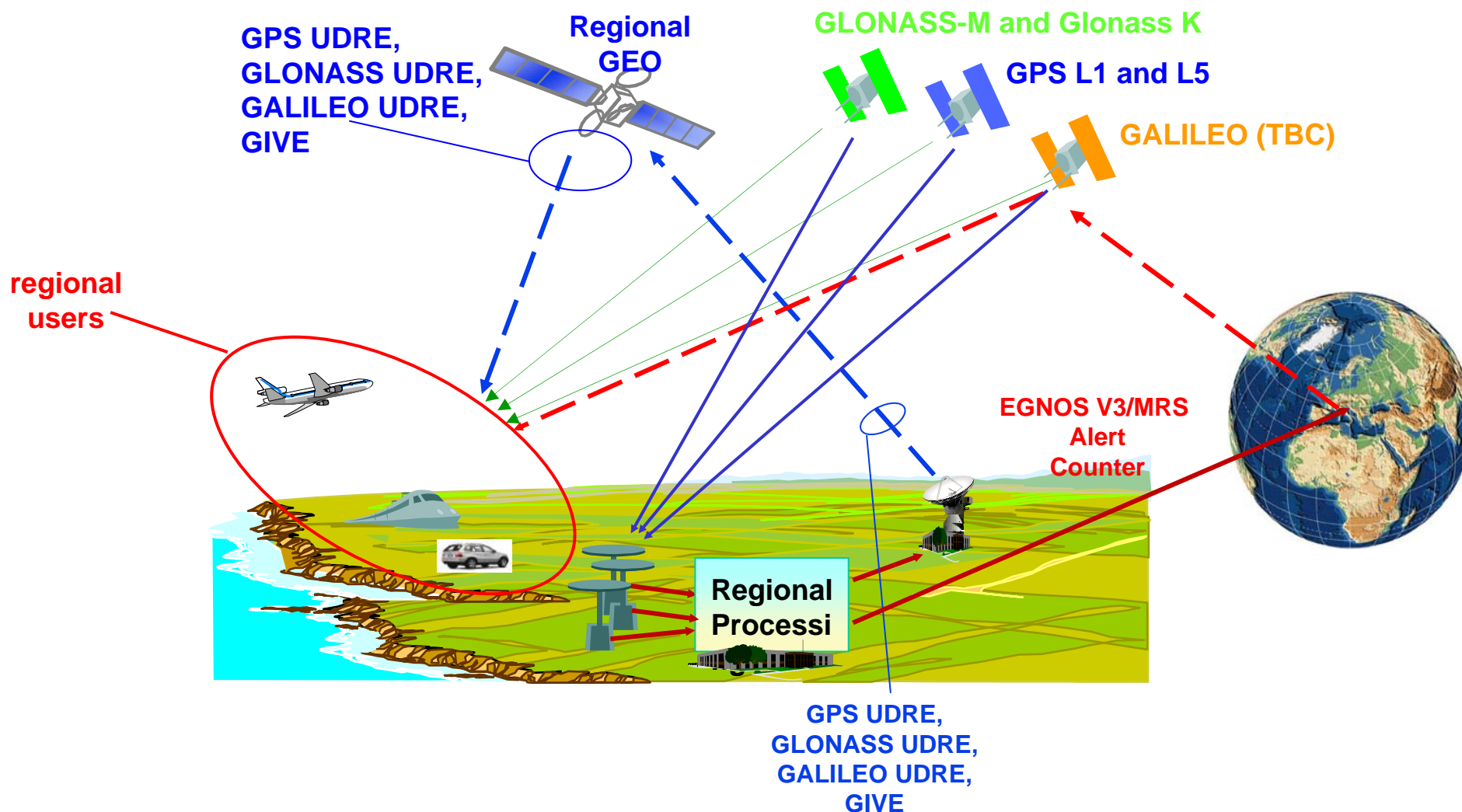
EGNOS V2.2: ESA ALIVE concept: provision of Disaster Alert messages through SBAS services (2/3)



EGNOS V2.2: ESA ALIVE concept: Why SBAS may help? (3/3)

- SBAS receivers get alert message and also have their position simultaneously. Only users concerned need to act;
- Unique worldwide standard: All SBAS receivers are identical;
- SBAS operated with all guarantees: Safety of Life, Institutional control, 24hour no Stop; confirmation message is broadcast in time.
- Can be implemented in very short term: pragmatic approach;
- Works in places with no infrastructure or where infrastructure is not operational
- Potential Global coverage with all other SBAS;
- GALILEO enabler: Service continuation/redundancy through Galileo.

Multi-constellation Regional System MRS: EGNOS V3 discussion concept (1/2)



EGNOS V3: multi-constellation context. Why? (2/2)

- EGNOS is already a multi-constellation system. **Concept is proven to work:** Two complete different constellation but same SBAS messages to users.
- SBAS users may take advantage of all Satellite constellations and frequencies: enhanced performances and **full Robustness (sole service)**.
- Other SBAS already indicated this is their modernisation trend. **Interoperability issue.**
- EGNOS V3 may have a **lower operational cost** than EGNOS V1 (e.g. GALILEO IPPs allows reducing number of EGNOS reference; some of the Galileo stations (GSS) could also be used as part of EGNOS V3, ...).
- Provision to Safety of Life (e..g. Aviation) based on well known UDRE/GIVE/xPL standardised concept which **simplifies SoL service introduction** and standardisation work.
- **ICAO (May 2005) has confirmed operational interest of GPS L1/L5 SBAS augmentation service** and the need to developed SBAS L5 Standards (on going at EUROCAE and RTCA).
- Allows obtaining **benefit** of GPS L5 and GALILEO while constellations are not fully deployed (say EGNOS V3 could provide SoL information to GPS L5 and Galileo already when, say, 6-8 satellites are deployed).

Currently, EGNOS V3 concept under ESA assessment in close coordination with the Galileo Joint Undertaking. This is only a study concept today.

Outline

- EGNOS Status and performance Summary
- Technical Information to Users
- EGNOS Evolution Plans
- Information on EGNOS Test bed Status
- Issues for assessment with Receiver Manufacturers

Information on EGNOS Test Bed (ESTB)

Outline

- EGNOS Status and performance Summary
- Technical Information to Users
- EGNOS Evolution Plans
- Information on EGNOS Test bed Status
- Issues for assessment with Receiver Manufacturers

Issue 1: Receivers compatibility: Preparing for EGNOS Open Service

- ESA following the request of the EGNOS Mission Board is implementing MOPS MT0/2. This will be technically ready Jan/Feb 2005, and could be installed for EGNOS Operations Q1 2005. European Commission and GJU should then decide if EGNOS Open Service is formally declared.
- In terms of user SiS receivers compatibility for Open service, to your knowledge, is there any additional MOPS issue (in addition to MT 0/2) that may be a potential problem (e.g. concerning current broadcast SiS PRN 124)?
 - DO 229 C MOPS MT 17 Configuration?
 - GEO set to non monitored in PRN 1?

Issue 2: Coexistence of Open service and testing satellites

- When Open service will be introduced MT 0/2 and MT0 GEO satellites will coexist (e.g. PRN 120 and 124 may transmit MT0/2 while PRN 126 is used for upgrades/testing in MT0 mode.)

- Is this situation anticipated? How will receivers make the difference? Where can ESA or EGNOS operator help in this respect?

Issue 3: MT27/MT28: preparing for EGNOS extension beyond ECAC service area

- EGNOS service extension beyond ECAC is currently under assessment by ESA. This requires the implementation of either MOPS MT 27 or MT 28. Both are currently under assessment. According to the MOPS standards, while these messages are optional to SBAS service providers, the capability to process/decode both messages is mandatory for receiver manufacturers. WAAS today implements MT 28.
- Based on your knowledge, may you please confirm that there is no problem for receivers compatibility whatever is the message extension option retained by ESA (either MT 27 or MT 28)?

Issue 4: Information provided today by ESA and planned EGNOS UID

- Today ESA provides information on EGNOS through some dedicated professional websites and is intending to provide the EGNOS User Interface Document.

- What additional information may ESA or EGNOS operator provide to Receiver manufacturers in their support?