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Operating EGNOS

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The European Satellite Services Provider (ESSP)

BIOGRAPHY

Ashley Lyon graduated in France in Engineering, complemented by a Master of Science Degree in Aerospace applications, Cranfield University, United Kingdom. His professional experience encompasses 6 years in France for a Telecommunication and Radar Environment company, before working as a Sales and Marketing Manager in Belgium for an aircraft equipment manufacturer. He then joined the ESSP as Business Development and Marketing Manager, where he is in charge of promoting and developing the EGNOS business.

Jon Westbrook graduated from the University of East Anglia in the UK with a degree in Electronics with Business Studies. He is employed by National Air Traffic Services UK and is currently detached to the ESSP. Prior to joining the ESSP he was detached to work for the European Space Agency in Toulouse as part of the ESA EGNOS project office and was the systems engineer responsible for overseeing the design, development and procurement of the EGNOS Central Processing Facility. He was the first member of the ESSP operations team and has project managed the operations preparation phase contract and managed the negotiations with ESA for the EGNOS Initial Operations Phase.

Umberto Guida is the ESSP Business Development Manager, responsible for the ESSP participation in European Research and Development projects and contributing to the EGNOS Safety of Life Service Provision set-up activities.
Before joining ESSP, he was the technical responsible at Alenia Spazio for projects and studies with ESA, EC, GJU, National Institutions and Public / Private Companies, related to the applications for Satellite Navigation, in view of the next EGNOS start of operations and the Galileo system development.

ABSTRACT

The ESSP (European Satellite Services Provider) has been created in April 2001 to operate the EGNOS system and provide signal and data services to users in Europe. The company has now seven shareholders, all European Air Traffic Service Providers: NATS (UK), DGAC/DSNA (F), AENA (E), ENAV (I), DFS (D), NAV-PT (P) and skyguide (CH). These organisations are also responsible for the hosting and operations of EGNOS system infrastructure.

The EGNOS system has been designed, developed and deployed by Alcatel under a European Space Agency (ESA) contract as part of the ESA ARTES IX programme.

The EGNOS system ESA milestone Operational Readiness Review (ORR), which concludes the EGNOS design and deployment activities led by ESA, was completed on June 16th 2005 and is followed by the EGNOS Initial Operations Phase (IOP).

A contract has been finalised between ESSP and ESA, to cover the EGNOS Operations Management for the duration of the Initial Operations Phase. This paper addresses the activities to be performed during the EGNOS Initial Operations Phase.

INTRODUCTION

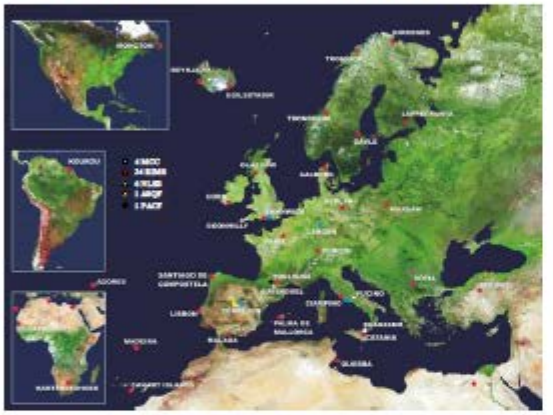
In 2003, the European Commission has officially acknowledged the European Satellite Based Augmentation System (SBAS) EGNOS (European Geostationary Navigation Overlay Service) as the precursor to the Global Navigation Satellite System (GNSS) Galileo, in the Communication to the European Parliament and the Council, COM(2003) 123 final, March 19th 2003. The decision of the European Commission regarding the integration of EGNOS into Galileo stated "the advent of EGNOS gives the European Union the unique opportunity to position itself now on the world market for satellite radio navigation and to enable European technology to serve the European market".

The provision of EGNOS Signal and Data Provision entity is a fundamental and important step for European GNSS policy and service provision.

The ESSP is responsible for EGNOS Signal and Data Provision including the operations management of the EGNOS system infrastructure and operations teams, bearing the overall responsibility of a complex, European-wide system and receives day-to-day support from its seven shareholders.

EGNOS architecture

The entire EGNOS architecture is composed of 46 ground elements spread over 22 countries worldwide.



The EGNOS architecture is composed of the *ground segment* which collects data from the GPS and GLONASS satellites via 34 Receiver Integrity Monitoring Stations (RIMS), computes the wide area differential and integrity corrections using 4 Mission Control Centers (MCC), and then redistributes the EGNOS navigation data to end users via 6 Navigation Land Earth uplink Stations (NLES) to the Space segment. Two support facilities ASQF (Application Specific Qualification Facility) and PACF (Performance Assessment Check Out Facility) complete the ground segment architecture.

The EGNOS space segment is composed of three geostationary satellites to meet the required EGNOS navigation performances.

The ESA Artemis satellite (PRN 124) is currently broadcasting the nominal EGNOS Signal in Space during the Initial Operations ramp-up phase. The broadcast Message Type 0 should be upgraded to the DO229C standard used by WAAS early in 2006.

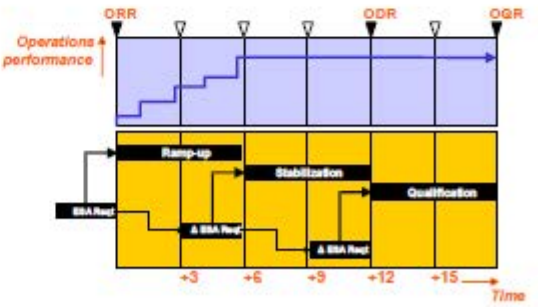
Meanwhile, the Inmarsat Atlantic Ocean Region East AOR-E satellite (PRN 120) is currently being used for the EGNOS System Test Bed (ESTB), a signal which also extends to Africa. The ESTB Signal in Space has the same standard as the WAAS Signal in Space. The transmission of the ESTB Signal in Space is foreseen to end during the Initial Operations phase and the AOR-E satellite will broadcast the nominal EGNOS Signal in Space.

Lastly, the Inmarsat Indian Ocean Region West IOR-W (PRN 126) is being used in the short term for the completion of the remaining industrial development activities. There are expected SIS interruptions on this satellite. The IOR-W satellite will then be used for EGNOS nominal broadcast. EGNOS full operations will dispose of three geostationary satellites to fulfill the required performances.

After describing the EGNOS architecture, the following section will address what impact the Initial Operations has on the system and the future services and performances.

Initial Operations Phase

The Initial Operations Phase is an eighteen-month period started in July 2005 with the objective to ramp up, stabilise and qualify the EGNOS system operations. The Initial Operations ramp up and stabilisation phases conclude with the Operations Definition Review (ODR) after 12 months. The ODR is followed by an operations qualification phase concluding with the Operations Qualification Review (OQR) at which point EGNOS shall be capable to support safety of life operations.



Ramp-up

This is the first time that the EGNOS Signal is broadcast in an operational mode by dedicated operations teams. During this 6 month period the ESSP organisation shall increase its staff and resources to fully support EGNOS operations. This period is designed to facilitate the transfer of knowledge and experience from ESA and industrial development teams to the ESSP operations organisation. A key activity will be the testing of the operational processes and procedures and delivery of the remaining training packages to build up the operational team capabilities.

Regarding the infrastructure, all components of the system are deployed with the exception of 3 remaining reference stations (RIMS) which are expected to be added to the system configuration once negotiations are complete. However, some of the EGNOS operations infrastructure is dedicated to the completion of the remaining industrial development activities through the use of the IOR-W satellite during the first months of the Initial Operations Phase. During this period the availability of the EGNOS infrastructure for nominal EGNOS operations will be reduced to allow for the completion of these activities.

Stabilization

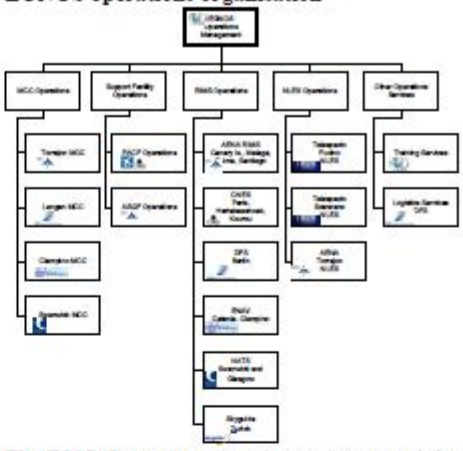
Following the completion of the Ramp Up phase the EGNOS Signal and Data provided during the Stabilization phase will correspond to the nominal EGNOS operations performance. Resource profiles will be harmonised to support EGNOS Signal and Data provision according to operations performance requirements, with nominal maintenance procedures running across the EGNOS system and the completion of remaining operations processes and procedure testing.

During this phase any remaining EGNOS infrastructure not yet under operations management by the ESSP will be formally transferred to the ESSP. At the end of this phase the transfer from ESA to ESSP of management of all EGNOS operations infrastructure will be complete.

Qualification

A period of nominal operations is required to gather evidence towards the EGNOS System Safety Case for the provision of EGNOS Safety of Life services. During the Qualification period, the ESSP will demonstrate that the EGNOS operations system, staff, procedures and documentation can support EGNOS operations performances required to support Safety of Life services. This period concludes with the Operations Qualification Review (OQR), planned for early 2007. Following the completion of these qualification activities Safety of Life the EGNOS System Operations will be declared capable to support Safety of Life service provision.

EGNOS operations organisation



The ESSP Operations organisation is composed of European entities with significant experience in the management of safety critical systems and Satellite Navigation operations.

The four Mission Control Centres are operated by AENA, DFS, ENAV and NATS. These entities have significant experience in the management of safety critical ground systems and infrastructure. On a cyclical basis the MCC's rotate between the status Master, Hot Back Up and Cold Back Up to provide continuous H24 operations.

The EGNOS ASQF Support Facility is operated by AENA. The PACF Support Facility is operated by a joint collaboration between CNES and DSNA, the French Space Agency and French Air Traffic Service Provider respectively. The EGNOS Support Facilities are operated on an office-hours basis and provide the support to the operations teams for matters such as operations coordination and planning, first and second line maintenance activities, operations user interface and the interface to industrial teams for third line maintenance activities. The CNES in particular have significant experience in the operations of satellite missions and infrastructure and have been responsible for the operations of the EGNOS System Test Bed.

All large proportion of the EGNOS RIMS network are hosted and operated by the ESSP Operations organisation. The remaining RIMS stations which are hosted and operated by other operational entities will be placed under full operations control of the ESSP as part of the transfer of operations responsibility planned between ESA and the ESSP during the Initial Operations Phase. A similar process is foreseen for the NLES uplink stations.
The ESSP are responsible for the management of the EGNOS operations organisation, ensuring the correct establishment of operations processes, procedures and control as well as the reporting towards ESA, the procurement entity for the Initial Operations phase.

Services

EGNOS is planned to provide several different service levels to end users: the Open Service, Commercial Services and the Safety of Life Service. The definition of such services is planned as part of the selection of the EGNOS Service Provider. This activity is on-going however for completeness, an indication of the planning and way forward for introduction of EGNOS services is provided:

The EGNOS *OS service* will start in early 2006 as soon as the EGNOS system is modified to broadcast the Message Type 0/2. This modification will enable interoperable use of SBAS receivers over European and the American continent. However, the EGNOS Open Service will be available to all users but the performances will not be guaranteed.

EGNOS *Commercial Services* are expected to be provided by mid 2006 following the addition of an EGNOS data interface server, enabling the provision of EGNOS commercial data to Commercial Service Providers.

The EGNOS *Safety of Life service* is expected to be provided in early 2007 following completion of qualification activities, nominally following the successful declaration of the EGNOS Operations Qualification Review. Only once the EGNOS system is qualified after the Initial Operations Phase, shall the service be guaranteed for Safety of Life applications such for Non Precision Approaches with vertical guidance, down to APVII in Europe.

Performances

The EGNOS system has been designed and will be operated to augment the performances of GPS over Europe, providing higher *accuracy, integrity, availability and continuity*. The performances expected will vary in function of the evolution of the EGNOS operations.

In the stabilization period of the Initial Operations, the EGNOS performances will be:

Horizontal Accuracy [meters]	Vertical Accuracy [meters]	Availability	Integrity
2	4	99%	N.A.

This Open Service SOL consist of signals for timing and positioning, freely accessible from EGNOS satellites without any charge. This service is accessible to any user equipped with a GPS/SBAS compatible receiver within the EGNOS Open Service area. No authorization or receiver specific certification is required to access and use the EGNOS Open Service signals.

As from the qualification of the system, after the Initial Operations Phase, the signal will be used for Safety of Life services in most transport applications where lives could be endangered if the performance of the navigation system is degraded below specific accuracy limits without giving notice in the specified time to alert.

The Safety of Life Service (SOL) is accessible to any user equipped with a GPS/SBAS compatible certified receiver within the EGNOS Safety of Life Service area.

The expected aviation SOL performances are:

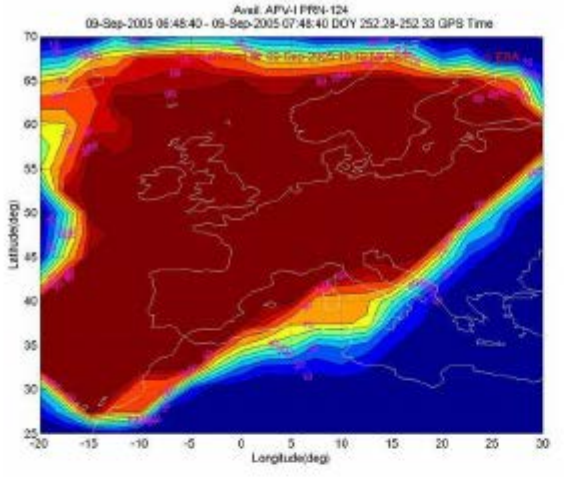
	Accuracy (95%)		Availability	Continuity
	Horiz	Vert		
APV-I	16 m	20 m	0.99 to 0.99999	$1\text{-}8\times10^{-6}$ in any 15 s
APV-II	16 m	8 m	0.99 to 0.99999	$1\text{-}8\times10^{-6}$ in any 15 s

	Integrity			
	Alert Limit Lateral	Alert Limit Vertical	Integrity Risk	Time to Alert
APV-I	40 m	50 m	$1\text{-}2\times10^{-7}$ per approach	10 s
APV-II	40 m	20 m	$1\text{-}2\times10^{-7}$ per approach	6 s

The Safety of Life service will consist of signals for timing and positioning, provided with a guarantee of service, accessible through the EGNOS geostationary satellites. The user will sign a specific Service Level Agreement with the EGNOS service provider.

During the Initial Operations Phase, the performances of EGNOS will ramp up and then stabilize for qualification.

Due to the fact that the system has entered the ramp up period of the Initial Operations, where 3 reference stations and the two remaining geostationary satellites need still to be connected to the core system, the existing availability performances are good and are improving. The illustration here below corresponds to the availability performances for the aviation non precision approach APVI over the EGNOS coverage area during September 2005.



The daily performances can be found on the ESA website: http://ravel.esrin.esa.it/docs/egnos/esfb/IMAGEtech/imagetech_realtime.htm At this address, one can also find the various Message Types broadcast, satellite monitoring, IGP (Ionospheric Grid Point) monitoring status, GIVE values at IGPs and mean HPL (Horizontal Protection Level) and VPL (Vertical Protection Level) values.