

EGNOS Project Status



The European Tripartite Group (ETG)¹, (ESA – EC – Eurocontrol) is implementing, via the EGNOS project, the European contribution to the Global Navigation Satellite System (GNSS-1), which will provide and guarantee navigation signals for aeronautical, maritime and land mobile Trans-European network applications. On behalf of this tripartite group, the European Space Agency (ESA) is responsible for the system design, development and qualification of an Advanced Operational Capability (AOC) of the EGNOS system.

EGNOS will significantly improve the accuracy of GPS, typically from 5-10 metres to 1-3 metres. Moreover, EGNOS will offer a service guarantee by means of the Integrity signal and it will also provide additional ranging signals. It will operate on the GPS L1 frequency, and will thus be receivable with standard GPS front-ends. EGNOS is part of a mosaic of inter-regional Satellite-Based Augmentation Services (SBAS) that complement GPS and GLONASS. The other systems are the United States WAAS and the

Felix Toran-Marti, Javier Ventura-Traveset and Laurent Gauthier of the European Space Agency GNSS-1 Project Office, discuss the plans towards the start of operations and future evolutions of EGNOS.

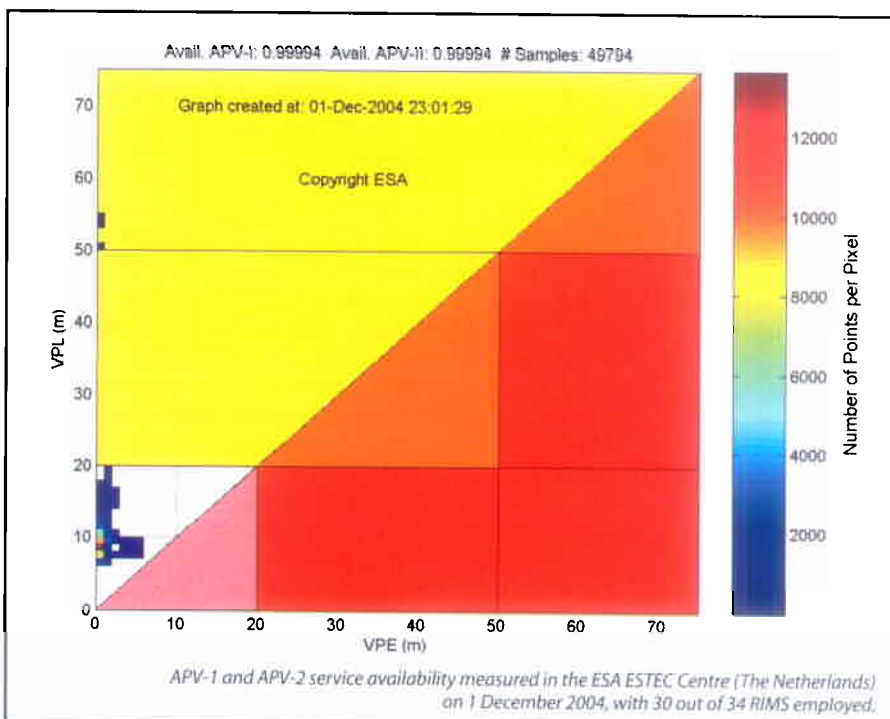
Japanese MSAS systems. Recently, India and China have launched similar initiatives, called GAGAN and SNAS, respectively. The EGNOS coverage area will be the ECAC (European Civil Aviation Conference) area but could be readily extended to include other regions within the Broadcast Area of the geostationary satellites, such as Africa, East of Europe and Russia. EGNOS will meet, in combination with GPS and GLONASS, many

of the current positioning, velocity and timing requirements of the land, maritime and aeronautical modes of transport in the European Region. EGNOS is the first step of the European Satellite Navigation strategy and a major stepping stone towards Galileo, future Europe's own global satellite navigation system.

This article presents the EGNOS Project status and performances, as measured in December 2004. It also shows the short-term plans towards Operational Readiness and Start of Operations, and the planned system evolutions.

EGNOS Status and recent measured performances

At the time of this writing (December 2004), the deployment of the EGNOS infrastructure is quasi completed, with all the four Master Control Centres (MCC) and all the six Navigation Land Earth Stations (NLES) deployed. A total of 31 out of 34 Reference stations (called RIMS) are installed, and all three EGNOS Geostationary satellites (Inmarsat 3 AOR-E, Inmarsat-3 IND-W and ESA's ARTEMIS satellite) are already transmitting successfully EGNOS test signals. The test transmissions started in December 2003, and are almost continuous since July 2004. While qualification tests are now approaching their end, current EGNOS performances measured during tests are quite promising, with vertical and horizontal accuracies of the order 1 to 2 metres. All these accuracy performances are complemented in the coverage area with APV-1 (Aviation Approach with vertical guidance) and APV-2 availabilities of the order of 99%, and conformable integrity margins. In terms of integrity, one of the key challenges was to develop adequate algorithms against any ionospheric limiting condition. In this sense, ESA just concluded an important study where the behaviour of EGNOS ionosphere algorithms against the 28 October-1 November storm of 2003 (considered among of the largest ionospheric storms ever recorded) was tested, showing full resistance in terms of



integrity and the ability to maintain in the core of Europe a vertical guidance service.

EGNOS start of operations

The EGNOS Operational Readiness Review (ORR) is the final milestone in the EGNOS development programme. The ORR comprises:

- The final system functional and operational requirements verification, verifying operator readiness to start Initial Operations, and checking that system releases and MCC/PACF platforms are available for operations; and
- The final Performance Qualification for verification of System Navigation performance requirements.

At the time of writing, the EGNOS ORR is expected to take place in March 2005. The completion of ORR will allow starting the operations phase, where main objectives are:

- To initiate and stabilise operations of the EGNOS GS (Ground Segment) and SF (Support Facilities);
- To qualify operations of the GS and SF; and
- To arrive at the Operations Qualification Review (OQR) +1 day with an operationally qualified system providing safety-of-life services (eg aviation).

To do this, we have a three-step approach based around:

- An Operations Preparation Phase, where operations are initiated and the system is exercised. This activity was contracted to the European Satellite Service Provider (ESSP) and was concluded in December 2004.
- An Initial Operations Phase, where we stabilise and optimise operations. This activity is planned to start after the EGNOS Operational Readiness review (ie around March 2005).
- An Operations Qualification Phase (OQP) where we qualify operations leading to the Operations approval, at a level compatible with the provision of safety of life operations for long-term EGNOS performance testing (today scheduled to be achieved typically 18 months after the start of operations).

EGNOS Future Evolutions

In parallel to the start of operations, EGNOS already plans to respond positively to the dynamic GNSS environment challenge. Indeed, since 1998, when the original EGNOS mission requirements were set, the GNSS environment considerably enlarged with the launch of the *Galileo* programme and the planned modernisation of the GPS (eg with the introduction of GLPS L5 civil frequency) and WAAS systems. In this

worldwide context, the Council of the European Union confirmed in June 2003 that EGNOS is an integral part of the European Satellite Navigation policy, resolved that EGNOS will be adapted as need be to follow the SBAS International Civil Aviation Organisation (ICAO) international standard upgrades, and that the EGNOS services should be extended determinedly to other parts of the world on a long term basis. In addition, several studies indicate that a modernised EGNOS (eg including GPS L5 integrity) in combination with the European *Galileo* service, could allow reaching a GNSS safety of life 'sole service'.

Aiming at responding positively to this GNSS dynamic context, a support programme was defined by ESA and the European Commission. This 'GNSS Support Programme', has been defined in two steps: Step 1, covering the 2005-2006 timeframe, and Step 2 to cover the 2006 – 2009 timeframe, to further maximise GNSS benefits to European citizens, and in particular to define and implement the more appropriate evolutions of the EGNOS system to best prepare for the *Galileo* services to be available from 2009 onwards.

Among the new EGNOS services, which could be introduced in the near future is the provision of the EGNOS corrections and reference stations data in real time through no-GEO means, maintaining integrity and being able to customise through post-processing the message format and transmission means. This has a tremendous commercial interest in the context of LBS (Location Based Services) applications and when several technologies are combined (eg mobile communications and satellite navigation). This future EGNOS service will be based on what ESA has named the EGNOS Data Access System (EDAS). This is further developed in the next section.

The EGNOS Data Access System (EDAS)

In the past years, ESA has conducted numerous studies in the field of non-GEO dissemination of EGNOS data. This includes the ESA SISNeT technology, which is offering, since early 2002, access to the EGNOS services through the Internet and Wireless Networks in real time. In addition, feasibility studies oriented to other dissemination means have been performed, covering, to cite some examples, the Radio Data System (RDS) and the Digital Audio Broadcasting (DAB) signals.

Results obtained from those activities have been quite promising. This has motivated ESA considering the

development of an EGNOS evolution, allowing Service Providers accessing the EGNOS products in real time (within guaranteed delay, security, and safety performance boundaries), in order to supply services to end users through a broad mosaic of non-GEO dissemination means.

This new interface, called EGNOS Data Access System (EDAS), will open the door to a broad mosaic of services, including:

- Provision of SISNeT services, where EGNOS corrections are obtained in real time through Internet (eg through a GPRS wireless mobile access);
- Development of EGNOS pseudolites;
- Provision of EGNOS services through Radio Data System (RDS);
- Provision of EGNOS services through Digital Audio Broadcast (DAB);
- Provision of Wide Area Real Time Kinematics (WARTK) services, allowing obtaining decimetre-level accuracies at continental scale;
- Accurate ionospheric monitoring;
- Provision of EGNOS performance information in real time.
- Archiving of EGNOS messages.
- Provision of EGNOS corrections in the standard RTCM SC104 format, ready to be used by DGPS receivers.

The EDAS will be developed via the GNSS Support Program Step 1, with a view to have an operational system before end 2005, thus opening the path to its commercial exploitation by the EGNOS Economic Operator.

Summary

This article has presented the status of the EGNOS Project in December 2004, drawing the pathway towards operational readiness and start of operations of the system, expected in March 2005. The performances measured during qualification tests - on a partially deployed system - have been presented, as a promising advance of the performances that can be expected in a near future from the operational EGNOS system. The plans towards the start of operations have been presented in some detail. In addition, the EGNOS long-term evolution plans, supported by the so-called GNSS Support Program have been presented, placing the focus on one particular evolution the EGNOS Data Access System (EDAS), which will pave the way for the EGNOS commercial exploitation.

References

1. A formal agreement based on article 228 of the EC treaty was signed between the European Community, Eurocontrol and ESA, for the development of the European Contribution to the first generation Global Navigation Satellite System (GNSS-1).