The ESA SISNeT Project: Current Status and Future Plans

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ABSTRACT

Likewise other Satellite Based Augmentation Systems (SBAS), EGNOS– the European SBAS – will broadcast augmentation signals for GPS through Geostationary Earth Orbit (GEO) satellites. GEO broadcasting is proved to be an efficient strategy for avionic applications and other modes of transport. For some applications, though, it may be of interest to complement GEO broadcasting through other transmission means. For instance, building obstacles in cities or rural canyons may difficult the GEO reception. In those situations, complementary real-time Internet-based broadcasting of the EGNOS signal is of major interest as a way to continue taking the most of the EGNOS potential, irrespectively of the user environment.

Responding to that need, ESA developed and launched the SISNeT service in 2001. SISNeT allows retrieving the EGNOS messages across the Internet in real-time, usually through wireless networks, like GSM or GPRS. Thanks to SISNeT, any user with access to the Internet (e.g. through wireless networks – GSM or GPRS –) may access the EGNOS product, irrespectively of the GEO visibility conditions.

In the early days of SISNeT, advanced simulation activities revealed that the combination of EGNOS and the almost unlimited capabilities of the Internet could open the door to a lot of innovative applications for Satellite Navigation. The evolution of SISNeT to the date has demonstrated and justified what simulations were anticipating, mainly thanks to:

- The launch of a number of ESA contracts with European industry, on SISNeT developments.
- The interest of worldwide companies, organisations and universities on applying SISNeT to a large variety of applications, research and development projects.
- The ESA internal work on SISNeT.

In fact, new application fields based on SISNeT have been identified, like educational applications, help to impaired people, quick initialisation of SBAS receivers, etc. The possibilities of SISNeT have revealed to be beyond ESA initial expectations.

This paper presents the current status of the SISNeT Project, including a review of the already performed ESA contracts around the SISNeT technology (PDA and desktop available receivers, trials in urban buses, helping blind pedestrians find their way around, etc.), presenting the ongoing contracts, and also placing the focus on future plans to make SISNeT an integral part of EGNOS. Some ESA contracts, which have considered the SISNeT technology as a potential added value, are also referenced. In addition, the EGNOS Message Server (EMS), a non-real time complement to the SISNeT concept, will be shortly introduced through this paper.

The Authors firmly believe that SISNeT, as a solid synergy between SBAS systems and the Internet, will continue opening new doors to innovative developments, and will become a mature technology, as an integral part of the EGNOS system.

INTRODUCTION

EGNOS, the European Geostationary Navigation Overlay Service [1], is the first step on the European contribution to the Global Navigation Satellite System (GNSS), and a fundamental stepping-stone towards GALILEO, Europe's own Global Navigation Satellite System. EGNOS is an augmentation system to the GPS and GLONASS Satellite Navigation systems, which provides and guarantees navigation signals for aeronautical, maritime and land mobile Trans-European network applications. In addition to EGNOS, there are two other Satellite-Based Augmentation Systems (SBAS) contributing to GNSS-1: the US Wide Area Augmentation System (WAAS) and the Japanese MTSAT Augmentation System (MSAS). Since February 2000, a pre-operational EGNOS signal is available through the so-called EGNOS System Test Bed (ESTB) [2-4]. The ESTB has proven to be an excellent vehicle to demonstrate the system operation to final users. Since year 2000, a number of demonstrations have been performed involving a large variety of user communities and, therefore, of user requirements. In particular, successful demonstrations were performed for land mobile, civil aviation, helicopters, trains, maritime and precision farming [2-4].

Similarly to other Satellite Based Augmentation Systems, EGNOS– the European SBAS – will broadcast augmentation signals to GPS through Geostationary (GEO) satellites. GEO broadcasting is proved to be an efficient strategy for avionic applications and other modes of transport. For some applications, though, it may be of interest to complement GEO broadcasting through other transmission means. For instance, building obstacles in cities or rural canyons may difficult the GEO reception. In those situations, complementary means of broadcasting (e.g. FM, Digital Audio Broadcasting – DAB – and the Internet) have a remarkable interest. In this context, the European Space Agency (ESA) launched an internal project to provide access to the ESTB messages in real time through the Internet. The product of this project has been a new technology, called SISNeT (Signal in Space through the Internet [5 - 16]), whose interest has greatly grown since the initial SISNeT service was put in place by ESA in 2001.

This paper presents the current status of the ESA SISNeT project, describing several ESA contracts performed around SISNeT – successfully completed at the time of this writing, April 2004 – and orienting the focus towards INSPIRE, the future evolution of SISNeT as an integral part of EGNOS. The consideration of the SISNeT technology as an added value, in the frame of several ESA contracts, is also addressed in a separated Section of this paper. In addition, a non-real-time complement to SISNeT, called EMS (EGNOS Message Server) [36] is briefly introduced.

THE EGNOS SYSTEM

The European Tripartite Group (ETG) – formed by the European Space Agency (ESA), the European Commission and EUROCONTROL – is implementing, via the EGNOS project [1], the European contribution to the Global Navigation Satellite System (GNSS-1). The EGNOS system will provide and guarantee navigation signals for aeronautical, maritime and land mobile Trans-European network applications.

On behalf of this tripartite group, ESA is responsible for the system design, development and technical validation of an Advanced Operational Capability (AOC) of the EGNOS system. Technical validation will be completed in mid 2004, making possible the operational use of the EGNOS Signal in 2004.

EGNOS will significantly improve the GPS services, in terms of accuracy, (from a typical performance of 20 meters to 1 - 2 meters), service guarantee and safety (via integrity signal) and availability (via additional ranging signals). It will operate on the GPS L1 frequency, and will subsequently be receivable by standard GPS front-ends.

In addition to EGNOS, there are two other Satellite-Based Augmentation Systems (SBAS) contributing to GNSS-1: the US Wide Area Augmentation System (WAAS) and the Japanese MTSAT Augmentation System (MSAS). Although all SBAS are currently defined as regional systems, it is commonly recognized the need to establish adequate co-operation / co-ordination among the different systems, so that their implementation becomes more effective and part of a seamless world-wide navigation system. The EGNOS system includes specific requirements, so that interoperability may be achieved.

In addition to interoperability, EGNOS has built-in expansion capability to enable extension of the services over regions within the broadcast area of the Geostationary (GEO) satellites used. The EGNOS coverage will first be the ECAC (European Civil Aviation Conference) area, and could be later extended to include other regions such as Africa, Mediterranean countries, and East of Europe. EGNOS will meet 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, the future European satellite navigation constellation, planned to be fully deployed and operational in 2008.

THE EGNOS SYSTEM TEST BED (ESTB)

The EGNOS System Test Bed (ESTB) [2 - 4] is a real-time prototype of EGNOS. It provides the first continuous GPS augmentation service within Europe, and constitutes a great step forward for the European strategy to develop the future European Satellite Navigation Systems: EGNOS and GALILEO. The ESTB objectives include:

- Support to EGNOS design. In particular, algorithm design benefits from the ESTB experience in design and usage.

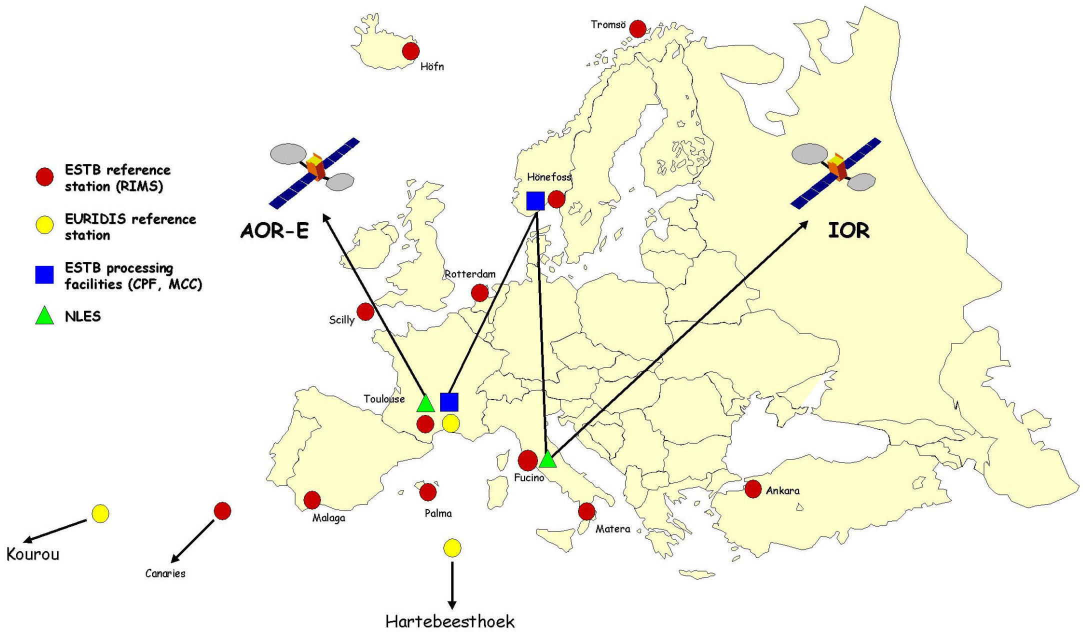

Figure 1 - ESTB ground elements location

- Demonstration of the system capabilities to users. The ESTB constitutes a strategic tool for the ETG, which plans to promote the use of EGNOS and analyse its capabilities for different applications. In particular, ESTB availability allows Civil Aviation authorities to adapt their infrastructure and operational procedures for future EGNOS use when it becomes operational. Three specific workshops sponsored by ESA, aiming at fostering the use of ESTB and analysing the needs of potential users, have been successfully organized since July 2000. A fourth workshop, focusing on EGNOS receivers and the transition from the ESTB to EGNOS took place at ESA Headquarters in Paris (France), in July 2003, with a major participation of worldwide receiver manufacturers.

- Analysis of future EGNOS upgrades.

- Acting as a backbone for continuous EGNOS experimentation and design improvement process.

The architecture of the ESTB is shown in Figure 1. The system includes:

- A network of 10 reference stations (RS), which are permanently collecting GPS / GEO / GLONASS data.

- A Central Processing Facility (CPF) generating the Wide Area Differential (WAD) user messages. This CPF is located in Honefoss (Norway).

- A second processing centre located in Toulouse (France), devoted to the generation of the GEO ranging data, which also acts as a node for the transmission of the user message.

- Two Navigation Land Earth Stations (NLES). One is located in Aussaguel (France), and transmits through the INMARSAT III AOR-E satellite; the other NLES is placed in Fucino (Italy) providing access to the INMARSAT IOR satellite.

- A real-time communications network based on frame-relay links.

THE SISNET TECHNOLOGY

EGNOS will broadcast their wide-area / integrity messages through GEO satellites. The ESTB is already broadcasting the EGNOS message through the INMARSAT III IOR-E GEO satellite.

Satellite broadcasting through GEO means is proved to be an efficient strategy for avionic applications and other modes of transport. For some applications, though, GEO broadcasting may provide some limitations. For instance, building obstacles in cities or rural canyons may difficult the GEO reception. Since the EGNOS message will still be very useful for those applications, a complementary transmission link may be considered to take the utmost advantage of the EGNOS potential.

For this reason, ESA launched specific contract activities (through the Advanced System Telecommunication Equipment program –ASTE–) to assess and demonstrate architectures where the ESTB signal is broadcast through non-GEO means (e.g. FM or GSM broadcasting).

In this context, ESA launched (in 2001) an internal project to provide access to the EGNOS test bed messages through the Internet. The product of this project is a new technology, called SISNeT (Signal in Space through the Internet) [5 – 16].

A first prototype of the SISNeT concept was set-up by the ESA GNSS-1 Project Office, in 2001. Since February 2002, the SISNeT service is accessible through the open Internet, via an authentication procedure. SISNeT accounts are free of charge, and can be requested by contacting the SISNeT team at SISNET@esa.int. Each account consists on a username, a password, the IP address of the SISNeT Data Server and the port to use. The SISNeT project is managed from the EGNOS Project Office (Toulouse, France), where the full platform design and development takes place. Maintenance of the SISNeT platform components is performed from the ESA ESTEC centre (Noordwijk, The Netherlands).

The SISNeT project can grant important advantages to the GPS land-user community. As this paper will bring to light, a user equipped with a GPS receiver and a GSM (or GPRS) modem can access the SISNeT services, thus being able to benefit from the EGNOS augmentation signals, even under situations of GEO blocking.

On the other hand, the Scientific and Engineering community may find major advantages in using SISNeT: the EGNOS signal can be received and processed without having to invest in an EGNOS receiver. Just a connection to the Internet is necessary. These benefits are also applicable to Educational environments (e.g. laboratory exercises based on the EGNOS signal do not imply acquiring receivers, only requiring computers connected to the Internet).

Another advantage is centred in the low bandwidth requirements of SISNeT: the transfer rate ranges from 300 bps to 700 bps, being 470 bps the average value. These characteristics make SISNeT very adequate to be used with GSM / GPRS wireless networks.

During SISNeT development, ESA has identified additional benefits that could be obtained from SISNeT, remarking the following:

- The indoor penetration of wireless networks as GSM or GPRS offers a lot of benefits for SBAS receiver initialisation. For vehicles, the SBAS receiver can be initialised in the garage, being ready to use (with EGNOS corrections) once reaching the street.

- In addition, when crossing long tunnels (or other segments with no GPS / GEO satellite visibility) SBAS/SISNeT receiver can start getting the necessary information before leaving the tunnel, since GSM / GPRS signals are normally accessible before reaching the exit. Considering the capability to retrieve previously broadcast messages via SISNeT, the SBAS system can be immediately used after leaving the tunnel in most of the cases, and the benefits of GEO ranging available without delay, just immediately after the EGNOS GEO(s) are again in visibility.

- Prior to reaching the urban environment (e.g. while a vehicle is in the garage or a person is inside a building), the GPS ephemeris information can be initialised from SISNeT, instead of waiting for the GPS message to be received (once on the urban scenario), reducing very much then the time to first fix.

At the time of this writing (April 2004), version 3.0 of the SISNeT platform is available to users for testing purposes (official release planned in May 2004). The new improvements will allow optimising bandwidth usage. In addition, SBAS receiver time-to-first-fix parameter will be noticeable reduced (typically achieving less than 10 - 20 seconds when using a GPRS link).

For extensive general and technical information about the SISNeT technology, the reader is addressed to references [5-16, 19-28].

COMPLETED SISNET-BASED INDUSTRIAL ACTIVITIES

In the 2002 – 2004 timeframe, a number of ESA contracts with European Industry were launched, aiming at demonstrating the SISNeT potential. These contracts – which have been successfully completed, – are the following:

- **Development of a Handheld SISNeT receiver [19 - 21].** This device is based on a Pocket PC Personal Digital Assistant (PDA) device. It includes a GPS card, and the Internet is reached through a GSM / GPRS wireless modem. Specific software is embedded, combining GPS measurements with the EGNOS corrections got via SISNeT. As a result, position accuracy is considerably improved. Almost any commercial GIS software can be used with SISNeT positioning, thanks to a specific driver. It is worth to remark that the handheld SISNeT receiver makes use of a low-cost GPS card. Therefore, the necessary access to the GPS pseudo-ranges is not allowed. To solve this, the developed software applies the EGNOS corrections in the position domain (see [21] for details). However, to do that, the GPS ephemeris information is necessary. Fortunately, SISNeT solves the problem by making ephemeris information available. In addition to this problem, the GPS receiver applies the GPS ionospheric model when computing position, so this correction must be removed before applying the EGNOS ionospheric corrections. SISNeT helps solving the problem, by making the GPS ionospheric model parameters available. As shown in [21], experimentation with the SISNeT handheld receiver took place in Finland, obtaining accuracies of 1 – 2 meters in the horizontal components, and 2 – 3 meters in the vertical component. The developed device has been integrated into a Siemens SX45 mobile phone (see Figure 2) and has been re-used as a key component in other SISNeT-related ESA activities.

Figure 2 - SISNeT handheld receiver embedded into a mobile phone

- **SISNeT technology applied to urban buses fleet management systems [22].** A one-box handheld SISNeT receiver was developed, based on a Psion NetPad device, equipped with the Windows CE .net operating system (see Figure 3). A mechanical adaptation was made to integrate a GPS receiver chipset. The link to the Internet is achieved through an integrated GSM / GPRS modem. Almost any commercial GIS software can be used with SISNeT positioning, thanks to a specific driver. The receiver was integrated in a real urban bus Toulouse (France), performing the usual trajectory. The selected bus line included open-sky, residential and downtown areas, allowing testing the robustness offered by SISNeT against different degrees of visibility. Results were quite promising, revealing that SISNeT could be a complement (or even a replacement) of the DGPS systems presently employed, which involve a high infrastructure cost.

- **Application of the SISNeT technology to help blind pedestrians navigate in cities [26,27].** This activity consisted on assessing the feasibility of applying the SISNeT concept to improve the performance of a navigation device for the blind. The selected device, called TORMES (Figure 4), was developed by the Spanish company GMV Sistemas and ONCE (the Spanish organisation for the blind) before the start of the activity. TORMES is a personal navigator for the blind, based on a device called Sonobraille (Figure 5), which includes a Braille keyboard, a voice synthesizer, and a cartography database. The TORMES device is based on the use of a GPS receiver, hence suffering the typical problems of signal blocking in urban areas. Thanks to the re-use of the SISNeT handheld receiver (based on a PDA), it has been possible to test the impact of injecting the EGNOS corrections, got from SISNeT, in the TORMES device. Tests have been performed in peripheral, central and downtown areas of Valladolid (Spain). Results have been quite promising, revealing a significant improvement in terms of correctly matched streets, and offering a level of accuracy that could allow locating objects even at the street level.

Figure 3 –SISNeT handheld receiver based on a NetPad device, for experimentation in urban buses in Toulouse (France).

Figure 4 – The TORMES Navigator for the Blind

Table 1 –Impact of the number of accessible GEO satellites in positioning availability (absolute improvement in availability percentage.)

SVs	Impact of 1GEO	Impact of 2GEOs	Impact of 3GEOs
4	29%	29%	36%
5	24%	24%	36%
6	15%	16%	27%
7	14%	15%	22%
8	28%	32%	36%
9	36%	57%	65%
10	19%	54%	73%

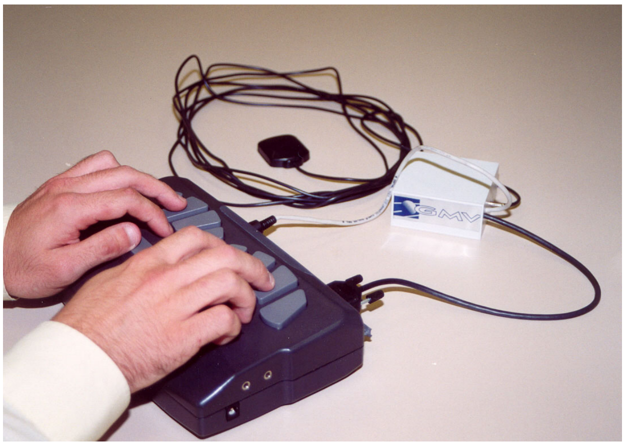

Figure 5 – The Sonobraille platform

Figure 6: The ShPIDER receiver

- **Development of a professional SISNeT receiver, and test in the context of an urban buses fleet management system.** An integrated professional device – called ShPIDER, see Figure 6 – including a GPS receiver and a GPRS modem has been developed. Its navigation algorithms allow significantly improving positioning accuracy and availability. Figure 7 shows results from a static test, where the accuracy improvement is visible. Furthermore, advanced availability improvement techniques have been applied, obtaining very promising results. The receiver has been tested in the context of bus fleet management systems in Valladolid (Spain), and also in the frame of the ESA EGNOS TRAN project, in Rome. For further details, the reading of [23] is strongly recommended. In the frame of this activity, a simulation study (based on the GMV Polaris simulation tool [30]) has been performed, assessing the impact of the number of accessible EGNOS GEO satellites in availability of positioning. Table 1 shows the main outcomes of this study, showing the percentage of improvement obtained when having access to one, two and three GEO satellites, respectively. In addition, the ShPIDER receiver has allowed testing the impact of EGNOS-SISNeT versus GPS-only, under low visibility conditions. This has been done via static tests in urban scenarios. Some representative results are shown in Figures 8 and 9. As it can be noticed, the impact of SISNeT is significant, and furthermore, it becomes more important when the visibility conditions degrade. As an example, for a mask angle of 40 degrees (low visibility conditions) an improvement of about 40% in accuracy is obtained thanks to SISNeT in the vertical component.

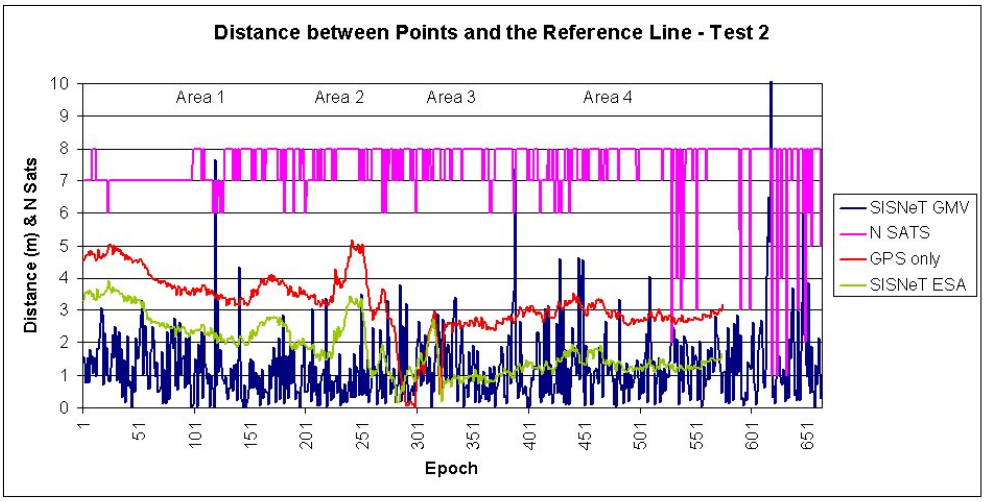

Figure 7 –Static test results using GMV's ShPIDER receiver. The red curve corresponds to GPS-only, the green curve corresponds to the PDA based SISNeT receiver, and the blue curve is obtained using ShPIDER. Note that no smoothing has been applied to the ShPIDER results.

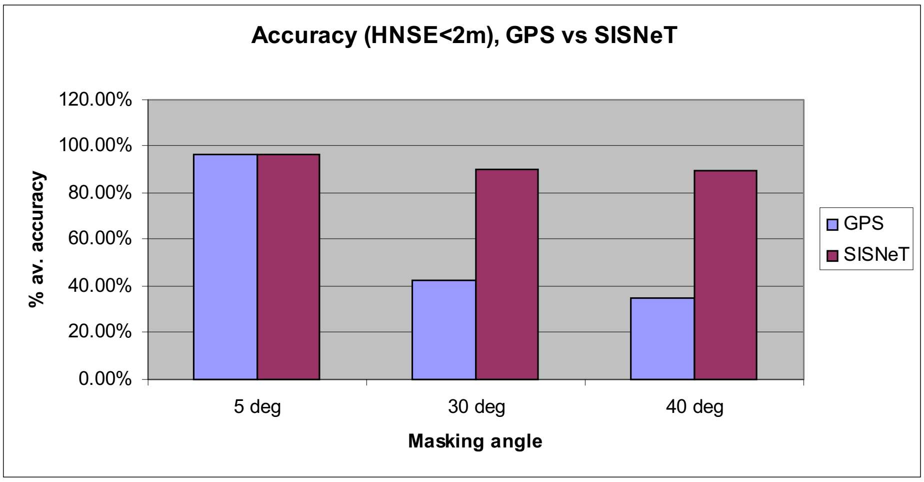

Figure 8- GPS-only versus SISNeT comparative bar plot based on real experimentation (availabilities for 2m horizontal accuracy)

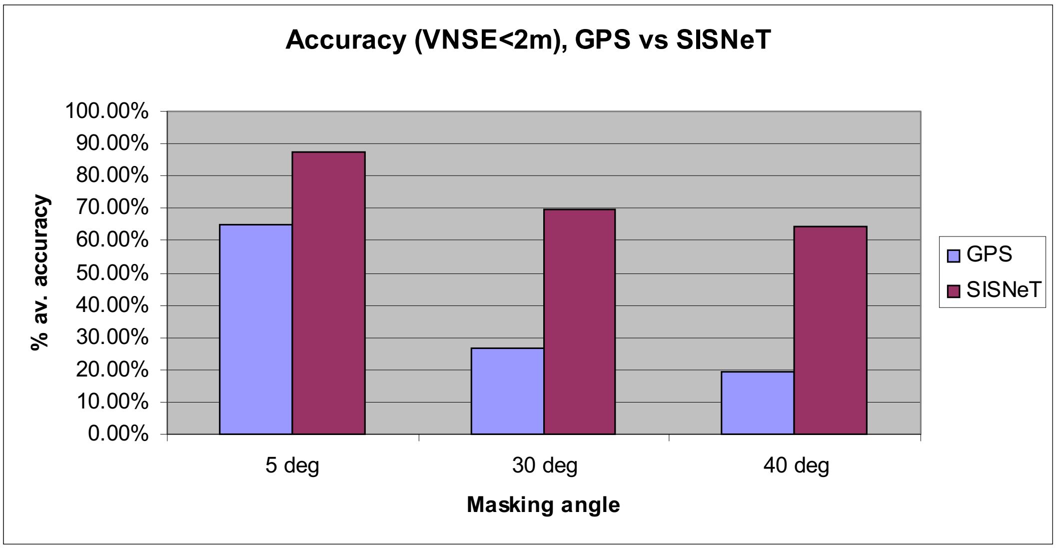

Figure 9- GPS-only versus SISNeT comparative bar plot based on real experimentation (availabilities for 2m vertical accuracy)

- **Improvement of the SISNeT network in terms of performance, security and confidentiality.** A consultancy study has been performed, obtaining specific indications on how to expand the SISNeT network to cope with tenths of millions of users, and offer high levels of confidentiality and security.

Next Section presents some ongoing ESA contracts, which are considering the SISNeT technology as a potential added value, in the context of multi-modal EGNOS and Galileo applications.

ONGOING ESA/GJU CONTRACTS TAKING BENEFIT OF THE SISNET TECHNOLOGY

The success obtained through the contracts explained in the previous Section, together with the big effort put by ESA and the Galileo Joint Undertaking (GJU) in the dissemination of results, has motivated the integration of the SISNeT technology in several other ESA projects. Some of those projects are the following:

- **FIBE (Fully Internet Based ESTB).** Considering that SISNeT allows linking the ESTB Central Processing Facility (CPF) and the users, through the Internet, this project aims at fully Internet enabling the ESTB. To do that, the Internet should replace the current Frame Relay links between the ESTB RIMS and the ESTB CPF. This could dramatically reduce the costs of communications and make the addition of RIMS an easy task, with a very special interest in the frame of ESTB expansion activities. In a first phase, the state of the art network communication technologies have been studied, finding that ISDN or ADSL could be excellent candidates to be used in the FIBE context. At the time of this writing (April 2004), preliminary feasibility tests are being performed by SGI (GMV Group, Spain). These tests should provide an initial confirmation of the ADSL feasibility for FIBE. Based on the obtained results, ESA will study any further experimentation that could be necessary, prior to the substitution of some ESTB – RIMS links by the Internet.

- **EGNOS Navigation Terminals (Eurotelematik, Germany).** In a first phase, this project has developed two land mobile terminals and one maritime terminal as prototypes, based on specific EGNOS receivers. In addition, three prototype applications were implemented and demonstrated. In a second project phase the industrialisation of the equipment and the applications is intended in order to achieve prices, which are competitive on the professional mass market. In this context the project performed a market survey on low cost EGNOS OEM receivers, selecting two of them and evaluating their actual operational characteristics. In addition, the added value of feeding SISNeT information (converted to RTCM format) into those receivers has been assessed, obtaining promising results (detailed information can be found in [28]). The applications demonstrated in the second phase exploit the advanced features of the EGNOS signal and thus benefit significantly from the improved availability of EGNOS data using SISNeT as a backup distribution channel. The applications covered in the project are: public services, transportation of goods, forestry applications, road tolling, steering aid for dredging and vessel monitoring. For further information about EGNOS Navigation Terminals, the reading of [29] is strongly recommended.

- **ADVANTIS**. This GJU project, developed by a consortium leaded by GMV (Spain), aims at providing integrity for liability-critical applications. In other words, ADVANTIS focuses on applications where liability regime has a legal or commercial nature. Integrity information is necessary for a satisfactory development of such applications. The single user-equipment / multiple services will be the main philosophy to be followed in this project. ADVANTIS user equipment will be able to access SISNeT and take benefits from the potential offered by this technology.

- **ARMAS**. This ESA project aims at developing an automatic road-tolling service. The ARMAS project is being developed under ESA contract, by several European companies, and its main objective is to assess the feasibility of an Intelligent Car Navigation System, based in GNSS and Cellular Network technologies, in order to improve the safety, make dynamic traffic management a realistic proposition and provide a competitive solution for Road Tolling based in Satellite Positioning.The interest of using SISNeT has been identified, and it is under assessment at the time of this writing.

In addition, it is worth to say that state-of-the-art simulation tools start including SISNeT simulation capabilities. A good example is the GMV POLARIS software [30], a professional tool including specific models to simulate SISNeT.

THE ESA EMS SERVICE: A NON-REAL-TIME COMPLEMENT TO SISNET

In October 2003, ESA launched the EMS (EGNOS Message Server), a 24h/24h archive of the EGNOS message broadcast through the IOR-W Geostationary satellite (PRN 126), publicly accessible via FTP.

EMS [36] stores the EGNOS messages in text files, each one containing one hour of transmissions. The following organisation is applied:

- Files corresponding to each day-of-year are put together into daily directories;

- Daily directories corresponding to each year are put together into yearly directories;

- Yearly directories are contained into top-level directories, each one corresponding to the transmission of a specific GEO satellite.

At the time of this writing, only the IOR-W satellite is being tracked by EMS, since this has been the one employed during EGNOS integration and verification activities. Current EGNOS transmission involves up to three GEO satellites (AOR-E, IOR-W and Artemis). Thus, ESA plans to include the broadcast of Artemis (PRN 124) in the EMS server, in the very short term. The next step will be the upgrade of the platform to include AOR-E broadcast as well.

The EMS server can be accessed at ftp://ems.estec.esa.int

All the details about the EMS file format and organisation can be found in the EMS User Interface Document [36], available at the EMS official website (http://www.esa.int/navigation/ems). More generally, ESA has created a dedicated EGNOS website for professionals [37], which covers the EMS and other services.

The EMS service is demonstrating a significant potential in the independent monitoring of the EGNOS broadcast and the validation of SBAS receivers. In addition, ESA has developed SISNeTlab, a tool able to connect to EMS, download the data corresponding to a requested period, and perform analysis of the SIS compliance to the standards.

AN OUTLOOK TO THE FUTURE: THE ESA INSPIRE INTERFACE

Since 2002, ESA has put a noticeable effort in the field of dissemination of the EGNOS messages through non-GEO means, with a significant effort in transmission via the Internet, but also considering other means like DAB (Digital Audio Broadcast) or RDS (Radio Data Service).

The high degree of success achieved in those activities has motivated ESA designing a consolidated and professional evolution of the SISNeT service, called INSPIRE (INterface System for the Provision In Real-time of the EGNOS products).

INSPIRE will consist on an interface to the EGNOS system, which will provide access to all EGNOS basic products (e.g. EGNOS messages, ephemeris information, RIMS data, etc.) in real-time, and with certain guaranties of delay, security, safety, etc.

Specific Service Providers will connect to the INSPIRE Interface and will exploit the EGNOS products, supplying multi-modal services to final users, principally through non-GEO means. The re-use of ESA technologies (e.g. SISNeT protocols, EMS, etc.) will be maximised. The mosaic of services that could derive from INSPIRE is really large, including:

- Provision of SISNeT services;
- Provision of the EGNOS information in RTCM format;
- EGNOS pseudolites;
- Provision of EGNOS services through RDS [31];
- Provision of EGNOS services through DAB;
- Provision of WARTK-based [32-35], corrections;
- Accurate ionospheric delay/TEC maps;
- Provision of RIMS data;
- Provision of performance data (e.g. XPL availability maps, GIVE maps, etc.)
- Provision of EGNOS message files (following the EMS format [36]);
- Provision of ready-to-use information via SISNeT: fast corrections, ionospheric corrections based on the user position, etc… these values being directly provided on demand.
- Provision of GPS (and then GEO and GLONASS) IGS-based services (e.g. by post-processing the EGNOS RIMS data and EGNOS messages.)

ESA plans to develop the INSPIRE interface during the 2004 – 2005 timeframe, in the context of the EGNOS evolution program, thus becoming an integral part of the EGNOS system version 2. To demonstrate the capabilities of such interface, the development of a generic INSPIRE multi-modal server is foreseen under Task 3 of the GNSS Support Program, through open competition.

SUMMARY AND CONCLUSIONS

This paper has presented the ESA SISNeT technology status and future plans.

After some background on the EGNOS project and the EGNOS System Test Bed, the SISNeT project has been introduced and described in general terms.

After that, the already performed industrial activities around the SISNeT project have been briefly introduced, including development of several receivers and their application in various fields like bus fleet management and helping blind pedestrians navigate. Some relevant experimental results from those activities have been also presented.

Then, several ongoing ESA contracts, which consider applying the SISNeT technology in a number of fields, have been briefly introduced. Those fields include liability critical applications, automatic road tolling, public services, forestry applications, transportation of goods, etc. In addition, the consideration of SISNeT in state-of-the-art simulation tools (like GMV POLARIS software [30]) has been highlighted.

All those activities have demonstrated further the potential of the ESA SISNeT technology, and have opened the door to new challenges in numerous fields.

This paper ends with an outlook to the future, presenting INSPIRE, the future professional evolution of SISNeT, which will provide the basic products of EGNOS, allowing service providers to exploit this information, supplying a large mosaic of multi-modal services through non-GEO means.

The successful results derived from ESA contracts on the SISNeT technology demonstrate the potential of this ESA technology. Moreover, the consideration of this technology in multiple contracts provides confidence on the future of SISNeT. The Authors firmly believe that SISNeT will continue opening doors to innovative applications, and will become a mature technology, becoming integral part of EGNOS through the INSPIRE interface and derived services.

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