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The GIANT Project

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BIOGRAPHY

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ABSTRACT

As the European satellite navigation programme moves forward, with EGNOS as the first step towards Galileo, the user community finds out the potential benefits that the GNSS-based applications can provide to the different economic areas of society. The aviation sector, which has played a decisive role in the specification of these systems, can obtain significant advantages by means of the combined use of GNSS (Global Navigation Satellite Systems) systems, once the technical, operational and regulatory problems are overcome.

This paper describes the activities that are planned in the context of the GIANT project, the organization of the proposed work and a detailed description of the flight trial campaign.

PROJECT OBJECTIVES

GIANT (GNSS Introduction in the AviatioN secTor) is the response of an international consortium, headed by INECO, to the European Commission (EC) 6th Frame Programme (FP6) Call 2411, Area 1A, "GNSS Introduction in the Aviation Sector", managed by the Galileo Joint Undertaking (GJU).

This project is aimed to support the introduction of EGNOS (European Geostationary Navigation Overlay System) and Galileo services in the aviation sector, maintaining the safety levels which are required by the responsible Authorities. It is essential that this project will be built on the results of the EUROCONTROL activities. The management of this project will be closely coordinated with EUROCONTROL continuing the cooperation with the GJU, and to ensure that the project directly supports, and provides added value to, the existing Navigation Domain tasks.

More specifically, the general objectives of this project are:

- Identify all the necessary steps to introduce and maximise the use of EGNOS/Galileo in Europe and in the world for aviation.
- Evaluate and assess all the EGNOS/Galileo safety, operational and economical benefits against current existing scenario.
- Carry out business, market, economical and safety studies.
- Support the GJU providing results from economical and business studies performed by entities independent of potential EGNOS Economic operators and Galileo Concessionaires.
- Progress on the definition of a fair cost allocation policy for aviation.
- Prepare a transition plan from EGNOS to EGNOS/Galileo in the aviation domain and to identify all the necessary steps and activities for the transition to GNSS sole means of navigation.
- Assess all the already identified EGNOS/Galileo applications in this user community domain versus all the different technical and non-technical enablers.
- Provide an instrument for the dissemination and promotion of the EGNOS/Galileo benefits and added-values with respect to the current GPS solution and the terrestrial navigation aids

solution (e.g. VOR, NDB, DME, ILS) targeting airspace users.
- Support technological developments (e.g. installation of the EGNOS/Galileo receivers on board ,…).
- Identify and promote new and innovative EGNOS/Galileo applications in this user community domain (e.g. support to surveillance applications) in order to explore all the potential of this technology in medium and long term.
- Assess the necessary legal and regulatory steps to be undertaken in order to enable the operational introduction of EGNOS/Galileo services in the aviation sector.

The project started on 12th July 2005 and will last two years.

BACKGROUND

In October 1992, the International Civil Aviation Organisation (ICAO) Assembly endorsed a Strategic Action Plan, developed by the Special Committee on Future Air Navigation Systems (FANS), which includes the CNS/ATM Concept (Communication, Navigation & Surveillance/Air Traffic Management). Since the realisation of that concept would take a high degree of international co-operative effort, ICAO established another special committee (FANS Phase 2) among whose tasks was the development of a global co-ordinated plan.

The Global Plan, approved by the ICAO Council on 9 March 1994, provides a description of the CNS elements and associated ATM requirements and, in general terms, their expected benefits. It also indicates achievable timescales for implementation of the system elements including details and dates for ground, airborne, space segment elements and ATM applications. This plan contains, as a principle, the most extensive use of the available satellite technology for navigation and communications. The CNS/ATM concept was understood as technical (CNS) and operational (ATM) components of the global system. It envisages the Global Navigation Satellite System (GNSS) as the main navigation system including satellite constellations, aircraft receivers, and system integrity monitoring, augmented as necessary to support the Required Navigation Performance (RNP) for specific phases of flight.

Recently, the 11th Air Navigation Conference of the ICAO (September 2003) has represented an important support for the introduction of GNSS services in the civil aviation domain. The Conference supported that Global Navigation Satellite Systems have the potential to become global and seamless aids for navigation for all phases of flight. The Conference also admitted that GNSS have inherent vulnerabilities that have to be mitigated, and that further work on this will be required.

Before concluding on a transition towards sole service GNSS, which is not expected before 2015 by ICAO, a magnitude of technical, legal and economical questions have to be solved. Special emphasis will have to be given to:
- Safety aspects (e.g. appropriate mitigation of GNSS vulnerabilities).
- Demonstration of the operational benefits to airspace users.
- Cost effectiveness of GNSS and fair allocation of costs.
- Development of receivers and their on-board integration.
- Legal and regulatory aspects.

As a first step of this transition to GNSS, the Conference explicitly encouraged National Authorities and Air Navigation Service Providers (ANSP) to implement navigation applications (e.g. Approach with Vertical Guidance -APV-) based on existing or upcoming space based augmentation systems (SBAS) like EGNOS in Europe or WASS in the USA.

Following ICAO recommendations and pursuing to implement the Council Conclusions regarding the use of EGNOS in the aviation domain, EUROCONTROL has recently included the introduction of APV operations based on EGNOS as one of its implementation objectives and will carry out the EGNOS/APV TEN-T supported activity, in partnership with the GJU, enabling the introduction of EGNOS services in Europe as integral part of its Navigation Domain Action Plan. The proposed activities will include among others: development of safety cases, preparation of the regulatory process, preparation of enablers for operational implementation, validation of the operational implementation methodology, increasing awareness amongst airspace users and supporting the airworthiness certification and operational approval process.

THE GIANT CONSORTIUM

GIANT is a user driven project. It means that this project deals with the development of a solution proposed by the industry, promoted by the Air Navigation Service Provider (ANSP) and accepted by the user (airlines).

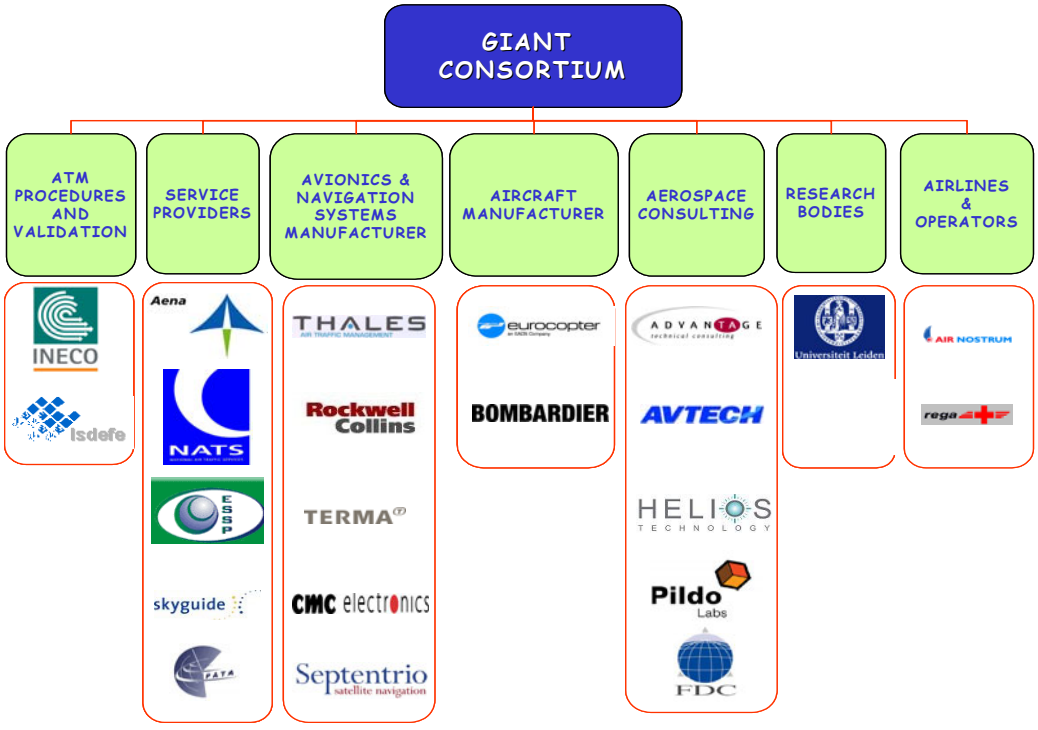

Figure 1. The GIANT Consortium

Being a user-pull project, the mobilisation of resources of GIANT shows the high involvement of the user community, supported by very specialized consultancy firms and the industry. It is worth to notice the implication of 5 SMEs (Small and Medium Enterprise) that represent more than 20% of the total budget, namely Helios, FDC, Pildo Labs, Advantage and Avtech.

The consortium is composed of 22 partners from 10 different European countries (Belgium, Denmark, France, Germany, Netherlands, Poland, Spain, Sweden, Switzerland and United Kingdom). The participation of 2 more relevant partners, outside of Europe (Canada) has been considered essential and strategic, to convince a specific type of aircraft users.

Furthermore, GIANT strongly aims at integrating results from past European projects. Through its consortium members, it will gain access to the results of these past projects. GIANT will also aim at establishing co-operations with ongoing and future initiatives to place the project in a bigger scale international effort. In fact, within the GIANT partnership there are partners who have been included in previous and ongoing related projects in Europe (e.g. ANASTASIA, OPTIMAL, GEM, GILT, ERNP, GARDA, etc). Hence, these partners will provide valuable inputs and continuity for the project.

Consortium and experts skills cover all required technical competences for the successful completion of the project entrusted to the GIANT consortium (See Figure 1):

- ANSPs (including providers from new EU member States) and airport operators: Aena, NATS, skyguide, PATA.
- EGNOS service provider: ESSP.
- Airspace users: Air Nostrum, REGA.
- Industries:
  - Aircraft and helicopter manufacturer: Bombardier, Eurocopter.
  - Receiver manufacturers: Septentrio, CMC Electronics Inc.
  - Local elements manufacturer: Thales ATM, Terma.
  - Avionics systems integrators: Rockwell Collins.
- Consultancy companies: INECO, Helios, FDC, Advantage, Avtech, Isdefe, Pildo Labs.
- Universities: International Institute of Air and Space Law (University of Leiden).

Considering that this project aims to increase the awareness among airspace users, aircraft and avionics manufacturers, GIANT has concentrated the flight demonstration campaign on the regional and rotorcraft market, probably the most interested airspace users for introducing APV approaches based on EGNOS. The consortium constitutes a complete value chain from the manufacturer to the actual end user (for the aircraft case):

- Air Navigation Service Provider and Airport Operator → Aena.

- Main Regional Airline → Air Nostrum.
- Main regional Aircraft Manufacturer → Bombardier.
- Avionics Manufacturer → Rockwell Collins.
- Receiver Manufacturers → Septentrio and CMC Electronics.

Similar product/service line is composed for the helicopter case with Eurocopter, (main helicopter manufacturer), CMC, skyguide and REGA.

THE GIANT STRATEGY

The starting point is the assumption that a ground based infrastructure will be required to provide a back-up to the GNSS for all phases of flight within the time-frame 2004-2015 due to the different issues to be addressed (systems susceptibility to localised spoofing and jamming, institutional issues associated with a strategic system such as GPS under the sole control of an individual state,…). In fact, the ECAC (European Civil Aviation Conference) Navigation Strategy recognizes the need for an independent navigation infrastructure based upon DMEs to guarantee availability and continuity in the en-route and terminal phases of flight.

The proposed concept, which will evolve through the project, is to consider for this study three steps for the transition to GNSS sole-service of navigation. For each of the proposed phases, the required activities will be performed to ensure an appropriate introduction of EGNOS/Galileo into Area Navigation (RNAV) applications for en-route, Terminal Airspace (TMA) and approach operations.

Phase 1: EGNOS as a complementary means to existing operations:

- En route: BRNAV (Basic Area Navigation).
- In TMA: PRNAV (Precision Area Navigation).
- RNAV SIDs (Standard Instrument Departure) & STARs (Standard Instrument Arrival).

The use of EGNOS for specific applications requires the approval by the appropriate regulatory body of the EGNOS installation in an aircraft complying with certain airworthiness certification standards and the operational approval of the operator, published by the Joint Aviation Authorities (JAA) and EASA

Phase 2: New operations: APV approaches.

Large aircraft manufacturers (namely Airbus and Boeing) have no plans to introduce EGNOS based systems as there is little demand from airlines. This project, co-ordinated with the EGNOS APV programme, should demonstrate positive cost and operational benefits to convince both operators and manufacturers. The aim of the demonstration proposed within GIANT is to promote the use of APV operations using GNSS (EGNOS) vertical guidance to enhance safety and accessibility (APV operations could be the required driver to take advantage of the EGNOS service).

APV operations provide enhanced safety and generally lower operational minima as compared to non-precision approaches (NPA). EGNOS could be definitively an enabler to introduce approach capability with vertical guidance on all runways, for a wide range of users.

Nowadays different GPS-ABAS (Airbone Based Augmentation System) based approaches are under investigation, it is therefore necessary to show:

1. Complementarities of the EGNOS approach
2. Improvement of EGNOS (vertical guidance, more accessibility for regional/general aviation,…)

Phase 3: Combined use of GALILEO/GPS, reinforced by regional integrity systems (EGNOS) for sole service solution

- RNP RNAV Operations (2015-2020)
- 4D RNAV Operations (+2015)

The third phase would consist of at least two independently operated fully interoperable constellations GPS and Galileo, reinforced by regional integrity systems (EGNOS integration under study), emitting their signals simultaneously on at least 2 different frequencies for aeronautical safety of life applications.

In this proposed concept , “fully-inter-operable” means that the frequency assignments and signal structures of the two systems are designed to allow the use of a single cost-effective receiver taking advantage of the availability of the two constellations.

In addition to that, the most stringent precision landing requirements (CAT II-III) would be met by means of local components, such as the Ground Based Augmentation Systems (GBAS).

This combined use of the different GNSS elements is expected to bring benefits in terms of performance and safety. The aviation will take the advantage of redundancy in frequencies and systems (GPS and Galileo will be two separate systems with no common modes of systematic failures). This added redundancy may be the enabler to provide a GNSS sole service.

GIANT will put the emphasis on the GNSS long-term vision for aviation and the introduction of EGNOS/Galileo/GPS combined services.

PROJECT WORK BREAKDOWN

The work has been organised in eight different work packages that interact among themselves to ensure the fulfilment of the objectives of the project.

WP 0, Project Coordination, deals with the project management issues, to ensure the proper coordination between activities and partners and with external groups and activities in order to achieve the expected results with the required quality and on time. This work package (WP) last over the whole duration of the project and have interactions with the rest of WPs.

WP 1, Action and Transition Plans. The purpose of the work package is to provide an exhaustive and comprehensive assessment of all the already identified EGNOS/Galileo applications against all the different technical and non-technical enablers and to propose specific action plans in order to build a strategic plan for the progressive introduction of GNSS services in aviation complementing the tasks to be developed by EUROCONTROL (e.g. EGNOS/APV project funded with the TEN-T grant). A specific transition plan from EGNOS to EGNOS/Galileo will be proposed, where all the necessary steps to introduce and maximize the use of EGNOS/Galileo in aviation will be identified.

WP 2, Development of Innovative Applications. This WP will identify innovative non-navigation applications and services that could be supported by GNSS. It is foreseen to deal extensively with three major fields of applications, namely Automatic Dependent Surveillance (ADS), Surface Movement Guidance and Control Systems (SMGCS) and Digital Data Link (DDL) synchronization. In addition, two more potential areas of applications may be Air Traffic Management and Operations based on 4D trajectories and In-Trail Separation of aircraft. This work package will also perform the corresponding assessment of each of the proposed innovative EGNOS/Galileo applications against all the different technical and non-technical enablers.

WP 3, Demonstration of the Operational Benefits of GNSS to Airspace Users. This WP will provide the appropriate instruments to increase the mutual awareness of the aviation and GNSS community to foster the introduction of GNSS in the Aviation Sector as well as the investment in GNSS (mainly oriented towards aircraft manufacturers and airlines). Different operational scenarios (including flight trial campaigns in a real operational scenario based on EGNOS) have been proposed to be representative of the future real operations of EGNOS. This WP will require useable results from business, market, economical and safety studies in order to have the material upon which to base the arguments of the awareness campaign

WP 4, Business, Market, Economical and Safety Studies. The WP will undertake safety and economic studies to support the awareness raising campaign. This WP will show the potential benefits of EGNOS/Galileo services and investigate their safety. Specific studies for the Air Nostrum case will be developed in this WP.

WP 5, User Terminal. The WP will define the airborne system that is required to take advantage of the performance provided by EGNOS and Galileo, taking into account that the airborne architecture will be different for the different categories of airspace users such as General Aviation and transport category aircraft. Thus, as a first step, potential GNSS users, GNSS functions and performance, and presently existing GNSS on board equipment installation will be identified. On integration of GNSS terminals in airbone system architecture, an analysis of retrofit and forward fit requirements for each group of users will be performed, as well as a discussion of the hybridization of GNSS data with other sensor data (such as inertial). Existing material with respect to airworthiness certification and operational approval related to GNSS equipment will be reviewed and a series of conclusions and recommendations will be raised. Specific studies for the CRJ aircraft case will be developed in this WP.

Figure 2. The Garmin GNS 400 SBAS receiver is the preferred option for the APV trials within GIANT

WP 6, Local Elements. The WP will identify the technical and non-technical service enablers as well as the open issues and the main risks linked to the introduction of the applications supported by the local elements. This part of the project addresses the augmentation, which will be provided in future by a Galileo GBAS type local elements installed at airports in order to provide precision approach and landing from CAT I to CAT III. Previous and on-going studies of Galileo local elements for aeronautical applications, with emphasis on system and ground infrastructure aspects, will be reviewed and an action plan for the introduction of Galileo local elements at airports from a European perspective will be elaborated.

WP 7, Assessment of Legal and Regulatory GNSS Enablers. The regulatory activity will perform a deep assessment of the current frameworks and consider proposals made to date and then formulate a recommended policy which can be used to overcome any identified obstacles, either by a legal work around or new legislative approach.

FLIGHT TRIAL CAMPAIGN

It is worth to mention the flight trial and test campaign that will be carried out within the framework of the GIANT project. The objective is to demonstrate to the aeronautical community the benefits of the services based on EGNOS/Galileo. Consequently, and after and initial analysis phase, there have been identified a couple of potential operational scenarios whose users can obtain a major benefit from the use of GNSS systems.

Figure 3. Air Nostrum Dash-8 aircraft

The benefits that the aeronautical sector can obtain, are classified into two categories:

- Operational benefits:
  - Reduction of the minimums in comparison with non-precision approaches.
  - Reduction of the number of missed approaches.
  - Better operational safety, thanks to vertical guidance with EGNOS.
  - New procedures in runways without ILS.
- Economic benefits
  - Reduction of the maintenance costs of the ILS infrastructure.
  - Flight time and fuel consumption reduction.
  - Simpler and lower-cost avionics, affordable for a greater number of users (i.e. regional airlines).

Scenario 1 – Aircraft

This scenario is devoted to demonstrate the estimated benefits of GNSS through a number of APV approaches based on EGNOS at the non-ILS-equipped runway at Valencia airport initially. Additional flight trials will be performed in other European airports. Due to the fact that RWY 12 is not equipped with an ILS, the minima of the available NPA approach is quite high (OCH=1000 feet). The trials will be performed by the Spanish regional airline Air Nostrum, using Dash-8 aircraft (Figure 3). The key added value for these trials is that, for the first time in Europe, the flights will be conducted by a regional airline plane using the available EGNOS signal.

The EGNOS avionics suite would be fully independent from the one already installed onboard in order to avoid detracting from the aircraft airworthiness and minimising the cost of the installation.

Scenario 2 – Helicopters

This scenario aims at performing a local demonstration of EGNOS capabilities for improving the safety and reliability of Helicopter Emergency Medical Service (HEMS) operations. Indeed, today almost all HEMS flights are still conducted under visual rules (VFR), even at night and in adverse weather. Firstly, some pre-demonstration flights will take place near Eurocopter installations in Marignane (Switzerland). Afterward, two major trials will be performed consisting in IFR APV approaches based on EGNOS in a helipad in Lausanne and low level IFR flights linking two Swiss hospitals. The Eurocopter EC155 Systems Demonstrator helicopter (shown in Figure 4) will be used, which is the Eurocopter flying platform for advanced systems research. Pilots from Sécurité Civile (French Search & Rescue service), REGA (main Swiss HEMS operator) and FOCA (Swiss Civil Aviation Authority) will be invited to take place inboard of the EC155 to fly some approaches.

Figure 4. The Eurocopter EC155 Systems Demostrator

Additional flight trials

Additional flight trails will be proposed for both the aircraft and helicopter scenarios described above. The former would consist of APV approaches with integrated SBAS avionics on CRJ 200 aircraft operated by Air Nostrum (Figure 5). WP 5 "User Terminal" outcome would be an input for this task. The helicopter scenario will cover EGNOS based approaches in oil rigs in the North Sea, which are characterized by severe meteorological conditions and a structural complex environment.

Figure 5. Air Nostrum CRJ 200 aircraft

ABBREVIATIONS

ADS	Automatic Dependent Surveillance
ABAS	Airbone Based Augmentation System
ANSP	Air Navigation Service Provider
APV	Approach with Vertical Guidance
ATM	Air Traffic Management
BRNAV	Basic Area Navigation
CAT	Category (Precision approach)
CNS	Communication, Navigation and Surveillance
DDL	Digital Data Link
DME	Distance Measuring Equipment
EASA	European Aviation Safety Authority
EC	European Commission
ECAC	European Civil Aviation Conference
EGNOS	European Geostationary Navigation Overlay System
ESSP	EGNOS Satellite Services Provider
EU	European Union
EUROCONTROL	European Organisation for the Safety of Aviation
FANS	Future Air Navigation System
FP	Frame Programme
GBAS	Ground Based Augmentation System
GJU	Galileo Joint Undertaking
GNSS	Global Navigation Satellite System
ICAO	International Civil Aviation Organisation
IFR	Instrument Flight Rules
ILS	Instrument Landing System
JAA	Joint Aviation Authorities
NDB	Non Directional Radio Beacon
OCH	Obstacle Clearance Height
PRNAV	Precision Area Navigation
RNAV	Area Navigation
RNP	Required Navigation Performance
SBAS	Space Based Augmentation System
SID	Standard Instrument Departure
SME	Small and Medium Enterprise
SMGCS	Surface Movement Guidance and Control System
STAR	Standard Instrument Arrival
TMA	Terminal Manoeuvring Area
VFR	Visual Flight Rules
VOR	VHF Omnidirectional Radio Range
WP	Work Package

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