European Union Sixth Research Framework Programme 2002 – 2006

Global Navigation Satellite System (GNSS) Research

Project Synopsis

European GNSS Supervisory Authority

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Global Navigation Satellite System (GNSS) Research

European GNSS Supervisory Authority

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Global Navigation Satellite System (GNSS) Research under the Sixth Framework Programme (FP6) for Research and Technological Development

With FP6 (2002-2006), the European Commission clearly identified areas of fundamental interest for GALILEO user recognition and market penetration, and earmarked €110 million for GALILEO R&D activities under its 'Aeronautics and Space' thematic priority.

FP6 GALILEO research is described in the 'GALILEO detailed work programme', which encompass all activities in the 2003-2006 timeframe. General research areas include applications, the user segment, standardisation, certification, local components and Galileo mission definition.

Beginning in July 2003, GALILEO R&D activities financed under FP6 were launched across three separate calls for proposals, with budgets of €20 million, €80 million and €10 million, respectively. Funding covered a wide range of tasks, areas and activities, all aimed at achieving the larger general objectives of GNSS research and development. Specific items included:

- Preliminary user receiver development
- Local elements core technology development - building upon concepts established under the Fifth Framework Programme
- Introduction of GALILEO Services using EGNOS
- Application market development, including safety-of-life (SoL) applications
- Initial mission implementation activities
- Early preparation of market penetration
- Optimisation of the GALILEO navigation mission and the complementary non-navigation missions
- Benefits of the combined use of GALILEO and GPS services
- Supporting European industry in key technological developments
- Involvement of SMEs to underpin innovation
- Support for the international dimension of GALILEO
- Tracking and tracing – electronic fee collection, animal tracking, transportation of dangerous goods, fisheries, etc.
- Crisis management – including convergence of GALILEO, SATCOM and GMES and all potential synergies between these systems and services
- Time and synchronisation
- Utilisation of the public regulated signal (PRS) - development of the user segment

- Complete GNSS signal simulator for receiver testing – development and early validation of user segment technologies.

All FP6-funded activities were meant to complement the development phase of GALILEO, jointly financed by the European Union and the European Space Agency, and have therefore been carried out in close coordination with ESA.

More information on European Union GNSS research activities can be accessed on-line at: **www.gsa.eureopa.eu**

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ADvantis: A centralised guaranteed integrity localisation service - a key for the EGNOS and Galileo business model

The advent of satellite navigation technology offers new possibilities which could result in a significant spread of potential commercial applications. The GJU commissioned a project to find out how Galileo could be used to advance non-safety critical applications by exploring the use of guaranteed integrity.

ADvantis focused on the possibility of establishing an 'integrity service provider' to demonstrate the feasibility of key GNSS-based liability-critical applications.

Background

Some GNSS-based applications are not feasible with the GPS system due to the lack of guarantee on service availability and service integrity, which wipe out confidence in the results and jeopardise the business case.

ADvantis' applicability extends to areas of safety non-critical application in which service integrity is essential, for example authorities responsible for the mobility of individuals and goods, road transport (interoperability among tolling systems, traffic management systems, traffic information), car insurance companies, transport regulators, justice/police.

The candidate applications have a weakness in the liability regime and integrity offers a means for resolving conflicts between the involved parties in these so-called 'liability-critical' applications, which are classified in two categories as a function of the nature of the liability regime:

- commercial, where integrity could be used to solve a conflict between two contractual parties;
- legal, where the two parties involved are a legal body and individuals/organisations subject to existing legislation.

The ADvantis concept is an efficient answer to the needs posed by the liability-critical applications to put the individuals using some non-navigation services in contact with the providers of the services.

It 'links' individuals using a single terminal with different companies/organisations that can exploit localisation, and adds value to both sides by guaranteeing that the user localisation at a certain time is known to be correct up to a certain predefined level.

Objectives

The objective of the ADvantis project was to define a centralised system, and associated business model, to provide multiple end users with a liability-critical, integrity-guaranteed position service using single mobile equipment.

Description of work

The concept was proved by the implementation of an ADvantis prototype and the execution of a relevant set of trials.

The provision of ADvantis services requires a minimum infrastructure:

- a global centre of localisation services with an integrity guarantee (GCLSI)

where localisation data from all the different units is centralised and where the integrity and privacy of this data is ensured.

- standard onboard units (OBU), which will implement Galileo receivers together with specific data processing and communications with GLCSI.

The business model looked at two types of customers:

- individuals, car owners or fleet managers who want access to the services provided by a third company/organisation;
- clients, companies/organisations, which use the localisation data of the aforementioned car owners or individuals.

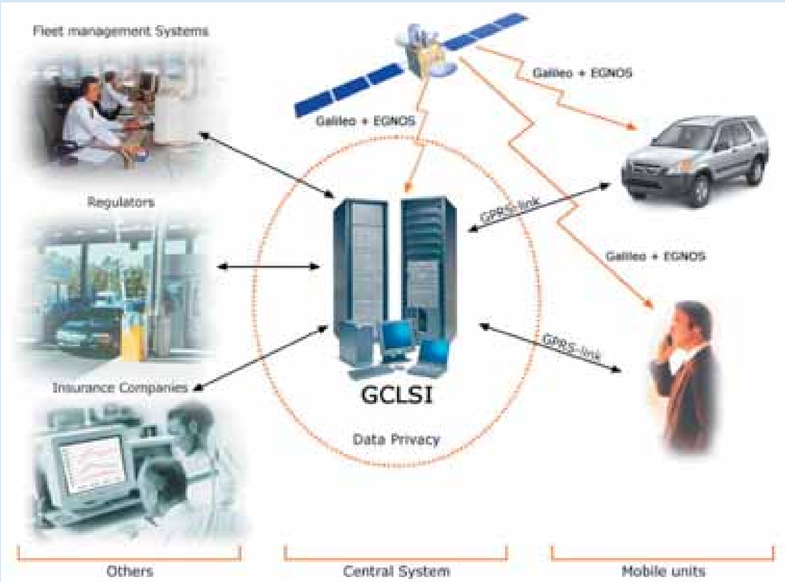
They will pay for the data as an efficient way (i.e. not requiring a dedicated infrastructure) of either charging for the use of the provided service or for monitoring and control purposes.

The project combined a multi-disciplinary approach to establish the basis for the implementation of an operational system and associated services in two phases:

Phase A covered the detailed analysis of the user needs, service and system definition focusing on:

- the legal and regulatory aspects for the future implementation of a European seamless system;
- clear specification of a single contractual framework;
- commercial feasibility of the project;
- maintaining data privacy;
- elaboration and refinement of centralised GCLSI.

Phase B covered the design and development of an operational prototype together with the execution of trials and analysis and the dissemination of results.



Results

During Phase B, the feasibility of the concept was proven through the development of a prototype, the planning and execution of a set of trials, and the dissemination of results.

The development of the prototype involved the use of new key technologies, for example new algorithms to preserve integrity at the user level in non-controlled environments, alternative means like SISNET for the EGNOS broadcast, and assisted GNSS.

The trials focused on two potential users identified as the most common probable users in market analyses: personal mobility and road transportation.

The project results fully demonstrated the concept: the feasibility of a system that guarantees the integrity of the position at user level and the availability of this guaranteed position for a number of service providers linked to liability-critical applications.

The 'single-user-equipment/multiple-services' concept solves many of the problems that today affect the automatic tolling in Europe. It is very well adapted to implement the EU Transport Policy due to its flexibility, interoperability and performance.

ADvantis will be a revenue collector for EGNOS and Galileo: real cash flow will be generated from the contract established with ADvantis customers. Thus ADvantis is a major enabler justifying the commercial feasibility of Galileo.

Finally, the implementation of new applications, in the range of the target applications identified, would not require any particular infrastructure to be developed but simply the establishment of a contract with the ADvantis service provider.

More information

Acronym:	ADvantis
Name of proposal:	ADvantis: A centralised guaranteed integrity localisation service - a key for the EGNOS and Galileo business model
Contract number:	1003/CTR/FP6/NV
Total cost:	€ 2 518 947
EU contribution:	€ 1 285 606
Call:	FP6 1st Call
Starting date:	03/02/2004
Ending date:	20/03/2006
Duration:	25 months
Website:	http://www.galileo-advantis.com
Coordinator:	Mr Santiago Golmayo, GMV Aerospace and Defence, S.A. Isaac Newton, 11. P.T.M. ES 28760 Tres Cantos - Madrid
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Project Officer:	Stefano Scarda
Keywords:	Liability-critical, integrity in non-controlled environment, data privacy, interoperability, business model

Partners	GMV Sistemas	ES
	ESSP	BE
	Alcatel Space	FR
	ERP	BE
	AON-Explorer	FR
	Septentrio Satellite Navigation	BE
	SGI	ES
	NSL	UK
	Skysoft	PT
	AEC	ES

AGILE

Application of Galileo in the LBS Environment

AGILE aims at fostering the take-up of Global Navigation Satellite Services in the key sector of mass-market location-based services (LBS), with special emphasis on the use of EGNOS and Galileo. The ultimate objective of AGILE is to define, in detail, a roadmap that will efficiently bring Galileo-based, value-added applications to reality. This will support mobile telephone users, as well as service providers who create and manage location-sensitive value-added services.

Background

Location-based services for personal mobility have for some time been recognised as the primary future market for Galileo in terms of the number of users and potential revenue. Previous GNSS/Galileo activities in this field have focused, primarily, on emergency services and professional applications. The challenge of the AGILE project is to address the overall LBS mass-market, focusing on all aspects (marketing, institutional and technical) that may facilitate the acceptance and success of EGNOS and Galileo-based solutions from the perspective of delivering profitable business returns.

The successful development of the Galileo business within the LBS market relies on the level of interest and confidence that the decision-makers at major telecom organisations have in Galileo for their business development. It is essential therefore that the telecom actors are made fully aware of the key features of EGNOS and Galileo in general and with respect to GPS. This promotion focus is especially important for Galileo as it continues to be developed, as the telecom world is mainly driven by short-term perspectives. However, with this in mind it is clear that the current EGNOS availability is the immediate solution to promote within the telecom environment. EGNOS' value-added services, which cannot be achieved by GPS, will enhance the solution and instil interest and confidence.

The AGILE project places emphasis on the LBS enablers which will foster the development of GNSS-based LBS applications for the mass market. The ultimate objective is to proceed and consolidate the overall roadmap and actions which will efficiently bring Galileo-based, value-added applications to reality for the benefit of users and investors.

Objectives

The two main objectives of AGILE are:

- In the context of fierce competition from American companies, AGILE consolidates the position of the European LBS industry in the emerging LBS domain and develops pre-commercial EGNOS-based applications.
- In the context of medium-term Galileo deployment, AGILE paves the way for the successful launch of Galileo-based LBS applications.

The short-term strengthening of European industry in the LBS business will be the result of a clear and precise assessment of the European LBS market, and the demonstration and promotion of EGNOS-based commercially reliable services (as an improvement on GPS).

The mid-term objective will be achieved by tackling the necessary LBS enablers (marketing, institutional and technical) in order to define a clear road map and consolidate a precise action plan for supporting the development of Galileo-enabled applications in the LBS user community.

Description of work

The working methods of AGILE can basically be split into technical and non-technical methods. Both of them are aiming at meeting the overall project expectation, i.e. paving the way for the successful launch of Galileo-based LBS applications.

Non-technical methods:

- Highly effective dissemination and awareness campaign linking Galileo intrinsically to LBS;
- Study and categorisation of mass-market LBS, including technical and feasibility assessment;
- Business aspects analysis for the LBS sector, including market sizing, business modelling and service provision aspects;
- Contribution to standardisation of location-based enabling technologies and implementations.

Technical methods:

Prototype development of a hybrid-positioning device, embedded into the following sample applications:

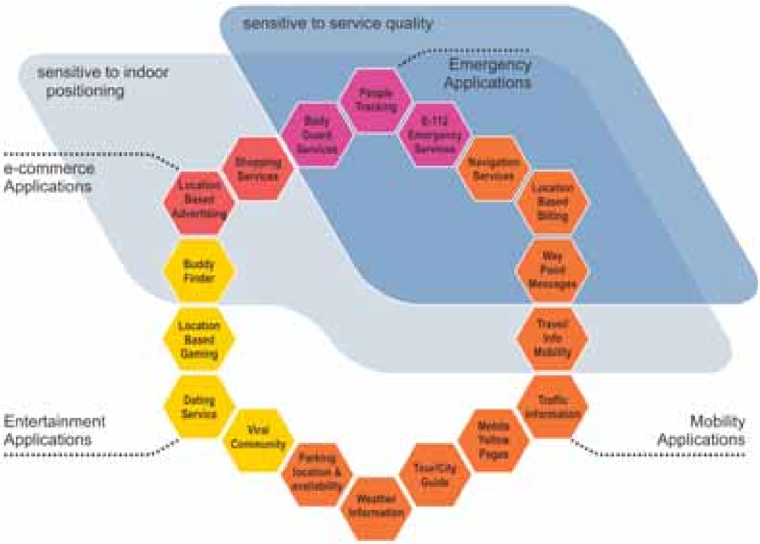
- buddy finder with 'community alert' functionality
- geo-marketing and location-based advertising.
- Demonstration event showing the hybridisation capabilities for a number of different positioning technologies (A-GNSS, mobile network-based, WiFi).

Results

The AGILE project will provide results covering all the key areas and elements required for the successful development of EGNOS and Galileo within the LBS business market.

The main outcomes therefore will be as follows:

- An assessment of the business and social benefits of EGNOS and Galileo within the LBS mass-market;
- A detailed road map for the development of EGNOS and Galileo in the LBS sector;
- A reference European consortium acting as representative of the overall LBS user community;
- An extensive and efficient promotion of EGNOS/Galileo value-added service within the telecom world;
- An active demonstration and awareness programme of pre-commercial EGNOS-based services at major events, especially within the telecom industries calendar;
- A flexible architecture that will integrate with the core (wireless) telecommunications infrastructure at minimum cost and disruption to the operator, allowing for its adoption by multiple operators in order to extend the continuous provision of commercial services across networks and international borders (roaming).
- An open LBS platform for validation, demonstration and awareness of European GNSS-based LBS applications, compliant with industry-recognised standards in the telecom, GIS and navigation sector.



More information

Acronym:	AGILE
Name of proposal:	Application of Galileo in the LBS Environment
Contract number:	GJU/05/2407/CTR/AGILE
Total cost:	€ 5 874 669
EU contribution:	€ 3 200 000
Call:	FP6 2nd Call
Starting date:	12/10/2005
Ending date:	30/11/2007
Duration:	25 months
Website:	http://www.galileo-in-lbs.com
Video:	The AGILE Movie **posted to ESN
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Project Officer:	Stefano Scarda
Keywords:	Galileo, GNSS, GPS, EGNOS, LBS, telecoms, location

Partners

LogicaCMG	SE
Thales Alenia Space	FR
CNES	FR
Deimos Space	ES
Enteos	IT
ERTICO	BE
ESYS	UK
GeoConcept	FR
INT	FR
IIASL - Leiden University	NL
Mapflow	IE
NAVTEQ	BE
NSL	UK
Skysoft	PT
Telecom Italia Lab	IT
TeleConsult	AT
Telefónica I+D	ES
Telefonica Moviles Espania	ES

ALIS

A proposal for the development of an At-sea Location Information Service

ALIS is a marine location-based information system for the leisure-marine market and is based on a flexible client-server architecture. The idea is that ALIS users subscribe to the ALIS service and from an onboard position ALIS clients are able to submit interactive real-time queries for navigation data related to their location, as well as receiving automatic navigation real-time data alerts relevant to their position. This aligns with the concepts of e-navigation being developed by the IHO and IALA.

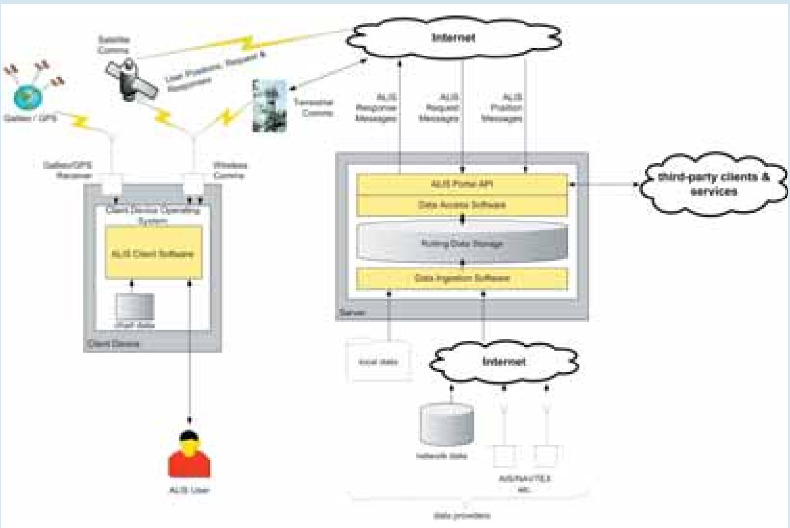
Background

Through previous feasibility work, current application development partnerships and in-depth knowledge of the marine information services marketplace, a new innovative commercial location-based service opportunity for the leisure marine market has been identified. This is an extensive expanding global market sector that is increasingly routinely concerned with accessing marine information as part of the decision-making processes. It also provides an easy test platform of concepts that can be applied to the commercial shipping sector.

Objectives

The project had the following objectives:

- definition of user requirements, specification and design of the service;
- identification of specific areas of Galileo-ALIS integration/linkage;



- implementation of a pilot service to provide an initial operational service;
- soliciting of pilot service user feedback in terms of service requirements, and future information needs;
- capture of market and business information, mapping out the commercial development of a full operational service.

Description of work

The work plan was as follows:

- Consolidation phase: The user requirements were developed, the system concept was documented and the pilot system specified for what it would contain in terms of functionality and data.
- Implementation phase: The pilot service's architectural components and interfaces were designed. On completion, a pilot service that demonstrates the major areas of service delivery was implemented.
- Technology transfer: Once the pilot service was tested, the project entered a period of pilot service operation, where it solicited feedback on the service. This feedback was input into a market assessment and creating a business plan.

Results

ALIS is based on mining geographical position data and accompanying GIS manipulation of dynamic and static spatial datasets to provide a unique marine location-enabled service. ALIS will tell a mariner who and what is in their vicinity, be it the nearest marina or a weather warning so they can react/plan accordingly.

ALIS uses a range of current GNSS, satcom and terrestrial data communication services and complements other onboard navigation systems. It is not intended to be safety critical, but it does provide advisory information. It is aimed at all classes of boat user, but particularly the mass-market general boat user who may not have many onboard electronics, and is based around a simple thin client and server architecture which is straightforward to deploy.

The ALIS system architecture is shown in the diagram. The various elements shown are:

- ALIS client: This consists of a bespoke software application resident on a user's onboard computing device (e.g. laptop, PDA, SmartPhone). The client software allows a user to define an ALIS query/request, transmit their location and to receive information from the ALIS server. The client software interfaces to:
- the user's onboard GNSS receiver, from which the ALIS client extracts their real-time position.
- the user's onboard mobile communications device(s), e.g. satcom terminal, satellite phone, etc., which provides a two-way internet connection from the client to the ALIS server.
- the user's locally stored nautical chart dataset for backdrop data display in the client software to give spatial context to ALIS data.
- ALIS server: The shore-based ALIS server consists of a data ingestion component that receives data from

a number of third-party sources, a RDBMS for storing this data and position information received from ALIS users, and a data access portal that provides an API to the database for client information requests and retrieval. The server interfaces to the following type of data sources:

- local data. Where data for ingestion is not available over a network, it may need to be ingested, either manually or via a process, from a local source. An example of this is Almanac information supplied as data files on CD.
- remote data. Much of the data ingested is available from remote databases or services. This includes data retrieved from third-party online databases or data received from third-party transmission systems (e.g. AIS or NAVTEX).
- third-party clients and services: ALIS has a well documented API and uses XML to pass requests and results between a client and the server. Therefore third-party client software developers can access ALIS. An example of this could be vessel-tracking services that access ALIS to retrieve position information on any ALIS subscriber.

More information

Acronym:	ALIS
Name of proposal:	A proposal for the development of an At-sea Location Information Service
Contract number:	GJU/06/2423/CTR/ALIS
Total cost:	€ 463 301
EU contribution:	€ 279 128
Call:	FP6 2nd Call
Starting date:	01/02/2006
Ending date:	30/04/2007
Duration:	15 months
Website:	http://www.alismarine.com
Coordinator:	Mr Richard Proud, ComSine Ltd 5, Elles View Barns Alton Road UK RG29 1RT South Warnborough
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Project Officer:	Eric Guyader
Keywords:	ALIS, e-navigation, leisure marine, information system, client-server, GNSS, mobile communications, LBS
Partners	GateHouse DK Techman Software FR Smartcom Software UK

ARTUS

Advanced Receiver Terminal for User Services

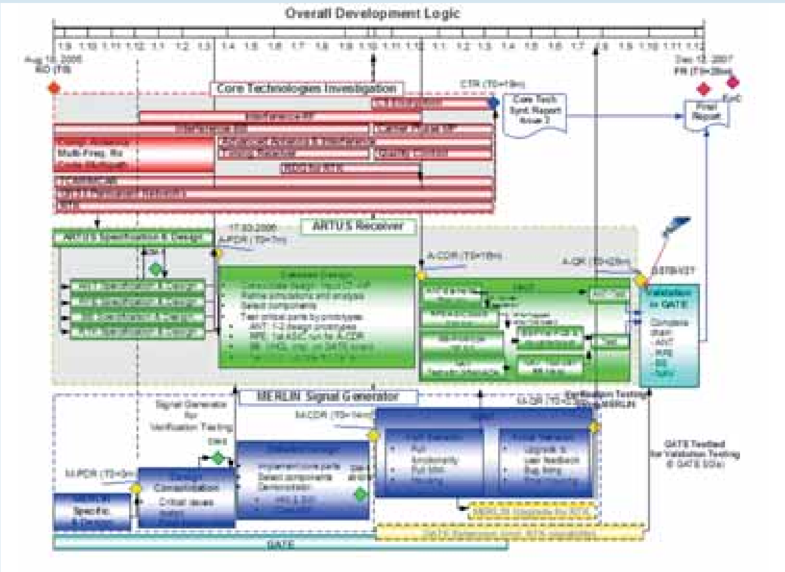
The main goal of this project is to implement and test a fully-fledged Galileo/GPS professional type receiver (ARTUS). As Galileo itself, as well as any Galileo signal sources, are not readily available, the second major goal is to design and build a Constellation Signal Simulator (MERLIN). As Galileo introduces new signal structures and becomes a new, innovative technology system, a central focus of the project is to develop corresponding new technologies for the receiver as well as for the signal generator.

Background

While the Galileo core system is developed in the frame of the ESA IOV phase, supported by the GSTB experimentation test beds, it is necessary to develop the necessary user application-driven user terminals in parallel, ensuring that commercial competitive receivers are available either as products or through applications and services as soon as the Galileo service is available.

Objectives

The ARTUS project is targeted towards the investigation of relevant core technologies for the professional receiver development. Based on Galileo receiver pre-developments, GPS RTK bread-boarding and on a complete Galileo professional prototype receiver (ARTUS), a receiver will be developed which supports all three Galileo frequencies including EGNOS. A Galileo/GPS signal generator (MERLIN) is being developed for signal validation which the consortium plans to commercialise as an independent product.



Description of work

The work in this project has been broken down into four interconnected main activities:

- Investigation of core technologies
- Development of ARTUS receiver prototype
- Development of verification signal generator
- Validation of the ARTUS prototype (with full receiver chain in real environment with SIS transmission).

For further information, please refer to the picture.

Results

The project plan foresees the following deliveries

Documents:

Task 1: Project & External coordination

PMP Project Management Plan KO

PR-n Progress Report 1-7

FR Final Report

IOV-TN Contribution to IOV Phase

ODP Overall Development Plan

A-DP-ANT Antenna Development Plan

A-DP-RFE RF-FE Development Plan

A-DP-BB Baseband Development Plan

A-DP-NAV Navigation Development Plan

M-DP-SG SG Development Plan

PB Project Brochure

PO Project Overview (Presentation)

Task 2: Core Technology Investigation

CT-SR Core Technology Investigation Syn-thesis Report

CT-TN 2110 Code Multipath Analysis

CT-TN 2120 Carrier Phase Multipath Mitigation

CT-TN 2130 Interference - Base-Band

CT-TN 2140 Interference Analysis for RF-FE

CT-TN 2210 RTK

CT-TN 2220 TCAR/MCAR

CT-TN 2230 RDG for RTK

CT-TN 2240 Permanent GNSS Networks

CT-TN 2310 Compact Antenna A-PDR

CT-TN 2320 Adv. Antenna and Interference Mitigation

CT-TN 2410 Commercial Service Code Encryption

CT-TN 2420 Quality Control

CT-TN 2510 (Bi-Frequency) Receiver

CT-TN 2520 Timing Receiver M-CDR

Task 3: Prototype Receiver Development ('ARTUS')

A-TS RX Overall Technical Specification

A-ADD RX Architectural Design Document

A-ICD RX Interface Control Document

A-TVP RX Overall Test & Validation Plan

A-DDD RX Detailed Design Document

A-TR RX Test Reports A-QR

A-UM RX User Manual A-QR

A-TS-ANT Antenna Technical Specification

A-TS-RFE RF-FE Technical Specification

A-TS-BB Baseband Technical Specification

A-TS-NAV Navigation Technical Specification

A-TVP-ANT Antenna Test Plan

A-TVP-RFE RF-FE Test Plan

A-TVP-BB Baseband Test Plan

A-TVP-NAV Navigation Test Plan

A-DDD-ANT Antenna Detailed Design Document

A-DDD-RFE RF-FE Detailed Design Document

A-DDD-BB Baseband Detailed Design Document

A-DDD-NAV Navigation Detailed Design Document

Task 4: Galileo Signal Generator ('MERLIN')

M-TS SG Technical Specification

M-ADD SG Architectural Design Document

M-ICD SG Interface Control Document

M-DDD SG Detailed Design Document

M-IVP SG Integration &Verification Plan

M-TR SG Test Reports M-QR

M-UM SG User Manual M-QR

Hardware:

MERLIN Galileo Signal Generator

ARTUS Professional Prototype Receiver

More information

Acronym: ARTUS

Name of proposal: Advanced Receiver Terminal for User Services

Contract number: GJU/04/2414-CL/NV

Total cost: € 4 669 990

EU contribution: € 2 469 977

Call: FP6 2nd Call

Starting date: 18/08/2005

Ending date: 12/12/2007

Duration: 28 months

Type: USER TECHNOLOGY

Website: http://www.artus-gju.org

Coordinator: Mr. Jon Winkel, IFEN GmbH
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Project Officer: Eric Guyader

Partners
Work Microwave -
University FAF Munich - Institute of Geodesy and Navigation -
Leica Geosystems -
NemeriX -
Istituto Superiore Mario Boella (ISMB) -
Roke Manor Research

BEAR

Bear Ethology Around Romania

There is a problem with signal availability in environments where there is extensive tree cover. The purpose of the BEAR project was to develop improved tracking techniques for use in difficult GNSS environments. A secondary set of activities that was related to wildlife management used data derived from the core aspects of the project.

Background

Environmental factors which cause difficulty with, for example, GPS and/or Galileo signal reception include tree canopies and urban canyons. This project developed strategies to mitigate some of these environmental factors.

Such problems arise naturally from the study of animal behaviour. The experimental 'vehicles' for this project were bears in the Transylvanian Alps.

The project methodology was based on the comparison of different techniques for animal tracking – high sensitivity (multiple-correlators) and post-processing of pseudo-range signals. In practice, four bears were equipped with multi-mode receivers so that tracking signals could be compared. In addition, innovative algorithms were developed and evaluated for 'height-aiding'. In parallel, the bears were tracked by foresters and monitored visually.

The major innovation related to post-processing techniques for the individual pseudo-range signals.

Objectives

The BEAR project relates to the development of innovative algorithms to improve signal availability for tracking in harsh GNSS environments. It includes the comparative evaluation of differing receiver strategies based on GPS and EGNOS: the innovation is based on the concept of advanced signal processing to derive improved tracking information from knowledge of the three-dimensional terrain and past history (time and spatial) of the track.

The experimental 'vehicles' were bears located in the mountains of Transylvania. The choice was dictated by the need to carry a relatively heavy payload in a difficult GNSS environment in terms of signal availability and continuity of coverage. It also provided a level of unpredictability of spatial behaviour that demanded true innovation from the algorithmic approach to signal processing.

Description of work

The work had five components:

1 Developing tracking collars and the associated telemetry system to capture, store and transmit full pseudo-range information from the hostile environment of the Transylvanian mountains. Because of the initial uncertainties, provision was made for three types of telemetry and tracking:

GSM radio based on SMS (the preferred option but problematic due to low signal strength in mountainous regions), UHF (less desirable due to the need to be relatively close to the bear(s) in order to download the data stream), and VHF (the least preferred solution as this requires triangulation and does not provide a data stream).

2 Ground survey and mapping of the terrain to be used by the bears, recognising that they are free to roam at will.

3 Analysis of the data to evaluate the performance of different types of receiver in a forested environment – specifically high-gain GPS receives utilising multiple correlators, and 'normal' receivers using standard technology.

4 Development and evaluation of new algorithms which exploit the concept of 'height-aiding' i.e. utilising knowledge of the terrain morphology (specifically its altitude) along tracks used by the bears.

5 Visual tracking and monitoring of the bears so that their behaviour could be correlated with the GPS results. This included diary records of the flora and fauna through which the bears travelled.

Results

There are three major potential benefits from the project:

- Improved tracking algorithms which may have general application in a variety of difficult environments;
- Improvements to animal tracking technology which may have direct commercial benefits;
- Knowledge of bear behaviour derived during the project may have applications for animal conservation and ecotourism.

There may also be knowledge gained during the project which relates to the safety of life: bear incursions into the human habitat are currently of major concern in Romania.

The project deliverables included -

- A comparative analysis of differing strategies for determining position in a difficult GNSS environment.
- Innovative techniques to maximise signal availability.

More information

Acronym:	BEAR
Name of proposal:	Bear Ethology Around Romania
Contract number:	GJU/06/2423/CTR/BEAR
Total cost:	€ 427 708
EU contribution:	€ 298 839
Call:	FP6 2nd Call
Starting date:	08/03/0006
Ending date:	15/07/2007
Duration:	16 months
Website:	http://www.bear-gju.org
Coordinator:	Mr Bill Metcalf, Geo Strategies Ltd St John's Innovation Centre Cowley Road UK CB4 0WS Cambridge
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Tel:	+44 (0)1223 20 50 80
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Project Officer:	Eric Guyader
Keywords:	Bears, ethology, Galileo, GPS, height-aiding, telemetry, pseudo-range, Romania, Transylvania

Partners	Geo Strategies SA	RO
	Vectronics Aerospace	DE
	University College London	UK
	Romanian Forestry Institute	RO

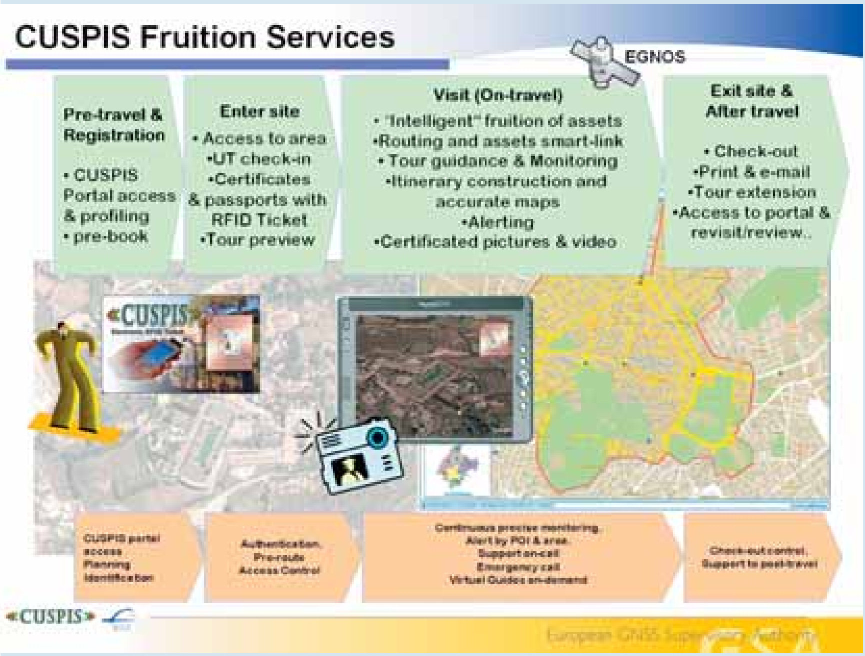
CUSPIS

Cultural heritage space identification system

The CUSPIS project deployed operative solutions for the transportation and fruition of secure assets in open archaeological areas using EGNOS and Galileo. CUSPIS is unique within the cultural heritage user community in merging GNSS aspects, authentication capabilities and 'infomobility' services in a single solution.

Background

The protection, fruition and support of the cultural heritage show evidence of a growing importance in European society, which is particularly rich in cultural assets. The European Commission gives great importance to the subject, promoting actions for protection, improving understanding and dissemination of the culture and history of European citizens, and making cultural heritage increasingly available and accessible. The cultural assets can be seen, as a consequence, as one of the most valuable 'infrastructures' owned by European citizens. The innovative idea behind CUSPIS is to combine the cultural assets infrastructure with another important European service infrastructure: Galileo and EGNOS. Galileo represents a unique opportunity to implement both institutional and commercial applications for the cultural assets protection, valorisation and fruition with value-for-money solutions under the appropriate regulation umbrella. In this context, the benefits coming from the Galileo and



EGNOS 'benefits' and 'differentiators', with respect to a solution based on GPS, are maximised together with the valuable role that a deployed solution can play for this user community.

Objectives

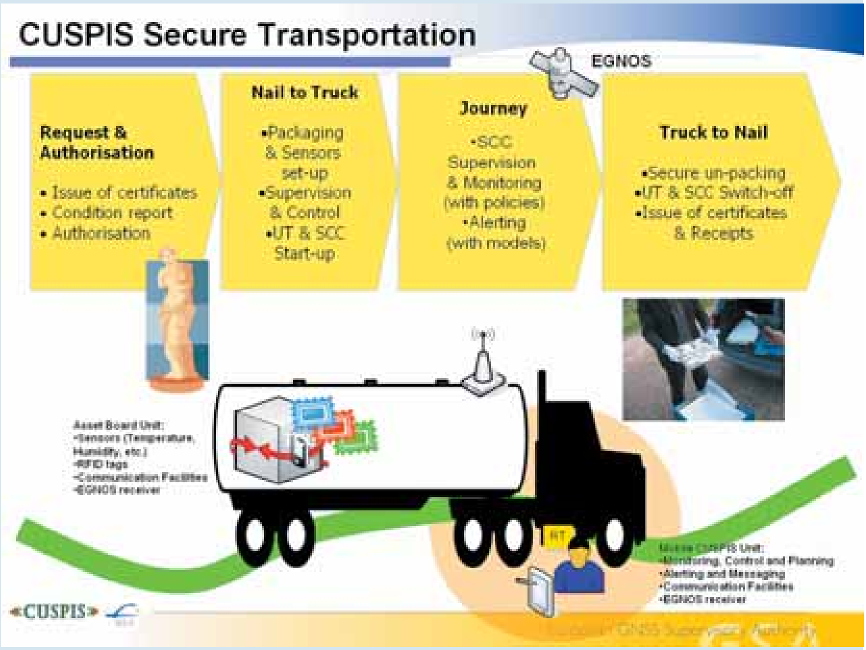
CUSPIS aims to demonstrate the benefits that EGNOS and Galileo can bring to the cultural heritage user community, with a strong accent on validation of results, economical and technical viability of systems and its dissemination. The goal of the project is to study the current situation in the cultural heritage sector, identifying the areas where innovative solutions, based on satellite navigation services, can prove to be beneficial. The CUSPIS project will establish proper user community groups, involve significant actors from the relevant community and institutional users, transfer to the cultural heritage world a new awareness of the innovative applications offered by GALILEO, and put an accent on authentication aspects, IPR and Digital Rights Management and European multilingualism.

The key to CUSPIS is the use of the so-called Geo-Time Authentication (GTA) for the unique cataloguing, authentication and determination of the precise location of indoor and outdoor cultural assets. The concept will be demonstrated for secure management, tracking and transportation of cultural assets between various sites (cultural asset management) and provision of information to both tourists and experts in the cultural heritage field (cultural asset fruition).

Description of work

The CUSPIS activities have been divided into Work Packages:

- Establish proper user community groups in the cultural asset context, enhancing their awareness of the potential of satellite navigation;



- Provide deep analyse on the issues related mainly to security, management and fruition;
- Identify all potential applications enabled by Galileo services in the cultural asset sector;
- Analyse the potential applications, examining all the elements that can affect the final services involving the key actors of the value chain, including the user community-related ones, and assessing the associated market potentiality and building the service models in order to complete a relevant application scenario;
- Design and develop major demonstrators and a key technological proof-of-concept related to the secure cultural asset management, services for the tourist and authentication;
- Assess and evaluate the results available from the demonstration campaigns;
- Perform a business and cost benefit analysis;
- Disseminate the project results via a dedicated CUSPIS portal, organising workshops, participating in conferences and selected national and international events.

Results

The CUSPIS project deployed operative solutions for the transportation of secure cultural assets and their fruition in open archaeological areas using EGNOS and Galileo. CUSPIS is unique in the scope of the cultural heritage user community in merging GNSS aspects, information management, fruition and secure information services, complemented by advances in authentication aspects using an advanced IT platform for robust and scalable service-oriented operations.

CUSPIS developments include identification and authentication using GNSS signals and RFID, sophisticated mapping techniques for EGNOS positioning/tracking, management of virtual gantries and area enforcement for secured operations and smart communication management (WiFi and cellular). CUSPIS user terminals are equipped with precise maps/ EGNOS receivers and secure communication, 2D and 3D smart interfaces for effective control, sensor data management and fruition. A virtual-reality reconstruction of areas and ontologies are additional capabilities designed to support intelligent fruition and multilingualism. CUSPIS was successfully demonstrated at the UNESCO Villa Adriana site in Italy and in Athens, and in real transportation for museums.

The CUSPIS system also fosters the advances of the City Tourist Fruition System derived from the TWIST project (one of the GJU FP6 projects dedicated to SMEs) and takes advantage of the NEXT X-Info.

More information

Acronym:	CUSPIS
Name of proposal:	Cultural heritage space identification system
Contract number:	GJU/05/2412/CTR/CUSPIS
Total cost:	€ 2 340 000
EU contribution:	€ 1 250 000
Call:	FP6 2nd Call
Starting date:	24/06/2005
Ending date:	30/03/2007
Duration:	21 months
Website:	http://www.cuspis-project.info
Coordinator:	Dr Luigi Mazzucchelli, NEXT Via Noale 345B IT 00100 Rome
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Project Officer:	Stefano Scarda
Keywords:	Cultural heritage, secure transportation, tourist fruition services, user terminals, RFID, sensors, advanced IT infrastructures, infomobility, authentication

Partners

ARCUS SpA	IT
Exodus SA	GR
Pricewaterhouse Coopers Advisory Ltd	IT
Provincia di Roma	IT
Municipality of Athens	GR
Vodafone SA	GR
Space Applications Services SA	BE
Centrica Srl	IT
D'Appolonia SpA	IT
Università di Firenze - MICC	IT
Opificio Pietre Dure Firenze	IT
Commissione Sicurezza Patrimonio Culturale	IT
Pagnanelli Risk Solutions Ltd	UK
Studio Legale Lombardi	IT
University of Rome 'Tor Vergata'	IT
University of L'Aquila	IT
CMC Associated Ltd	UK

ERIG

Education, Research and Innovation in GNSS

European players looking to build new business on the back of Galileo need qualified staff, education, training, access to research and support to get products into the marketplace. ERIG will stimulate the knowledge exchange process for stakeholders by assessing what is already in place and making recommendations for further actions to ensure competitiveness.

Background

European investment in the Galileo system will present significant economic opportunities as new navigation applications come on stream. Innovations are already underway for controlling and planning transport. The mass mobile phone market alone promises huge potential for new location-based services.

But where will the engineers and commercial managers come from to support this economic growth? Is there sufficient, targeted research underway? And what support is there for innovation, especially for small companies?

Previous European workshops have highlighted the need for a detailed assessment of what should be done to keep Europe competitive in GNSS through a more effective transfer of knowledge, technology and innovation. The ERIG study is a response to that requirement.

Objectives

ERIG aims:

- to assess the actions to be taken to develop education, research and innovation/technology transfer (ERI) in the field of GNSS in Europe;
- to better understand the specific dynamics between ERI and economic growth in the field of GNSS.

In order to achieve this, the project will:

- establish the current situation within education, research and innovation in GNSS (including priority applications in navigation);
- analyse the interactions between education, research and innovation in GNSS, and how they might be developed to deliver social and economic benefits;
- compare the situation with other technologies that have been through similar growth cycles;
- compare the situation with geographical areas outside of Europe;
- use the above information to derive recommendations to promote greater awareness and European competitiveness through education, research and innovation/technology transfer.

Description of work

The project has undertaken a number of iterations of data collection and analysis via its network of partners across Europe. Data has been sought in the following areas:

- University courses

- Training and education for professionals
- Research programmes/projects
- PhD theses
- Research facilities
- Private sector research investment
- Innovation programmes/tools
- Innovative products/services

Analysis of these data is still underway, aiming to answer a number of questions:

For education:

Where and how is education and training in GNSS being offered? Is it producing sufficient numbers of suitably qualified people? What else is needed to improve the provision of education in the future and to provide the skills/knowledge that industry is looking for?

For research:

What type of research is currently underway and where are the areas of strength/weakness in Europe? What is the contribution of the private sector in GNSS research and what are the differences between SME and large companies' activities? Where should future R&D in Europe be focused to support economic growth and who should drive the priorities?

For innovation:

What innovative products and services are currently produced in Europe and how are standards/mandated applications influencing the market? Where can Europe expect to lead innovation and what research is required to support this? What are the expectations of return on investment? What support mechanisms are in place now to help the innovation process and what is needed in the future?

Three reports summarising key findings and recommendations from the first European phase of analysis will be presented for critical review in October/November 2007. Planning for phase 2 of the analysis (international and technological comparisons) is expected to be finalised in December 2007 depending on the results of the critical design review.

Results

Initial recommendations for fostering education, research and innovation will be available in November 2007. These will provide useful input to EU and national policy-makers and practitioners looking to enhance the competitiveness of European GNSS.

In addition to the three reports, a repository of data collected for ERIG will also be made available to the GSA. This will represent a substantial Europe-wide information resource which may be made available for further expansion/updating where data is not commercially sensitive.

An industry needs analysis has been undertaken and will be delivered to the GSA in September 2007. This will provide data on the current and future needs of industry with respect to ERIG priorities.

An education kit will be delivered at the end of the project as a self-contained CD-ROM/web resource. It is aimed at developers who need a reasonable level of technical detail about GNSS in order to understand how it can be integrated in different applications. This first version will provide a technical module and an application-oriented course with exercises and feedback mechanisms. The kit is designed to be further expanded and customised outside of the ERIG project.

More information

Acronym:	ERIG
Name of proposal:	Education, Research and Innovation in GNSS
Contract number:	GJU/06/8070-CTR/ERIG
Total cost:	€ 664 378
EU contribution:	€ 664 378
Call:	FP6 3rd Call
Starting date:	01/10/2006
Ending date:	31/12/2007
Duration:	15 months
Type:	USER TECHNOLOGY
Website:	http://www.esys.co.uk/erig
Coordinator:	Mr. Andrew Davies, ESYS plc 3 Stirling House, Stirling Road Surrey Research Park UK GU2 7RF Guildford
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Project Officer:	Daniel Ludwig
Keywords:	Knowledge transfer, education, research, innovation, technology transfer, economic growth

Partners

Aalborg University	DK
COWI A/S	DK
Ecole Nationale de l'Aviation Civile (ENAC)	FR
FDC	FR
Imperial College	UK
Instituto Superiore Mario Boella	IT
Politecnico di Torino	IT
The 425 Company	UK
University College London	UK
University FAF Munich	DE
University of Nottingham	UK
University of Porto	PT
University of Warmia and Mazury at Osztyn	PL

FIDELITY

Implementation of Galileo time service provider prototype

The Fidelity consortium is developing the Galileo Time Service Prototype Facility (GTSPF) for the GNSS Supervisory Authority (GSA). The GTSPF will be used by the Fidelity consortium to deliver time services to Galileo to ensure that Galileo System Time (GST) stays aligned to International Atomic Time (TAI).

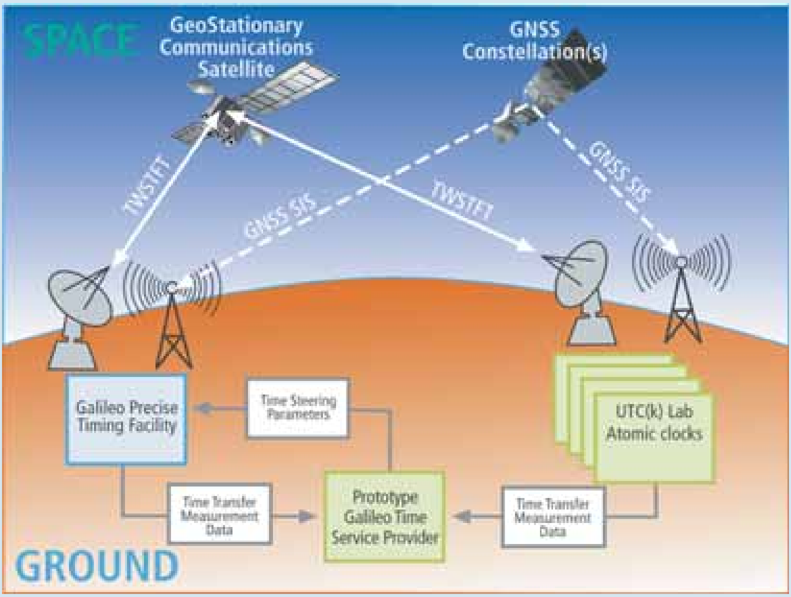
Background

With one nanosecond of time difference on a satellite, the equivalent to about 30 cm on the ground, highly accurate time is essential to the success of any Global Navigation Satellite System (GNSS), including Galileo.

Even the best atomic clocks lose time, including those at the core of Galileo. Monitoring and correcting these time drifts enables the fundamental accuracy of Galileo to be maintained. Precision time plays a fundamental but often neglected role not just in navigation, but also in electricity distribution, the functioning of e-mail and the Internet, deep space exploration and telecommunication networks.

To address the accurate time needs of Galileo the Fidelity consortium are creating an operational Galileo Time Service Prototype Facility (GTSPF) which will be used by the Fidelity consortium to deliver time services to Galileo for its In-Orbit Validation (IOV), due in 2008.

Fidelity was specifically established to undertake this project. The project began



in 2005 and has now successfully passed its critical design review and key-point milestones.

Objectives

The Fidelity consortium is developing the GTSPF as a means to keep GST aligned to TAI within tight specifications.

This is achieved by conducting time transfer measurements between Galileo's precision time facilities (PTFs) master clocks and the timescales within the core UTC(k) laboratories in the Fidelity consortium. These core UTC(k) laboratories are the National Metrological Institutes of France, Germany, Italy and the United Kingdom.

The time transfer measurements are then forwarded to the GTSPF where they are used to predict the retroactively published TAI timescale to the current time. The GTSPF then measures the deviations between the PTF master clock timescales and the predicted TAI. From these measurements, steering corrections are generated by the GTSPF. These corrections are then provided daily to Galileo, along with the offset between UTC and TAI, for use in steering the PTF master clocks.

In addition, the GTSPF will examine the supplied time transfer data for the presence of anomalies (e.g. clock frequency jumps) and issue warnings to the relevant UTC(k) or Galileo if any are detected. The GTSPF will also compile statistical measures of the performance of the various timescales and make these available to designated users.

This processing will be carried automatically by the GTSPF on a daily basis without operator intervention.

Description of work

The Fidelity consortium is coordinated by Helios, a technical and business consultancy specialising in navigation and transport, on behalf of the GSA. The pan-European consortium of nine partners consists of experts in timing, industrial mathematics, software and system engineering.

Fidelity is responsible for the design, development and operation of the GTSPF for Galileo IOV before delivering it, complete with software and documentation to the GSA. The GTSPF will comprise commercial off-the-shelf (COTS) hardware and software as well as a specifically developed software application. This application is being developed using the formal structured methodology standardised amongst the European UTC(k) laboratories.

The application at the heart of the GTSPF has, at its core, software containing innovative, complex and unique algorithms. The most sophisticated technical development is focused around two elements which contain the complex mathematics used to provide the time service. The first element is a composite clock to establish a highly accurate and stable virtual timescale using the input of an unlimited number of atomic clocks. The second element contains prediction and steering algorithms which generate the steering corrections needed to maintain a highly aligned and stable Galileo system time. Both these elements incorporate state-of-the-art Kalman filter-based algorithms, whose development has pushed beyond that which was previously possible.

Results

The Fidelity consortium will develop the GTSPF and then use it to deliver time services to Galileo for IOV in 2008. The GTSPF will then be delivered to the GSA, including all hardware, software and documentation. As part of the operations of the GTSPF carried out for IOV, the Fidelity consortium will demonstrate the quality of the timing services provided using the GTSPF before the facility is finally delivered to the GSA.

In parallel to the technical development of the GTSPF, the Fidelity consortium will also plan and document the operational and institutional migration path from operation of the GTSPF by Fidelity during IOV to the GTSF being operated by the permanent TSP during FOC. This will enable a seamless transition of services as part of the future implementation of the Galileo FOC. In addition, this planning activity is addressing potential uses of the timing services by a wider community including not only other GNSS services but also non-navigation users such as public utilities, financial institutions, etc.

In summary, the Fidelity consortium is delivering a key piece of infrastructure for Galileo IOV that will enable the full performance potential of the Galileo system to be realised. It will also develop the planning needed to ensure a smooth transition of timing services to support Galileo FOC together with the

More information

Acronym:	FIDELITY
Name of proposal:	Implementation of Galileo time service provider prototype
Contract number:	GJU/05/2419/CTF/FIDELITY
Total cost:	€ 3 000 000
EU contribution:	€ 3 000 000
Call:	FP6 2nd Call
Starting date:	30/04/0005
Ending date:	30/10/2008
Duration:	42 months
Type:	SYSTEM INFRASTRUCTURE & EVOLUTION
Website:	http://www.askhelios.com/fidelity/
Coordinator:	Dr Ray Jones, Helios Technology Ltd 29 Hercules Way, AeroPark, Aerospace Boulevard UK GU14 6UU Farnborough
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Project Officer:	Jean-Marc Pieplu
Keywords:	Helios, Galileo, time, metrology, UTC, TAI, fidelity, atomic clocks
Partners	LNE-SYRTE, Observatoire de Paris FR Physikalisch-Technische Bundesanstalt DE Kayser-Threde GmbH DE Centre national d'études spatiales FR Istituto Nazionale di Ricerca Metrologica IT Astrogeodynamical Observatory PL Thales Research and Technology UK National Physical Laboratory UK

FIELDFACT

Introduction and promotion of GNSS in agriculture

FIELDFACT investigates the benefits and opportunities of Galileo in agriculture. The project will increase the awareness of the sector in the potential of Galileo and promote the platform and associated services in agriculture.

Background

The agricultural sector is an arena supporting a large user community: In the EU-25 some 11 million farmers grow crops and depend upon 110 million hectares of land. This land is divided into millions of different shapes and sizes. Approximately 5 million farms are larger than 5 ha in size and one million farms are larger than 50 ha.

Moreover, whilst farmers form the majority of members in this community, they are not the only direct stakeholders in the agricultural process – the community is also complemented by stakeholders from the business and policy spheres. There were nearly 8 million tractors in use in the EU-15 (2002) and the share of agri-food in the total value added in the EU represented 5-15% in 2000. The Common Agricultural Policy is the conduit for nearly half of the EU budget.

The motives for using Galileo in agriculture are:

1 Increased demand for documentation from the agri-business chain for transparency, quality control and traceability;

2 Increased demand for documentation from government for a 'licence to produce';

3 Linking agricultural production to environmental impacts of activities/benefits to the environment, part of the so-called 'cross compliance';

4 Decrease of costs, increase of efficiency.

Objectives

The FIELDFACT project aims to promote the use of GNSS in the agricultural community through the demonstration of innovative EGNOS and Galileo applications and the active engagement of the stakeholders.

To satisfy this objective, the project has set out four objectives:

1 Develop a useful and simple GNSS application for use on a (small) farm;

2 Develop a high-end (expensive and complex) demonstrator that collects land and crop positioning data and integrates it with other farm management data to reduce the administrative workload for large farms and co-operatives;

3 Promote these applications and other GNSS opportunities through professional networks;

4 Stimulate the development of a spatial data infrastructure (SDI) for useful content collection and sharing.

The project derives from the increasing dependence of the agricultural community on the need for accurate positioning data in the daily management of land. The range of uses for this data includes conventional cadastral activities, land policy development, claims for subsidies, effective crop-yield analysis and the intelligent use of expensive farm machinery, such as combine harvesters.

The target user community is much broader than just the farmer and includes the agribusiness chain as well as national and European regulatory

authorities. Accordingly, FIELDFACT has assembled an appropriate team and proposes to establish a stakeholder council that will provide useful input and advice as the project progresses.

Description of work

FIELDFACT builds a Galileo promotion and training campaign around demonstrators that show the integration of GNSS and topographic data, and also the benefit of the Galileo differentiators in a farm management context. In order to reach as broad as possible audience, two different demonstrators are focused on:

- An application of mass-market (hand held) receivers to reach the larger part of the user community (low-end demonstrator);
- An application of a dedicated receiver integrated with sensors and machine monitors. This second, so-called high-end, application will serve a smaller market segment but has a 'formula 1' attractiveness to farmers.

As a basis for application development and promotion activities, the needs and requirements from the various stakeholder groups will be researched through the organisation of a stakeholder platform and stakeholder meetings. The current state of the application of GNSS in agriculture and the definition of priority applications will be elaborated.

The results analysis finalising the FIELDFACT project will evaluate the achievements of the project objectives, provide feedback on the medium and long-term objectives, and identify remaining open points and barriers for the introduction of Galileo in the agricultural sector. The raised awareness will be measured by stakeholders and a list of recommendations and guidelines for additional activities drawn up.

Results

The main deliverables of the FIELDFACT project are:

- Stakeholder platform and follow-up reports
- Critical analysis report
- Demonstrators
- A testing and training programme on GNSS and Galileo
- Promotion events and promotion material (website, posters, leaflets, etc.) on application of Galileo in agriculture
- Result analysis report

The whole set of executed activities and delivered products will increase the awareness of stakeholders in the agricultural sector regarding the application of GNSS and the benefit of the Galileo differentiators. Stakeholders will realise that the advantages of Galileo in the field of integrity and authentication open up new business opportunities in the areas of, for example, agricultural subsidy application, authentic registration and documentation of activities. This will directly lead to market opportunities in the field of open as well as commercial Galileo services.

A set of medium and long-term objectives and recommendations and guidelines for additional activities will be delivered in order to be able to determine follow-up activities to further increase the momentum for the introduction of Galileo applications in the agricultural sector.

More information

Acronym:	FIELDFACT
Name of proposal:	Introduction and promotion of GNSS in agriculture
Contract number:	GJU/06/2412/CTR/FIELDFACT
Total cost:	€ 1 797 114
EU contribution:	€ 1 028 346
Call:	FP6 2nd Call
Starting date:	21/08/2006
Ending date:	31/08/2008
Duration:	24 months
Website:	http://www.fieldfact.com
Coordinator:	Ir. Tamme van der Wal, Alterra - Wageningen University and Research Centre, Postbus 47 NL 6700 AA Wageningen
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Project Officer:	Stefano Scarda

Partners	ISPC-JRC	IT
	Ekotoxa Opava	CZ
	Vexcel Netherlands	NL
	Praktijkonderzoek Plant en Omgeving	NL
	University of Warmia and Mazure	PL

FIX_8

High-accuracy positioning using EGNOS and Galileo products

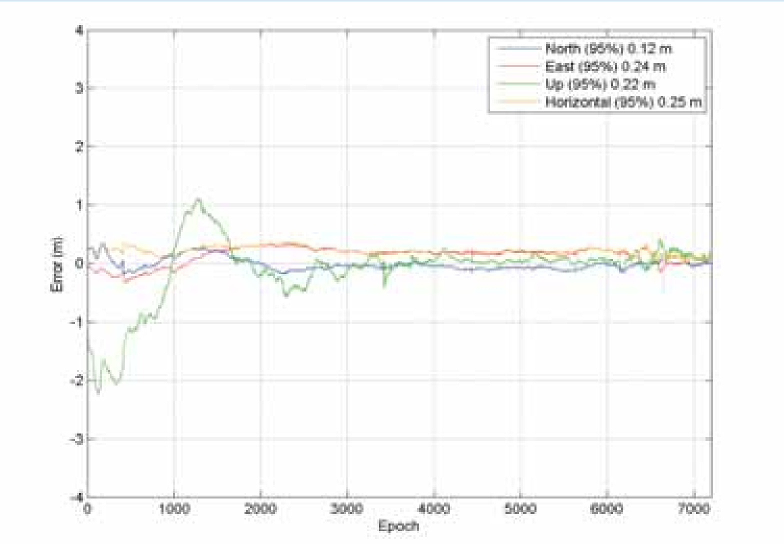
FIX_8 developed a prototype for a new GNSS service with a performance comparable to that of existing commercial high-accuracy differential services. It explored the performance which can be achieved with a stand-alone GNSS receiver using only free-to-air signals, assessing the accuracy which can be achieved today using EGNOS data within a PPP solution and in the future with using Galileo.

Background

At the core of the FIX_8 solution is a GNSS positioning technique known as Precise Point Positioning (PPP). PPP is a method of processing un-differenced pseudorange and carrier phase observations from a single GNSS receiver to compute positions with decimetric, or even centimetric accuracy, globally.

In recent years, commercial services have applied the PPP technique to offer an accurate and flexible positioning solution which has proved particularly popular in the precision agriculture and offshore markets. The services rely on providing high-accuracy satellite data (orbit and clock predictions) to users for real-time operations. Using this satellite data and applying complex algorithms on the user-receiver, the services typically provide a positioning solution for a moving platform with a horizontal accuracy of 20 cm (95%) following a 30-minute convergence period. The solutions are completely independent of the distance to reference stations.

Using similar satellite data to the commercial service providers, FIX_8 can replicate these levels of positioning accuracy and has also shown the potential to reduce the convergence period. The FIX_8 project also explored the level of accuracy which could be achieved without subscribing to a service supplying this precise satellite data.



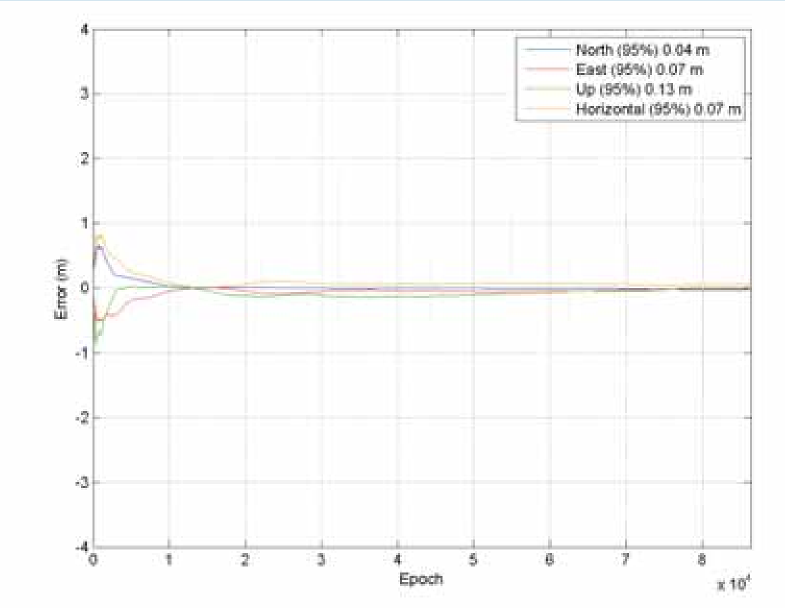
Objectives

The first objective of FIX_8 was to develop a PPP solution with performance comparable to that of the existing commercial high-accuracy differential GNSS services. The prototype is a real-time software implementation of the positioning algorithms which would be applied on a GNSS receiver. The software was designed to be flexible, allowing for modifications to classical PPP algorithms to be explored.

FIX_8 has also aimed to demonstrate the accuracy which can be obtained from a stand-alone GNSS receiver using EGNOS-corrected orbit and clock data in place of commercial products. Finally, the prototype can be used to estimate the performance which could be achieved in the future using the Galileo Open Service and also to explore the potential of a high-accuracy Galileo Commercial Service.

Description of work

To implement a PPP solution, the GNSS errors which are usually removed or reduced by differencing in high accuracy applications must be compensated for using other error mitigation techniques. These techniques include combining observations to overcome ionospheric delay errors and applying models to estimate satellite antenna phase centre offsets, relativity effects, site displacement effects due to Earth tides, etc. These mitigation methods are included in the FIX_8 prototype. The FIX_8 processing algorithms also introduce a number of innovative techniques which are intended to improve upon classical dual frequency PPP solutions. It uses raw code and carrier phase observations, and includes the ionospheric delay on each satellite range as a state in the Kalman filter rather than forming an ionospheric free observable. This is intended to reduce convergence time with respect to traditional PPP solutions.



The performance of the prototype solution was initially investigated using a large number of static datasets. Dedicated field trials were then undertaken in conditions designed to be representative of those found in target applications. For each trial a centimetre level reference solution was used to determine the error in the FIX_8 solution. Orbit and clock data with varying accuracy was used to establish the relationship between these inputs and the accuracy of the resultant position solution. This then allowed an extrapolation to predict the level of accuracy which should be reached by applying FIX_8 processing algorithms on a Galileo receiver.

Results

A baseline FIX_8 solution using precise orbit and clock products at a static site produced accuracies of 10 cm (95%) in the horizontal component and 20 cm (95%) vertically, similar to commercial PPP services. When precise satellite data was replaced with a broadcast GPS message with EGNOS corrections applied, the accuracy achieved was 30 cm (95%) for the horizontal component.

Field trials demonstrated a typical accuracy of less than 20 cm (95%) for horizontal positioning onboard a boat using precise satellite data. The trials were not able to provide a comprehensive assessment of a FIX_8 solution based on EGNOS because in 2006 corrections were not available for a significant number of the GPS satellites in view. Results suggest that if corrections are available consistently for five or six satellites, a positioning accuracy of half a metre will be achieved. A 50 cm, or perhaps better, solution using only free-to-air signal represents a significant improvement on a standard EGNOS code position.

Extrapolations to future Galileo operations suggest that a 50-cm solution should also be possible with a dual frequency receiver using only the Open Service. A 20-cm solution is possible if predicted clock and orbit data can be distributed without some of the constraints of the proposed dissemination approach for Galileo orbit and clock data. The provision of more precise satellite data, allowing a high accuracy positioning solution with a suitably equipped receiver, may become a Galileo Commercial Service.

More information

Acronym:	FIX_8
Name of proposal:	High-accuracy positioning using EGNOS and Galileo products
Contract number:	GJU/05/2423/CTR/FIX_8
Total cost:	€ 246 363
EU contribution:	€ 216 670
Call:	FP6 2nd Call
Starting date:	20/09/2005
Ending date:	18/12/2006
Duration:	15 months
Type:	SUPPORT ACTIVITY
Website:	http://www.nsl.eu.com/Fix_8.html
Coordinator:	Dr Kevin Sheridan, NSL Loxley House Tottle Road UK NG2 1RT Nottingham
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Tel:	+44 (0)1159 682960	
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Project Officer:	Eric Guyader	
Keywords:	Precise Point Positioning, EGNOS, Galileo, high accuracy	

Partners	TUD	NL
	FGI	FI

GAC

Galileo Advanced Concepts

The major axes of investigation included:

- assessment of the Galileo signals, codes and navigation data message;
- short-term developments, implementation of a messaging mission;
- long-term developments, technology advancements and future complementary missions.

Background

The work was directed towards three distinct sectors. The signal studies were the most urgent and provided independent assessment and consolidation of the Galileo signals. The short-term development studies were aimed at optimising resources as SAR payloads were not required on every Galileo satellite and a complementary messaging mission was investigated which would be compatible with the first generation satellites. The long-term development studies were clearly aimed at second-generation Galileo satellites and the envisaged Galileo infrastructure.

Objectives

The objective of GAC was to develop new ideas and to conduct activities to evolve and/or to consolidate the critical aspects of the Galileo system in order to anticipate the future context of the satellite navigation technology and to sustain Galileo's competitiveness.

Description of work

Task 2000: Signals, Codes, Navigation Message

The work on this task was arranged in three study cycles. During the first study cycle the baseline signals, codes and navigation messages were reassessed. The consortium performed some specific, urgent analysis of the proposed modifications to the SIS ICD as directed by ESA and the Signal Task Force (STF).

The work on the second and third study cycles continued the first cycle work looking at other modulation types and focused on signals achieving the MBOC spectrum. In addition a study on the feasibility of a higher data rate E6 signal was performed as a complement to the messaging task. Apart from the signals work, the second cycle of activities also involved simulations and analysis of receiver performance with optimised L1 signals. The work on optimisation of spreading codes included further testing of some newly proposed chaotic codes. Also consolidation of the navigation data message was performed with comparisons of GPS and Galileo navigation data messages and a catalogue of potential innovations to the navigation data message was produced.

Task 3000: Short-term developments – implementation of the messaging mission

Recommendations were made on the number of satellites required for the SAR mission and hence the number of SAR payloads that could be replaced by a new, optional messaging payload. In fact studies have led to the selection of a dual-mode architecture as the optimum solution in which both SAR and messaging payloads are incorporated on each satellite with a switch allowing either payload to be operable as required.

Feasibility studies and an assessment of system boundary constraints were completed for the dual mode payload with a review of the overall system architecture. Maritime applications such as LRIT, LRR, VMS, etc. were retained as the primary choice applications. The messaging system network architecture

was proposed and the air interface has been studied in detail. The study also addressed a preliminary definition of the terminal for maritime users. A messaging payload accommodation study was completed which addressed the issues of payload implementation on the Galileo satellites.

Task 4000: Long-term evolutions

The GNSS technology advancements task addressed the current status and trends in electronic components like ASIC/FPGA, processors and memory devices in satellite payload and user receiver applications. Architecture and performance of such devices was assessed as well as radiation hardening issues for space applications.

The Galileo Flexible Payload Architecture task studied a novel concept based on the use of common intermediate frequencies for all of the payload's RF interfaces. It also assessed possible future use of a digital receiver to the maximum possible extent replacing analogue equipment.

A further study line addressed possible future Galileo-complementary missions. An Earth atmospheric gases monitoring mission was proposed. This mission assumed implementation of optical sensors operating at various wavelengths on the Galileo satellites.

Results

The following major deliverable items were achieved:

Signals, codes, navigation message:

- Assessment of Galileo signals;
- Assessment of Galileo spreading codes;
- Assessment of Galileo navigation data structure;
- Report on difficult environments;
- GSVF2 software update (CD);
- Galileo precision ephemeris – assessment on accuracy;
- Galileo OS signal authentication – second opinion;
- Flexible NSGU, coding and modulation techniques;
- Evaluation of multipath performance of the MBOC modulations;
- New chaotic codes performance simulations.

Short-term evolutions

- Report on strategy for SAR mission;
- Identification of messaging mission applications report;
- Regulations, competitiveness and operations report;
- Messaging mission spectrum assessment;
- Feasibility study of dual-mode SAR and messaging;
- Dual mode (SAR/messaging) breadboard demonstrator (antenna breadboard) which has been manufacturer and tested as proof of concept;
- Dual mode antenna test results;
- Recommendations on user terminals;
- Combined network architecture and air interface report;
- Platform accommodation report.

Long-term evolutions

- Assessment of GNSS technology advancement;
- Assessment on flexible payload architecture;
- Complementary mission and requirements;
- Complementary mission payload assessment;
- Complementary mission operations.

More information

Acronym:	GAC
Name of proposal:	Galileo Advanced Concepts
Contract number:	GJU/05/2418/CTR/GAC
Total cost:	€ 3 215 000
EU contribution:	€ 3 215 000
Call:	FP6 2nd Call
Starting date:	17/06/2005
Ending date:	16/06/2007
Duration:	24 months
Type:	SYSTEM INFRASTRUCTURE & EVOLUTION
Website:	http://gac.eutelsat.fr
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Project Officer:	Werner Erderle
Keywords:	Galileo signals, codes, navigation message, search and rescue, messaging, flexible architecture, technology advancment, complementary mission

Partners		
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	Thales Alenia Space España S.A.	ES
	LogicaCMG UK Ltd	UK
	EADS Astrium GmbH	DE
	France Developpement Conseil SARL.	FR
	COM DEV Ltd	CA
	Queen Mary, University of London	UK
	Indra Espacio S.A.	ES
	Universitat Politècnica de Catalunya	ES
	University of Leeds	UK
	Telespazio S.p.A.	IT
	Atos Origin SAE	ES
	Carlo Gavazzi Space S.p.A.	IT
	Surrey Satellite Technology Ltd	UK
	Skysoft Portugal S.A.	PT
	LogicaCMG Nederlan-d B.V.	NL

GADEM

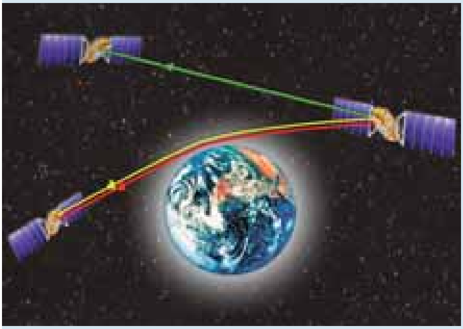
Galileo Atmospheric Data Enhancement Mission

The objective of GADEM was the study of concepts for atmospheric sounding by using K-band radio links between Galileo and LEO satellites or between Galileo satellites and ground stations with the goal to provide a worldwide measure of atmospheric data. The study included detailed scientific assessments for different measurement scenarios, the establishment of mission and system requirements, design work and the planning of a demonstrator mission.

Background

GADEM is driven by the need for a cheap, worldwide measure of atmospheric data which can be used for improving Galileo navigation data, but would also be highly appreciated for climate research and weather prediction.

In particular the water vapour content in the troposphere is highly variable and difficult to predict. For that reason a novel measurement concept using radio occultation measurements with two K-band frequencies is proposed for GADEM. During each occultation raw transmission profiles for phase and amplitude are measured at the receiving satellite. Transmission measurements are very sensitive to the contents of water vapour if a frequency near the water vapour absorption line of about 22 GHz is used. By using a second frequency in parallel in the range of 17 GHz to 20 GHz, the influence of temperature and pressure can be separated. As a result, vertical profiles for temperature, pressure, humidity and water vapour through the troposphere can be calculated with unprecedented accuracy in a post-processing procedure.



Objectives

The objective of this study is an analysis of the improvement in atmospheric sounding by using some new Galileo capabilities:

- the K-band capability expected for the Galileo inter-satellite link;
- the possibility to receive this K-band in a receiver mounted in low-earth-orbit spacecraft;
- the possibility of receiving this K-band signal in ground stations.

The basic idea behind this is that with the processing of the K-band after crossing through the atmosphere, the atmospheric properties can be derived, especially the water vapour content. This type of information can be very useful for several scientific applications including weather and climate prediction/analysis.

The project includes:

- an analysis of the improvement in scientific and commercial application that this concept would provide;
- the performance assessment for the different scenarios (Galileo-to-Galileo link, Galileo-to-LEO link, Galileo to ground station link, etc.);

- establishment of preliminary mission requirements for the different scenarios, to assess their feasibility;
- defining the system requirements for the K-band system, i.e. transmission and reception;
- the identification/selection of a space-based demo mission to make a prove-of-concept, system complexity and performance assessment of the atmospheric data.

Description of work

During the GADEM project the following study work was performed:

Scientific applications and performance analyses:

- establishment of observational requirements for Galileo radio occultation links;
- modelling of the links and their error characteristics;
- performance analyses results for atmospheric data.

Galileo and commercial applications:

- potential applications for improvement of Galileo system performance;
- possibilities for novel commercial services.

Constellation analysis:

- determination of link geometry for different mission scenarios.
- orbit modelling using satellite tool kit software.

Mission requirements analysis:

- establishment of a complete set of mission and system requirements;
- analysis of scientific requirements;
- analysis of accommodation options for the GADEM payload.

Operational concept:

- analysis of operational cycles for the Galileo-LEO mission concept;
- definition of interactions between space and ground segment.

System architecture and trades:

- definition of main components of the system;
- selection of a technical baseline.

Detailed system design:

- design of transmitter payload;
- design of receiver payload;
- antenna design;
- final budgets for mass, volume and power.

Demonstrator mission options, requirements and design:

- analysis of a feasibility of a demonstrator mission by using the 'Glonass-M' and LEO satellites;
- selection of the GADEM demo mission baseline concept.

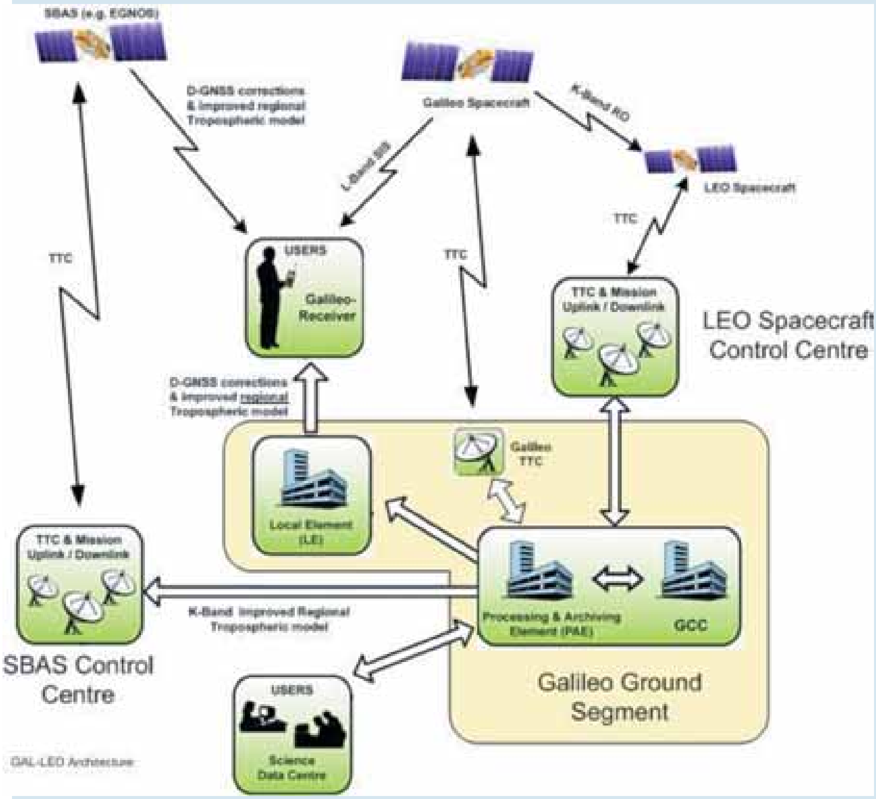
Results

The major outcomes of GADEM are:

- Identification of applications for Galileo and commercial services;
- Identification of applications for scientific purposes;
- Definition of measurement principle and performance analyses;
- Preparation of complete set of mission and system requirements;
- Analysis of accommodation options for the payload hardware on Galileo;
- Proof of concept and payload design data;
- Demo mission definition and planning (e.g. on the GLONASS satellite).

The following main documents were established and delivered during GADEM:

- Scientific applications of Galileo K-band radio links;
- End-to-end scientific performance analysis for retrieval of atmospheric data from Galileo K-band radio links;
- Galileo and commercial applications;
- Constellation analysis report;
- Mission requirements specification;
- System design report;
- Demonstrator mission options and requirements;
- Demonstrator mission design report;
- Demonstrator design, development and implementation plan.



GAL-LEO Architecture

More information

Acronym:	GADEM
Name of proposal:	Galileo Atmospheric Data Enhancement Mission
Contract number:	GJU/05/2423/CTR/GADEM
Total cost:	€ 406 000
EU contribution:	€ 299 974
Call:	FP6 3rd Call
Starting date:	06/03/2006
Ending date:	30/06/2007
Type:	SYSTEM INFRASTRUCTURE & EVOLUTION
Website:	http://www.kayser-threde.com/GADEM/
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Project Officer:	Eric Guyader
Keywords:	Radio occultation, K-band, atmospheric sounding, water vapor, climate research, weather prediction

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	Geo ZUP	RU

GALILEA

Galileo local element augmentation system

The project addresses new methods and algorithms to locally predict, monitor and possibly improve in near real time the performance of the positioning service offered by the Galileo satellites. The proposed application in the GALILEA project can be considered as a Galileo local element which augments the global Galileo service in a local area.

Background

The target for the applications includes the following potential user groups:

- Safety-of-life users (SoL): requiring high performance requirements both in accuracy and safety;
- Medium-accuracy and low-safety users (MA-LS), public/private transport, traffic management: here, the low cost constraint for terminals could help in the diffusion of local messages providing information useful for accuracy enhancement.

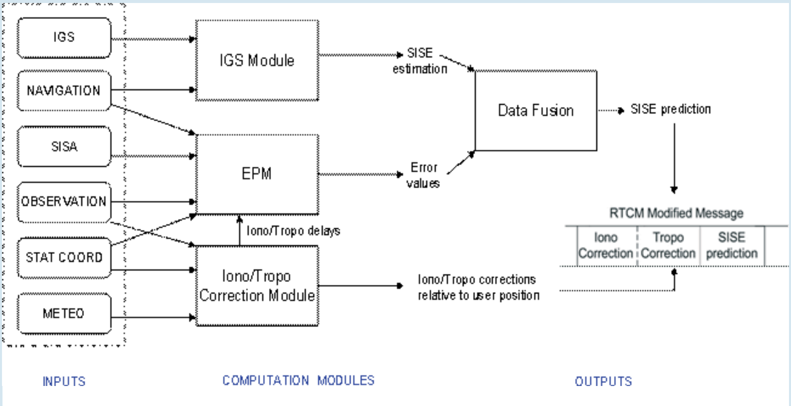
Objectives

The operational scenario reported in Figure 1 is composed of:

Reference stations: each station has to produce observation and navigation files (in RINEX format) with high rate, and transmit them in real time to the processing facility. The necessity of more than one station for the GALILEA application has been stated for two principal reasons: the transmitted ionospheric and tropospheric corrections can be user-location dependent only if a grid in space is defined; a SISE prediction can be independent on signal errors relative to a specific station only if a multiple station approach is selected.

Processing facility: the facility has to collect data from different sources and elaborate them.

- Error prediction and correction module: this tool generates the SISE predictions, and ionospheric as well as tropospheric corrections that have to be transmitted to the user.



- Offline integrity monitoring module: the offline integrity monitoring computes the integrity risk and/or the user protection level in the local service area and compares them with the envisaged service levels.

Weather stations: local meteorological information (pressure, temperature, humidity) can significantly improve the tropospheric modelling accuracy.

Radio broadcast facility: direct radio transmission to SoL users is via a dedicated broadcast facility, while communication with MA-LS users is performed using the Internet.

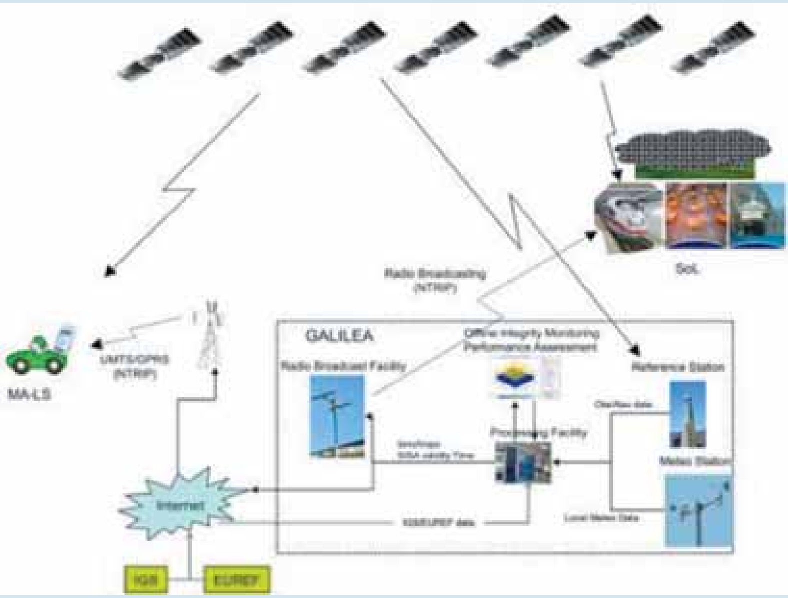
Description of work

The following complementary research directions were investigated:

- Efficient computational methods for generating high-accuracy local data in a very short time making use of only local reference stations;
- Innovative data fusion techniques to merge local data with global/regional data, in order to predict and monitor SISE, tropospheric and ionospheric corrections;
- Efficient local communication architecture able to disseminate the SISE and the derived information with the lowest latency time using Internet or UMTS technology.

The error prediction and correction module (EPCM), whose architecture is reported in Figure 2, is the GALILEA software designed to generate the SISE prediction and the iono/tropo error corrections to be transmitted to the user. The software can be split into four computation modules:

1 IGS module: its task is to compare the coordinates from the IGS ephemeris with the ones calculated from the navigation message in order to estimate the signal in space error due to orbit and clock errors, called OCE.



2 Error prediction module: this computes the pseudorange residuals at each time and for each satellite-station combination, fits them with a modified RBTB model and computes the instantaneous error value at satellite level with a multiple station approach.

3 Iono/tropo correction module: this computes, for each reference station and satellite, the iono-free pseudoranges and the coefficients to correct the first and second (only if three frequencies are available) order refraction effects, both in the two (GPS) and three (Galileo) frequency cases. It also calculates a grid of ionospheric and tropospheric corrections for the network of reference.

4 Data fusion module: this acquires the IGS SISE estimation from the IGS module and the instantaneous error value from the EPM. It computes the SISE correction to be applied to the IGS SISE estimation using the instantaneous error trend. Finally, it computes a SISE prediction to be output to the user.

Integrity monitoring

As part of GALILEA, three candidate concepts for Galileo local element integrity monitoring were discussed based on service volume simulations:

1 Generation of local error corrections and relay of the Global Galileo integrity information to the users: the local processing facility generates ionospheric and tropospheric error corrections and broadcasts these corrections to the users for improving the accuracy. Since no improved SISA, SISE and SISMA values are determined, it is not possible to increase the integrity performance as compared to the global system.

2 Generation of local error corrections and also locally improved Galileo SISA/SISE values while the SISMA values are simulated: in this case the integrity performance can be improved. The level of the integrity performance improvement is dependent on the number and geometry of regional ground sensor stations and the access to the global ground sensor station data in (near) real time keeping the necessary TTA (time-to-alert). In this case e.g. CAT-1 aircraft precision approach requirements seem to be achievable.

3 Adaptation of the GBAS concept to Galileo: the highest levels of integrity can only be reached with a local reference station architecture as is the case for GBAS. Most likely the final architecture will become a multi-constellation GPS and Galileo local element.

Results

The following SISE prediction results were achieved simulating several operational scenarios:

SISE prediction refresh rate: 60[s] for SoL and 20[s] for MA-LS

SISE prediction duration: 300[s]for SoL and MA-LS

SISA validity time prediction accuracy: 20% for SoL and 30% for MA-LS

Local area radius: 50[KM] for SoL and 100[KM] for MA-LS.

More information

Acronym:	GALILEA
Name of proposal:	Galileo local element augmentation system
Contract number:	GJU/06/2423/CTR/GALILEA
Total cost:	€ 446 530
EU contribution:	€ 284 960
Call:	FP6 2nd Call
Starting date:	16/03/2006
Ending date:	30/04/2007
Duration:	14 months
Type:	SYSTEM INFRASTRUCTURE & EVOLUTION
Website:	http://www.galilea.navpos.de
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Project Officer:	Eric Guyader
Partners	NavPos DE CISAS IT University of Budapest HU FACG DE

GALOCAD

Development of a GAlileo LOcal Component for the nowcasting and forecasting of Atmospheric Disturbances affecting the integrity of high precision Galileo applications

Atmospheric effects on GNSS signal propagation remain an important limitation to the reliability of GNSS applications. The goal of GALOCAD is to create a prototype Galileo local component which will assess the effects of the atmosphere on Galileo high-accuracy positioning through 'nowcasting' and forecasting.

Background

Atmospheric effects on GNSS signal propagation remain an important error source for GNSS applications. In particular, high-accuracy real-time positioning is affected by small-scale irregular structures in the ionospheric plasma or in the neutral atmosphere water vapour. For example, the occurrence of local irregular structures in the atmosphere due to disturbed space weather conditions or to strong thunderstorms can be the origin of 'out of tolerance' errors. GNSS users are not necessarily aware when such events occur. This is a major concern for Galileo services which will offer certified accuracy levels to their customers.

Objectives

Based on a dense network of GNSS stations in Belgium, the goal of GALOCAD is to create a prototype Galileo local component (over Belgium) which will assess in real time, and forecast a few hours in advance, the effects of the atmosphere on Galileo high accuracy positioning. In other words, this local component will monitor the integrity of Galileo with respect to 'atmospheric threats':

- 'nowcasting': on the one hand, the service will inform users (in real time) about the atmosphere influence on their applications (can Galileo certified accuracy be reached?)
- forecasting: on the other hand, the service will forecast, a few hours in advance, the occurrence of ionospheric disturbances which could degrade significantly Galileo accuracy.

Description of work

Small-scale atmospheric structures can be studied using GPS measurements. Nevertheless, until now the 'density' of available GNSS stations in Europe was not sufficient to make a detailed study of these atmospheric (ionospheric and tropospheric) structures which can have a 'very local' behaviour.

Since the end of 2003, Belgium has been equipped with a network of 67 permanent GPS stations. The typical distance between the stations ranges from 4 to 30 km. The idea of GALOCAD is to use data from this network to perform a detailed study of atmospheric small-

scale structures, to build a model of representative small-scale activity, and to assess the influence of these structures on the reliability of Galileo precise positioning applications. In addition, the project will study the correlation which exists between small-scale ionospheric activity and geophysical parameters (like the local geomagnetic K index): the existence of such a correlation between small-scale structures and local K would enable forecasting the occurrence of degraded positioning conditions a few hours in advance.

Then, the results of these investigations will be used to develop and to validate a prototype Galileo local component for 'nowcasting' and forecasting the effect of atmospheric disturbances on the integrity of high-precision Galileo applications.

Results

The expected outcomes are:

Improving Galileo product reliability:

The idea of GALOCAD is not to provide improved atmospheric corrections but to inform users when a Galileo certified positioning accuracy level is not reached due to atmospheric and space weather conditions. In other words, GALOCAD will provide a location dependent Galileo 'integrity' monitoring with respect to atmospheric disturbances.

Forecasting 'positioning conditions' for the next few hours:

GALOCAD will forecast the occurrence of geophysical phenomena or space weather conditions a few hours in advance, which can be the origin of degradations of Galileo positioning accuracy. The service will warn Galileo users when degraded positioning conditions are expected.

More information

Acronym:	GALOCAD
Name of proposal:	Development of a GAlileo LOcal Component for the nowcasting and forecasting of Atmospheric Disturbances affecting the integrity of high precision Galileo applications
Contract number:	GJU/06/2423/CTR/GALOCAD
Total cost:	€ 250 000
EU contribution:	€ 250 000
Call:	FP6 2nd Call
Starting date:	01/11/2006
Duration:	21 months
Type:	SYSTEM INFRASTRUCTURE & EVOLUTION
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Project Officer:	Eric Chatre
Keywords:	Ionosphere, space weather, troposphere, atmosphere, reliability, accuracy, integrity
Partners	Geophysical Institute of the Bulgarian Academy of Sciences BG Royal Meteorological Institute of Belgium BE

GAMMA

Assisted Galileo/GPS/EGNOS Mass Market Receiver

The project consortium aim to develop an assisted Galileo/GPS/EGNOS satellite receiver prototype, and a multi channel Galileo/GPS/EGNOS signal generator to evaluate the performance of the receiver. For the communication link, UMTS was selected. To be able to focus on the receiver development, the necessary UMTS link will be emulated.

Background

The majority of Galileo users will be Galileo Open Service users who will be using a mass market type of receiver. The project emphasises the development of such technologies for the mass market receiver and its specific limitations. By combining the positioning services with other services (such as communication, map visualisation, guidance or others) and physically integrating the user receiver into an user terminal, the end user will have a terminal that delivers a full set of services.

Objectives

By focusing on mobile terminals and automotive applications the consortium will develop an L1-band GALILEO/GPS/EGNOS mass market receiver. The receiver should have a mobile communication link to speed up the signal acquisition and to find weak satellite signals in indoor environments or urban canyons. Special emphasis will be put on a low cost, low power processing of weak signals for indoor navigation, pilot tone tracking, and assisted acquisition. Additionally, a Galileo/GPS/EGNOS signal generator is under development by the GAMMA project. In a first stage, the signal generator will be used to test the receiver developed by GAMMA.

Description of work

The following tasks will be carried out within this project:

- Study the implementation and architecture of assisted GNSS solution within the Galileo receiver;
- Elaboration of algorithms that use the assistance data to improve the time-to-first-fix and the sensitivity within the scope of the Galileo-assisted signal processing;
- Study implementing an indoor GNSS solution within the Galileo receiver. Trading off algorithms and selecting the one(s) that promise to provide best results;
- Definition of system performance for a SDR-based multi standard GNSS receiver;
- System definition and partitioning of RF and baseband IC architectures.

Results

The receiver to be developed within this project should combine Galileo L1 signals with GPS C/A-code and EGNOS signals. The signal acquisition should be supported by a mobile communication link to speed up the acquisition and to find weak satellite signals in indoor environments or urban canyons. Additionally, a Galileo/GPS/EGNOS signal generator is under development within the GAMMA project.

The GAMMA receiver will fulfil both main requirements of the second call of GJU to elaborate core technologies and to implement a low cost/low power receiver solution for mass market applications. Developing a low cost applica-

tion with a high degree of integration is mainly dependent on the design of the RF-front end.

GAMMA also investigates the market opportunities and competition in two major application domains: the automotive and location-based services (LBS) segments. In the automotive area the project examines route guidance, fleet management, emergency call, road toll enforcement, speed enforcement, theft protection, precision farming, and advanced driver assistance systems (ADAS). In the LBS sector the project examines information services, personal routing and navigation, tracing services, emergency services, location based gaming, location based advertising, location based billing, buddy finder, and outdoor sports activities.

More information

Acronym:	GAMMA
Name of proposal:	Assisted Galileo/GPS/EGNOS Mass Market Receiver
Contract number:	GJU/05/2413/CTR/GAMMA
Total cost:	€ 4 447 239
EU contribution:	€ 2 310 240
Call:	FP6 2nd Call
Starting date:	07.11.2005
Duration:	24 months
Type of Project:	USER TECHNOLOGY
Website:	http://www.gamma-project.info
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Project Officer:	Eric Guyader

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	Thales Alenia Space	FR
	SAW Components Dresden GmbH	DE
	TeleConsult Austria	AT
	AGILENT Technologies	BE
	The 425 Company Ltd.	UK
	University of Bologna, ARCES	IT
	Associated partner: Volkswagen AG	DE

GARDA

GAlileo user Receiver Development Activity

GARDA has developed a prototype receiver capable of processing L1, E5a/E5b and E6 Galileo signals in addition to GPSL1. The aim of the GARDA project was also to develop a modular architecture that could be the basis for future TAS-I GPS/Galileo receiver products and prepare the way for user receivers to be already on the market when the Galileo system becomes operational.

Background

The user segment, and in particular the user receiver, is at the heart of business opportunities. Tools and systems adapted to user requirements need to be developed in order to enable the optimal integration of Galileo services (timing, positioning and navigation) into everyone's life.

Receivers and user terminals must be commercially available in time for the Galileo exploitation phase to ease and catalyse the market penetration of Galileo services. Therefore, the user segment of Galileo must be developed in parallel with the core system.

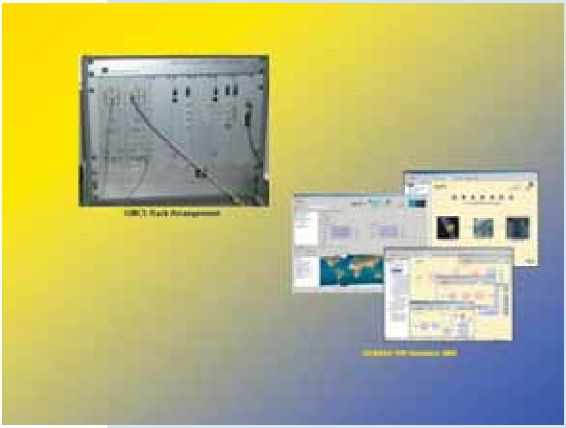
Furthermore, fostering the European industry in the area of GNSS receivers and terminals is another important motivation, recognising that Galileo is a unique opportunity to encourage the development of GNSS receivers in Europe.

Objectives

The following were primary objectives of the GARDA project, which have been organised into three main tasks:

- define a road map to the Galileo receiver pre-development (Task 1)
- identify and study the receiver core technologies (Task 2)
- develop a software receiver, an open tool conceived for receiver developers and receiver users supporting investigation on the core technologies (Task 2)
- develop a receiver prototype (Task 3)
- develop a Galileo mono-channel simulator to support prototype receiver test and validation (Task 3)

Coming up with a time frame in which the Galileo signal-in-space (SIS) specification is not definitively frozen, one of the main issues has been the design for flexibility, in order to be able to react promptly to the evolution and changes in the Galileo signal specification. The GARDA project has also provided the opportunity to analyse the future market of Galileo applications, to study some core receiver processing techniques and to develop two important components such as the Galileo multi-frequency RF signal simulator, as well as a complete Galileo receiver and environment software simulation tool.



Description of work

Much time was given to user-receiver development plan definition, with an increased analysis depth and involvement of system and service providers (through surveys and interviews).

Three main classes of receivers have been defined: consumer, professional and safety critical.

GARDA identified the core technological areas as being essential for future Galileo receivers and selected a set of specific topics that have been subsequently studied in detail.

GRANADA covers a dual role: it is a test bench for integration and evaluation of receiver technologies and a software receiver as an asset for GNSS application developers. It is conceived as a modular and configurable tool, in which the user can embed and test his/her own algorithms with a user-friendly interface.

The GARDA receiver architecture is composed of three main modules (see Figure 1):

- antenna and RF front-end section
- RF/IF section
- digital section.

The receiver model has been tailored towards high performance, professional and safety-of-life applications. The receiver is capable of processing the Galileo signals on the L1, E5a, E5b and E6 bands and the GPS (EGNOS/WAAS) signals on the L1 band.

Laboratory equipment designed to produce signals that faithfully represent the GNSS SIS are an indispensable tool for the development and verification of GNSS user receivers. This is particularly true for the case of Galileo, whose space and ground-segment are being concurrently developed.

A Galileo Mono Channel Simulator (GMCS) has been therefore designed as a tool to support the development and performance assessment of Galileo receivers. The GMCS is able to generate the three carriers defined in the Galileo SIS ICD produced by a single satellite of the constellation. These features made the GMCS a complete and self-standing test set for validating the GARDA receiver prototype.

GARDA receiver prototype test

Receiver functional and performance testing has been carried out using Galileo single/multi channel RF signal simulators. Live testing activities have been performed using the SATIMO antenna and it has been possible to acquire and track GPS satellites on L1CA.

Results

The GARDA receiver is one of the first Galileo receivers and this is the basis of several ongoing projects and future receiver product lines:

- the GIRASOLE safety-of-life receiver will be the pre-cursor of a combined GPS/Galileo receiver product to be used in rail, aviation and maritime applications;
- building blocks from the GARDA design are being re-engineered for use within the Galileo reception chain

receiver (GRC), which is a key element of the Galileo mission segment ground infrastructure;

- building blocks from the GARDA design are also being re-engineered for the test user-receiver that will be used to test the performance of Galileo in the in-orbit validation phase;
- The GRANADA software simulator tool as well as the Galileo RF signal simulator (see Figure 2) are available to Galileo receiver and user applications and will be further improved to include additional features.

The receiver has been tested with the multi-frequency RF signal simulator and it is also worth mentioning the successful attempt to track the live in-space signal provided by the test satellite GIOVE A.

More information

Acronym:	GARDA
Name of proposal:	GAlileo user Receiver Development Activity
Contract number:	1008/CTR/FP6/A/GARDA
Total cost:	€ 3 800 000
EU contribution:	€ 3 800 000
Call:	FP6 1st Call
Starting date:	27/02/0004
Ending date:	18/10/0006
Duration:	24 months
Type:	USER TECHNOLOGY
Website:	http://www.garda-project.it
Coordinator:	Mr Lucio Foglia, Thales Alenia Space Italia S.p.A. S.S. Padana Superiore 290 IT 20090 Vimodrone
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Project Officer:	Vincent Gabaglio
Keywords:	GARDA, GRANADA, GMCS

Partners	Prague Technical University	CZ
	Audens Act	DE
	Deimos Space	ES
	Satimo	FR
	Space Engineering	IT
	Booz Hallen Hamilton	IT
	Politecnico di Torino	IT
	Advanced Aviation Technologies	UK
	ST Microelectronics	UK

GARMIS

GAlileo Reference Mission Support

GARMIS aims at providing the GJU/GSA with continued engineering support for completing the Reference Mission definition of the Galileo system. The project addresses the EGNOS/Galileo mission consolidation and evolutions, the development of EGNOS and Galileo signal and service interface control documents (ICDs), the EGNOS/Galileo international standardisation, the design and development of a Galileo prototype service centre (SC) and of an EGNOS data access system (EDAS).

Background

To allow new receivers and novel applications to be developed by a broad spectrum of service providers, it is critical to have a precise and complete definition of what Galileo will provide to its end-users. Some areas of EGNOS/Galileo's services, mission and signals still have open issues that need to be addressed in order to complete the reference mission definition of the systems. The GARMIS project lies within this framework. It continues some of the many activities that were begun for Galileo in earlier phases (e.g. GALILEI, GALA, GENESIS, SAGA) and extends those carried out more recently in the framework of GEM (first Galileo call in FP6).

Objectives

The main objectives of the project are to:

- support the EGNOS/Galileo mission consolidation and evolutions;
- support the timely production of EGNOS and Galileo SIS and service ICDs, and the consultation of international user communities on the public ICD releases;
- develop the work started in former projects on international standardisation of the Galileo signals and receivers in three important areas of application: those of civil aviation, maritime applications, and location based services (LBS);
- design and develop a prototype version of the Galileo SC in order to support the development of the SC concept during the IOV phase and in particular the validation of the external interface with the ground mission segment (GMS);
- design and develop an operational EDAS, which will constitute the main pillar of the EGNOS commercial service provision.

Description of work

Despite an overall consistent objective to consolidate the Galileo Reference Mission, the project is composed of a series of activities that are very diverse from a technical point of view. The work is therefore structured in six Work Packages (WPs).

WP1000 ensures the management of the entire GARMIS contract, its coordination and the deliverables' progress management.

WP2000 addresses the mission consolidation and evolutions. The work is divided into four activities dealing with:

- the evolution of the EGNOS mission;
- the implementation of the Galileo global integrity operational concepts;
- the consolidation of the multi-constellation regional system (MRS) mission definition;
- the impact of particular ionospheric conditions on the design of Galileo and EGNOS mission evolutions.

WP3000 addresses the development of ICDs and the consultation of the international user communities. It covers signal in space (SIS) and service ICDs of Galileo and EGNOS, and dedicated studies on EGNOS and Galileo key performance indicators (KPIs).

WP4000 addresses the standardisation issues facing EGNOS and Galileo. This area covers safety-of-life applications, including aviation and maritime domains and mass-market applications, where commercial interest dominates, covering the location-based services. GARMIS supports the standards development in particular through active participation in the related standardisation groups (EUROCAE, RTCA, ICAO, IMO, RTCM, IEC, ERMF, IALA, OMA, 3GPP).

WP5000 and WP6000 respectively cover the design and development of:

- a breadboard of the Galileo SC for the IOV phase;
- an EDAS.

Results

The work performed or still ongoing has produced the following results:

- evolution of the EGNOS MRD document;
- consolidation of the Galileo baseline integrity concept thanks to:
- analysis of the existing integrity concepts used by the main safety-of-life user communities;
- critical analysis of the Galileo global integrity baseline and the elaboration of recommendations to secure its acceptance by safety-of-life users;
- development of operational concepts for Galileo and combined Galileo/GPS/SBAS receivers combining GPS/SBAS and Galileo integrity data.
- substantial progress in the characterisation of the ionosphere at high and low latitudes relevant to the investigation of its effects on the performance and availability of GNSS and EGNOS in particular services.
- development of ICDs for Galileo OS and SoL SIS and services and for EGNOS L1 services, some progress on the definition of Galileo KPIs and measurement methodology, and in the outline of a practicable KPI regime between the EGNOS SoL service provider and added-value service providers (AVSP) for the EGNOS SoL service in civil aviation.

In addition, the standardisation work enabled the progress on introducing and using EGNOS and Galileo in the aviation, maritime domains and in location-based services through the development of standards and the active participation in the related standardisation groups.

Last but not least, GARMIS developed a Galileo SC prototype for the IOV phase. The Galileo SC will act as the main link between the Galileo system and the outside world, in particular with the commercial service providers and the end-users of the Galileo services.

- An operational EDAS, which constitutes a single interface point where multiple EGNOS multimodal service providers can obtain the EGNOS products in real-time and within guaranteed delay, security, safety and performance boundaries, for service provision through non-geo means.

More information

Acronym:	GARMIS
Name of proposal:	GAlileo Reference Mission Support
Contract number:	GJU/05/2417/CTR/GARMIS
Total cost:	€ 5 097 028
EU contribution:	€ 5 097 028

Call:	FP6 2nd Call	
Starting date:	03/05/2005	
Ending date:	02/05/2008	
Duration:	36 months	
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Keywords:	EGNOS, Galileo, mission, ICD, standardisation, integrity, service centre, EDAS, ionosphere	
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	LogicaCMG	UK
	AENA	ES
	Airbus	FR
	Alcatel Lucent	FR
	CMC	CA
	Cortim	FR
	DLR	DE
	DSNA	FR
	ENAC	FR
	ESSP	BE
	Eutelsat	FR
	GMV	ES
	Helios	UK
	Huntaskill	BE
	ICTP	IT
	IEEA	FR
	IFAC	IT
	IGAM	AT
	Integricom	NL
	Kongsberg Seatex	NO
	NATS	UK
	Navpos	DE
	NSL	UK
	SGI	ES
	Skysoft	PT
	Telespazio	IT
	Thales ATM Germany	DE
	Thales Avionics	FR
	Trinity House Lighthouse Service	UK

GEM

Galileo mission implementation

GEM provided engineering support to the GJU in a range of crucial activities needed to ensure the success of Galileo, e.g. standardisation, certification, frequency issues, optimisation and validation of services, time service provider, search and rescue, regional integrity, service centre and integration of EGNOS.

Background

To gain acceptance in the world community, Galileo must not only be developed, deployed and operated; many complementary activities have to also proceed in parallel with the development and deployment of Galileo to ensure its success. These include its international standardisation for a wide range of applications, its certification and spectrum management. Galileo spectrum usage must go unchallenged and its signal in space performance, as expressed to the user through its positioning data, must be attractive to gain acceptance alongside GPS. Galileo must be seen as a global system. Many of the issues Galileo is facing apply to elements beyond the satellites and their supporting ground infrastructure.

GEM built on numerous activities undertaken in earlier phases within projects like GALILEI, GALA and SAGA. GEM activities are now continued mostly within the GARMIS project.

Objectives

The objective of the GEM project was to provide engineering support to the Galileo Joint Undertaking (GJU) for a range of complementary activities to be carried out in parallel with the development and deployment of Galileo and its success needed to be ensured. The purpose of the project was to present the right experts to support the GJU in areas of standardisation, certification, spectrum management and development of the Galileo mission.

Description of work

The work was structured into five Work Packages (WP):

WP1000 ensured the management for the entire GEM contract, its coordination and the deliverables' progress management. GEM's diverse but related activities required a close coordination to maintain quality and reduce duplication of work.

WP2000 addressed the standardisation issues facing Galileo. This area has been divided into safety-of-life applications, where regulation and certification would be involved, including the aviation, maritime and rail domains, and the mass-market applications, where commercial interests dominate, covering location-based services and road. Priorities were given to aviation and location-based services, then to maritime. Progresses on standards have been performed in particular through participation to the related standardisation groups (EUROCAE, RTCA, ICAO, IMO, RTCM SC104, IEC, EMRF, IALA, ERTMS/ETCS CG, 3GPP, CEN and ICTSB/ITSSG.)

WP3000 addressed the certification issues facing both EGNOS and Galileo. It was divided between the system certification issues i.e. the certification of combined and augmented services, and the certification of specific application

i.e. those faced by aviation and maritime user groups.

WP 4000 aimed at fully establishing the Galileo spectrum, at ensuring that when Galileo is providing RNSS it does not harmfully interfere with the system of any other service but also that the performance of Galileo signals are not degraded due to transmissions of other systems in the various frequency bands. WP4000 provided active technical support on frequency/regulatory issues at national, regional (CEPT, APT, CITEL) and international (ITU-R) level.

WP5000 comprised a set of self-contained sub-Work Packages (SWP) aiming at ensuring that a consistent Galileo mission implementation approach was put in place. The SWP addressed the following topics:

- assessment and optimisation of the Galileo service's signal in space as well as the user segment;
- development of a proposal for the role of time service provider;
- technical and operational interfaces of Galileo with the search and rescue community;
- regional integrity capability of Galileo, and the Multiconstellation Regional System (MRS) concept;
- preliminary definition of the service centres which will provide an interface to the users and added-value service providers;
- methodology for the validation of Galileo services as seen by the users;
- integration of EGNOS into Galileo.

Results

The work performed enabled significant progress in various fields.

- The standardisation work area enabled a swift introduction and use of Galileo in various user communities such as aviation, maritime, location-based services, rail and road through the development of receiver standards and the active participation to the related standardisation groups.
- The certification task allowed the certification framework to be used as a basis for service guarantees for both commercial and safety-of-life applications.
- The frequency Work Package contributed to fully establish the Galileo spectrum and to ensure that Galileo when providing RNSS does not harmfully interfere with a system or any other service and also that the performance of Galileo signals are not degraded due to transmissions of other services.
- The Galileo mission task enabled:
- developing a Galileo service ICD based on a preliminary assessment and optimisation of the Galileo services performance;
- defining a global approach for implementing the Galileo system by specifying the Galileo role in a broader information system concept;
- developing a Galileo service validation plan, which will be needed to support the mission validation and the system acceptance phase, and which is also a prerequisite for certification activities;
- to analyse the integration of EGNOS into Galileo and to elaborate an EGNOS service ICD.

More information

Acronym:	GEM
Name of proposal:	Galileo mission implementation
Contract number:	1004/CTR/FP6/E
Total cost:	€ 5 000 000
EU contribution:	€ 5 000 000
Call:	FP6 1st Call
Starting date:	15/12/2003
Ending date:	31/01/2006
Duration:	26 months
Type:	SUPPORT ACTIVITY
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Keywords:	Galileo, standardisation, certification, frequency, Galileo service performance optimisation, time service provider, search and rescue, regional integrity, service centre, EGNOS

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DNV	NO
ESS-P	BE
Pole Star	FR
Telespazio	IT
Thales ATM GmbH	DE
Thales Avionics	FR
AENA	ES
Airbus	FR
CMC	CA
CNES	FR
DFS	DE
DLR	DE
DSNA	FR
Ertico	BE
Eutelsat	FR
France Telecom	FR
GMV	ES
IEN	IT
INDRA	ES
Ineco-Tifsa	ES
Kongsberg	NO
NATS	UK
NPL	UK
PTB	DE
Trinity House	UK
UIC	F

GEO6

Science with GNSS

The project has the overall objective of encouraging the innovative use of GNSS, in particular of EGNOS and Galileo, in appropriate areas of the scientific research community.

Background

While the consortium recognises that there are a number of areas in which the Galileo SIS is of particular value to the scientific research community, it suggests that the benefits to the community do not lend themselves to simple commercial criteria. Accordingly, the approach for selecting priority applications will be based on the development of knowledge, leaving the exploitation of the results to others.

Objectives

This project wants to foster possible novel applications within the scientific community of GNSS signals, and particularly of GALILEO. On the basis of potential number of users, a set of priority applications (PA) will be selected by the consortium and they will be developed within the time frame of the project. The potential revenues of a Galileo Operating Company or concessionaire (GOC), international relevance, and level of innovation will also be researched.

These applications will help to increase and optimise the use of EGNOS services as well as the opportunities offered by the Galileo Signal Test-Bed (GSTB-V2) and the Galileo (IOV) phase.

The proposal explored two application areas on which to focus the critical analysis: signal science (SS) and navigation/positioning science (NPS). Within these two areas a number of specific research topics were identified: SS (Oceanography, troposphere, weather forecasting, ionosphere and space weather, hydrography), and NPS (Solid earth geodesy, volcanism & seismology, cryosphere, robotics precise orbit determination, altitude determination and formation flying, UAVs and space navigation, archaeology, botany, biology etc where precision positioning is important).

Description of work

- To facilitate the introduction of GNSS and in particular of EGNOS and Galileo in the addressed user community sector.
- To provide a platform for the representation of the interests of this user community in the overall discussion of EGNOS and Galileo optimisation in term of different aspects (e.g. commercial, PPP scheme and risk allocation between public and private sides, social benefits and public interests, industrial and research development and innovation, operational and system evolution).
- To provide a platform to link satellite navigation experts with user community experts in order to optimise the use of this technology in the target environments.
- To provide an instrument for the dissemination and promotion of the EGNOS/Galileo benefits and added-values with respect to the current GPS solution inside this user community, targeting expertise on satellite navigation.
- To evaluate and assess all the EGNOS/Galileo social and commercial benefits against current exiting scenarios (e.g. investments, standards, regulations, applications, services and infrastructures).
- To identify all the necessary steps to maximise the beneficial use of EGNOS/Galileo in Europe and in the world for this user community, in particular by using EGNOS SIS, Galileo GSTB-V2 SIS and Galileo IOV opportunities.
- To assess the major EGNOS/Galileo applications in this user community against all the different technical and non-technical aspects.

- To identify and promote new and innovative EGNOS/Galileo applications in this user community in order to explore all the potentials of this technology in the medium and long term timeframes.
- To support the validation, qualification and certification of the different applications/services (for different aspects and with different involvement depending on the nature of the addressed application/service) in the overall frame of EGNOS and Galileo user segment validation, qualification and certification.
- To define and execute activities aimed at increasing and optimising the use of the EGNOS services, as provided by the fully deployed and operational system, in this user community.
- To define and execute activities aimed to maximise the benefits for the addressed user community coming from the opportunities offered by the GSTB-V2 and Galileo IOV phase.

Results

Once finalised the plan's conclusions shall be as critical as possible, identifying problem areas, open points and future work. The identified open points and barriers will be mapped against the applications' enablers according to technology, market, regulation, standards and certification, and awareness and training. The priority applications of the GEO6 Project, according to the value chain, will be developed by the partners during the second phase of the project. The selected topics will be classified as:

- Signal science applications, which are oceanography, troposphere, weather forecasting, ionosphere and space weather, hydrology and climatology.
- Navigation and positioning science applications, which includes solid earth (geodesy, volcanism, seismology), cryosphere, robotics precise orbit determination (attitude determination and formation flying), archeology and UAVs and space navigation.

More information

Acronym:	GEO6
Name of proposal:	Science with GNSS
Contract number:	GJU/05/2412/CTR/GEO6
Total cost:	€ 1 939 384
EU contribution:	€ 1 004 582
Call:	FP6 2nd Call
Starting date:	01.07.2006
Ending date:	31.03.2008
Type of Project:	APPLICATION
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	Institute of Atmospheric Physics (Academy of Sciences of the Czech Republic)	CZ
	Ifremer (French Research Institute for Exploitation of the Sea)	FR
	Chalmers University of Technology AB	SE
	Technion – Israel Institute of Technology	IL

GEOLOCALNET

Innovative concepts for high-accuracy local geodetic networks

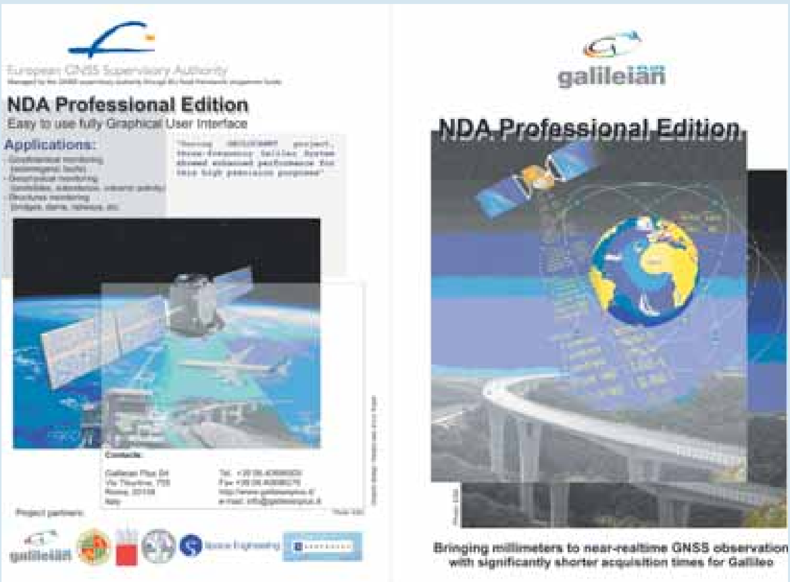
The objective of the proposed research was to develop and validate innovative algorithms, models and procedures to improve the accuracy and to promote the use of local geodetic networks for Earth crust deformation monitoring. The proposed research aimed to fully exploit the new expected performances of the Galileo system.

Background

The proposed research project addressed the use of GNSS local networks for geophysical monitoring.

Among many geophysical events requiring highly precise and fast update monitoring, crystal and seismogenic faults monitoring is the most demanding one, as a performing informatics tool for other geophysical events (landslide, subsidence, etc.) monitoring can be a by-product derived from a professional tool developed using this reference application.

Deformation monitoring through GNSS measurements, integrated with seismological studies and geophysical forward modelling, is becoming of paramount importance to discriminate areas prone to earthquake events with a given magnitude. These results are obtained by applying the so-called intermediate-term middle-range earthquake prediction algorithms and the geophysical forward modelling, which translate surface strain fields obtained by GNSS data analysis in deep stress field at the level of the seismogenic fault. The objective



of geophysical forward modelling is to derive seismic hazard maps.

However, seismic hazard maps are associated with time and space uncertainties that are respectively of a few years and a few hundred kilometres, thus not allowing an effective early warning service to protect the local population.

More refined monitoring of active faults, based on a near-real-time processing of data collected by local geodetic networks and on local seismic analysis that is bridged together through geophysical forward modelling in the areas prone to earthquake events, is the current goal to further reduce time and space uncertainties in the prediction of seismic events.

Objectives

GEOLOCALNET investigates the feasibility of the synergistic use of the Galileo signals (three frequencies) and geophysical models for near-real-time (NRT) monitoring of earth crust deformations. The objective is to decrease the GNSS observation time while maintaining the maximum accuracy achievable today with geodetic networks, through the use of Galileo's third carrier frequency. In the long term, the aim is to achieve an early warning system for seismic activity, subsidence and landslide events.

Key activities in the project include:

- Identification of the monitoring requirements for NRT geodetic networks, in terms of the trade-off between accurate and observable durations.
- Testing of GSSF (Galileo System Simulation Facility) simulator for GPS- and Galileo-like signal outputs.
- Development and testing of new algorithms based on three frequencies for upgrading the Galileian Plus NDA (network deformation analysis) product for geodetic networks.
- Comparison of the use of GPS, simulated GPS and simulated Galileo signals (the latter from the GSSF) within

an existing geodetic network in Slovenia using the upgraded NDA analysis software.

- Awareness activities to promote the use of Galileo in geodetic network monitoring.

Description of work

A preliminary requirement definition phase was carried out to set the objectives.

During the early phase of the project the Galileo data simulator (GSSF) was analysed and understood.

Algorithm studies and definitions for the three frequencies of Galileo data preceded the implementation phase where the already existing Galileian Plus software called NDA Professional was upgraded with the aim of processing three frequencies of Galileo data.

Innovative algorithm implementations concerned cycle slips removal, ionosphere and three frequencies of ambiguity fixing. Meanwhile, the test bed, including GPS (two frequencies of real and three frequencies of simulated) data and Galileo (three frequencies of simulated) data, was prepared.

Mobile equipment was set up and data was acquired by Harpha Sea, which provided micrometric movements for the NRT test bed.

Results

GEOLOCALNET demonstrated that by using three frequencies of simulated data a remarkable improvement in very precise positioning could be achieved by exploiting Galileo data.

Both repeatability tests and near-real-time tests demonstrated the increased capability of Galileo.

These tests were carried out by using an upgraded version of NDA professional, a Galileian Plus product for GNSS data analysis, which has been upgraded during the project for three frequencies of Galileo data processing.

In particular, using the same observation time a more precise relative positioning was obtained. For the same precision, i.e. repeatability, shorter observation times could be exploited. This will allow for a reduction in the costs of mobile GNSS campaigns. In general, Galileo will allow the measurement of small movements in shorter time periods thus opening up new interesting scenarios for applications such as pre-seismic non-linear deformation monitoring. This will bring important improvements in early warning services to protect the local population against a seismic hazard.

More information

Acronym:	GEOLOCALNET
Name of proposal:	Innovative concepts for high-accuracy local geodetic networks
Contract number:	GJU/05/2423/CTR/GEOLOCALNET
Total cost:	€ 478 404
EU contribution:	€ 284 404
Call:	FP6 3rd Call
Starting date:	23/11/2005
Ending date:	15/05/2007
Duration:	18 months
Type:	SUPPORT ACTIVITY
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Project Officer:	Eric Guyader
Partners	Harpha Sea SI Space Engineering IT University of Lubljana SI University of Jaen ES University of Milan IT

GGPhi

A low-cost, low-power Galileo/GPS carrier phase positioning system

A low-cost, low-power, high-accuracy Galileo positioning system for use in remote areas in developing countries. Research covered:

- the design and characterisation of the remote carrier phase sensor;
- the design of the local area wireless network;
- algorithms and software for accurate positioning.

Background

The motivation is to extend the capabilities of high-accuracy GNSS (Global Navigation Satellite System) positioning systems, used very successfully in the developed world, for applications such as landslide monitoring or building deformation monitoring, to the developing world. The difficulties in the developing world are to do with requirements for low-power, low-cost, robust equipment and constraints due to lack of infrastructure.

Other potential pseudo-static monitoring applications for this type of technology are monitoring of avalanches, glacier movements, volcanic ground deformation, subsidence, tsunamis and built structures.

Objectives

The low-cost, low-power Galileo/GPS carrier phase positioning system (GGPhi) project aimed at making high-precision positioning attainable for applications that at the moment are constrained by environmental and cost issues. In particular, in the target application of ground deformation monitoring the required accuracy is very high, while the sensor equipment will likely have no access to the power grid and be active for long periods of time, so will have to have a very low power consumption. Also the ranging sensors will be multiple, remotely located and might not be retrievable, so must be low cost. For this purpose, a measurement system composed of remote wireless-connected Galileo/GPS

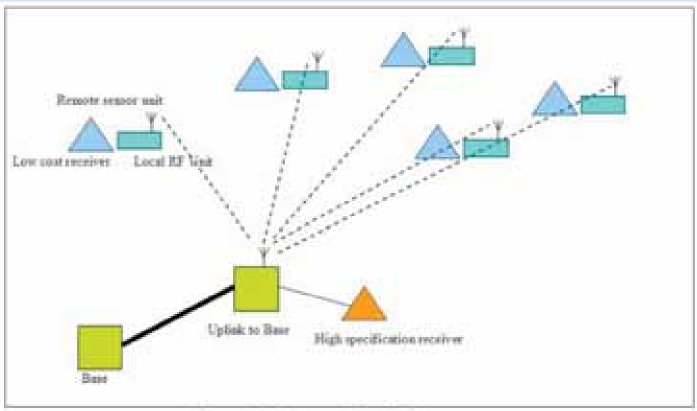

Figure 1.1 System Block Diagram

carrier phase-only measurement units supported by a GNSS aiding and processing unit was designed.

Description of work

Technological innovations

1 The low-cost, low-power carrier phase sensor design relies exclusively upon tracking a double frequency component of the Galileo and GPS (modulation-suppressed) carrier frequencies by squaring the received satellite signal prior to tracking it in a phase-locked loop. The design and evaluation steps were reported in WP2 report RP3 'Receiver design document'. A study on the impact of the Multiplexed Binary Offset Carrier (MBOC) modulation is provided in TN1: 'CBOC effect on GGPhi'.

   To satisfy the requirements for time referencing in the phase measurements and the impact of timing error in this reference for double- and triple-difference carrier phase observables, a solution was proposed in the form of having one single code tracking channel in the remote GGPhi sensor (as opposed to a total of 20 or more channels in the receiver).

2 The requirements for the GGPhi wireless network in terms of area of radio coverage, frequency bands, antenna types and cell deployment, network topologies and time and frequency synchronisation, under the overall system goals of low cost and power consumption, were studied in WP3 report TN 2: 'Communications systems high level design'. Candidate radio technologies for the GGPhi data communication requirements given by the positioning software were evaluated for robustness and resilience, energy requirements, time synchronisation characteristics and system costs, and reported in WP3 report TN 3: 'Communications systems low level design'. Three network configurations – ring topology, mesh topology and cluster topology – were proposed as appropriate to different network deployments. Examples of the three system deployments and suitable wireless network topologies were given providing complete estimated costs for the local elements, the link-to-home satellite connection and appropriate solar power devices.

3 Algorithms and software have been developed for accurate positioning using the GGPhi remote sensors carrier phase-only and reference station measurements and reported in WP4 report RP4: 'Galileo/GPS carrier phase positioning algorithms'. The most important task was the development of the triple difference processing software using simulated data and based on criteria provided by the receiver development work.

   An end-to-end evaluation of the integrated system combining the outcomes of the three areas of work has been carried out in WP5 and reported in WP5 report RP5: 'Evaluation of an integrated system'. To evaluate the expected quality of the GGPhi sensor measurements, satellite availability and the distribution of the GGPhi visible satellites, carrier to noise density ratio (CNR) was calculated for the Galileo and GPS constellations for an evaluation experiment period of two days.

Results

User groups in Iceland and Korea expressed their interest during presentations on the potential of the GGPhi system. There is a need for low-cost measurement networks for environmental monitoring, and current implementations could certainly be improved making best use of off-the-shelf conventional technology.

Technology transfer can take place through the integration of the GGPhi

concept on an encompassing geological monitoring system or by the project partners, further developing the results on this project into a commercial product, either directly or through a spin-off company.

More information

Acronym:	GGPhi
Name of proposal:	A low-cost, low-power Galileo/GPS carrier phase positioning system
Contract number:	GJU/05/2423/CTR/GGPhi
Total cost:	€ 299 917
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Call:	FP6 2nd Call
Starting date:	02/01/2006
Ending date:	13/06/2007
Duration:	18 months
Type:	SUPPORT ACTIVITY
Website:	http://www.ggphi.eu
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Keywords:	Low-cost, low-power Galileo/GPS carrier phase positioning system, local area wireless network, software algorithms, remote areas, developing world
Partners	University of Nottingham UK Informatics Development Institute (IDI) IE

GGSP

Implementation of Galileo Geodesy Service Provider prototype

The main function of GGSP is the realisation of a precise and stable GTRF, fully compatible with the ITRF and a realisation of the ITRS. The GTRF will be the basis for all Galileo products and services, serving both the Galileo core system (GCS) and the Galileo user segment. This implies that the GGSP should enable all users of the Galileo system to rapidly access the GTRF with the precision required for their specific application.

Background

For many Earth science applications as well as for satellite navigation, geodesy has the potential to provide a TRF, as a realisation of a TRS, to which are related valuable observations of parameters that govern the Earth system.

Since the 1980s, continuous improvement of space geodesy techniques, in terms of technology and modelling of their observations, has drastically improved our ability of TRF determination and its maintenance over time to reach the one-millimetre accuracy level.

While any individual space geodesy technique (VLBI, SLR, DORIS, GNSSs including Galileo in the future) is able to provide observations allowing a TRF determination, a combination of station positions and velocities from independent techniques has long been the standard method to realise global terrestrial reference frames. In principle, the particular strengths of one observing method can compensate for weaknesses in others if the combination is properly constructed, suitable weights are found, and accurate local ties in co-location sites are available. None of the space geodesy techniques is able to provide all the necessary parameters for the TRF datum definition (origin, scale and orientation). The utility of multi-technique combinations is therefore recognised for the reference frame implementation, and in particular for accurate datum definition. Since the creation of the International Earth Rotation and Reference Systems Service (IERS), the current implementation of the International Terrestrial Reference Frame (ITRF) is based on a multi-technique combination, incorporating individual TRF solutions derived from space geodesy techniques as well as local ties of co-location sites. The IERS has recently initiated a new effort to try to improve the quality of ties at existing co-location sites, without which the ITRF could not exist.

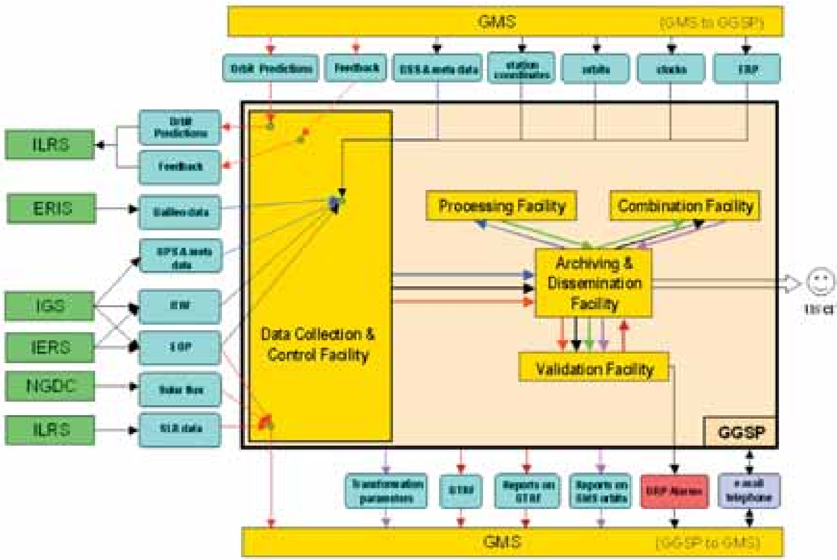
Objectives

The GGSP contract covers the specification, design, implementation, testing and operation of the prototype Galileo Reference Service Provider (GRSP) to support the Galileo IOV phase.

The prototype of the Galileo Reference Service Provider is responsible for establishing the Galileo Terrestrial Reference Frame (GTRF), and its relation with the International Terrestrial Reference Frame (ITRF) within tight specification.

The GTRF has to fulfil general requirements as there are accurate TRFs for all relevant Galileo operations, long-term stability with high accuracy and reliability, connection to ITRF at the same accuracy level and, to the maximum extent, independent maintenance of GTRF from other TRF realisations.

There are a wide range of users, user groups and user communities of Global



Navigation Satellite Systems such as Galileo. These users need knowledge about the inherent reference frame as the basis of all Galileo services and applications. Among the potential users of the GGSP are geodetic users, scientific users and application users.

Description of work

The main Work Packages of the GGSP prototype are:

- Consolidation of GGSP prototype (specification, definition and planning phase);
- Realisation, validation and maintenance of the GTRF;
- Validation of satellite orbits, clocks and earth rotation parameters;
- Outreach and applications in geodesy;
- Recommendations for the implementation and operation of the permanent GGSP.

The prime task of the GGSP is to provide station coordinates and velocities for the Galileo sensor stations for the In-Orbit Validation-phase of Galileo.

Furthermore, the GGSP responsibilities will include the generation of other precise products that are needed by the advanced Galileo geodetic user community to get full access to the GTRF. These products, generated simultaneously with the GTRF activities performed within the GGSP, will comprise of at least:

- precise Galileo satellite orbit and clock estimates;
- Earth rotation parameters (ERPs);
- GTRF data and information for the users.

Results

The GGSP results will comprise specification for the GTRF implementation, datum definition and analysis strategy for GTRF derivation and maintenance over time.

The GTRF is designed to be compatible with the International Terrestrial Reference Frame (ITRF) and will therefore be a realisation of the International Terrestrial Reference System (ITRS).

The GTRF station coordinates shall be identical to the ITRF station coordinates within a tolerance of 3 cm (at 95% confidence level) for all station markers that appear in both frame realisations.

More information

Acronym:	GGSP
Name of proposal:	Implementation of Galileo Geodesy Service Provider prototype
Contract number:	GJU/05/2420/CTR/GGSP
Total cost:	€ 1 799 536
EU contribution:	€ 1 799 536
Call:	FP6 2nd Call
Starting date:	01/07/2005
Ending date:	30/06/2008
Duration:	36 months
Type:	SYSTEM INFRASTRUCTURE & EVOLUTION
Website:	http://www.ggsp.eu
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GIANT

GNSS introduction in the aviation sector

GIANT aims to support the introduction of EGNOS and Galileo services in the aviation market, while demonstrating that the required safety levels are maintained for the responsible authorities and show economic and operational benefits to end-users.

Background

For some time, ICAO has stated the recommendation to make 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. However, it is also recognised that GNSS have inherent vulnerabilities that have to be investigated, mitigated and solved.

Following the ICAO's recommendation and the Council Conclusions regarding the use of EGNOS in the aviation domain, EUROCONTROL has included the introduction of APV operations based on EGNOS as one of its implementation objectives (ECIP).

Thus, the GIANT project will continue some of the many activities that were begun for Galileo in earlier phases (e.g. GALILEI, GALA, SAGA, GILT and GEM).

Objectives

The aim of GIANT is to support the introduction of EGNOS and Galileo services in the aviation market, maintaining the required safety level imposed by the responsible authorities. Therefore its goal is the implementation of a strategic plan for the progressive introduction of GNSS services in aviation which complement the tasks being developed by EUROCONTROL.

The main objectives and challenges of the project have been to provide a wide range of civil aviation users (airlines, regional/general aviation, helicopters) with first-hand experience on the benefits of GNSS for air navigation from the point of view of:

Safety:

- vertical guidance (LPV) available on all runways (CFIT reduction);
- low height routes (helicopters, obstacles);

Cost savings:

- low cost, high performance avionics for all users;
- potential to rationalise conventional navigation aid infrastructure.

Efficiency and operational benefits:

- LPV
- Back -up to ILS approaches;
- Lower operational minima on non-ILS runways;
- Advanced procedures (e.g. curved approaches);
- Approach operations;
- Lower noise impact;
- More efficient routes and fuel savings;
- Operations in areas with poor navigation infrastructure;

Integrated avionics:

- Definition of different ways of integration of GNSS receivers in the airborne architectures;
- Integration of EGNOS application on a CRJ-system architecture.

Description of work

The GIANT objectives require much work in different fields – air navigation technical aspects, economy and business aspects, safety, regulation, etc. The activities to be performed have been broken up into the following sub Work Packages:

- Action and transition plans;
- Development of innovative applications;

- Demonstration of the operational benefits of GNSS to airspace users;
- Business, market, economical and safety studies;
- User terminal;
- Local elements;
- Assessment of legal and regulatory GNSS enablers.

GIANT is a user-driven project. This means that this project deals with the development of a solution proposed by the industry, promoted by the service provider (ATSP) and accepted by the user (airlines).

The activities performed within GIANT address, among others, the safety aspects for the implementation of GNSS, the demonstration of the operational benefits to airspace users through flight trials and the cost effectiveness of GNSS. In addition, GIANT promotes GNSS in aviation through the development of innovative applications, analysis of required technological developments (user terminal and local elements) and covers any legal and regulatory aspects necessary

for its successful implementation. Special effort within the project is devoted to the flight demonstrations.

Results

The main results will be proposals and solutions for GNSS operational implementation, legal aspects and onboard and ground elements of GNSS, especially issues regarding:

1 Definition and validation of new GNSS approach and landing procedures, LPV approach procedures for Valencia, San Sebastian and Bologna airports (for aircraft) and Lausanne and North Sea oilrigs helipads (for helicopters).

2 Enabler and action plan for the GNSS operational implementation, addressing the open points and the risk mitigation for the short term and medium to long term.

3 Development of innovative applications that could be supported by GNSS.

4 Required technological developments (user terminal and local elements) which allow flying these new GNSS procedures.

5 Assessment of the new GNSS approach procedures and its technical suitable implementation in terms of operational, safety, environmental and economic benefits.

6 Demonstration of the feasibility and 'flyability' of the studied GNSS approach procedures through flight trials, flight demonstrations and simulation campaigns.

7 Study of the impact of these new GNSS techniques in the current legal frame and recommendations for regulatory procedures.

In particular, the technologies and concepts involved in the GIANT project would allow aviation operations in areas with poor navigation infrastructures, while the technologies and concepts involved in the GIANT project will also derive in an enhancement of the approach operations, in terms of:

- Lower noise impact;
- More efficient routes and fuel and emissions savings.

More information

Acronym:	GIANT
Name of proposal:	GNSS introduction in the aviation sector
Contract number:	GJU/05/2411/CTR/GIANT
Total cost:	€ 5 481 856
EU contribution:	€ 2 998 832
Call:	FP6 2nd Call
Starting date:	13/07/2005
Ending date:	15/02/2008
Duration:	31 months
Type:	APPLICATION
Website:	http://www.gnss-giant.com
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	CMC Electronics -
	ESSP -
	Eurocopter -
	FDC -
	Helios Technology -
	IIASL -
	Isdefe -
	NATS -
	PATA -
	Pildo Labs -
	REGA -
	Rockwell Collins UK -
	Septentrio -
	Skyguide -
	Terma -
	Thales ATM -

GIGA

Galileo Integrated Georeference Applications

GIGA intends to introduce satellite navigation technology in user community (UC) energy processes with a special view on current satellite positioning systems like, for example, GPS and GLONASS and the future European Galileo system.

Background

E.ON Ruhrgas, a large player in the European energy industry, recently decided to tackle safety and security-related risks and the negative economic impact from accidents. Excavation works threaten to damage pipelines, and pipes are destroyed in construction and maintenance activities mainly because of unavailable or inaccurate georeferences. This causes high immediate costs as well as follow-up costs to the European economy. Vulnerability to permanent or temporary disruption of energy supply was dramatically confirmed by a recent pipeline accident in Belgium in July 2004.

As a consequence, E.ON Ruhrgas decided to develop a full-scale GNSS-based application to significantly reduce this cost position in the entire E.ON Ruhrgas group of consolidated companies.

In Europe, such a GNSS-based solution is still lacking in user community energy. Without public co-funding, E.ON Ruhrgas would have focused on its internal application only, as resources for a commercial application and for business development would most probably not be available within the medium term.

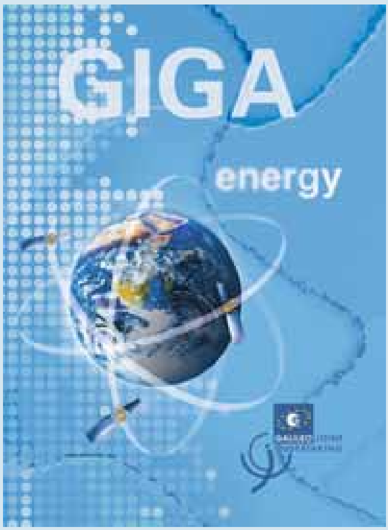
GIGA brings together a consortium of complementary partners which take the E.ON Ruhrgas application concept and develop it to a commercial application for the European energy community.

The expected impact of GIGA's results (a commercial GNSS-solution for the special user community energy together with the appropriate steps for concurrent business development) becomes clearer when seen from the viewpoint of Europe's high dependency on fossil fuels, both internally and externally.

Objectives

GIGA aims at analysing, demonstrating and disseminating the benefits of EGNOS and Galileo (+GPS) for high precision positioning applications in the area of energy exploitation and supply. GIGA will help to increase the awareness on Galileo/EGNOS and the related chances and positive impacts for the 'energy' community.

Measures and technologies will be defined, developed and made known to



UC energy by using design concepts, demonstrators and public events.

The project is defined in three phases:

- Phase I: Critical analysis
- Phase II: Demonstrator implementation
- Phase III: Results analysis.

Description of work

Results

The following results could be identified:

- Analysis, prioritisation and benchmarking of applications within the UC energy and comparable applications outside the UC energy;
- Feasibility studies concerning mobile communications, service centre components and dissemination concepts;
- Demonstrator for high-precision positioning (comprising of both service centre components and field devices) with improved integrity and QoS information for field devices, and a new approach for low-cost field devices based on reverse GNSS processing;
- Outcome of a business plan describing different scenarios for the set-up of a Galileo service centre (local component) and the basis of estimations on investment costs and pricing models.

More information

Acronym:	GIGA	
Name of proposal:	Galileo Integrated Georeference Applications	
Contract number:	GJU/05/2414/CTR/GIGA	
Total cost:	€ 2 227 462	
EU contribution:	€ 1 244 047	
Call:	FP6 2nd Call	
Starting date:	24/08/2005	
Ending date:	24/07/2007	
Duration:	24 months	
Type:	USER TECHNOLOGY	
Website:	http://www.giga-energy.info	
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	BT – British Telecom	UK

GILT

Galileo Initiative for Local Technologies

The GILT project aimed to develop key parts of a technological base for Galileo-based local elements (augmentations). GILT focused on Galileo-specific technical opportunities for local integrity, tropospheric error correction, location-based services (LBS), pseudolites and interference.

Background

Local elements or augmentations are used to enhance the performance delivered by global navigation satellite systems (GNSS). Such enhancements include improved position accuracy, the verification of accuracy, interference detection, and improved signal coverage in difficult environments. Though described as local for historical reasons, these enhancements may cover geographical areas ranging from a single building up to the size of a continent.

All users will see significantly improved satellite navigation performance with the new Galileo signals, especially when used in combination with GPS. Nevertheless, local elements will continue to be needed to provide yet higher levels of performance. Although the need for some local element functions is reduced or eliminated, new applications are emerging where local elements will be as important as ever. These new areas include safety critical transport applications, location-based services, accuracy optimisation for precision surveys, and tool positioning in agriculture, construction, and other segments.

Objectives

The objective of the GILT project was to develop key parts of a technological base for Galileo-based local elements in advance of the implementation of local infrastructures. The project focused on Galileo-specific high performance features. GILT also aimed to prepare an overall planning framework for the introduction of Galileo-based local services, including prioritisation and interactions with external drivers (GPS modernisation etc).

Description of work

The technological base was implemented using a "building block" approach that focussed on the innovative technical opportunities created by Galileo in seven application areas. The seven application areas are:

1. Integrity solutions for local areas - High Integrity Spot Coverage (HISC) to serve aviation and other applications;

2. Integrity solutions for regions - High Integrity Area Coverage (HIAC) to serve rail and road applications and potentially other land based activities;

3. Integrity solutions for coastal regions - Medium Integrity (MI) to serve maritime and other applications;

4. Troposphere corrections for accuracy optimisation;

5. Location-based services (LBS);

6. Pseudolites for improved availability in locations with poor satellite visibility;

7. RF interference detection for signals that represent a threat to the performance of GNSS services.

Results

The building blocks were tested by analysis or by simulation (in advance of the Galileo SIS), using tools that were available within the GILT team. For HISC, different approaches for raw data pro-

cessing were investigated and service volume simulations were used to analyse the availability of the different performance levels for several frequency combinations of Galileo/GPS satellites. By using these signals, greater accuracy and advanced integrity determination will be achieved more efficiently. The feasibility of the HIAC architecture was tested using simulations. Integrity risk values were achieved, approaching those for safety critical applications. Methods for achieving further reductions in alert limits were proposed. Updates to the RTCM 3.0 standard were proposed for the broadcast of correction parameters.

MI results included an architecture tested by simulation to (1) allow use of separate satellite constellations or a combined Galileo and GPS satellite constellation to be selected by the user of local element data, (2) use of Internet protocols to achieve a scalable infrastructure, and (3) provision of a solution where the performance trade-offs (accuracy/integrity) are user selected.

Tropospheric corrections were prototyped and it was shown that the solution could provide a global accuracy of better than 2 cm residual RMS zenith delay error, which is a significantly improvement over a priori models using a "standard atmosphere", such as the EGNOS model. A protocol was defined for disseminating corrections.

For LBS, techniques were demonstrated for reducing the volume of assistance data to be passed through mobile networks. Several techniques were used including computing long term ephemeris and broadcasting new navigation data. Time transfer accuracy of +/- 1ms was demonstrated and also a 50% reduction in time-to-fix.

Pseudolite ranging, channel sounding, and truth recordings were gathered in some typical city centre environments. Analysis showed how the wide bandwidth signals to be employed by Galileo will provide improved pseudolite ranging. It was confirmed that reliable pseudolite pseudo-ranging is a practical proposition in these environments.

Interference detection techniques and algorithms were defined and evaluated for the continuous and pulsed signals that pose a threat to user receivers and augmentations. These algorithms were tested using simulation.

More information

Acronym:	GILT
Name of proposal:	Galileo Initiative for Local Technologies
Contract number:	1010/CTR/FP6/B
Total cost:	€ 3 800 000
EU contribution:	€ 3 800 000
Call:	FP6 1st Call
Starting date:	01/03/2004
Ending date:	01/05/2006
Duration:	26 months
Type:	SYSTEM INFRASTRUCTURE & EVOLUTION
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	Alenia Spazio	IT
	Indra Espacio SA	ES
	EADS Astrium Ltd	UK
	Kayser Threde GmbH	DE
	GMV SA	ES
	Politecnico di Torino	IT
	Ingenieria y Economia del Transporte SA (INECO)	ES
	DFS GmbH	DE
	Thales ATM GmbH	DE

GIRASOLE

Galileo Integrated Receiver for Avanced Safety Of Live Equipment

The GIRASOLE project offers several interesting and attractive elements:

- three GNSS receiver manufacturers are involved in the design and development, thus allowing the exploitation of different and complementary expertise;
- each GNSS receiver manufacturer is pushed to develop basic technologies for the Galileo system, which will be transferred afterwards to other potential users;
- the activities are distributed among different manufacturers and countries, thus allowing dissemination on a Galileo safety-of-life service.

Background

One of the most appealing features of Galileo that GPS does not have is the signal-embedded integrity, which enables the system to inform users about the possible failure of the system.

Thanks to this provision, the possibility of using GNSS in a safety-critical application (i.e. safety of life, SoL) can be envisaged for both EGNOS and Galileo.

The receivers used for safety-critical application share some common specifications and are generally classified under the term 'safety-of-life receivers'. The main characteristics of these types of receivers are their robustness and their capacity to identify failures coming from the constellations, from the signal

in space, from the environment and from the receiver itself.

Safety-of-life receivers are also subjected to a large quantity of specifications, resulting in a rigorous certification process.

Objectives

The activities within the project are aimed to reach four main objectives:

- carry out thorough technological research oriented to identifying the technologies needed for SoL receivers;
- develop common structures which can be shared among the different application-oriented receivers;
- develop three basic SoL receivers prototypes for the three different application – aviation, maritime and rail;
- develop tools to assist in the development phase – two Galileo signal simulators will be developed.

The programme can be considered as a natural continuation of the GARDA programme. Core technology investigation and implementation will evolve, targeted at the SoL application of the GARDA core technologies.

Description of work

Inputs to the project

Several inputs are foreseen for the project, and those coming from the GARDA project have a particular importance. They include studies about the development activities of the Galileo receivers, identification and investigation on some core technologies, and development tools and preliminary development activities of a professional receiver. All these inputs will be taken into account and further developed within the current project.

Requirements and specifications

A first issue of the 'requirement and specification' document will be created based on the input to the project; this issue will then be considered the initial input to the subsequent task on the core technologies. A second issue of the requirement and specification docu-

ment will be released covering the feedback coming from the core technology investigation task, and the third and final issue will be completed at the end of the project covering the feedback from the breadboard development task.

Core technologies task

Candidate core technologies are studied and criticised in order for them to be tailored to the specific needs of SoL applications. The result will be a set of technologies that act as a common base for all SoL applications, plus others which represent those specifically related to the targeted SoL applications.

Once the technologies are identified, they will be analysed by means of the GRANADA tool in order to produce solutions and any other indications that will be used as a starting point in the breadboard development task.

Breadboard development

This activity derives from, and is conducted in parallel with the core technologies task, to which it provides feedback for a better identification, and which is aimed at the design and development of a receiver breadboard for each of the three identified applications: rail, maritime and aviation.

Common platform concept

The common platform concept has been included as a logical attempt to reduce costs and development schedule, and to avoid spreading the efforts on similar designs of each receiver target application.

The definition of a common receiver architecture is to be considered a good starting point. This means that the main characteristics of the 'ideal' receiver can be retained by a customised receiver for each application.

Results

Currently the project is in the phase of testing the three receiver breadboards developed.

The testing phase will be conducted using the developed simulation tools.

One simulator has been developed by Space Engineering, which has evolved from the GARDA mono-channel simulator (GMCS). A second simulator has been developed by NAVIS.

The GRANADA software tool has been upgraded and now includes some features useful for investigating and analysing SoL technologies.

The investigation on the core technologies has been completed and an assessment of the basic technologies for the SoL application done. Some basic technologies have been analysed with GRANADA.

The investigation and analysis on the core technologies has highlighted some interesting topics that deserve further investigation.

The first version of the GIRASOLE breadboard developed for rail application will be used on the test campaign on a train within the framework of the GRAIL project.

More information

Acronym:	GIRASOLE
Name of proposal:	Galileo Integrated Receiver for Avanced Safety Of Live Equipment
Contract number:	GJU/05/2415/CTR/GALILEOSOL
Total cost:	€ 6 275 000
EU contribution:	€ 3 325 000
Call:	FP6 2nd Call
Starting date:	20/09/2005
Duration:	24 months
Type:	USER TECHNOLOGY
Website:	http://www.garda-project.it/garda/girasole
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Project Officer:	Eric Guyader
Keywords:	GIRASOLE, GARDA, SoL, GRAIL, GRANADA

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	Navis	RU
	DEIMOS Space	ES
	DEIMOS Engenharia	PT
	CASC	CN
	Space Engineering	IT
	CNIT	IT
	DLR	DE
	Ascom	CH
	ERA	UK

GIROADS

GNSS introduction in the road sector

GIROADS is a research initiative commissioned by the European GNSS Supervisory Authority (GSA) which seeks to achieve a shared understanding of the relevance of Europe's satellite navigation programme to the everyday needs of the road transport sector.

Background

Dwindling public investment available for road infrastructure coupled with legitimate societal aspirations for cleaner, safer and smoother roads have underlined the need for new answers to the traditional challenges posed by increased road transport demand:

- Achieving a significant and lasting decrease in road deaths;
- Identifying stable mechanisms of funding for road improvement;
- Eradicating bottlenecks and curbing pollution.

The resulting shift by road users and operators towards a culture of journey optimisation is at the heart of the exponential growth in the offer of intelligent transport applications. By cancelling the need for expensive roadside ??? and allowing the introduction of bundled services, EGNOS and Galileo will precipitate this trend, reduce the negative impact of road transport and offer new services and business opportunities.

Objectives

GIROADS aims to facilitate the introduction of GNSS (EGNOS & Galileo) in the road sector by:

- identifying all potential GNSS applications in the road sector;
- evaluating their market potential and proposing a successful commercial model;
- assessing their impact on the regulatory environment;
- establishing a technical platform providing support to all planned services;
- field-testing the platform on high-potential applications (electronic fee collection and congestion charging, traffic information services, pay-per-use insurance, livestock tracking)
- raising awareness of the tangible benefits of GNSS,
- establishing recommendations facilitating the take-up of GNSS applications in the road sector.

GIROADS will play the role of a reference platform for the development of EGNOS/Galileo applications to the road community as a whole.

Description of work

The underlying philosophy behind the GIROADS project is that a number of key applications hold the potential to become enablers of transport policy as a whole, while giving rise to commercially viable service provision schemes of interest to a wide range of stakeholders. These applications have been individually analysed to understand user requirements, assess the existing regulatory framework and build a realistic market study that can serve as a reference to the sector.

GIROADS has based its technical programme on an architecture which associates existing components previously developed under community-funded research projects (ADvantis, VeRT and

SCORE) within an open, robust and scalable system, which can support application-specific service centres through a common technical structure.

Once in place, a series of field trials covering the most promising applications (such as pay-per-use insurance, electronic fee collection and traffic information services) will be held in urban and inter-urban environments through the collaboration of municipalities and road operators already associated to the project. These live demonstrations will seek not only to demonstrate the smooth integration of the overall system design, but also to validate that EGNOS and Galileo offer a new class of applications which are currently unavailable.

Results

The main limitation on a massive penetration of GNSS-based telematic applications is the complexity and cost of application-specific systems. GIROADS will demonstrate that a device supporting multiple simultaneous applications can lead to significant economies of scale and enable the emergence of bundled services of interest to the road community.

GIROADS will also demonstrate the benefit of Galileo by focusing on integrity as an enabler of 'liability-critical applications', such as road tolls or pay-per-use insurance, where position data becomes the basis of commercial strategies.

More information

Acronym:	GIROADS
Name of proposal:	GNSS introduction in the road sector
Contract number:	2408
Total cost:	€ 5 976 754
EU contribution:	€ 3 163 281
Call:	FP6 2nd Call
Starting date:	01/09/2005
Ending date:	31/12/2007
Duration:	28 months
Website:	http://www.intelligentroads.org
Video:	Galileo in the road sector http://www.dailymotion.com/video/x2axit_giroadsenglishok_tech
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Keywords:	EGNOS Galileo roads	
Partners	Telvent Control Systems (Beijing) Co	CN
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	Alcatel Lucent	FR
	Thales Alenia Space Italia	IT
	GMV Sistemas S.A.	ES
	Grupo GMV S.A.	ES
	Soluciones Globales Internet (SGI) S. A.	ES
	Asociación Española de la Carretera (AEC)	ES
	4iCom - PYRAMIS S.A.R.L	FR
	Ian Catling Consultancy (ICC)	UK
	TTS Italia – Associazione Italiana della Telematica per i Trasporti e la Sicurezza	IT
	Bain & Company Italia	IT
	HITEC - Vereinigung High Tech Marketing	AU
	BRISA – Auto-Estradas de Portugal S.A.	PT
	Autostrade per l'Italia – ASPI S.p.A	IT
	Sinelec S.p.A.	IT
	Telespazio S.p.A.	IT
	MAPFRE Mutualidad	ES
	Pagnanelli Risk Solutions Ltd.	IT
	Asociación Cooperación Sino Española en Tecnología e Innovación (CSETI)	CN
	European Satellite Services Provider EEIG (ESSP)	BE
	Futian Transportation Consultants Co	CN
	Universidad de Murcia	ES
	Universitat de València	ES
	Laboratoire Central des Ponts et Chaussées – LCPC	FR
	Geoville Information Systems GmbH	AT
	NEXT Ingegneria dei Sistemi S.p.A	IT
	ATAC S.p.A.	IT
	THETIS S.p.A.	IT

GISAR

Galileo Implementation of Search And Rescue interfaces

The main objective of the GISAR project is the design, development and validation of a MEOSAR (medium Earth orbit search and rescue) ground segment prototype, as well as the participation in both the DASS POC experimentation and the Galileo In-Orbit Validation (IOV) phase.

Background

Members of the consortium have been involved in all previous SAR/Galileo studies back to Galileo Phase B2 and have led the definition of SAR/Galileo at system, segment and element levels. The consortium is therefore well aware of the benefits provided by the current COSPAS-SARSAT system, as well as its weaknesses and the requirements of its operators. The planned inclusion of a SAR payload in the Galileo satellites represents a major opportunity to dramatically enhance the performance provided by this system, and to ultimately save more lives.

The MEOLUT prototype will offer a proof-of-concept platform to present the new SAR/Galileo system to COSPAS-SARSAT. It will also represent a test bench for technical and operational purposes as a major step towards the final MEOLUT.

Regarding the demanding performance requested of the algorithms, i.e. to combine different satellite constellations' relayed signals to decode a beacon message and find the position of that beacon on earth with high accuracy in a short time, will be achieved by means of specifically designed and optimised algorithms. These algorithms are verified with the aid of extensive simulations with specially developed tools which recreate the different elements that constitute the system and with real data, thanks to the experimentation with real SAR signals from existing satellites (e.g. DASS proof-of-concept).

Objectives

The main objective of the GISAR project is the design, development and validation of a MEOSAR ground segment prototype, as well as participating in the Galileo In-Orbit Validation (IOV) phase.

The MEOSAR ground segment prototype consists of a medium Earth orbit local user terminal (MEOLUT) prototype and a return link service provider (RLSP) prototype. The MEOLUT prototype is a receiver station capable of processing the SAR/Galileo distress signals trans-

mitted by COSPAS-SARSAT emergency beacons, recovering the transmitted beacon message and locating the user in distress. The RLSP prototype manages the dissemination of return link messages providing feedback information to the beacon.

This project is developing a prototype of a MEOSAR ground station which will provide significant improvements over the ones currently in use in the COSPAS-SARSAT system, including higher accuracy and responsiveness. The targeted operational MEOLUT will also be affordable equipment that can be used worldwide, thereby enhancing the rescue activities for remote regions by allowing the deployment of a wider network.

The implementation, test and validation plan for the developed prototype are also considered, together with an implementation and operational plan for the permanent or definitive MEOSAR equipment.

Finally a set of enablers for the MEOLUT development are performed which will aim at ensuring the success of SAR/Galileo activities.

Description of work

The main source of research activities derives from the new MEOLUT concept. The subject of these activities includes SAR processing algorithms, MEOLUT antenna and RF front-end and experimentation with DASS and SAR Galileo signals.

The signal processing algorithms implemented at the MEOLUT are responsible for producing accurate results, ultimately for the final performance levels; thus MEOSAR represents a benefit with respect to the current LEO/GEOSAR systems. Location techniques using the wealth of information provided by the simultaneously received signals are providing far-reaching benefits in terms of location accuracy and responsiveness, crucial for rescue operations. Furthermore, the consecutive reception of bursts for the same distress event provides a degree of diversity that will help to reduce the influence of noise and enhance BER, location accuracy, etc.

The signal processing techniques implemented in the MEOLUT prototype are the result of a trade-off between the power and flexibility of state-of-the-art techniques versus the complexity and cost brought about by these techniques.

Two solutions have been traded-off for the MEOLUT front end: one is based on the use of a set of steerable dish antennas, and another is based on the use of an array antenna with digital beamforming and spatial processing techniques.

The MEOLUT development intends to perform a preliminary experimentation with DASS and IOV SAR/Galileo signals. The core of these experiments is the reception of signals in S-band and L-band to provide a preliminary assessment of the MEOSAR concept, including initial performance comparison between MEOSAR and LEO/GEOSAR systems.

Results

The key deliverables of GISAR are prototypes for the MEOLUT ground station and the RLSP.

Both the high performance SAR forward link station and the innovative SAR return link service will drastically improve the current COSPAS-SARSAT search and rescue service performance levels.

With the GISAR innovations and developments, it is expected to substantially improve the SAR operations and open new markets for the consortium.

More information

Acronym:	GISAR
Name of proposal:	Galileo Implementation of Search And Rescue interfaces
Contract number:	GJU/05/2421/CTR/GISAR
Total cost:	€ 4 000 000
EU contribution:	€ 4 000 000
Call:	FP6 2nd Call
Starting date:	01/05/2005
Ending date:	31/05/2009
Duration:	48 months
Type:	SYSTEM INFRASTRUCTURE & EVOLUTION
Website:	http://www.indra.es/space
Coordinator:	Dr Josep Perlas, Indra Espacio S.A. C/ Roc Boronat, 133 ES 08018 Barcelona
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Project Officer:	Jean-Marc Pieplu
Keywords:	MEOSAR, MEOLUT, RLSP, seach and rescue, SAR / Galileo, DASS

Partners

TAS-F	FR
CNES	FR
INTA	ES
Thales Airborne Systems	FR
Edisoft	PT
Capgemini	FR
Canadian Communications Research Center	CA
MARTEC - SERPE IESM	FR
ISS	CZ
RMR	UK

GLECIA

Ground Local Elements for Continuity Improvement on Airports

The escalating number of accidents on airport surfaces is becoming a major safety concern. The objective of GLECIA was to develop an integrated system for the surveillance of airport vehicles, taking benefits of the synergies between GNSS-based tracking systems and additional sensors for poor visibility areas.

Background

The continuous and steady growth of air traffic has led to an escalating number of accidents on airport surfaces. Existing systems for surveillance of ground movements are mostly based on the 'see and be seen' principle to maintain the separation between aircraft and/or vehicles. These systems have demonstrated their weaknesses in cases of low visibility, resulting in increased ground movement hazards (runway incursions). Today, identified solutions (A-SMGCS – Advanced Surfaced Movement Guidance and Control Systems) aim at providing accurate positioning services, based on guidance and communication capabilities. However, these solutions rely on costly surface radars, or on GNSS solutions, which are cheaper but do not operate in satellite shadowing areas.

The A-SMGCS solutions aim at providing accurate positioning and surveillance services, based on guidance and communication capabilities. However, these solutions rely either on costly surface radars or on GNSS solutions, which use satellite navigation systems as basic positioning sensors complemented with EGNOS. These GNSS solutions enable improving the positioning accuracy and integrity, and are cheaper than surface radars (no requested ground infrastructure), have a global coverage and give better performances (EGNOS integrity/accuracy).

However, the use of GNSS systems induces continuity and accuracy limitations, due to :

- Complete shadowing effects in areas where GNSS and EGNOS satellites are not visible, leading to an incapacity to localise and to monitor vehicles (inside buildings, hangars, tunnels, etc.);
- Partial shadowing effects, where the visibility configuration of the GNSS satellites induces bad geometric conditions to provide accurate position solutions;
- Multipath effect induced by particular airport environment, such as hangars and aircraft, which are mainly composed of materials with high electromagnetic reflective properties.

Objectives

The objective of GLECIA was to develop an integrated system based on the integration of the IndoorNav system, which uses WiFi as a positioning system, with the AIRNET system, which uses EGNOS as a positioning system: this ensures the continuity of the positioning service in identified critical areas of the airport. The detailed objectives of the GLECIA project were to:

- Assess the benefits (performance improvements) of integrating the IndoorNav and AIRNET systems;
- Assess methods and develop algorithms for the integration of IndoorNav (hybridisation of IndoorNav and GNSS/EGNOS measurements);
- Develop a demonstrator to illustrate the benefits of the AIRNET/IndoorNav integration in an airport-like environment.

Description of work

The integrated system is based on the integration of the IndoorNav system, which uses WiFi as a positioning system, with the AIRNET system, which uses EGNOS as a positioning system. This overcomes the limitations of GNSS-based systems' shadowing effects (continuity issue) and multipath effects (accuracy issue), thus ensuring the continuity of the positioning service in identified critical areas of the airport and therefore ensuring that airport users have the optimal quality of service in all the airport areas.

A key factor to success was the definition of an optimal hybridisation scheme and algorithms between the IndoorNav system and the AIRNET system. The hybridisation efficiency was assessed and demonstrated, and the resulting integration costs considered.

Results

The GLECIA system enabled validation of the most innovative features of the project and demonstrated that the availability and continuity of the AIRNET positioning service could be improved thanks to the hybridisation with the IndoorNav system. However, because of the limited time frame between the field trials and the project completion, it was not possible to evaluate the improvement on the accuracy of the positioning service.

Besides, some limitations were identified, namely interferences between the GNSS receiver and the antennas. These limitations will be carefully addressed if the decision is made to continue with the development of an operational system.

GLECIA was therefore an excellent opportunity for the partners to acquire specific knowledge, thus enabling them to further develop the GLECIA concept in other applications.

More information

Acronym: GLECIA

Name of proposal: Ground Local Elements for Continuity Improvement on Airports

Contract number: GJU/06/2423/CTR/GLECIA

Total cost: € 459 379

EU contribution: € 289 616

Call: FP6 2nd Call

Starting date: 23/03/2006

Ending date: 15/07/2007

Duration: 16 months

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Project Officer: Eric Guyader

Keywords: A-SMGCS, aiport surface, runway incursion, surveillance positioning, EGNOS, accuracy, integrity, continuity

Partners

Com Nova	DE
Skysoft	PT

GR-POSTER

Galileo-Ready Positioning Terminal

The GR-POSTER consortium proposes the development of a Galileo-ready mass market receiver that can take advantage of previous investments by the partners, while at the same time providing guidance for the industrial development of a competitive solution.

Background

Due the status of the Galileo implementation roadmap at the time of the proposal presentation, it was premature to design a chipset fully compliant with Galileo's requirements. This was evident when comparing the maturity of Galileo specification and deployment plans with the typically limited life-cycle of a commercial mass market positioning chipset. Nevertheless, technology providers and terminals manufacturers were working to produce new generation receivers with features like indoor sensitivity, low power consumption, and optimised size and cost.

For the above reasons, the partners planned to develop "Galileo-ready" receiver technology integrating a consortium composed of companies with proven complementary technical characteristics, that is:

- Established presence in localisation technology and solution providing (STM);
- Established market presence in the architecture, design, integration and production of terminals for mass market applications that are using GPS and EGNOS at this time (MMSE, C-Map);
- Top experience in professional positioning technology and solutions, and presence in GARDA programme (Thales, DEI, ISMB);

Technology experience and presence in the fast growing Far East market (CASC).

Objectives

The GR-POSTER project was conceived with the objective of creating "Galileo-ready" receiver technology, and to achieve with a limited project budget two main results:

- Provide "Galileo-readiness" in the next chipsets and terminals to be produced, with a focus on mass market cost-optimisation (single-chip receiver feasibility).
- Provide the former GJU with a flexible receiver platform, compatible with Galileo signal and re-programmable for maximum flexibility, to be used in GR-POSTER (and in future projects) so as to anticipate the compatibility of Galileo with future generations of mass market terminals.

The project focused on the development of a Galileo-ready flexible terminal with the following characteristics:

- Low-cost Galileo-ready receiver implementation (mass market requirements);
- Targeted and optimised for automotive and handheld applications;
- Scalable architecture to be applicable to a broad range of product designs;
- Compliant with GJU specifications (in connection with GARDA project).

Description of work

The Galileo-ready flexible technology for mass market applications was developed through study, development and demonstration. The starting point was a study of the mass market for positioning-enabled terminals, for automotive (car navigation, vehicle telematics, etc) and handheld terminals (cellular phones, PDAs, etc). The objective was to collect all the required information (key technologies, architectures end user requirements,

and previous Galileo project results) so as to define a preliminary specification for the mass-market terminal platform.

The study results were used for developing the core technology, the terminal integration and the testing tools. In the third phase, after completion of the testing, the exploitation of the proposed platform solution was made for the two end-users: developing a Galileo-ready terminal demonstration in the automotive and handheld fields.

Results

The "Galileo-ready" technology is now available for the next generation of mass-market chipset and terminals. All the project objectives have been reached as planned and the Galileo-ready flexible terminal has been developed with the promised characteristics. These are: cost optimisation for mass-market applications; scalability of the architecture applicable to a broad range of product designs; compliance with EGSA specifications; targeted and optimised for automotive and handheld applications.

Moreover, they have obtained results beyond the project objectives. In fact, as the interest of the partners in the Galileo technology ranged beyond the execution of the project, many activities have been extended to achieve unforeseen results. The extra effort was fully paid for by the involved partners. Some examples of those important achievements beyond the project's objectives are:

- The hardware and software development was extended, resulting in a receiver with standalone Galileo capability, while the project objective was just a GPS-plus-Galileo receiver.
- The research relating to the RF architecture was extended to the silicon part of the radio chip, while the original project was to focus on just the design.
- The substitution of a partner involved in the handheld demonstrator with another one with competences in the marine sector provided us with the additional opportunity to develop a marine application.

More information

Acronym:	GR-POSTER
Name of proposal:	Galileo-Ready Positioning Terminal
Contract number:	GJU/05/2413/CTR/GRPOSTER
Total cost:	€ 4 572 259
EU contribution:	€ 2 372 805
Call:	FP6 2nd Call
Website:	http://www.st.com/stonline/galileo/index.htm
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Partners	Thales Alenia Space	IT
	DEIMOS Space S.L	ES
	China Aerospace Science & Technology Corporation	CN
	Jeppesen Italia S.R.L.	IT
	Istituto Superiore Mario Boella	IT
	Magneti Marelli Systemes Electroniques	FR

GRAIL

GNSS introduction in the rail sector

GRAIL will introduce GNSS technology in the railway domain for different applications in Europe. Technology developments following different paths has prevented the use of a common approach, which would allow interoperability of the technical solutions at different system levels in similar applications, and the reusability of products for different applications.

The project proposes a strategy, consistent with the current deployment process of ERTMS/ETCS in Europe, for a smooth integration of GNSS into control and command applications and particularly in signalling.

Background

During the last few years, several projects funded both by ESA and the EC have been studying and demonstrating the use of GNSS for safety-related applications in railways, especially the ERTMS/ETCS application. In the framework of the GADEROS project a workshop was organised by the GJU to bring together representatives from these projects (GADEROS, INTEGRAIL, RUNE and LOCOLOC/LOCOPROL) with the EC, ESA, ERTMS users group and the GJU. During the review of the findings of those projects, it was detected that although they do not follow the same approach the conclusions reached were similar. These projects have proved the feasibility of introducing GNSS in railways and in particular ETCS by means of theoretical studies and demonstrations:

- Safety analysis on these concepts has already been performed (however, not yet as formal safety cases) and the results are positive;.
- Some system prototypes have already been developed by the industry;
- Both railway signalling and GNSS industry have provided good co-operation towards a common interest.

Several different functional and technical concepts have been presented by these projects but they can be mainly summarised as follows:

1. GNSS system as odometry: GNSS-based location is used as a substitute or complement of the current odometry sensors (tachometers, INS, Doppler radar, etc.). Thus it can remain internal to the ETCS.

2. GNSS for the fixed balise marker: The GNSS system is used to provide the ETCS onboard system with a message equivalent to that provided to a fixed balise in the track for a position marker.

Objectives

This project proposes a strategy, consistent with the current deployment process of ERTMS/ETCS in Europe, to provide a smooth integration of GNSS into control and command applications, particularly in ERTMS/ETCS. The GRAIL project will be based on three main objectives:

1 To specify, develop and test a GNSS prototype system for enhanced odom-

etry, ready to be integrated in ETCS onboard systems;

2 To pave the way for the future introduction of more ambitious approaches at different levels of ERTMS/ETCS architecture;

3 To complete the perspective of safety-related applications with the study and demonstration of non-safety applications and the study of economical and legal issues.

Description of work

The technical approach being followed to fulfil the first objective is:

1 Determining the user requirements for this application: functional, performance, RAM and safety requirements.

2 Achieving a full specification for the user terminal (including system, GNSS receiver, interface and test specifications) to be integrated in ETCS equipment.

3 Carrying out a safety analysis of the GNSS odometer module for ETCS, based on the user terminal specifications and taking into account the boundaries imposed by the ETCS system, as the target application.

4 Building a prototype of the user terminal. Two different prototypes will be developed to cover the objectives of the testing activities:

  a One lab prototype will demonstrate, in a simulated environment, the capabilities of Galileo by means of a Galileo simulator.

  b One HW/SW prototype will be integrated in an ETCS onboard system in a train cabin, using an EGNOS signal and other sensors.

5 Testing these prototypes in order to demonstrate the fulfilment of the user requirements. The scope of the tests are:

  a Laboratory tests (integration and functional laboratory tests) will be carried out at the CEDEX premises. It is worth mentioning that a simulated GNSS environment is being developed in the GARDA project and will be adapted for this project.

  b On-site tests will be carried out on a high-speed line in Spain with a train provided by ADIF.

The approach for the second project objective will be similar, aimed at advanced applications like Absolute Positioning and Train Awakening, but testing will only be done in simulated environments.

The results of this process will be used to draw conclusions about how the enhanced performances or the new odometry system can be used to improve the operation of trains or to reduce the equipment installed in the tracks. Also, comparison between the use of EGNOS and Galileo for this application will be made.

More information

Acronym:	GRAIL
Name of proposal:	GNSS introduction in the rail sector
Contract number:	GJU/05/2409/CTR/GRAIL
Total cost:	€ 6 627 191
EU contribution:	€ 3 685 000
Call:	FP6 2nd Call
Starting date:	31/08/2005
Ending date:	29/02/2008
Duration:	30 months
Type:	APPLICATION
Website:	http://www.grail-project.com
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Project Officer:	Stefano Scarda
Keywords:	GNSS ERTMS EGNOS Railway

Partners		
	ADIF	ES
	Thales Alenia Space	IT
	Alstom	BE
	Thales	DE
	Bombardier Transport	DE
	DLR	DE
	ANSALDO STS	FR
	CEDEX	ES
	Deimos Space	ES
	Invensys-Dimetronic	ES
	ESSP	BE
	ESYS	UK
	IIASL	NL
	Indra Espacio	ES
	RSSB	UK
	Siemens	DE
	TIFSA	ES

GRAL

GSPF Reference Application Line

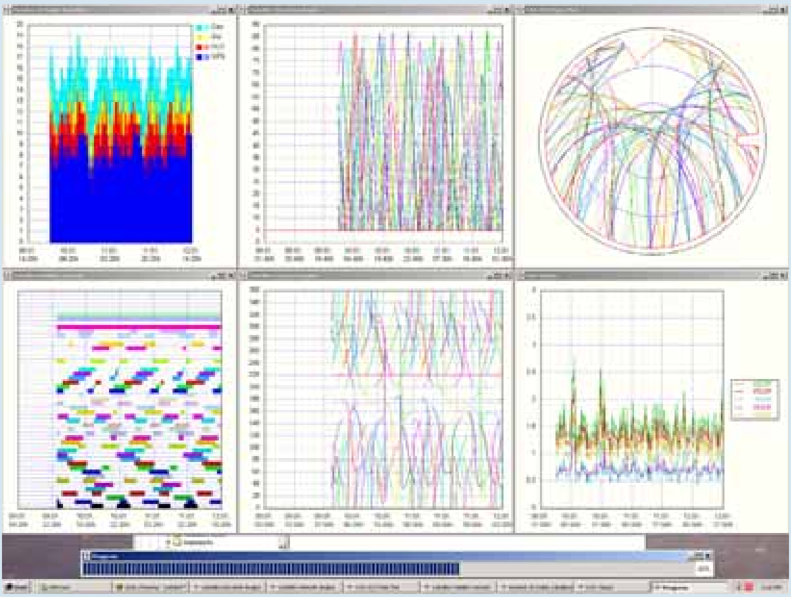
GRAL is the prototype of a software package for processing GNSS observation data, providing tools to perform much of the day-to-day work for surveyors or research engineers working in the field of satellite navigation. The tools are based on a very flexible core software and enable the users to do their specific processing with only a minimum of interaction required.

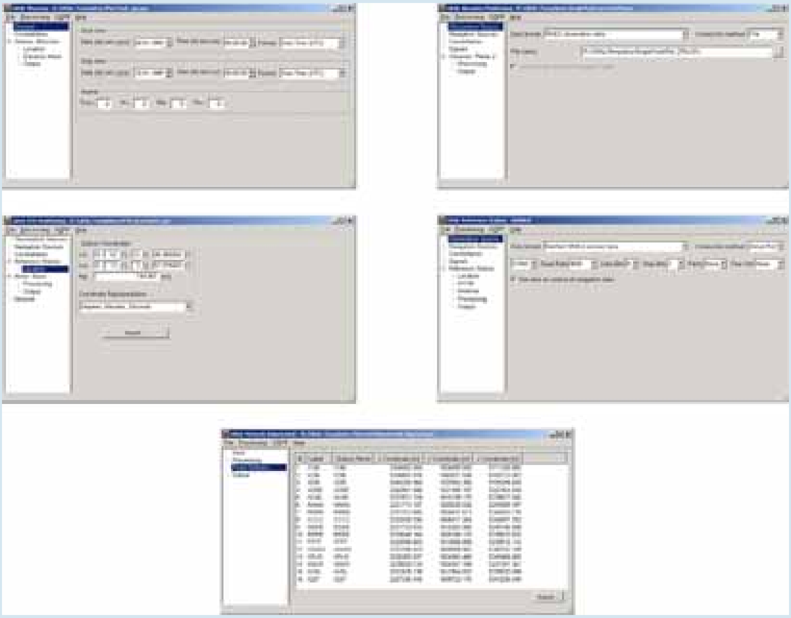
Background

Some tasks such as computing user positions from satellite observations occur regularly in the day-to-day work of, for example, surveyors. For these tasks, complex software packages are often offered, but users are mainly interested in tools that are easy to use.

Within the framework of the ESA GSTB-V1 project, IFEN had developed the Experimental IPF to provide a hosting structure for experimentation. Meanwhile this was developed further into the GSPF (GNSS simulation and processing facility). This tool is very flexible and certainly able to fulfil many of the user tasks. But with its overwhelming capacities it is only suitable for expert users. IFEN also had developed the GNSS Software Series, a suite of tools each for a limited purpose, but with an intuitive MMI which was easy to use, even for the non-expert user.

The idea was to combine the advantages of both of these tools. It should support experimentation by research engineers, but also be suitable for the common tasks of the surveying engineer. Simultaneously, algorithmic capabilities were to be extended further into geodetic applications.





Objectives

The objective of the GRAL project was to combine the advantages of both the GSPF and the GNSS Software Series in a single, newly developed software package. This new software tool should provide the expert user with the flexibility to put together their own configuration in order to experiment with algorithms and data flow, while simultaneously allowing the non-expert to easily perform their simple tasks.

A further objective was to extend the tool into the area of geodetic applications by adding more algorithmic models, which were to be implemented by DGC.

It was intended to develop the software up to prototype status. Any further steps such as commercialisation of the software were not part of the project.

Description of work

The GSPF software package consists of three basic elements: a user interface to create executable configurations, a processing kernel to execute these configurations, and a number of dynamically linked libraries (DLLs) to provide algorithmic modules that can be used in the configurations. Configurations are built of modules and their connections. The modules define algorithms to be executed, while their connections define the data flow between algorithms.

The GRAL software was based on the GSPF, and the same basic architecture was adopted. A user interface provides the possibility to select the necessary settings, such as the definition of input data to be processed. These settings are then translated into a GSPF configuration and executed by the processing kernel. Algorithmic modules used in the GRAL tools are supplied by means of DLLs.

User interfaces, so-called default applications, are provided for common tasks that are expected in the day-to-day work of the standard user. Where this is not sufficient, e.g. for experimentation purposes, it is possible to start the GSPF user interface and adapt the default application configurations, for example with alternative algorithms or data flows, or with additional output.

The activities necessary to accomplish this task were divided into three steps. First of all, the algorithmic functionalities of the GNSS Software Series were ported to GSPF algorithmic modules. Then the algorithmic modules provided by DGC were added. Finally, suitable user interfaces were implemented, based on the functionalities of the GNSS Software Series. These user interfaces were developed so that there is as much commonality between them as possible.

Results

The project succeeded in developing a software prototype that meets the above-mentioned objectives. Default applications have been set up for a number of common tasks: satellite visibility planning, single point positioning, differential positioning, differential corrections generation (reference station) and network adjustment.

The positioning applications work both offline (post-processing data from files) and in real-time (processing data directly from a receiver connected via a serial port). Besides RINEX files, the NovAtel OEM 4 and OEM V receiver formats are supported. All relevant satellite navigation systems – Galileo, GPS, GLONASS, as well as SBAS (WAAS / EGNOS / MSAS) – are supported in most of the applications.

As already stated, the GRAL software is in a prototype status. In order to turn it into a commercially available product, additional work will be performed by the consortium members at their own expense.

All relevant development documentation has been generated within the project. The final report is available to the public, but other documentation is confidential to the consortium.

More information

Acronym:	GRAL
Name of proposal:	GSPF Reference Application Line
Contract number:	GJU/06/2423/CTR/GRAL
Total cost:	€ 390 000
EU contribution:	€ 300 000
Call:	FP6 2nd Call
Starting date:	18/01/2006
Ending date:	30/06/2007
Duration:	18 months
Website:	http://www.gral-gju.org
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Project Officer:	Eric Guyader
Partners	Danish GPS Center DK

GRDB

Galileo Receiver for Distress Beacon

Galileo satellites will carry search and rescue (SAR) repeater payloads. Consequently, GRDB's aims were:

- to contribute towards understanding the difficulties encountered on GPS receiver integrated in actual Cospas-Sarsat distress beacons;
- develop a Galileo receiver prototype, accounting for the RF beacon's interference issues, which is able to decode the RLM messages;
- integrate the prototype Galileo receiver in a Cospas-Sarsat beacon platform;
- propose and demonstrate new operational uses in order to contribute improvements in efficiency and false alarm reduction.

Background

Detection and localisation of distress signals are performed today by the Cospas-Sarsat (CS) international organisation with worldwide coverage. The system performs global SAR functions and has been operational since 1987. The space segment is actually based on receivers embedded on LEO constellations and repeaters onboard GEO constellations. More than 400 000 beacons on various models with and without integrated GNSS receivers are in service worldwide today. The space segment will be replaced by SAR repeaters embedded on board Galileo MEO satellites and GPS satellites.

The expected advantages are an important reduction in alert delay, and the introduction of a return link capability (RLM) dedicated to SAR beacons that will enable improvements in the sensitive domain of false alarms.

The issues addressed are:

- GPS receivers which are integrated in beacons and used in harsh environment sometimes present non-operational performances;
- Galileo receivers are not available and must be designed with a RLM decoding capability;
- GPS receivers used in distress beacons are not designed for integration in beacon conditions (5W transmitter in close vicinity);
- New operations of distress beacons fitted with RLM capability are possible.

Objectives

The objectives are to:

- improve the use of GNSS receivers in beacons – making recommendations to manufactures and suggesting ways

of improving the performance of beacons by adding pertinent tests in the certification process;

- develop a flexible Galileo E1 receiver prototype in order to develop new and optimised solutions applicable for the design of new components dedicated for future beacons. Within GRDB, the prototype will be used to demonstrate the reception of positioning signals and the decoding of return link messages;
- propose and demonstrate on a beacon demonstrator platform what the operation mode of a beacon fitted with RLM capability could be. The beacon demonstrator platform will have a beacon distress transmitter and will integrate the Galileo receiver prototype developed in the GRDB project. Within GRDB, the platform will be used to demonstrate new operational uses in order to contribute improvements of efficiency and false alarm reduction.

Description of work

A fully working and flexible Galileo E1 receiver prototype was developed and validated with a full constellation Galileo RF signal simulator (Spirent GSS7800). The radio frequency (RF) front-end (FE) circuits have been measured and characterised individually during the PCB board implementation. FE final specifications are NF = 2.92dB with a gain=89dB±19dB. RF FE has successfully demonstrated processing the satellite signals, even in the presence of the beacon's strong emissions.

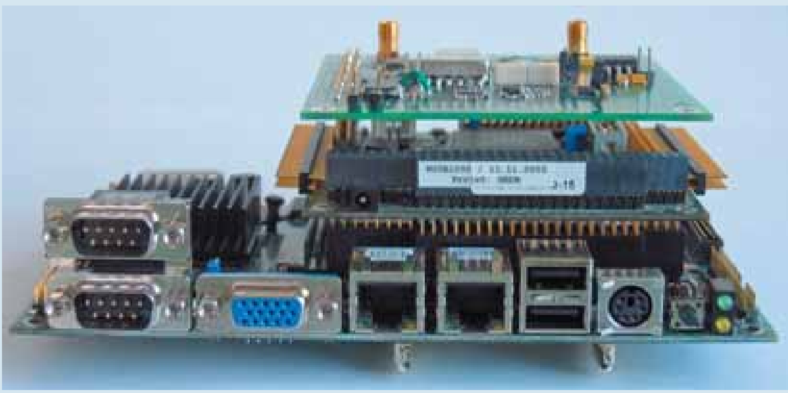
Twelve-channel correlators on a compact PC/104 FPGA board were designed, coded and tested, hard coded in a modest size FPGA (38K logic elements), and occupying <65% of the chip memory.

The PVT was designed, coded and tested. It measured minimum sensitivity during acquisition and becomes unreliable below -134 dBm and during tracking below -136 dBm.

GPS receiver usage in distress beacon: based on trials in different outdoor environments by using standard and modified beacons (antennas, with and without amplification), it was established that some GPS do not work in distress conditions – a position fix is not obtained.

The Galileo receiver and the beacon transmitter were coupled within the beacon's platform and associated trials and validations were carried out.

The RLM capability was integrated in the beacon's platform; proposition and demonstration of new operating modes was achieved.



Results

The following results were achieved:

- Laboratory prototype of distress beacon integrating Galileo receiver with SAR RLM decoding;
- Custom RF-FE has been optimised to be suitable for low power and low-cost silicon integration (ASIC), reusing the beacon's reference frequency, and designed to cope with the beacon's strong emissions;
- Investigations and recommendations on issues regarding the GNSS integration in distress beacon have been made;
- Proposals for possible utilisation of the SAR RLM have been developed and concepts have been demonstrated in the laboratory;
- A GRDB beacon platform containing a Galileo E1b receiver prototype and a 406 MHz CS beacon has been developed.

Impact for IMT and MSI:

- Continuation of IMT's work in the field of GNSS;
- Design and implementation of a new RF-FE architecture specially designed to cope with the beacon's strong emissions;
- Design and implementation of a real-time baseband architecture and algorithms for processing (acquisition, tracking, PVT solution) the Galileo E1b signal and SAR RLM messages;
- Establishment of a good partnership with MSI for the next stages in the field of SAR Galileo and future projects in other domains of GNSS receiver design.

More information

Acronym:	GRDB
Contract number:	GJU/05/2423/CTR/GRDB
Total cost:	€ 420 000
EU contribution:	€ 294 000
Call:	FP6 2nd Call
Duration:	20 months
Type:	USER TECHNOLOGY
Website:	http://www2.unine.ch/esplab/page14024_en.html
Coordinator:	Mr. Patrice Brault, Martec
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EC Officer:	Eric Guyader
Partners	Uni Neuchatel -

GREAT

Galileo REceiver for the mAss

GREAT will deliver a library of IP elements exploiting the special capabilities of the Galileo signal.

The project is researching and developing technologies for mass-market receivers, which include the development of novel front-end RF designs and baseband technology, as well as the advanced algorithms for multipath mitigation, hybrid data fusion and assisted GNSS.

Background

High volume mass-market receivers are key to opening up the market for precision location services and to helping a number of suppliers move quickly towards volume supply. Through this project the GREAT consortium will exploit the special characteristics of the Galileo signal to deliver real benefits to the European consumer and the location-based services market.

The EU forecasts a rapid adoption of dual-system GNSS receivers which support both GPS and Galileo. By 2011, more than 50% of the installed base of GNSS receivers will support Galileo. This in turn means that the majority of new GNSS receivers sold are dual system GNSS receivers.

The predicted fast adoption depends significantly on the success of deploying the Galileo systems and the promised technical benefits turning into reality.

The low cost, low power consumption, low footprint, good accuracy and high sensitivity are key benefits to the user and are the main attributes of a typical mass-market receiver, especially for the receiver to be used in a mobile terminal.

Improved TTFF (small search space) is crucial to the user, for instance, when positioning an emergency call.

Objectives

The project has the following objectives:

1 Study, design and develop a RF subsystem, able to operate with Galileo and GPS satellite signals in the presence of the 2G/3G cellular signals and to investigate the multiband approach covering different frequency bands.

2 Study, design and develop a 'fast track' Galileo advanced baseband, capable of operating with both the Galileo and GPS signals in the L1-E5a dual band.

3 Investigate advanced multipath mitigation (MM) algorithms. GREAT will develop a software test environment for MM algorithms and assess the potential performance improvement and impact on receiver hardware.

4 Identify critical scenarios where pure GNSS navigation is not sufficient and investigate the use of efficient hybrid data fusion (HDF) algorithms for PVT computation using multiple sources. GREAT will develop a test and simulation environment for HDF algorithms. GREAT will also assess the impact of HDF on the hardware design of mass-market navigation receivers.

5 Investigate the enhancements needed or made possible by Galileo, leading to high accuracy, fast TTFF designs. Assisted-GNSS uses assistance data available from the mobile phone network to enables accurate location with improved sensitivity and time-to-fix. GREAT will investigate A-GNSS archi-

tectures and also provide liaison into 3G standards bodies.

6 Promote dissemination and exploitation of results from all

Work Packages to influence the future broadband mobile radio cellular (4G) systems.

Description of work

GREAT consists of six work packages, one for each of the objectives, addressing the various technology areas for a mass-market receiver. The project will comprise three distinct phases – core technology development, prototyping and testing – achieving major blocks of demonstrable baseband IP, which in turn will allow further developments to be kick-started.

Results

The low cost, low power consumption, low footprint, good accuracy and high sensitivity are the key benefits to the user and are the main attributes of a typical mass-market receiver front-end, especially for the receiver to be used in mobile terminal. The GREAT RF front-end chipset will also provide a flexible and easy to use interface, allowing rapid conversion in a single chip receiver and consequent implementation into existing basebands.

Likewise the advanced baseband technology for GNSS receivers, developed by GREAT, keeps the system costs low, which is one of the crucial requirements for a mass-market receiver. This technology of a 'fast track' Galileo baseband consumes less power, supporting different Galileo system services and the complete receiver will be able to compute positions from mixed constellations (e.g. 3D position from two GPS and two Galileo satellites).

GREAT will also provide more sophisticated algorithms improving the end-user experience.

Multipath mitigation (MM) algorithms can reduce the multipaths in complex urban scenarios where there will probably be a greater number, and this MM can also lead to greater accuracy and better positioning in complex scenarios. Where pure GNSS navigation is not sufficient Hybrid Data Fusion (HDF) algorithms allow for PVT computation from multiple sources – cellular and GNSS. Finally, assisted-GNSS enables accurate location with improved sensitivity and time-to-fix.

More information

Acronym:	GREAT
Name of proposal:	Galileo REceiver for the mAss
Contract number:	GJU/05/2413/CTR/GREAT
Total cost:	€ 4 565 703
EU contribution:	€ 2 365 072
Call:	FP6 2nd Call
Starting date:	24/03/2006
Ending date:	23/03/2008
Duration:	24 months
Type:	USER TECHNOLOGY
Website:	http://www.greatproject.org
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Project Officer:	Eric Guyader

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	Qualcomm CDMA Technologies GmbH	DE
	Tampere University of Technology	FI
	u-blox	CH

GREHDA

GALILEO software Receiver for High Dynamic Applications

GREHDA addresses the design of Galileo receivers for space applications with limited financial and engineering budgets. The objectives are:

- to design high-dynamic signal processing algorithms;
- to propose a conceptual design of the receiver hardware and software;
- to define a flight technology validation experiment.

Background

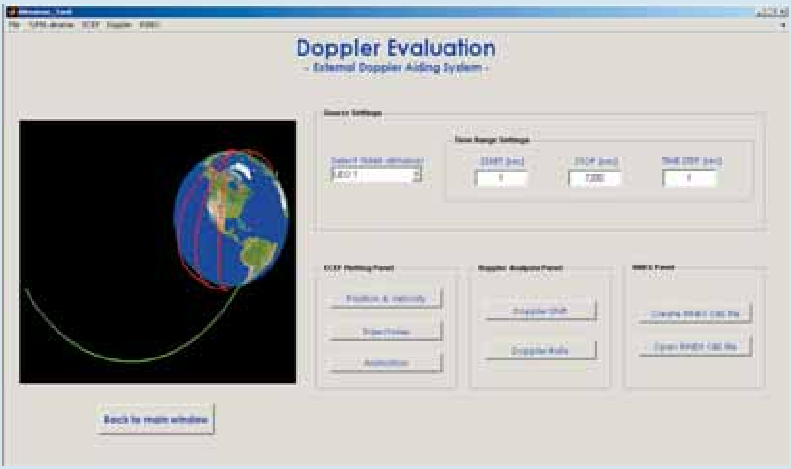
Major technical and financial efforts are currently employed in developing ground Galileo receivers, considering mass market, professional market and safety-of-life applications. However, the market constituted by onboard applications can be very satisfactory and profitable for small and medium-size enterprises.

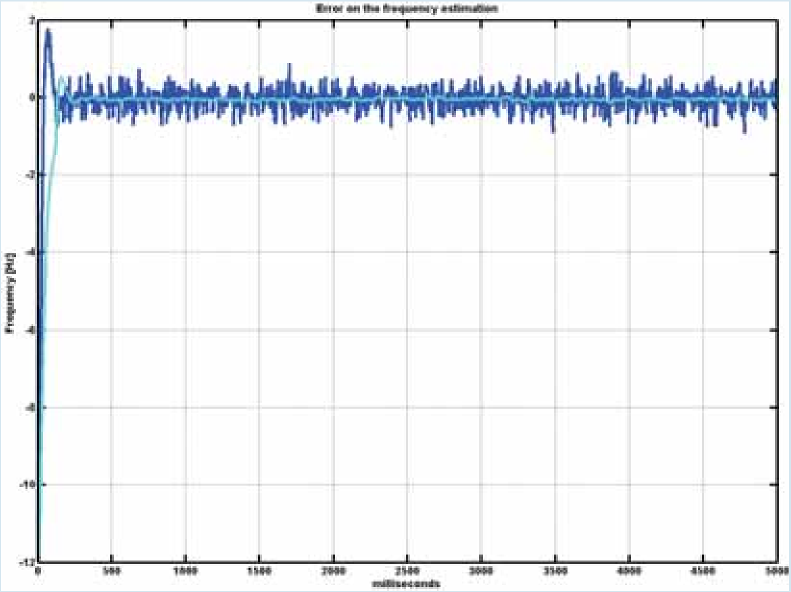
The GREHDA project focuses on all those applications that require optimised costs and limited engineering budgets, like size, weight and power consumption. Moreover, apart from space-environment requirements, these applications also have tight high-dynamic technical requirements due to the high relative motion between the receiver and the Galileo satellites.

Objectives

The main objectives of the GREHDA project are:

- to design, develop and validate the software receiver algorithms to fulfil the application-related requirements, starting from dedicated simulation tools and tailoring them to specific needs;
- to propose a conceptual design of the basic receiver hardware and software platforms;
- to define a flight technology validation experiment to test such algorithms





in the real environment and specify a detailed configuration of a spaceborne Galileo receiver.

Description of work

A detailed assessment of Galileo signals as received by high dynamic vehicles, as well as a survey on state-of-the-art spaceborne GPS receiver technologies, have been carried out, together with a dedicated analysis on market requirements and opportunities. Extensions of Galileo signal simulators and analysis tools have been developed, involving modelling of high-dynamic trajectories and generating digitised signals at IF.

Basic signal processing algorithms, including acquisition strategies and schemes, as well as steady-state code and carrier tracking structures, have been studied and designed. To minimise TTFF, the study focused on partial correlation and post-correlation FFT. A warm-start approach using Doppler-aiding techniques has been adopted to reduce the frequency search space.

These algorithms were implemented in the NordNav R30 R&D software receiver, equipped with a Galileo extension. Application protocol interfaces dedicated to signal processing tasks allowed a deep customisation of the digital channel behaviour. Tests during validation activities relied on raw IF data streams generated both by the software signal generator, modified to handle high dynamic scenarios, and by the Galileo RF constellation simulator available at the ESTEC Navigation Laboratory.

A preliminary architectural design of a software-defined radio Galileo receiver was carried out based on the FPGA/DSP approach. The key objective was the correct partitioning of the receiver functions between hardware and software domains.

Finally, a set of flight technology validation missions has been identified and

benchmarked, and a flight experiment has been outlined, to allow testing of the simulated algorithms' validity and robustness in the real environment.

Results

GREHDA was the only European project dealing with high-dynamic applications.

One of the main achievements of the project includes the design and implementation of signal processing algorithms for acquisition and tracking of GPS and Galileo signals affected by severe Doppler shifts and rates. Moreover, a preliminary concept design of a software-defined-radio GNSS receiver has been performed, and some potential LEO missions have been identified, fulfilling the requirements needed for in-flight validation of the developed algorithms.

So far, the algorithms developed during this project will be of great benefit to the consortium members, providing deep insights on these particular operating conditions and constituting the basis for further technology exploitation activities, both on research and development. The research activities will be focused on knowledge consolidation and on exploitation of signal processing algorithms for other applications with similar characteristics (e.g. long integration times for indoor location). The final industrial objective is the design and development of a spaceborne SDR GPS/Galileo receiver with limited engineering budgets, whose signal processing tasks are based on the algorithms studied in this project.

More information

Acronym:	GREHDA	
Name of proposal:	GALILEO software Receiver for High Dynamic Applications	
Contract number:	GJU/05/2423/CTR/GREHDA	
Total cost:	€ 442 392	
EU contribution:	€ 289 320	
Call:	FP6 2nd Call	
Starting date:	12/12/2005	
Ending date:	30/04/2007	
Duration:	16 months	
Type:	SUPPORT ACTIVITY	
Coordinator:	Mr. Paolo Lorenzi, Carlo Gavazzi Space S.p.A. Via Gallarate, 150 IT 20151 Milan	
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Project Officer:	Eric Guyader	
Keywords:	Galileo, high dynamics, software receiver, software-defined radio, SDR	
Partners	DLR	DE
	Politecnico di Torino	IT

GUTD

GNSS and UMTS Technology Demonstrator

GUTD conducts a feasibility analysis of the hybridisation between Galileo and UMTS systems with the goal of assessing the increase of position availability. The synergies between both systems are studied at two critical levels: signal processing and navigation.

Background

Positioning based on a mobile radio network (currently GSM in Europe but in the near future UMTS) reaches high levels of availability in urban environments. The received signal by the mobile terminal is strong when compared to GNSS and can easily penetrate walls and reach inside buildings. However, accuracy is usually poor and typically GNSS positioning provides between 10-50 times greater accuracy than mobile phone positioning. Thus it is clear that by merging both these systems in an efficient way, advantages could be taken from the strengths of each individual system, overcoming their respective deficiencies.

The GUTD concept is a processing system which allows the study of the synergies identified at signal processing level and navigation level, because these are the enablers of the combination of UMTS technology into a mass-market receiver. The system is implemented in MATLAB® and VHDL. The first provides the means for studying the signal processing algorithms, hybridisation of the systems and identification of synergies of these algorithms. The second is focusing on the hardware feasibility for the high data-rate processing, in particular at the level of signal processing. These functions have been used to run simulations which are representative of simple cases, in which GNSS and UMTS signals are brought together. Signal processing has proven that the signal was acquired and tracked, and symbols from base-band signal have been extracted from both GNSS and UMTS base-band signals. At the level of the hybridisation, the partial tight coupling approach was adopted and the measurements were combined, leading to a computed position solution.

Objectives

The synergies between the Galileo and UMTS systems are studies at two critical levels: signal processing and navigation.

At a signal processing level, the objective was to study the synergies in terms of baseband receiver architectures, considering that both systems employ a CDMA scheme, use PN codes to spread the signal spectrum and rely on correlation processes to track the incoming signal and recover data.

At a navigational level, the synergy of GNSS/ UMTS uses tight partial hybridisation algorithms, being a trade off between performance and complexity. The idea is to exploit the generalisation of the explicit closed-form estimator used in the Fang estimator for the generic case of independent TDOA measurements.

Description of work

Signal processing: the analysis of the receiver architectures shows that both receivers use acquisition and tracking blocks at baseband level.

Navigational level: the hybridisation between GNSS and UMTS at navigation level is achieved by running simulations on three scenarios i) GNSS and UMTS, ii) there are more measurements from one

than the other, and iii) only two TDOAs are available for each system. This approach has proven the increase of availability of the position at the receiver by using both GNSS and UMTS systems following a hybrid approach.

The work plan of this project involved parallel activities for:

- scientific investigation and specification of algorithms;
- software development.

VHDL was also implemented and tested in comparison against software functions. In the end, simulations were performed and results analysis in the light of the expected results which bring up synergies.

Results

The results show that the simulator is able to track the code delay and carrier phase of the signals using different signal to noise ratios; hence proving the synergies between the GNSS and UMTS receiver architectures. Also, in parallel implementation of the signal processing under MATLAB®, the development of the high-rate signal processing functions in a hardware description language (VHDL) has been performed. In addition to the low-rate signal processing functions commonly computed into processors (software), this hardware implementation constitutes the core of a receiver on which the GNSS/UMTS synergy has been applied.

This approach has proven the increase of the position's availability at the receiver by using both GNSS and UMTS systems following a hybrid approach.

The VHDL development and results show that a future receiver (based on FPGA or ASIC), using both GNSS and UMTS signal processing to improve the positioning with a limited increasing of logic, is feasible.

More information

Acronym:	GUTD	
Name of proposal:	GNSS and UMTS Technology Demonstrator	
Contract number:	GJU/06/2423/CTR/GUTD	
Total cost:	€ 428 274	
EU contribution:	€ 299 792	
Call:	FP6 2nd Call	
Duration:	14 months	
Type:	USER TECHNOLOGY	
Website:	http://www.gutd-gsa.eu	
Coordinator:	Mr. Luis Nunes, Skysoft Av. D. João II Lote 1.17.02, 7º Andar PT 1998-025 Lisbon	
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Project Officer:	Eric Guyader	
Partners	IMST	DE
	University of Catalunia	ES
	M3 Systems	FR

HARMLESS

HARMLESS: Humanitarian aid, emergency management and law enforcement support applications

HARMLESS is an initiative carried out by the European Commission, the Global Navigation Satellite System industry, and technology experts, with the objective of promoting the use of the European navigation satellite systems in the areas of emergency management, humanitarian aid and law enforcement.

Background

Galileo and EGNOS, telecommunications, geographic information systems and earth observation are the technologies for the future of emergency management, humanitarian aid and law enforcement domains. The combination of these technologies makes possible a set of applications and procedural improvements that will drastically change operations in these fields.

The maturity of GNSS technologies within these three areas is different: GNSS is already widely used for emergency management and law enforcement, but much less so for humanitarian aid. HARMLESS will therefore address these areas in different manners to fit with their specificities.

It seems however that there is a feeling shared among these three user communities that the technology industries, including GNSS, do not have sufficient knowledge of their activities to respond to their real needs. This feeling is a barrier to the penetration of GNSS in their communities.

The HARMLESS project will address this issue, establishing a link between the GNSS industry and the users.

Objectives

The objective of this project is to investigate and analyse the use and application of EGNOS and Galileo for emergency management, humanitarian aid and law enforcement paying special attention to the cases where EGNOS and Galileo (as compared to GPS) are the enablers for those applications.

HARMLESS is organised so as to allow dialogue between two different worlds: GNSS and the user communities of these three areas, establishing the required mechanisms to create the dialogue between the experts of these two worlds. The project will establish a platform of experts that serves as reference for this and future investigations of the application of Galileo and EGNOS for these user communities.

In short, the main objectives of the project are:

- Achieving a deep perspective of the potential for EGNOS and Galileo in emergency management, humanitarian aid and law enforcement, identifying, analysing and promoting the most promising applications in these areas;
- Demonstrating the benefits of the European GNSS with the trials of prototypes for some applications covering different missions of the three user communities;
- Creating contacts between the user communities and the GNSS world. The GNSS world will identify the user requirements while the users will have a vision of what GNSS can bring them.

Description of work

End-users within emergency management, humanitarian aid and law enforcement communities are the real focus of HARMLESS. The first task is to contact all the possible potential users, not only country by country, but also at European level.

A set of applications will be analysed, trying to cover all the necessities of those three user community operations. For that aim, it is absolutely necessary to have a co-operation with end-users in order to focus the analysis in the right direction. Based on the information collected and on the technological expertise of the consortium, each application will be studied and a solution defined (requirements, architecture, market assessment, etc.).

In the end, some trials will be carried out in which the benefit of GNSS for some of the applications identified will be demonstrated. The feasibility of Galileo and EGNOS services will be proved in different situations. In addition, end-users should provide consortium partners with feedback about the proposed system and its performances.

During the whole project, end-users will be informed about HARMLESS developments by means of press releases, workshops, updated information on the HARMLESS website, and any media that can be suitable for reaching all the entities concerned with emergency management, humanitarian aid and law enforcement.

Results

The expected results of HARMLESS are:

- A deep knowledge of the user communities from the GNSS world, based on the participation of a wide range of members of these communities.
- An in-depth analysis of the applications that were identified as the most promising for these user communities. This analysis will include, among other features, application requirements, architecture, market assessment, cost benefit analysis, standardisation and regulation aspects.

- A demonstration to the user communities of the benefits of EGNOS and Galileo for some of the most relevant applications for the three user communities, namely:
- GNSS support to damage assessment for humanitarian aid;
- GNSS for people tracking, covert surveillance and as legal evidence for law enforcement;
- GNSS to support flood and fire management and for resource management for the emergency management community.
- The creation of lasting links between the GNSS industry and the three user communities to keep a continuous information exchange between these two worlds.
- A clear vision of the future steps to be taken to increase the penetration of GNSS and specifically Galileo and EGNOS within the user communities' activities, including recommendations for specific R&D projects focusing on the applications evaluated as very promising and beneficial for the users.

More information

Acronym:	HARMLESS
Name of proposal:	HARMLESS: Humanitarian aid, emergency management and law enforcement support applications
Contract number:	GJU/06/2412/CTR/HARMLESS
Total cost:	€ 2 172 486
EU contribution:	€ 1 187 500
Call:	FP6 2nd Call
Starting date:	31/05/2006
Ending date:	30/04/2008
Duration:	23 months
Website:	http://www.galileo-harmless.eu
Coordinator:	Dr Ramon José Caro, GMV Aerospace and Defence, S.A. Isaac Newton, 11; P.T.M. Tres Cantos ES 28760 Tres Cantos (Madrid)
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Keywords:	GNSS applications, humanitarian aid, law enforcement, emergency management, EGNOS, Galileo, GPS

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	EADS Astrium	FR
	Infoterra Ltd	UK
	EADS Secure Networks SA	FR
	Nottingham Scientific Ltd	UK
	Ingeniería y Servicios Aeroespaciales S.A.	ES
	NEXT S.p.a.	IT
	Leiden University of Law	NL
	GMV Sistemas	ES
	MAP Action NGO	UK
	Association of Chief Police Officers	UK

HARRISON

Timing and synchronisation

The project deals with time and synchronisation applications and aims to study the advantages offered by Galileo for these.

Background

The initial application of precise time came from the telecommunication industry. The basic concept was a hierarchical architecture with a central point – a centralised Master Clock that distributed the time reference to other nodes arranged according to priority level or layers. This architecture imposed a dedicated infrastructure and intrinsic synchronisation degradation performances from the upper to lower layers and with distance from the Master Clock.

The availability of GNSS changed this approach: the signal in space (SIS) is available to all network nodes with the same level of accuracy and without any additional distribution infrastructure. The availability of an inexpensive timing receiver able to extract the time reference from the SIS makes this approach cheaper than any other previous time distribution system.

GNSS is therefore of interest for high performance synchronisation to any application domain that can be described in terms of nodes distributed over a geographical area.

Two different aspects are related to time services: the need for high accuracy in time determination and event synchronisation, and the need for using an authenticated and certified time. The first aspect is quite clear to understand: the better the synchronisation the better the accuracy and resolution in case of localisation of events propagating on a transmission network; while the second aspect answers to the need of demonstrating to a third party that a certain event has happened (i.e. time stamped) at a certain time.

The two aspects described above are not mutually exclusive nor present with the same level of required performances in the various application domain.

The users are all those applications that need a precise time reference for event synchronisation and time event recording.

Objectives

Applications are mainly driving these requirements into two main categories: high accuracy and resolution for demanding users in science, power distribution and telecommunications.

The main objectives of the project are:

- to demonstrate the benefit of using GNSS services in time distribution and event synchronisation over wide geographical areas and to define the requirements for added value services;
- to demonstrate that the basic GNSS services can be improved to offer custom added-value solutions to the time and synchronisation user community;

this objective is achieved by putting the Galileo satellite system developers in contact with the user community to identify a set of user requirements;

- to define and develop a hardware/software solution that is able to offer authenticated and certified time for event synchronisation purposes over wide geographical networks with the implementation of a service centre and remote terminals;
- to implement pilot projects that use the authenticated and certified time solution (ACTS) for field demonstrations;
- to disseminate information on the project to reach the greatest number of potential users.

The ACTS concept is linked to the definition of legal time and to the possible application of this concept. A Work Package deals with the laws and acts on the subject in the EU and other major countries.

Particular attention has been paid to the integrity information provided by the Galileo system SIS that is one of the major key features of Galileo concerning the possibility of using the Galileo time reference as certified time.

The project proposes the Concept of the ACTS, which is a system that uses the Galileo distributed signal and integrity to build a certified and authenticated time reference with an additional crosscheck made with a GNSS independent time reference source.

Description of work

The project is basically arranged in three major phases:

User community analysis

The user community analysis includes a market analysis performed by a specialised company to identify business opportunities in timing applications for the forthcoming Galileo constellation.

The purpose of this project phase is to analyse the time and synchronisation applications for each domain and study the advantages offered by the availability of a common precise time reference recovered by the Galileo SIS. Moreover this activity is also stimuli for the development of new ideas. During this analysis phase, consolidation of user requirements and service provision schemes and interfaces will also be performed.

Development of an ACTS demonstrator

The proposed demonstrator is called Authenticated and Certified Time Solution (ACTS) and is aimed at studying the feasibility of using the time distributed by the Galileo system, which would be authenticated and certified through the Galileo System.

Field trials of the ACTS

The demonstrators are in the following application domains:

- astronomy and quantum cryptography by performing synchronised observation in Ljubljana and in Asiago (PD);
- power and energy by performing synchronised measurement of voltage and current grid to detect failure, failure propagation and transient waveform propagation;
- cryptography.

Results

The output of the project will be the analysis reports and the hardware and software produced for the demonstrators.

More information

Acronym:	HARRISON
Name of proposal:	Timing and synchronisation
Contract number:	GJU/06/8068-CTR/Harrison
Total cost:	€ 3 123 683
EU contribution:	€ 1 883 635
Call:	FP6 3rd Call
Starting date:	30/11/2006
Ending date:	29/11/2008
Duration:	24 months
Website:	http://www.exodus.gr/harrison
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Project Officer:	Stefano Scarda

Partners		
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	CESI RICERCA SpA	IT
	Exodus SA	GR
	ISMB (Istituto Superiore Mario Boella)	IT
	Nottingham Scientific Ltd	UK
	Polish Academy of Sciences	PL
	Puslaidininkiu Fizikos Institutas	LT
	Sistemi Elettronici per Automazione SpA	IT
	Telespazio SpA	IT
	Thales Alenia Space France	FR
	Thales Alenia Space Italia SpA	IT
	TÜV Rail GmbH	DE
	Universita di Padova	IT
	Universita di Roma La Sapienza	IT
	Univerza v Ljubljani	SI

HeliCity

Precision helicopter guidance for cities and emergency support

HeliCity aims to fulfil a demand by developing and demonstrating a support system using EGNOS (and Galileo in the future) as the enabling technology for precise positioning with an adequate level of accuracy, integrity and improved positioning performance in terms of continuity.

Background

A helicopter's capability to operate to and from locations without landing aids, for example in medical evacuations or rescue missions, often makes them the only feasible method of transport. Compared to aircraft, weather conditions have a lower impact on helicopter operations and respective flight safety. For example, weather threats concerning wake vortex and windshear events are not as dangerous as they are for aircraft because the helicopter has better manoeuvrability at lower speed and will not stall because of airspeed. A weather radar is useful for avoiding thunderstorms but its warning or information are less critical than those for terrain or traffic.

Airborne support to emergency medical services and search and rescue missions is often performed under bad weather conditions or at night, implying poor visibility and great danger. Due to the lack of performance of today's onboard navigation system, a great number of missions have to be aborted causing loss of human life.

Currently, the Western European helicopter market for emergency and medical support (EMS) is served by 125 operators running around 450 helicopters. These have been supporting two distinct missions: transport from the scene of an accident to hospital and transportation between hospitals. Despite the fact that most of these helicopters are fitted with digital autopilots and are instrument-flight-rules certified, nearly all EMS operations are carried out under Visual Flight Rules (VFR), even in adverse weather conditions. This is due to the lack of helicopter-specific IFR procedures and the lack of a landing system suitable for helicopter instrument approaches.

Objectives

The main goal of HeliCity was to develop and demonstrate a pre-operational system supporting enhanced positioning services aimed at helicopter VFR operations performed under adverse conditions and scenarios.

The HeliCity system was based on the coupling of a high quality EGNOS receiver and a cockpit display unit which enabled the display of the helicopter position to the pilot. This system was evaluated in a sequence of flight trials which occurred in the Lisbon area in the summer of 2006. During these flight trials, both the performance and HMI improvements were evaluated.

Description of work

HeliCity has identified a need for a secure, affordable positioning system that provides improved capabilities to helicopters and, more specifically, improved positioning system performances. Performance here is not only meant in terms of accuracy, but also of safety (integrity of the position) and con-

tinuity. GNSS, and in particular EGNOS and Galileo, are the candidates to answer this need.

The concept proposed by the HeliCity project is to enhance flight safety by giving the crew the means to be aware of their surrounding environment and enable them to adopt a corrective action. For helicopters, it is a means of enhancing operational possibilities for VFR flights especially under low visibility conditions during the approach and landing phases, even though always in VMC. This means that the HeliCity prototype will be a good way to help the pilot watch external threats and be aware of the surrounding geographical environment. IFR certification issues were largely beyond the scope of the HeliCity project.

HeliCity evaluated the use of EGNOS on helicopters as part of an emerging solution to improve the ability of helicopters to fly in adverse meteorological conditions. To achieve the project objective, the team has integrated the HeliCity prototype – a GPS/SBAS receiver together with a cockpit display unit – on a helicopter.

Results

In order to assess both the analytical and operational aspects of the overall system, the HeliCity project set up an evaluation programme which relied on the performance of flight trials. The flight trials were conducted with the main purpose of evaluating the performance of EGNOS within a civil aviation context, expressed in terms of Required Navigation Performance parameters specified by ICAO. These parameters are accuracy, integrity, availability and continuity.

The analytical evaluation was performed by comparing the helicopter positions obtained by the data logged by the onboard system with positions data resulting from using the CP-DGPS (Carrier Phase Differential GPS) method.

Another important objective of these flight trials was to technically verify the system, proving its reliability and usability in real flight situations. To accomplish this objective, a simulated Helicopter emergency medical service mission was chosen to allow demonstrating the usefulness of the HeliCity system in missions where flights may occur in poor weather and low visibility conditions, always with the highest safety standards. The evaluation of the system's operational aspects, such as usability and HMI improvements, was performed by interviewing the test pilot.

More information

Acronym:	HeliCity
Name of proposal:	Precision helicopter guidance for cities and emergency support
Contract number:	GJU/05/2423/CTR/HELICITY
Total cost:	€ 424 196
EU contribution:	€ 299 977
Call:	FP6 2nd Call
Starting date:	16/09/2005
Ending date:	30/10/2006
Duration:	13 months
Type:	SUPPORT ACTIVITY
Website:	http://www.helicity.org
Coordinator:	Mr Jose Neves, Skysoft Av. D. João II, Lote 1.17.02, Torre Fernão Magalhães, 7º PT 1998 - 025 Lisbon
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Project Officer:	Eric Guyader
Keywords:	HeliCity, EGNOS, helicopter
Partners	Septentrio BE Eurotelematik DE

HPLE

High Precision Local Element

HPLE addresses the problem of improving the accuracy, reliability and the TTFF (time to first fix) in high precise positioning, between two receivers, by processing GNSS (Global Navigation Satellite System) signals and particularly Galileo signals.

Background

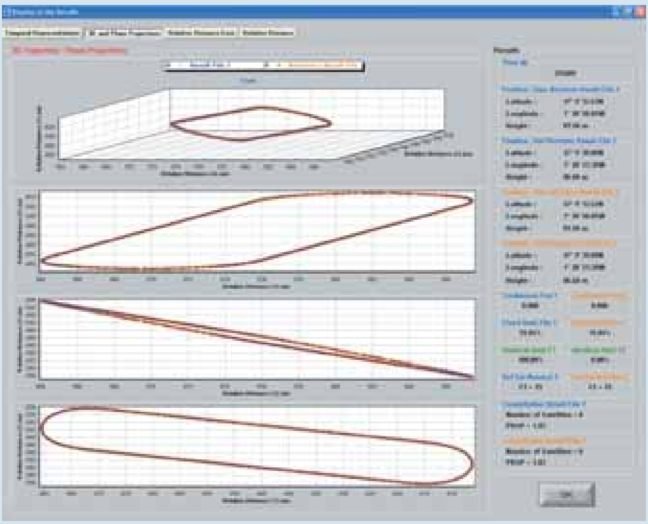
Classically, the processing steps in the ambiguity resolution (AR) domain are the following:

- Pre-processing of the observables;
- Computation of the double differences;
- Computation of the float ambiguities;
- Computation of the 'integer ambiguities';
- Validation of the integer ambiguities;
- Computation of the precise position.

DIGINEXT has already worked in this domain and has processed real GNSS data. This is essential so as to adapt the algorithms, designed by research organisations, to real world conditions and integrate them in adaptive software architecture.

TU Delft is a recognised expert in the AR domain (LAMBDA method) and is continuously developing innovative methods to improve the accuracy, the reliability or the TTFF. The major contribution of TU Delft in this project is the 'innovative validation' method aimed at providing improved results in terms of both reliability and rapidity.

CERFACS has a fresh and critical view on the work performed in the AR domain so far. It aims at developing advanced methods for the numerical simulation and the algorithmic solution of large scientific and technological problems of interest for research as well as for industry. Its background in various scientific domains, such as in algebraic graph theory, is an interesting contribution to the other partners of the consortium.



Objectives

The aim of the project is to design, develop and validate an innovative GNSS demonstrator providing the users with a high precision service.

To improve the accuracy, reliability and the TTFF, DIGINEXT and TU Delft have merged their knowledge to build a complete processing structure:

KALMAN approach:

- Pre-processing of the observables;
- Computation of the double differences;
- Computation of the float ambiguities (KALMAN);
- Refining of the float ambiguities (DIA);
- Computation of the integer ambiguities (LAMBDA);
- Validation of the integer ambiguities (IVM);
- Computation of the precise position.

The innovative validation method (IVM) automatically assigns the threshold value to validate the ambiguities on condition of the maximum allowable failure rate delivered by LAMBDA.

In the framework of this project, CERFACS aims to develop an alternative approach based on the use of a RLS filter processing the reduced differences instead of the classical double differences. This led to the following processing architecture:

RLS Approach:

- Pre-processing of the observables;
- Computation of the reduced single differences;
- Computation of the float ambiguities (RLS);
- Refining of the float ambiguities (RLS DIA);
- Computation of the integer ambiguities (NEAREST);
- Validation of the integer ambiguities;
- Computation of the precise position.

Description of work

The methodology followed so as to design the various algorithms was to respect the following guidelines:

- Improve the quality of the processed data;
- Reduce the integer ambiguities space of search;
- Reliably validate the integer ambiguities;
- Develop a GNSS observables generator to simulate a complete range of scenarios;
- Develop a demonstrator to test the algorithms on real and simulated GNSS data.

Bearing these guidelines in mind, the partners of the consortium analysed the various steps of AR processing and then designed the algorithms. The pre-processing and the DIA procedure are designed to improve the quality of the processed data, the adjustment of the KALMAN and the RLS filters are aimed at reducing the space of search and the ambiguity validation methods (the IVM and the method applied in the RLS architecture) are developed to improve the reliability of the chosen solution.

To design the GNSS observables generator, an essential part of the work consisted of analysing the way the observables could be disturbed and biased so as to make this generator as realistic as possible. All the perturbations should be present and easily configurable in the generator.

The HPLE demonstrator is the final software that gathers all the developed algorithms and enables their test and validation.

Results

The HPLE demonstrator, enabling the test and the evaluation of the algorithms designed in this project, has been developed. This demonstrator has a modular (choice of the applied processing) and a scalable (in terms of the present processing) architecture.

This software also contains a GNSS observables generator (RINEX 3.00 format). The whole perturbations present in the observables are configurable allowing the simulation of a wide range of scenarios.

Very encouraging results have been reached thanks to the work performed by the consortium:

- the DIA procedure proves to be very efficient to correct data from outliers or to handle high dynamic receiver situations.
- the innovative validation method provides very impressive results. The adaptation of the ambiguity validation threshold in accordance with the confidence of LAMBDA proves to both improve the TTFF and the reliability of the accepted solution.
- the RLS approach proposes a complete set of tools. The various step of this algorithm are satisfactory:
- the multipath are efficiently found;
- this procedure accurately corrects the outliers;
- NEAREST generates the right integer ambiguities;
- the ambiguity validation procedure is robust.

More information

Acronym:	HPLE	
Name of proposal:	High Precision Local Element	
Contract number:	GJU/06/2423/CTR/HPLE	
Total cost:	€ 396 227	
EU contribution:	€ 299 900	
Call:	FP6 2nd Call	
Starting date:	20/02/2006	
Ending date:	20/05/2007	
Duration:	15 months	
Type:	USER TECHNOLOGY	
Website:	http://www.diginext.fr	
Coordinator:	Ms. Tanya Bertozzi, Diginext 45 Impasse de la Draille, Parc d'Activités La Duranne FR 13857 Aix-en-Provence Cedex 3	
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Project Officer:	Eric Guyader	
Partners	TU Delft	NL
	CERFACS	FR

IADIRA

Inertial Aiding Deeply Integrated Receiver Architecture

IADIRA focuses on the field of inertial aiding, referring to the use of inertial-derived position and velocity for the improvement of the GNSS receiver tracking loops, and inertial coasting, which in turn refers to the use of inertial-derived position and velocity to interpolate GNSS trajectories for short periods, either because of GNSS data gaps or just to interpolate between GNSS fixes.

Background

Hybridisation of GPS and INS units is a well-known concept, with strong developments in the field, especially in the United States for military applications. So far, hybridisation of GPS and INS units has been mainly limited, either to processing the navigation output of both systems (loose coupling) or to integrating measurements from both systems into a Kalman filter (tight coupling). Although there is ongoing research on INS/GPS integration of the tight level, the INS/Galileo integration has not yet been investigated.

Recent studies concluded that new developments should focus on low-cost and fully integrated GNSS-IMU systems based on miniaturised sensors. IADIRA is a step further towards this objective, where a tightly coupled or deeply integrated architecture is used to aid the receiver's tracking loops, reducing the dynamic stress uncertainty, allowing a reduction of the loop bandwidth and an increase of the integration time from the typical figure of a few milliseconds. As a consequence, velocity and position accuracy improve substantially and the minimum C/N0 to track the signal is reduced even in high-dynamic environments. Furthermore, since the inertial aiding signal allows tracking loops to operate even during a signal blockage (both PLL and DLL), reacquisition times are very small and cycle-slip occurrences are reduced, therefore increasing service availability.

Objectives

The main project goal is aimed at developing and testing the concept of an 'inertially enabled' GNSS receiver through simulating tightly coupled integrating architecture. The simulation experience and the available software tool will help in designing an aided receiver. Such a receiver will be of superior performance in terms of satellite signal tracking, signal (re)acquisition and navigational accuracy in comparison to its unaided counterpart. The improved receiver performance should widen the spectrum of satellite positioning applications as well as enhance the existing ones.

Description of work

The chosen study plan for IADIRA is as follows:

Task 1: System engineering – This task corresponds to the Consolidation Phase defined in the statement of work. It defines in detail the objectives of the project and the system requirements.

Task 2: Requirements engineering – This phase defines the technical specification and the architecture for the deeply integrated receiver, the inertial units evaluation, selection and characterisation, the target application architecture design, the test-bench architecture design and the algorithms selection and specification.

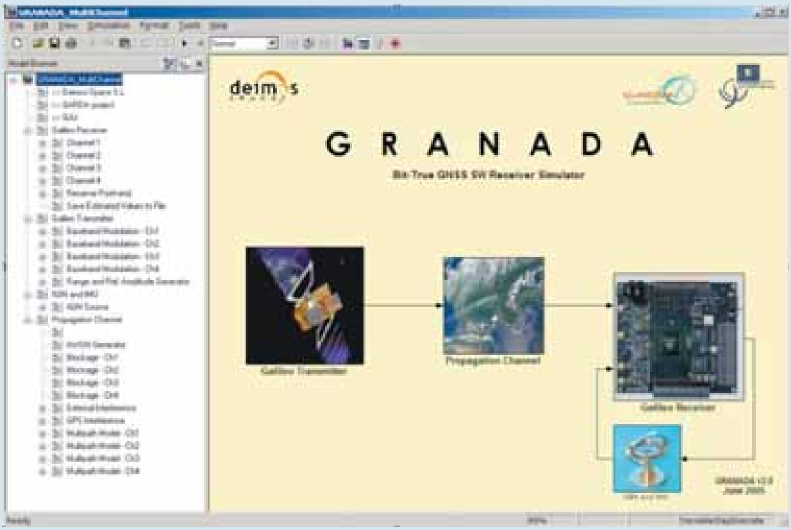
Task 3: Design and implementation engineering – This phase comprises the detailed design and implementation of the receiver algorithms, in signal processing, navigation processing and GNSS/INS integration, and of the test bench. The test bench includes the customisation of the GRANADA software receiver.

Task 4: Verification and validation – Verification is performed to guarantee that the software produced is conforming to the technical specification made during the requirements engineering task and that the software architecture and implementation is free of any faults. Validation testing will be performed by means of a demonstration to guarantee that the software produced meets the system requirements.

Task 5: Technology transfer analysis – This phase concludes the study. It aims at transferring the achieved technical and innovation objectives to the identified market. It comprises the evaluation of the deeply integrated receiver functions for the target application, the analysis of the applicability of the concept to different receivers, the dissemination of results and the compilation of the synthesis and recommendations.

Results

The IADIRA test bench allows the testing of the IADIRA concept in a friendly and intuitive environment, keeping a modular software approach. The test bench



uses a modified version of GRANADA Bit-True to simulate the deeply integrated receiver including the developed combination of IMU/GNSS receiver algorithms.

A test campaign was carried out in order to test the IADIRA concept and the IADIRA test bench. The reference trajectories were generated based on data collected in real environments – a low-dynamic track switch simulation and a medium-dynamic urban rail layout simulation. Different receiver configurations and test scenarios have been used and the IADIRA concept validated.

Tests conducted with this hybrid receiver have shown the following main benefits:

- Carrier and code noise – noise reduction when compared to the unaided solution;
- Position and velocity accuracy – accuracy increase when compared to the unaided solution;
- Minimum required C/N0 for successful tracking – possible operation under lower C/N0 when compared to the unaided solution;
- Reacquisition time – faster or even instantaneous reacquisition of signal lock when compared to the unaided solution;
- Overall system robustness.

IADIRA has demonstrated the potential of such technology by showing promising results. Envisaged applications should typically have stringent accuracy and integrity requirements and operate in high dynamics such as trains and aircraft.

More information

Acronym:	IADIRA	
Name of proposal:	Inertial Aiding Deeply Integrated Receiver Architecture	
Contract number:	GJU/04/2423-SOW/AK/DL/mg	
Total cost:	€ 447 282	
EU contribution:	€ 300 000	
Call:	FP6 2nd Call	
Duration:	15 months	
Type:	SUPPORT ACTIVITY	
Coordinator:	Mr. Augusto Caramagno, Deimos Engenharia S.A. Av. D. João II, Lote 1.17.01 10º PT 1998-023 Lisbon	
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Project Officer:	Eric Guyader	
Keywords:	GALILEO, MEMS, GPS, inertial	
Partners	Deimos Space S.L. Institute of Geomatics	ES ES

IRC2G

Integration of a Regional Component to the Galileo Global component - with demonstrations in Europe and China

IRC2G will prototype a system which provides end-users with a combined GPS/Galileo positioning solution with SBAS-augmentations. The system has been demonstrated in both Europe and China.

Background

Combining GPS and Galileo will provide the end users with better positioning accuracy and availability. SBAS-like augmentation corrections and integrity information will further improve the performance, not only in positioning accuracy and availability but also in integrity monitoring.

Objectives

The objective of the project is to prototype a system which provides end-users with a combined GPS/Galileo positioning solution with SBAS-based augmentations. It will demonstrate the concept of multi-constellation augmentation.

Description of work

The implementation of the project consists of the following major tasks:

1. Prototyping a simple multi-constellation augmentation system based on EGNOS SIS and the simulated Galileo augmentation and integrity information. Two SBAS message streams have been generated in the project, one for GPS (based on EGNOS SIS), and the other for Galileo which was generated in the project.
2. Simulating the Galileo orbit and raw measurements as well as the corresponding augmentation corrections and integrity information. The error models for the Galileo satellite orbits and clocks were developed in the project and applied to the simulated Galileo raw measurements, corrections and integrity information. The error models were derived by comparing the IGS precise orbits with the corresponding GPS ephemeris.
3. Developing a GPS/Galileo combined positioning user terminal to explore the GPS/Galileo augmentation service. The user terminal supports positioning with measurements ranging from

multiple GNSS constellations (e.g. GPS and Galileo); multi-constellation augmentations (SBAS-based); real-time GPS measurements and simulated Galileo data in RINEX format; user-configurable positioning modes with different combinations of ranging measurements (GPS or Galileo) and SBAS corrections, and data logging and replay for any positioning mode.

4 Demonstrations were carried out in both Europe and China. For the demonstration in China, a simple CPF was developed. It utilised the IGS predicted orbits to estimate the satellite clock and orbit corrections and estimated the real-time ionospheric corrections.

Results

The project has successfully prototyped a functional multi-constellation augmentation service. The implementation of the project covers the aspects of real-time data collections, real-time data processing, Galileo simulation, SBAS signal generations, dissemination of the SBAS signal over the Internet and the development of a pocket-sized PC-based user terminal for exploring the multi-constellation augmentation service.

Field tests have been carried out in Helsinki (FI), Nottingham (UK) and Beijing (CN). The field tests have demonstrated the functionalities of the system, though the system is not advanced enough yet for a 24/7 operation. The system prototype is well suited for demonstrating the concept of multi-constellation augmentation.

More information

Acronym:	IRC2G	
Name of proposal:	Integration of a Regional Component to the Galileo Global component - with demonstrations in Europe and China	
Contract number:	GJU/06/2423CTR/IRC2G	
Total cost:	€ 432 151	
EU contribution:	€ 280 246	
Call:	FP6 2nd Call	
Starting date:	26/04/2006	
Ending date:	03/07/2007	
Duration:	14 months	
Type:	SYSTEM INFRASTRUCTURE & EVOLUTION	
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Project Officer:	Eric Guyader	
Partners	Chinese Academy of Surveying and Mapping	CN
	IESSG, University of Nottingham	UK

ISIS

Internet-based Station Investigation Service

ISIS is a processing service that allows automated processing of GNSS observation data via a web-interface. The service provides products characterising the measurement station in terms of accurate position, measurement data quality, as well as the station clock. The service automatically searches and uses the International GNSS Service (IGS) for precise satellite clock and orbit data to produce high-accuracy products.

Background

From time to time everybody working in the field of satellite navigation has need of determining a station position or characterising the quality of data coming from a monitoring station. Normally data is collected and processed with some commercial or self-developed software in the office. More accurate solutions can be obtained when precise GNSS satellite orbit and clock data are used from the Internet, like IGS data. However, some amount of time is needed to search and obtain the right data and do the proper processing and analysis. Hence, the idea of ISIS is to ease this process by offering a web-based service to provide the best processing products in an automated way. The products here are not auxiliary intermediate products helping the user in the processing, but are actually the final processing results.

The final service is considered relevant for potential customers like engineers and researchers in satellite navigation and geodesy domains, as well as for

authorities who are in need of setting up navigation sensor or monitoring stations for whatever purpose. The products will help to identify issues related to the sensor station receiver and clock quality, and also to the environmental conditions of the site.

Objectives

The objective of the service is to allow for web-based online data processing of GNSS raw data without the need for user interaction. The results from this processing allow a characterisation of a GNSS observation station. For this processing, sources of additional auxiliary data are used, for example precise satellite orbit and clock data, which are available on the Internet. The basic idea, therefore, is to make use of such available data in an automated way and take the burden of searching for and obtaining such data away from the user.

Description of work

A set of service products has been defined within a storyboard that was used as a basis for development. The storyboard contains several characteristic products for a station-like position, quality of pseudorange and carrier-phase data, range accuracy after synchronisation, signal-to-noise figures, as well as clock characteristics in terms of Allan-variance curves. Different views on these data are available, like statistics per frequency or elevation or values versus elevation and azimuth, etc.

The ISIS demonstrator consists of two components: the web-component and the processing component. While for the web-component a use of standard web-hosting tools like Tomcat have been made, the processing component has been built on an internally developed software core that is called GSPF – GNSS simulation and processing framework (which is a registered trademark and a product of IFEN). This C++ software is platform independent and provides an ideal basis for data processing, algorithm development and performance analyses, and has been customised to the ISIS project needs. The GSPF allows the design of any operational data processing capability in a very modular way, thus allowing an easy replacement of algorithmic models and extensions to additional functionalities.

Compared to other services that provide measurement corrections for high-accuracy data processing, the ISIS approach is quite innovative in that it provides complete solutions instead of corrections. The processing is not done at the user side, but at the central ISIS server, which is hosted and maintained by the service provider IFEN.

Results

The result of the ISIS project has been defined as being a service demonstrator without charging, but dependent upon the acceptance of this service, a later commercialisation is anticipated. For this purpose different service levels are defined providing products at different detail levels.

The project succeeded in setting up a demonstrator service that allows for automatic GNSS data processing. The data processing carried out so far is according to the objectives of data from a single static station. The outputs are all the service products as defined within the storyboard. However, as ISIS is an operational service, the product availability is currently limited to GPS only. An extension to Galileo is foreseen at a later stage.

As a result of the project, all the relevant development documentation has been generated. The final report and the user manual of the service are available to the public. Other deliverable design documentation is confidential to the consortium.

At the moment the ISIS demonstrator may be used for free. The decision for a

final commercialisation will be taken at a later stage when more user feedback and suggestions have been gathered and evaluated. Several further improvements have been identified like usage of EGNOS SISNet or extending the service with differential or kinematic capabilities.

More information

Acronym:	ISIS
Name of proposal:	Internet-based Station Investigation Service
Total cost:	€ 300 000
EU contribution:	€ 300 000
Call:	FP6 2nd Call
Starting date:	18/01/2006
Ending date:	31/03/2007
Duration:	14 months
Website:	http://www.isis-gju.org
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Project Officer:	Eric Guyader
Keywords:	Sensor station, characterisation, identification, Internet, web-based data processing service

LMHC-TTCS

Free traffic-toll collection system with protection of personal data – including passenger monitoring system

The project was established to develop an innovative toll collection system using EGNOS-based Global Navigation Satellite System and Cellular Networks (GNSS/CN) using intelligent vehicle device and program modules which will ensure greater personal data protection, guarantee fair charging of the distance travelled and prevent avoidance of toll payments at the open toll collection systems.

Background

Other electronic toll collection systems take advantage of vehicle-to-roadside communication technologies to perform an electronic monetary transaction between a vehicle passing through a toll station and the toll agency. Most of those technological components are based on GPS or infrared communication and have been tested and demonstrated but open up different problems:

- tracking the vehicle owner and thereby the question of personal data protection,
- the systems do not offer an entirely accurate and timely location determination.

According to the European traffic policy and recommendations on personal data protection there is a need for such a technological solution, which will insure greater protection of personal data while simultaneously considering the principle of actual road usage, prevention of forgery and fraud, undisturbed toll collection, low costs of toll collection, etc.

The system also offers the possibility of changing the classic road taxes payment (flexible tariff policy) for payment according to the actual use (monthly, annually, pre-payment).

Objectives

Within the project there were five main objectives to develop the following:

- Prototype of the control centre (CC);
- Prototype of the toll meter or the onboard unit (OBU);
- Protected communication between the CC and OBU;

- A system that can charge tolls in relation to the number of bus passengers;
- An electronic map of the virtual toll stations.

Description of work

During the process of development the aim was to solve the problems of existing toll collecting systems.

Users were provided with an OBU that captures the location of the vehicle and detects crossings of predefined toll stations, defined by using dynamically loaded maps. Data concerning entry into tolls, the loading of maps and user data was communicated from the OBU to the CC using GPRS. Charging the users' accounts, along with account management and the processing of passenger statistics, was performed within the CC.

The software, activity sequence and use case diagrams was designed using the UML 2.0 standard. The result was the specification of a very well defined and modular system. The consortium decided to build the CC software on a Microsoft Windows CE 5.0 platform using Microsoft eMbedded Visual C++ 4.0, and focused on the problem of building this concept and not on other technical issues which were not among the project objectives. Data encryption was implemented using library rsaeuro 1.04.

Results

Building the Galileo electronic tolling system demanded the design of an electronic map model, an OBU with all of the peripheral devices, a control centre and communication between the CC and OBU devices.

An electronic map represented a set of all the toll stations with coordinates for the entire tolling region. Since all OBU units do not need all the data at once the electronic map was split into fragments called cells, which were organised as a tree structure. In this model a cell is a rectangle aligned with meridians of longitude and parallels of latitude. Each cell has the exact position given by vertices coordinates. A cell contains all the toll stations that are at least partially covered by the cell's rectangle. A cell represents the smallest part of an electronic map that can be loaded in the OBU's memory.

The onboard unit is a universal device that is not tied to a vehicle, vehicle category or driver. It contains a smart card reader for user personalisation.

When considering the number of passengers on a bus for fair charging, a piece of equipment for passenger counting was added – IRMA. The system was plugged directly into the vehicle's OBU.

The OBU is constantly calculating the GNSS position of the vehicle. Every second the OBU calculates the positions and creates a list of received positions – the trace. The second activity is processing each item of the trace, following the FIFO rule. If the item is inside any of the tolling stations, the OBU sends a description of the crossing event to the CC, which contains the account number, the category of the vehicle, the ID of the tolling station, the exact date/time of detection and (in the case of vehicle of commercial

use) the number of passengers. The OBU never sends data which compromises privacy to the CC, such as current or previous positions of the vehicle, the driving direction, etc.

The control centre consists of a highly efficient server and programming equipment. Its basic role is to process the demands from OBU, i.e. confirmation of the cells or charging the toll. The CC sends segments of the electronic map to the OBU. Every time the OBU determines a toll station has been crossed it sends a demand to the CC to charge for the toll. The CC then calculates the toll, subtracts it from the user's account and sends the information about this event back to the OBU. Throughout the system software, the CC is the one actually responsible for charging tolls and subtracting it from users' accounts.

More information

Acronym:	LMHC-TTCS
Name of proposal:	Free traffic-toll collection system with protection of personal data – including passenger monitoring system
Contract number:	GJU/2423/CTR/LMHC-TTCS
Total cost:	€ 428 499
EU contribution:	€ 299 949
Call:	FP6 2nd Call
Starting date:	10/03/2006
Ending date:	31/05/2007
Duration:	15 months
Coordinator:	Mr Damjan Strucl, Logina Vodnikova cesta 252 SI 1000 Ljubljana
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Project Officer:	Eric Guyader
Partners	Hamburg - Consult DE Morris IT Univerza v Ljubljani - Prometnotehniški inštitut SI

LOCCATA

Location-based and context-aware multimodal mobile hiking guide

LOCCATA is a mobile, digital hiking guide in the form of a PDA or mobile phone with pictures, texts and audios. The software ascertains the position of the hiker with the help of satellites and makes location-based information available to them.

Background

New ways of getting information are beginning to be available for the nature lover and hiker. Location-based information about the landscape, history and culture can be received on the spot with the help of Galileo satellites. The technology that was initiated by the Austrian company, Telesis, is based on the mobile telephone and the PDA, both of which need to be connected to a Galileo receiver (currently GPS is used). If a hiker gets close to a point of interest (POI), their phone or PDA will draw their attention to it by vibrating or sending an audio signal. Users can then access the location-based information sent to them.

Objectives

The objective of the LOCCATA project was the implementation of a location-based and context-aware mobile multimodal hiking guide application for the Montafon region in Austria. The technical work was divided into two parts: first the development of mobile clients and secondly the development of the relevant content.

Description of work

Based on research in mobile applications and context-aware and multimodal interfaces, a lightweight mobile phone hiking assistant application was devel-

oped. Selected modules of the mobile application development framework were used and adapted for use on a Java-enabled phone. Complementing existing approaches of accessing broadband networks, the application relies on standard GSM phone services.

Employing the Mobile Java (J2ME) Bluetooth capabilities, any mobile phone equipped with it can be used to query an external positioning receiver for a current location. The system forms an unobtrusive companion that employs different modalities to meet the requirements, allowing the user to continue walking, enjoy their route but still be informed. The MontaPhone application is a new and innovative way to retrieve in-depth spoken narratives. The application can be downloaded from the LOCCATA website.

The SmartGuide is an innovative mobile application for Windows Mobile enabled devices (e.g. PDAs or Smartphones) bundling the latest development from research in mobile applications and systems into the domain of tourism. Because of the higher computing power and storage capacity of these devices compared to cell phones, the realisation of more ambitious applications is possible. The SmartGuide is able to provide a multimedia-enriched hiking experience with personalised and location-aware information.

At the moment the Digital Hiking Guide on the PDA contains a movable map, which has a 3x zoom. The entire route is shown on the display. The map shows the route, the points of interest and the current position of the user. The user can also keep track of where he has been. By pressing a point of interest the user can access historical, natural landscape and cultural landscape information in the form of texts, pictures and narratives.

Due to the flexible framework on which the SmartGuide application is based it is easy to extend the application and enable Galileo support as soon as the appropriate receivers are available.

In contrast to previous systems, the openness of the architecture is one of the main ideas of the software components. One group of software is object models. These models define the real memory representation of objects and their services for construction and destruction. Furthermore they specify communication channels between objects. This group includes programming language dependent on and programming language independent of object models.

A second group is component models. Components, which can also be referred to as modules, are objects that encapsulate the functionality and data on a higher level of abstraction than the object models. The component models define interfaces and concrete rules for the design and implementation of software components based on object models. A software component usually consists of different objects, which are combined to solve a certain task.

Results

All the objectives of the project were reached and a highly sophisticated system was designed and implemented. Currently six hiking routes with more than 80 points of interest are entered in the system and additional routes are already in development. The tourism institutions in the Montafon region have committed themselves to introducing the system to the public and the project partners are available to adapt the system to future requirements.

More information

Acronym:	LOCCATA
Name of proposal:	Location-based and context-aware multimodal mobile hiking guide
Contract number:	GJU/06/2423/CTR/LOCCATA
Total cost:	€ 523 497
EU contribution:	€ 298 192
Call:	FP6 2nd Call
Starting date:	01/03/2006
Ending date:	01/03/2007
Duration:	12 months
Website:	http://galileo.telesis.at
Video:	LOCCATA Product Presentation http://www.youtube.com/telesisboard
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M-TRADE

Multimodal TRAnsportation supporteD by EGNOS

M-TRADE is the European platform to promote EGNOS and Galileo in the freight transport community. The project identified applications reflecting the user needs and maximising EGNOS/Galileo differentiators. It also analysed and validated the use of EGNOS commercial services for remote assets and the tracking and tracing of goods.

Background

Europe's transport policy has been characterised by liberalisation and harmonisation over the years, which has shaped the current transport system. Globalisation and the concept of a wider Europe create further challenges. Rapidly increasing freight transport contributes to growth and employment but also causes congestion, accidents, noise and pollution.

M-TRADE targets European policies in support of transport's sustainable development and short-sea-shipping promotion.

In the '2001 White Paper on Transport' mid-term review, the European objective was to shift to more environmentally friendly modes, especially on long distance jounrneys and on congested corridors, in favour of co-modality (i.e. the efficient use of different modes on their own and or in multimodal integration in the European transport system).

The 'Programme for the Promotion of Short Sea Shipping' recommends measures aimed at enhancing the quality of transport, by increasing the reliability throughout the whole transport chain and facilitating administrative procedures.

A common vision is that intelligent transport systems (ITS) can play a key role. Advanced solutions based on GNSS, coupled with other technologies such as RFID, can contribute towards reach-

ing an optimal and sustainable use of resources. Services for remote localisation of cargo in all modes allow a reliable tracking of both journey and goods, thus decreasing the need for individual controls, and contributing to an efficient and safe management of supply chains.

Objectives

The M-TRADE objective is to analyse the use of EGNOS/Galileo in freight transport applications.

Description of work

M-TRADE developed an end-to-end solution providing user-oriented services for freight containers and tracking and tracing. The M-TRADE solution's basic elements are:

- commercial-off-the-shelf components;
- standard protocols and interfaces;
- two onboard units using GPS/EGNOS assisted via GPRS and integrating RFID;
- web-based applications to provide service access.

The project implemented a real-life demonstration to validate the M-TRADE solution and services in operative pilots, involving representative actors of the freight transport domain.

Four real-life pilots were set-up over combined maritime-road-rail-river freight chains based on users' interests and covering operational scenarios:

Pilot 1 – Bologna Freight Village: Remote monitoring of locomotives position and manoeuvres during shunting operations.

Pilot 2 – Rail and road (Brescia-Bologna-Modena) chain: Tracking and tracing and temperature monitoring of a reefer carrying perishable goods.

Pilot 3 – Danube River (Vienna-Budapest-Vienna): Tracking and tracing of a river vessel loaded with petrol, through three European countries (Austria, Slovakia and Hungary).

Pilot 4 – Rail chain (Genoa-Ferrandina-Dordrecht-Zeehaven): Tracking and tracing a tank rail wagon loaded with oil products through four European countries (Italy, Switzerland, Germany and The Netherlands). Demonstration results were analysed in terms of main enablers: technology, EGNOS/Galileo benefits and differentiators, user acceptance and awareness, and market and business opportunities for EGNOS and

Galileo services/products in the sector. Moreover, the project also evaluated the M-TRADE solution's introduction in customs and border control applications.

The M-TRADE work was deployed through three sequential phases.

- Phase I: Critical analysis, performing the analysis of GNSS applications for freight transportation.
- Phase II: Implementation, elaborating an action plan, developing the solution and implementing the real pilots.
- Phase III: Results analysis: based on the demonstration results, it produced recommendations and priorities for the exploitation of M-TRADE services in the domain, from the initial introduction of EGNOS to the further addition of Galileo.

Results

M-TRADE validated the use of EGNOS Commercial Services for remote asset and the tracking and tracing of goods.

M-TRADE developed an end-to-end solution, demonstrated it in real-life operative scenarios and evaluated its introduction in customs and border control applications. Two different onboard units were developed, using GPS/EGNOS assisted via GPRS and integrating RFID technologies. M-TRADE tracking and tracing services are conceived to cope with safety and efficiency operative needs, in line with standards and regulations, and to exploit 'market' value for EGNOS/Galileo differentiators, i.e. dangerous goods, perishables and remote assets.

M-TRADE performed four pilots over European freight chains, combining maritime, road, rail and river. Gathered user feedbacks showed friendly service access and benefits in operations, and provided recommendations for enhancements.

M-TRADE also studied the case of EGNOS/Galileo introduction in the customs domain. The analysis evaluated user interests and identified opportunities for GNSS to provide benefits in customs operations, supporting anti-fraud enforcement and trade flows control.

M-TRADE is the first step towards the operative use of GNSS in multimodal freight applications and shows the way for future progress in the regulated applications domains.

More information

Acronym:	M-TRADE
Name of proposal:	Multimodal TRAnsportation supporteD by EGNOS
Contract number:	GJU/05/2412/CTR/M-TRADE
Total cost:	€ 2 250 000
EU contribution:	€ 1 239 000
Call:	FP6 2nd Call
Starting date:	19/09/2007
Ending date:	21/03/2007
Duration:	18 months
Website:	http://www.newapplication.it/mtrade
Video:	m-trade movie: http://galileo.cs.telespazio.it/mtrade/public/M-TRADE%20Movie/
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Keywords:	EGNOS CDDS, freight transport, RFID, demonstrations, dangerous goods, perishables, customs applications

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	GMV Sistemas	ES
	HiTec	AT
	Indra Espacio	ES
	Interporto Bologna	IT
	Kayser-Threde	DE
	LogicaCMG Nederland	NL
	SeT-ELSAG	IT
	Trenitalia – Direzione Generale Operativa Logistica	IT
	TTS Italia	IT
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MAGES

Mature Applications of Galileo for Emergency Scenarios

The MAGES project addresses GNSS support to the management of various types of emergency relief including disaster relief, helicopter operations and fire rescue. It focuses on the unique differentiators emanating from the introduction of Galileo and EGNOS, and on their particular importance and relevance for the different actors in emergency management. Following a consolidation of user needs, detailed technical analysis will lead to the creation of three major demonstrations.

Background

GNSS offers a unique tool to support the operations that are needed for the management of various types of emergencies. Positioning and position reporting is vital during the operations of various entities involved in emergency management, such as the police, fire brigades, civil protection, ambulances, etc.

Crisis and emergency situations require a joint effort of several different forces and teams, in a coordinated way and sometimes in particularly stressful environments. In the case of large-scale disasters, the infrastructure for transport and communication is likely to be unavailable. Also roads, power lines, water distribution systems may be damaged or even destroyed. As a consequence, the operations for rescue or assistance could be very difficult, and it is vital that the basic infrastructure is quickly restored in order to give first aid to the victims.

Galileo will be a valuable tool to support these types of situations. Its high reliability, even in emergency situations and difficult environments, is therefore a key characteristic of paramount importance to ease the management of natural or non-natural disasters. Prevention of catastrophic events with the survey and monitoring of assets, dams, bridges, including support to cartography for the management of emergencies, are also areas where Galileo and EGNOS can bring significant benefits.

Objectives

The project has the following objectives:

- contribute to the introduction of Galileo and EGNOS for emergency management applications;
- investigate technical and non-technical benefits and advantages of Galileo in comparison to existing solutions;
- derive business value for the actors involved in the service provision, from the Galileo operator to the final user;
- investigate the role of GNSS for disaster alerting in coordination with relevant parallel objectives in GMES;
- provide a platform to involve the user community in the optimisation of EGNOS and Galileo.

Description of work

The MAGES project addresses all the key actors in the emergency management community and aims to represent the next stage in their adoption of Galileo.

The starting point of the project will benefit from all the accumulated results and experience of the partners and users in precursor projects, e.g. HARMLESS, SCORE, HELICITY. The involvement of the partners in previous related activities ensures that MAGES will constitute an instrument of continuous effort of dissemination and promotion activities.

The involvement of the users group in previous projects in this area ensures a solid and conscious users community.

A depth assessment of the EGNOS and Galileo differentiators, in technical and non-technical aspects, at system, service and user segment level, including the proposal of specific local elements, and the assessment of alert broadcast services to support emergency operations will be performed.

The project will then define and carry out a set of three representative demonstrations of pilot systems to support the emergency management operations

showing a clear benefit over the applications based on the currently existing technology (GPS) and with the objective of being a solid basis for the future deployment of the respective operational services. The demonstrations chosen are:

- Helicopter navigation
- Disaster relief management
- Fire brigade management.

Results

The expected results are:

- Reports on the user survey, survey on current situation, planned evolution and exploitation of synergies, future mission requirements, requirements for emergency management.
- Scenario definition report;
- Design documents on local elements, user terminal, user interfaces;
- Report on service provision aspects;
- Design document: alert broadcast via GNSS;
- Demonstration: Helicopter navigation – definition document, design and AIV document, results and analysis;
- Demonstration: Disaster relief management – definition document, design and AIV document, results and analysis;
- Demonstration: Fire brigade management – definition document, design and AIV document

results and analysis;

- Dissemination plan and final report.

More information

Acronym:	MAGES
Name of proposal:	Mature Applications of Galileo for Emergency Scenarios
Call:	FP6 3rd Call
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	Eurocopter	DE
	GMV	ES
	GMV Sistemas	ES
	Helios Technology	UK
	IAI	IT
	Logica CMG	NL
	Logica CMG	UK
	Septentrio	BE
	Skysoft	PT
	Tele+ Italia	IT
	Terma	DK
	The 425 Company	UK
	TNO	NL

MAGIC

MAnagement of Galileo Interference and Counter measures

The objective of the MAGIC project is to define and validate the technical solutions that will allow Galileo operators to offer an interference-free system. The three topics: detection, isolation and mitigation will be defined, studied and validated through a theoretical approach, software simulations and real field trials. Finally the MAGIC project will define the system GIMS (Galileo Interference Management System) by implementing the ad-hoc techniques and making it connectable to the local element.

Background

GIMS (Galileo Interference Management System) is a strategy proposed by the MAGIC project to deal with the problems caused by the presence of interfering signals. The strategy is based on the following main types of equipment:

- IOS (Interference Observation Site): devices able to detect the presence of interfering signals and that provide information on them, such as frequency, bandwidth, AOA and so on.
- ICC (Interference Control Centre: a control centre that receives the information from each IOS and extracts the position of each interfering signal associating it with its main characteristics.

Further more the GIMS also provides:

- A signal alert to warn about the presence of interference;
- Estimates of the X,Y,Z interferer positions;
- Notification of the surveillance authority;
- A mitigation strategy to each GR (including those belonging to the LAA).

Objectives

The objective of the MAGIC project is to define and validate the technical solutions that will allow Galileo operators to offer an interference-free system. The three topics: detection, isolation and mitigation will be defined, studied and validated through a theoretical approach, software simulations and real field trials.

- Interference detection: This consists in determining with confidence that interfering signals are currently affecting the area being managed, and the interference characteristics. When appropriate, alerts shall be generated to inform users that any positioning and/or timing data still being obtained may no longer be reliably used;
- Interference mitigation: While interference is in place, mitigation mechanisms shall be activated so as to reduce its adverse effects;
- Interference isolation: Once presence of interference has been detected, actions shall immediately be taken to determine the interference source location. Such information will be of great value for the administrative/police procedures which will end forcing the interferer to cease transmissions.
- Finally the MAGIC project will define the system GIMS (Galileo Interference Management System) implementing the ad-hoc techniques and connectable to local element.

Description of work

The MAGIC project will have two phases:

- Definition of future GIMS system and demonstration of concept (call 2416)

- GIMS development (target GIMS)

The three topics: detection, isolation and mitigation will be defined, studied and validated through a theoretical approach, software simulations and real field trials. Finally the MAGIC project will define the system GIMS implemention, the ad-hoc technics and connectability to the local element.

GIMS will provide a local or regional component with:

- Detection of interferences
- Characteristics of interference for low cost mitigation
- Location of interference

(1)Proof of concept and validation

Investigation of techniques for signal detection and classification:

- Energy detection (Conventional power spectrum
- Cyclostationary spectrum
- Polyspectra (higher order moments)

Investigation of suitable techniques for interference mitigation amongst:

- Time domain (TD) techniques
- Frequency domain (FD) techniques
- Spatial domain (SD) techniques
- Combined spatial, time and frequency domain (STFD) techniques
- Trade-off and selection of the most appropriate techniques in each operational scenario.

(2)Proof of concept and validation.

Suitable techniques for isolation and best choice amongst:

- TDOA: limitation due to interference bandwith
- FDOA: requires a mobile element
- AoA: requires only two stations

Functional demonstrator (no real time required)

- To be supressed because no interest: digitization of signals
- work on existing known interferers (See ESA report on interferences)

Results

Please see the file named "MAGIC_Growing_GAL_V4.3.pdf", which can be downloaded at http://www.research-projects.org/projects/magic/download or https://www.research-projects.org/projects/magic/download.

More information

Acronym:	MAGIC
Name of proposal:	MAnagement of Galileo Interference and Counter measures.
Contract number:	GJU/05/2416/CTR/MAGIC
Total cost:	€ 3 264 140
EU contribution:	€ 1 874 020
Call:	FP6 2nd Call
Starting date:	11.08.2005
Ending date:	30.11.2007
Duration:	24 months
Type of Project:	USER TECHNOLOGY

Website:	http://www.research-projects.org/projects/magic or https://www.research-projects.org/projects/magic	
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Partners	France Development Conseil (FDC)	FR
	University of Bologna	IT
	Space Engineering	IT
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MARGAL

Maritime GALILEO - Seamless harmonised services for ports and inland waterways

The MarGal project addressed the application of EGNOS/GALILEO services to the maritime user community. In particular, it aimed to demonstrate the use of differential corrections and integrity alarms to provide more accurate and reliable positioning services, as well as establishing a harmonised and seamless service from high seas to inland waterways.

Background

In the context of increasingly stringent safety and security requirements in ports and inland waterways, the new possibilities offered by EGNOS/GALILEO offer many opportunities for new GPS based applications for the maritime user community. The MarGal project looked at ways of taking advantage of these opportunties and developed prototype demos of new applications.

Objectives

The aim of the project was to addresses the various challenges related to port and harbour approach, navigation, monitoring and docking as well as inland waterway monitoring, precise navigation and calamity abatement. The objective was to develop new local maritime services based on EGNOS/Galileo differentiators to support costal and inland waterways operations.

In addition to functionality, MarGal also looked at issues relating to: safety and security; accuracy; integrity; continuity and availability.

Specific project objectives included:

- to provide input to standardisation and legislation work for a common infrastructure for Port and Inland Waterways;
- to provide a working prototype of an infrastructure to implement the services needed to support business cases on EGNOS and Galileo;
- to investigate and propose solutions to applications and business cases covering the safety and security issues connected with use of EGNOS and Galileo, both SIS and distributed signals using Local Elements;
- develop a technological platform enabling transition from EGNOS to Galileo to be cost effective from a user perspective by introducing Software Defined Receivers;
- support networks of local elements to wide area coverage and integrity monitoring.

Description of work

The current situation and expected user requirements were evaluated by MARGAL, based essentially on IMO requirements. A set of practical scenarios were identified and public demonstrations organised on this basis. For port applications, teh selected scenario looked at what could be done if the inlet to a harbour is limited, and high position accuracy and integrity is needed for safe passage of two vessels. For inland waterways, the selected scenario addressed the tracking and reporting of hazardous goods, and the need for reliable position reporting in order to ensure damage control and limitation.

MARGAL focused on the use of Automatic Identification Systems (AIS) and integrity monitoring using differential corrections and integrity information received directly

from both Galileo and EGNOS satellites. As a local component for Galileo, AIS Base Stations were used to transmit differential corrections and integrity information.

This led to the succesful demonstration of port approach and calamity abatement external services.

Results

MARGAL was succesful in raising awareness of Galileo in the maritime and inland waterway sector, and in identifying key service areas in which Galileo may provide a benefit to the users. These services were then demonstrated using MARGAL prototype equipment.

For port and harbour approaches, the key service differentiators were identified as the potential to provide an improvement in accuracy, continuity, availability and integrity (service permitting) over current GNSS services.

Two public demonstrations were organised in autumn 2005, one in the Danube river in Hungary and the other in the UK Port of Harwich.

More information

Acronym:	MARGAL	
Name of proposal:	Maritime GALILEO - Seamless harmonised services for ports and inland waterways	
Contract number:	GJU 1009/CTR/FP6/C	
Total cost:	€ 3 238 363	
EU contribution:	€ 1 273 384	
Call:	FP6 1st Call	
Starting date:	25/02/2004	
Ending date:	25/02/2006	
Duration:	24 months	
Type:	APPLICATION	
Website:	http://www.seatex.no/margal/	
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	Trinity House	UK
	Telematica	DE
	Nordnav	SE
	VUD	SK

MARUSE

Maritime user segment

MARUSE is examining and addressing the navigational needs of the maritime user community by taking into account the developing Galileo system. In particular it is focusing on future requirements for maritime navigation, which have already been expressed formally from the IMO and other authorities. It addresses topics like security and safety, integrity, continuity, availability and accuracy where Galileo will play a vital part.

Background

MARUSE focuses on technology and application development, implementation and demonstration in key maritime applications where the utilisation of Galileo will be of clear benefit. Typically, these are professional, high-end applications where the benefits include improved safety and efficiency of the broad range of maritime operations.

Particular user domains selected are ports and inland waterways, with particular emphasis on marginal ships. The work includes developing and demonstrating service prototypes.

Objectives

The objective of the MARUSE project is to bring together SMEs, maritime GNSS industry, other GNSS industry and key service providers and users within maritime and inland waterways with the aim of introducing EGNOS and Galileo to the maritime domain. The work builds upon the major completed and ongoing activities within maritime use of EGNOS and Galileo. Important building blocks for the work will be redistribution of EGNOS data for inland waterways as demonstrated in the ESA GALEWAT project, the local element work in the GILT project, the maritime harmonised seamless service concept developed in the MARGAL project, as well as the maritime standardisation work performed in the GEM projects. It is also foreseen that close co-operation with the MARNIS project, one of the larger maritime FP6 projects, will be of benefit, as well as close co-operation with other parallel GJU contracts within GNSS receiver development, maritime standardisation and service centre development.

The project includes development, integration and test activities related to maritime EGNOS/Galileo receivers and user terminals as well as maritime local elements and pseudolites (pseudo-satellites). MARUSE will demonstrate the benefits of EGNOS and Galileo for port operations and docking, in inland waterways and for intermodal transport utilising prototype user terminals and local elements. A special emphasis has been put on the development of AIS to provide differential services for maritime operations in ports, inland waterways and other areas where accuracy, integrity and continuity requirements are high due to traffic and restrictions in navigational ability.

Description of work

The MARUSE technical work will consist of studies and technical development activities. The main focus will be on the technical development activities while the studies aim to support the technical development activities on specific technical issues and in related areas such as market development, standardisation activities, legislation, etc.

The key technical development activities within MARUSE are:

- maritime Galileo pseudolites;

- Galileo/GNSS receiver prototype capable of tracking GIOVE-A signal and Galileo pseudolites;
- maritime user terminal;
- maritime local element;
- integrated navigation test bed;
- utilisation of communication links (VHF, IALA, AIS, WLAN, GPRS/UMTS).

The work will be supported by:

- market analysis;
- business models;
- legislation and regulations;
- interaction with other standardisation activities;
- technical studies (e.g. tropospheric issues, authentication, charts, LRIT).

Results

The results from MARUSE are published in several reports and are also demonstrated in four user demonstrations for different user communities.

More information

Acronym:	MARUSE
Name of proposal:	Maritime user segment
Contract number:	GJU/05/2410/MARUSE
Call:	FP6 2nd Call
Duration:	24 months
Type:	APPLICATION
Website:	http://www.maruse.org
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	Sogei	IT
	Telematica	DE
	Terma	DK
	Thales Research & Technology	UK
	Trinity House	UK
	Ursa Minor Space & Navigation	NL
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MENTORE

Implementation of GNSS tracking and tracing technologies for EU regulated domains

MENTORE targets the Commission's Green Paper on *Satellite Navigation Applications*.

MENTORE will define a roadmap for GNSS technologies and services in the tracking and tracing regulated market. The project will give guidelines for the creation of best practices in regulated tracking and tracing services of EGNOS to Galileo.

Background

The European Union has already established a number of regulations requiring precise, reliable and up-to-date knowledge of geographic positions. In the near future, present policies may evolve towards new regulations.

These regulations take advantage of satellite navigation applications, commonly regrouped under the term 'tracking and tracing', as a tool to localise and remotely monitor assets and persons.

The Commission has recently presented a Green Paper on satellite navigation, defining a framework for satellite applications in regulated tracking and tracing domains.

With the advent of EGNOS and Galileo, tracking and tracing applications and services are expected to develop rapidly.

Objectives

MENTORE's objective is the definition of a roadmap for GNSS technologies and services in the tracking and tracing regulated markets.

Radioactive transport-regulated control of fissile material transport ensures the protection of the public and the environment. Present remote tracking and tracing systems make use of GPS. EGNOS and Galileo differentiators rely on enhanced performances and new services, such as signal authentication and PRS.

Livestock transport – a Council Regulation on the international transport of livestock introduces the compulsory use of satellite navigation systems by 2009. The need to guarantee the information related to position, travelling times and routes is a must which can only be achieved through the signal integrity provided by EGNOS/Galileo.

Food traceability – the European Union is the world's largest importer/exporter of food products. In 2002, the Community adopted the General Food Law, Regulation (EC) 178/2002, and advocated traceability for the protection of consumers. The use of technology solutions based on satellite navigation provides food transportation tracking and product monitoring, thus supporting 'farm to table' food safety policies.

eCustoms – the EU COM/2005/608 and COM/2005/609 propose actions for the modernisation of Customs Codes and the implementation of electronic customs. The goal is to achieve interoperable and accessible automated customs systems in the Member States, thus supporting coordinated processes and services. This will facilitate communications/transactions between traders and customs, increase the competitiveness of companies doing business in Europe, and improve EU security. The cargo traceability and the use of tracking technologies (including GNSS) are the basis of the implementation of eCustoms policies.

Other regulated applications in various markets will be explored during the project.

MENTORE demonstrates five pilot services. It will use the results of the demonstrations for the definition of the roadmap.

Description of work

During its two-year duration, the project will analyse the technologies, service platforms, market scenarios and service provision schemes of EGNOS/Galileo-based tracking and tracing regulated services.

The MENTORE work is deployed through two main phases:

Phase I – Application group analysis, including two main activities namely analysis, and classification and ranking;

Phase II – Pilot service implementation, including two main activities namely implementation of pilot service demonstrations and synthesis.

In the analysis activity, capitalising on the results of previous and on-going European initiatives, MENTORE performs an inventory of regulations, trends, technological platforms, services for different tracking and tracing application domains and sectors (transport, freights and goods, animals and persons).

The project then classifies and prioritises the analysed applications, upon commercial and public interest requirements.

On these bases, MENTORE completes Phase I by ranking tracking and tracing applications, and selecting two of them to be implemented in Phase II.

During Phase II, MENTORE demonstrates five pilot services: radioactive material shipment, livestock transport and dependant persons tracking, in addition to the two cases previously selected.

The results from the pilot service demonstrations are used for the final synthesis: gaps identification, recommendations and guidelines elaboration, actions and plan definition.

Results

The project will analyse the EGNOS/Galileo-based tracking and tracing regulated services, in the framework of the regulations, standardisations and European Union policies on public interest.

MENTORE will implement and operate five real-life pilot service demonstrations in various application domains. The regulated services are driven by commercial and public interest requirements.

The project will propose a roadmap for GNSS technologies and services in the tracking and tracing regulated market to:

- Support the application of regulations already in place;
- Accelerate the process of setting up regulations presently under development/discussion;
- Trigger the development of new regulations, from the initial introduction of EGNOS to the further addition of Galileo.

More information

Acronym:	MENTORE
Name of proposal:	Implementation of GNSS tracking and tracing technologies for EU regulated domains
Contract number:	GSA/06/8066/CTR/MENTORE
Total cost:	€ 3 950 000
EU contribution:	€ 2 340 000
Call:	FP6 3rd Call
Starting date:	09/07/2007
Duration:	24 months
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Keywords:	Regulated services, EGNOS/Galileo differentiators, tracking and tracing, regulations

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	HiTech	AT
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	Italian Ministry of Transport	IT
	Università di Parma	IT
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	RFI	IT
	Interoprto Bologna	IT
	IBERTEC	ES
	LAIPAC	CA
	ELSACOM	IT

MONITOR

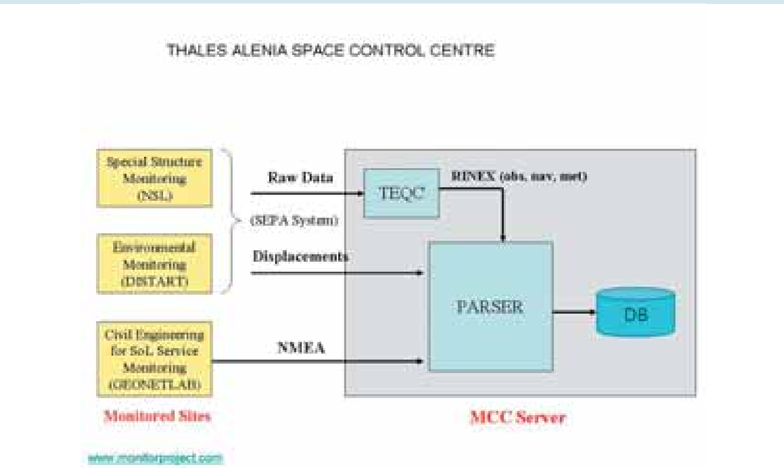
Land surveying and civil engineering monitoring

Galileo would be an essential tool in several GNSS applications in civil and environmental engineering, especially with regard to monitoring building and bridge movements, landslides, and the position of workers in construction yards so to increase their safety.

Background

Europe has a history of natural disasters, such as earthquakes, landslides, floods and volcanic activity. For nearly 50 years, geodesists and surveyors have developed deformation-monitoring techniques based on traditional land surveying equipment, such as theodolites, EDMs and levels. From the 1980s onwards, these traditional techniques were first supplemented and later completely replaced by satellite positioning technology based on GPS. At the start, the time-related measurement data was collected from the different GPS sensors placed at critical locations on the structure and then post-processed. Later, these measurements were broadcast to the control centres by using dedicated links, such as short-range radio, fibre optic cables and the Internet for quasi-real-time collection, processing and monitoring.

However, on its own, GPS suffers from a number of limitations which affect the coverage, accuracy and reliability of the satellite measurements. The eventual emergence of Galileo and its proposed interoperability with GPS, and the use of EGNOS, will contribute substantially to the quantity and quality of the satellite measurements, thereby improving the quality of the deformation monitoring process. Moreover, the availability of signals from two different satellite systems is likely to reduce the price of GNSS receivers and sensors, thus enabling a wider spatial coverage with an increased number of monitoring points.



Objectives

The project objectives are:

- to demonstrate, via pilot projects, the use of GNSS for environmental and civil engineering monitoring;
- to demonstrate, via pilot projects, current satellite positioning technologies and through simulation the added benefits of EGNOS/Galileo;
- to design and realise an operational centre for environmental and assets monitoring;
- to analyse the barriers to the wider penetration of GNSS within the land survey and civil engineering markets, and propose enablers to overcome these barriers covering technology advances, strategy for market penetration and a regulatory framework.

Description of work

The consortium has analysed many applications of GNSS in civil and environmental engineering and in cartography. From among about 25 applications, the consortium has selected three, which were:

- monitoring buildings on landslides
- monitoring bridges
- monitoring the position of construction yard workers and their machines to ensure workers' safety.

These cases became pilot projects, for which a real time monitoring centre facility at Thales Alenia Space has been added.

In the first two cases, a network of radio-interlinked L1 GPS receivers has been used. Differential data has been sent to the monitoring centre.

Tests have been performed at the Severn Bridge (UK) and at Gaggio Montano (IT), a village subject to landslide.

In the construction-yard pilot project, all types of GPS and DGPS receivers have been used for accuracy from 10 metres (trucks and machines positioning when driven towards and away from the yard, for yard organisation) to submetric level (mutual position of workers and machines). Vehicles equipped with DGPS/INS have been used also. EGNOS has been used for DGPS, when available, or, alternatively, local reference GPS stations have been used. Tests have been done at the Consorzio di Bonifica Valligrandi, Legnago (IT) which is considered to be a large yard by workers' safety legislation and at a small yard in the old town centre of Trieste.

Results

The experiments have confirmed that Galileo or an equivalent GNSS system has to be added to GPS so as to increase the position availability in civil and environmental engineering applications. No guarantee is possible if only GPS or GPS+GLONASS is used to monitor workers and machines in construction yards. The same is for landslides and building monitoring in deep valleys or in town centres.

As confirmation, when GPS is available, as in the test at Valligrandi which is entirely on the River Adige plain, then the GNSS monitoring has been demonstrated as feasible.

While the GNSS monitoring of the Severn Bridge suffered only from satellite eclipsing due to its structure, in thousands of other cases it was found that hills and buildings create problems when carrying out GNSS monitoring. Hence more satellites are needed.

Moreover, particular features of Galileo, like the 3-band commercial service, could be of general interest in an area which cannot be easily covered by RTCM via GPRS or any wireless data communication system. However, the SIS guarantee by Galileo is succeeding.

More information

Acronym:	MONITOR
Name of proposal:	Land surveying and civil engineering monitoring
Contract number:	GJU/05/2412/CTR/MONITOR
Total cost:	€ 2 225 000
EU contribution:	€ 1 248 000
Call:	FP6 2nd Call
Starting date:	25/11/2005
Ending date:	31/10/2008
Duration:	24 months
Website:	http://www.monitorproject.com
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Project Officer:	Stefano Scarda
Keywords:	Civil engineering, environmental engineering, monitoring

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Elsacom	IT
IDS Italia	IT
Nottingham Scientific Limited	UK
Pagnanelli Risks Solutions	UK
Provincia di Bologna	IT
Regione Emilia Romagna	IT
SEPA	IT
SISTEMATICA	IT
Sogei	IT
University of Thessalonikyi	GR
DISTART - Università di Bologna	IT
Università di Bologna II	IT
Value Partners	IT

MTTS

Multi-modal Tracking and Tracing Service centre

Since SAR/Galileo is one of the main differentiators of Galileo it is proposed to fully exploit the potential of the Galileo return link message (RLM) and the return link service provider (RLSP) concepts by means of introducing a new virtual Multimodal Tracking and Tracing Service Centre (MTTS) which links directly to the RLSP and operates in parallel with the rescue control centre (RCC).

Background

It is proposed to study the feasibilities and demonstrate a system that will be able to import the data from the Mission Control Centre (MCC) using standard formats and allowing for maximum interoperability with the RLSP, the MCC and RCCs, and potentially other emergency service parties.

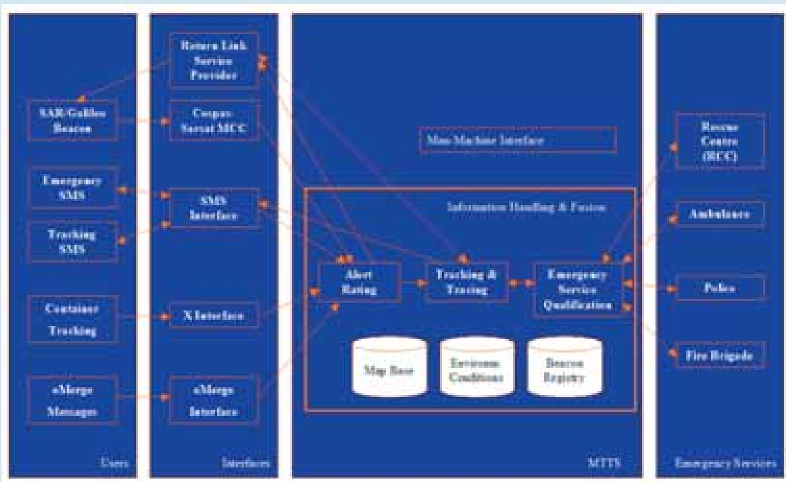
The MTTS will also have interfaces to map, environmental and medical data. In order to show the feasibility of the approach described here a proof-of-concept for the maritime user community will be part of the project.

Objectives

The GJU/GSA aims at launching dedicated, sharply focused activities, which consequently should bring new knowledge to Galileo and will aim, among others, at developing services. Therefore the project members have joined forces in order to demonstrate the viability of a new virtual service centre that is able to improve and extend existing SAR/Galileo location-based services (LBS). SAR/Galileo, especially the return link service, is one of the main differentiators of Galileo.

A so-called Multimodal Tracking and Tracing Service centre (MTTS) will be developed and set up to:

- ensure safe navigation to European citizens and to increase the effectiveness of rescue workers;



- operate a commercially viable maritime data collection, and (location-based) distribution and service centre to support safety at sea using the benefits of Galileo.

Description of work

The MTTS centre holds all the vital data of leisure vessels and their respective crews. The centre will also be capable of rating the distress calls, provide a standard interface for other distress systems, augmenting or combining the distress location with environmental data such as wind, waves, currents, sea level and bathymetry on demand for the geographical areas covered. It can also trigger the generation of 'environmental alert return link messages' to war vessels in a certain area for dangerous environmental conditions.

This project will combine new and existing technology and data and in order to:

1 Facilitate the rescue control centre (RCC) in providing SAR information details to the return link service provider (RLSP);

2 Provide a common interface to the RCC for various (new) forms of distress calls like eMerge messages, short message service (SMS) and Mobitex;

3 Rate the incoming distress calls (on a scale of 0 to 100) in order for the rescue services to perform more effectively;

4 Track changes in the distress situation and report them to the rescue services;

5 Automatically handle distress situations based on available information;

6 Engage in communications with people in distress by means of voice support, SMS, etc, allowing for a refinement of the alert rating service;

7 Efficiently coordinate emergency activities by having access to information (such as accessibility of the area where the alert is coming from, environmental conditions, availability of nearest rescue resources) in order to decrease the rescue time;

8 Inform the public on environmental conditions (including MSI data) to increase safety and limit the need for rescue measures.

A new virtual service centre will be designed which, in order to avoid complexity, can be seamlessly integrated with existing centres, and perform a proof-of-concept.

Results

MTTS feasibility study

The feasibility study aims to consult SAR authorities in the major European countries besides the Netherlands and Sweden in order to get their view on applications that utilise the Galileo return link service and the effect it has on their respective operations.

MTTS demonstrator for the maritime industry

The Galileo return link service provides capabilities for the dissemination of environmental alerts. Using the results of the feasibility study, the demonstrator constantly monitors the maritime conditions and generates weather alerts when the safety limits are close to being exceeded.

More information

Acronym:	MTTS
Name of proposal:	Multi-modal Tracking and Tracing Service centre
Contract number:	GJU/06/2423-CTR/MTTS
Total cost:	€ 385 235
EU contribution:	€ 269 665
Call:	FP6 2nd Call
Starting date:	23/10/2006
Ending date:	23/10/2007
Duration:	12 months
Type:	SYSTEM INFRASTRUCTURE & EVOLUTION
Website:	http://www.mtts.info
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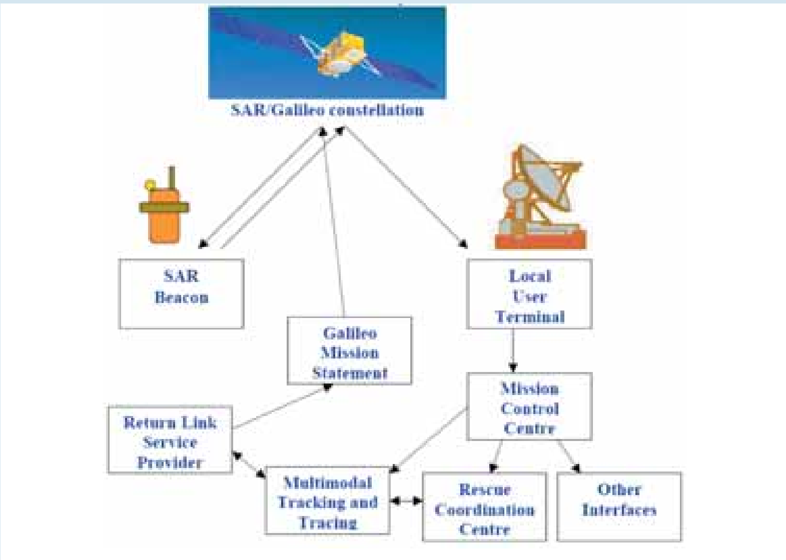
Project Officer:	Eric Guyader
Partners	Pilot Fish SE Ursa Minor NL Argoss NL



NAVELEC

Innovative Application of European GNSS for a better Synchronization of Electrical Power Transport Networks

NAVELEC proposed to assess the added value to be brought by the European GNSS solutions in the context of electrical power system operation and control, both from a technological and an economic standpoint.

Background

The opening up of the European electricity grid has led to increased exchanges of power which is good from a market point of view. In addition, the growth of renewable energy sources (solar power plants, wind farms) are introducing many uncertainties in the grid operations. These two elements have, however, also led to an increased risk of blackouts.

Recent, large-scale blackouts such as those which happened in 2003, could have been avoided or mitigated by appropriate coordination of Time Synchronized Operations of different control areas of electrical power transmission networks.

NAVELEC set out to assess the feasibility of implementing a real-time GALILEO based information infrastructure which would give high quality and synchronised time-stamped information to the different control areas of a continental wide electrical grid.

Objectives

NAVELEC aimed to enable Intelligent Wide Area Monitoring (iWAMS) and Wide Area Control Systems (WACS)in order to reliably synchronise measurements and to assist the operation of national grids through the provision of real-time indicators on the health of the continental power system. It set out to evaluate the performance of GALILEO with regard to user requirements and to simulate a number of typical scenarios to demonstrate the added value of GNSS.

Description of work

The NAVELEC consotrium conducted an overall assessment of the current state of play with regard to grid performance, monitoring and contral, including an experience return analysis of current GNSS applications and a functional analysis of European end user needs.

They assessed the various strategies for the upgrading of current power systems with regard to new measurement devices such as PMUs or digital fault recorders and the required telecoms infrstructure investments.

They also carried out a competitive analysis of the advantages of GALILEO and a cost/benefit assessment; and established a road map for future deployment and technology transfer.

Results

The project resulted in a comprehensive overview of the requirements of power system operators and a detailed description of the key advantages of GALILEO with regard to these requirements. Appropriate software was developed for scenario modeling aimed at assessing the impact of using GALILEO on a wide-area electrical network. This provided an initial demonstration of how GALILEO-related advanced technology will offer a significant enhancement in the area of electrical power transmission systems.

More information

Acronym:	NAVELEC
Name of proposal:	Innovative Application of European GNSS for a better Synchronization of Electrical Power Transport Networks
Contract number:	GJU/06/2423/CTR/NAVELEC
Total cost:	€ 417 080
EU contribution:	€ 291 956
Call:	FP6 2nd Call
Starting date:	01.03.2006
Ending date:	31.10.2007
Duration:	15 months
Type of Project:	APPLICATION
Website:	http://www.pepite.be/users/navelec/
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Partners	Uni Liege	BE
	M3Systems	FR
	Deling Doo	BA

PACIFIC

PRS Application Concept Involving Future Interested Customers

The main objective of the PACIFIC project is to pave the way for the introduction of governmental applications of Galileo (PRS service) into User Communities, by precisely identifying the needs of the PRS user communities in order to draw up plans and recommendations for an efficient development of the PRS technologies and for a smooth introduction of the PRS in these communities. Note that this exercise may help the definition of the operational needs to be defined by the Member States but is not intended to replace these national assessments.

Background

This study has been launched by the GJU (Galileo Joint Undertaking) in order to clarify the PRS market, the needs and potential requirements of future PRS users and the organisational and technical impact at user segment level.

Objectives

- identification of all potential prs user communities
- interaction with these user communities to better define their needs and expectations
- drafting of a development plan for the main prs user segment technologies

Description of work

PACIFIC directly involves some 20 companies from 14 European countries, and gathers a unique set of expertise across the PRS value chain, including equipment manufacturers, system integrators, secure system operators & secure service providers.

The project is coordinated by EADS through Astrium Services. The contractors also include Thales, FDC, LogicaCMG and TNO.

The extended consortium includes Astrium Satellites, Abertis Telecom, Alcatel Alenia Space, EADS Defence & Security, Eurocopter, Honeywell, Kongsberg, PIAP, Patria, Secunet, Septentrio, Skysoft, Terma, Teletel and Telespazio.

During the PACIFIC Survey, User Communities have contributed to the project by filling questionnaires about their knowledge, technical and operational needs in terms of positioning, navigation and timing (PNT).

Some 250 questionnaires have been collected from various Users Communities across all Europe. The results have been consolidated and carefully analysed in order to select a representative subset of 25 organisations, with the objective to further discuss their requirements and expectations in terms of future PNT technologies and services.

Results

Some of the deliverables are available on the PACIFIC website; others can be requested to the PACIFIC project officer.

More information

Acronym:	PACIFIC
Name of proposal:	PACIFIC proposal ESS- Galileo FP6-2006-2 11 September 2006
Contract number:	GJU/06/8069-CTR/PACIFIC
Total cost:	€ 3 690 286
EU contribution:	€ 1 030 286
Call:	FP6 3rd Call
Starting date:	12/09/2006
Duration:	18 months
Website:	http://www.prs-pacific.eu
Coordinator:	Mr. Alan Kendall, Astrium Services 6, rue Laurent Pichat - 75216 Paris Cedex 16 FR Paris
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	FDC	FR
	LogicaCMG	UK
	TNO	NETH
	Astrium Satellites	DE
	Abertis Telecom	SP
	Thales Alenia Space	IT
	EADS Defence & Security	UK
	EADS Defence & Security	DE
	Eurocopter	FR
	Honeywell	CZ
	Kongsberg	NO
	Malik managemetn zentrum st. gallen	AU
	PIAP	PL
	Patria	FIN
	Secunet	DE
	Skysoft	PT
	Terma	DK
	Teletel	GR
	Telespazio	IT
	Thales Communication	FR

POP-ART

Precise Operation Positioning for Alpine Rescue Teams

The idea of POP-ART is to support the emergency operators more effectively in their rescue activities in mountainous regions through the integration of GPS and EGNOS with currently available communication systems.

Background

Mountain activities, like mountaineering, skiing, mountain biking and hiking, can be regarded as some of the most popular which involve a large number of people. Annually, more than 150 million people in the European Union – sportsmen, nature enthusiasts or simply tourists – are estimated to search for recreation in the mountainous regions of the Alps. This large number of 'users' has dramatically increased the number of times that rescue teams help people who are either injured or in dangerous situations.

Despite the high level of professionalism acquired by the Alpine rescue teams over the years, the effectiveness of the rescue is often limited by the efficiency of the operational management. Also, it has to be remarked, a percentage of the rescue team is made up of volunteers who need to be efficiently guided towards the accident area. A short rescue time and highly trained rescuers are often essential to assure the safety of those being rescued.

For example, during the search of a missing person on a mountain, the area covered has to be efficiently patrolled so as to ensure that it is thoroughly investigated but avoiding multiple patrolling.

Knowledge of the exact positions where team members are can significantly improve the management of the operation.

Objectives

POP-ART aims to develop a system for Precise Operation Positioning for Alpine Rescue Teams (POP-ART). The team is working closely with the Alpine Rescue Association in Piedmont, Italy – the *Soccorso Alpino Regionale Piemontese* (SARP) – and will provide them with a prototype system which offers integrated communication and positioning services to control and coordinate the rescuers in the field.

The key activities of the project include:

- a consolidation phase: to collect user requirements in close collaboration with the end-users (SARP) and following analysis of these requirements, to prepare the system and service requirements for the POP-ART prototype.
- implementation phase: to realise the prototype system which will comprise an integrated VHF/GPS/GPRS terminal, an operation coordination system and a remote data centre, as well as the necessary software development. This phase will also include in-lab and in-field testing by the POP-ART team.
- technology transfer: includes in-field testing with SARP during real or training rescue exercises, as well as dissemination activities to other potential user communities, other companies and the scientific community.

Description of work

Consolidation phase

- Critical review of the project requirement. This activity will be supported by members of the alpine rescue team of the Piedmont region;
- Consolidation of requirements and test platform design;
- Definition of the system/service prototype. This activity aims at defining the basic functionalities of the system architecture – the hardware/software platform can be the baseline for other added-value service and applications that will be studied and designed.

Implementation phase

- Realisation of users' handset prototypes;
- Implementation of the user software prototype;
- First test of the user handset;
- Implementation of the software for the CPU to be able to integrate user measurements with EGNOS corrections;
- Implementation of the software to be able to represent user tracks and to compute waypoints;
- First test of the SAR MCC;
- Implementation of the software for the test service;
- First test of the test service;
- Overall system integration and optimisation;
- On-site trial.

Technology Transfer Phase

- Identification of the group of users which can benefit from using the POP-ART technology;
- Identification of possible markets where the POP-ART system can be introduced;
- Action plan toward potential companies that can integrate POP-ART within already existing larger emergency management systems;
- Dissemination action plan towards regulatory and administrative entities which can potentially introduce such a system in different emergency management organisations.

More information

Acronym:	POP-ART
Name of proposal:	Precise Operation Positioning for Alpine Rescue Teams
Contract number:	GJU/06/2423/CTR/POP-ART
Total cost:	€ 428 550
EU contribution:	€ 299 985
Call:	FP6 2nd Call
Starting date:	21/03/2006
Ending date:	31/05/2007
Duration:	15 months
Type:	APPLICATION
Website:	http://www.popart-project.com
Coordinator:	Mrs Alessia Donadio, Sistematica via Sandro Pertini 17 IT 12030 Manta
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Project Officer:	Eric Guyader

Partners		
	Ifen	DE
	ISMB	IT

POSIRIS

Positioning with Impulse Radio Improving Satellite

The POSIRIS concept is based on an innovative combination of GNSS signals and a new technology known to be adaptable to indoor environments – the Impulse Radio Ultra Wideband (IR-UWB) technology. Indeed, IR-UWB signals are claimed to present adequate propagation properties in an indoor environment, offer good wall-penetration capacity and allow multipath discrimination.

Background

The dramatic impact of environments like urban canyons and indoor areas on GNSS signal reception have led to the development of innovative concepts in order to overcome the imitations of navigation satellite systems. Satellite signals suffer from dramatic attenuation and multipath phenomena in indoor environments leading to either degradation or a total loss of the positioning information.

POSIRIS intends to increase the Galileo services into indoor localities through the use of an alternative radiated signal relaying the outdoor level of performance to this restricted environment.

Objectives

GNSS solutions suffer from signal attenuations and lack of visibility in urban or other masking areas, giving unsatisfactory performances. The POSIRIS concept intends to extend the positioning and navigation functions into indoor environments since satellite-based systems are limited to outdoor/light indoor environments. The origin of the concept to be studied during the POSIRIS project was based on Pole Star R&D department identifying complementarities between GNSS and a new technology referred to as UWB.

Using UWB signal characteristics, i.e. fine timing resolution and indoor propagation, a network of relays sends satellite synchronisation signals inside buildings, which allows the user terminal to track and acquire in-view GPS satellites. These signals are also processed by the user terminal to compute the deep indoor position. A first relay prototype will be developed during the project with the aim of completing the first POSIRIS signal studies and UWB channel propagation characterisation.

Description of work

The work was divided into three phases.

Consolidation phase:

The goals of this phase were to complete the specification of the POSIRIS system and to refine the development process and organisation issues in a project plan.

The scope of the project has been specified in order to demonstrate the feasibility of the POSIRIS signal generation with the help of a relay prototype. Work related to the prototype development has been achieved in the phase referred to as the implementation phase.

Implementation phase:

The implementation phase included two types of activities managed in parallel. The first was based on a paper study to perform a trade-off on the potential solutions leading to the identification of a complete system design. The second focused on the activities leading to the development required for the emission of the POSIRIS signal.

Added to the technical part of the project, activities related to business and

marketing were performed. A business plan document has been achieved.

In parallel to this market consideration, a study on the technology transfer gave the opportunity to complete a survey on UWB technology. A review of standardisation and promoting bodies allowed identifying the actors which would be useful for assisting the technology transfer phase of the future POSIRIS product. One of the main issues that came out of this study was the impact of regulation. Since the UWB devices are emitting signals that overlay other systems, the regulation bodies (CEPT in Europe and FCC in the USA) defined an emission mask to avoid any potential interference. This emission mask is a critical issue for the POSIRIS signal definition.

Technology transfer phase:

Results

One part of the POSIRIS relay prototype has been developed. The relay architecture is divided into two subsystems, the GNSS subsystem and the UWB transmitter.

The GNSS subsystem is composed of two main modules, the typical component of a GNSS receiver and the POSISIR core. The GNSS receiver was selected in order to offer the highest access level of the inner signal processing. The POSIRIS core has been implemented on a FPGA that runs the applications designed for the process of the GNSS inputs data to generate the output POSIRIS logical signal. A UWB transmitter (Tx) has been developed.

The objective of the UWB Tx was to generate a short pulse (3ns) triggered by the input signal supplied by the GNSS subsystem. Once the relay beacon prototype interfaces have been validated, the impact of the antenna and propagation channel will be investigated. A large set of parameters (pulse repetition frequency, phase, burst length, etc.) have been tested. These measurements led to highlighting the needs of the complete indoor channel characterisation following its dramatic impact on signal reception. Indeed, the first link budget analysis shows the need for a good knowledge of UWB signal propagation properties to design a processing gain process at receiver level.

More information

Acronym:	POSIRIS
Name of proposal:	Positioning with Impulse Radio Improving Satellite
Contract number:	GJU/05/2423/CTR/POSIRIS
Total cost:	€ 396 084
EU contribution:	€ 285 299
Call:	FP6 2nd Call
Duration:	19 months
Type:	SUPPORT ACTIVITY
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Project Officer:	Eric Guyader
Partners	Acorde ES Uni Cantabria ES

PROGENY

PROvision of Galileo Expertise, Networking and support for International Initiatives

PROGENY addresses the main aspects of the Galileo development and in particular the creation of a framework to support both innovation and international initiatives. This includes the support to the Galileo R&D activities performed under FP6, the preparation of future R&D activities and the establishment of co-operation with partners originating from non-European countries.

Background

The implementation of a programme like Galileo requires that very different issues are addressed, which includes technical aspects, market aspects, programmatic aspects, etc.

This in turn requires that a large panel of expertise is made available to the organisations that are leading the programme.

In the past, the European Commission has made an extensive use of independent organisations and experts to support the Galileo programme. The Thematic Networks GENESIS and GALILEAN illustrate that perfectly.

Projects such as ProDDAGE can also be considered as precursors in the promotion of EGNOS and Galileo on the international scene, thanks to demonstrations, studies, training and awareness actions.

PROGENY is the natural successor to these projects.

Objectives

The principal objectives of the project are to:

- support FP6 Galileo-related R&D activities;
- prepare the ground for future R&D activities;
- foster international co-operation.

The achievement of the first two objectives is mainly based on the strong involvement of European GNSS experts originating from both public bodies and private companies, and on specific actions oriented towards SMEs, which are recognised as a permanent source of innovation.

The achievement of the third objective is based on a set of activities that all converge towards a stronger co-operation with non-European companies or organisations, with the aim of promoting the European GNSS programme abroad.

Description of work

In line with its first two objectives, PROGENY will carry out the following activities:

- Organisation and performance of technical project reviews. These reviews cover the FP6 research projects funded by the GSA, including those funded under the Call dedicated to SMEs;
- Setting up advisory expert groups upon request. Depending on individual companies' needs, these groups range

from two to ten experts and potentially address any kind of issue (technical, programmatic, etc.);

- Supporting innovation by encouraging SMEs to participate more actively in the Galileo programme. This is achieved mainly through awareness actions aimed towards European SMEs.

The achievement of the third objective (i.e. to foster international co-operation) relies on the following activities:

- Funding of technical studies in co-operation with non-European partners;
- Performance of EGNOS and/or Galileo demonstration in non-European countries;
- Study of the extension of EGNOS to the ACAC region;
- Promotion of the European GNSS programme at events such as conferences, workshops or seminars.

In addition to the activities described above, the project includes tasks related to the study of possible revenue recovery mechanisms for Galileo and the study of the GNSS market in a few regions.

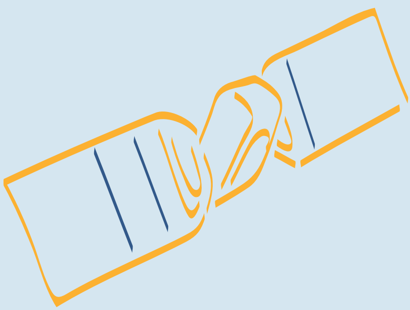
Results

As far as the support to Galileo-related R&D activities is concerned, the following activities have been performed or are still ongoing:

- The technical review activity covering more than 55 projects in total; over 120 reviews have already been performed;
- More than 20 advisory expert groups have been established so far, covering a wide range of issues (geodesy, timing, SAR, future R&D activities, etc.);
- Numerous awareness actions directed towards SMEs have been performed: organisation of a workshop dedicated to SME, organisation of 'face-to-face' meetings, production of a catalogue of European SMEs, dissemination of information through networks of SMEs, interviews of SMEs, etc.

Concerning international co-operation, five technical studies (involving partners from Ukraine, Korea, Canada, etc.) and five demonstrations are foreseen during the project. Several of them have already been launched. The study of the extension to the ACAC region will be completed by June 2008. PROGENY has provided support to the GSA or has acted on behalf of the GSA in order to promote EGNOS and Galileo in many events throughout the world (Brisbane, Sidney, Dubai, Sao José Dos Campos, etc.). A total of 15 events have already been covered by the project.

Moreover, a library of EGNOS and Galileo-related documents is available online at the project website.



More information

Acronym:	PROGENY
Name of proposal:	PROvision of Galileo Expertise, Networking and support for International Initiatives
Contract number:	GJU/05/2422/CTR/PROGENY
Total cost:	€ 4 951 596
EU contribution:	€ 4 951 596
Call:	FP6 2nd Call
Starting date:	08/12/0005
Ending date:	07/12/0008
Duration:	36 months
Type:	SUPPORT ACTIVITY
Website:	http://progeny.galileoprojects.eu
Coordinator:	Mr. Frédéric Collomb, FDC 10 Cours Louis Lumière FR 94300 Vincennes
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Project Officer:	Eric Guyader

Partners		
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	Thales Alenia Space	FR
	ECORYS	NL
	Eurotelematik	DE
	Helios	UK
	NSL	UK
	Polestar	FR
	SPMJ	UK
	Telespazio	IT

ProDDAGE

Programme for the Development and Demonstration of Applications of Galileo and EGNOS

In readiness for the market preparation phase of GNSS, the principle aims of ProDDAGE were:

- establishing the reference set of market and applications data
- demonstrating European capability outside the existing GNSS community
- raising awareness, training and organising promotional activities.

Background

In recent years, European GNSS projects for Galileo and EGNOS have established the technical designs for infrastructure and the business cases for their successful operation.

A number of detailed studies had already been undertaken concerning the general market for GNSS products and services. The requirement for ProDDAGE (Programme for the Development and Demonstration of Applications of Galileo and EGNOS) was to build upon those previous studies, taking maximum benefit from the investment that had already been made in order to produce concrete results. The imminent availability of EGNOS was a practical asset in understanding and developing the more complete market for similar Galileo applications and services.

The requirement for ProDDAGE was to provide access and insight into the available market intelligence to those organisations best placed to undertake either risk mitigation exercises or market testing campaigns and to establish early feedback from the market response to applications and demonstrations.

Objectives

The objectives set for ProDDAGE were to:

1 Deliver accurate, reliable, impartial advice to the GJU on market issues and to ensure that:
   - all potential revenue mechanisms, markets and regions were properly addressed to maximise the potential for commercial funding
   - revenue mechanisms and market forecasts were realistic
   - a proper balance between commercial revenues and public benefits was achieved in order to sustain long-term political support for GALILEO.

2 Ensure that the opportunities for, and the needs of, the whole European downstream industry were addressed, maximising the economic benefits of GALILEO to Europe.

3 Take maximum advantage from the previous investment in EGNOS, helping to bring EGNOS to as wide a user community as possible, and using it to understand and develop markets for GALILEO.

4 Demonstrate, practically and visibly, the advantages of EGNOS and GALILEO to real users with real needs.

5 Raise awareness of the benefits of GALILEO and EGNOS, technically, commercially and politically outside Europe to ensure enthusiastic support and participation in the programme by international partners.

Description of work

A wide range of activities was undertaken in terms of analysis, documentation, event management and demonstrations (Figure 1). One third of the effort was dedicated to demonstrations, a third to market and business analysis activities, and a third to the remaining activities.

The key tasks undertaken within ProDDAGE were:

1 Producing an initial development plan covering the complete range of Galileo applications as a starting point for specific applications and regional analyses.

2 Updating the 2003 GMO (Galileo Market Observatory) market data and model, prioritising aviation, road transport, maritime, personal location-based services and professional GNSS markets.

3 Producing a forecast of the number of receivers and worldwide revenues from GNSS products and services.

4 Organising four demonstrations: in Germany, South Africa and Poland, and an EGNOS flight trial from Dakar to Nairobi.

5 Examining the viability of potential new services for five detailed business cases including:

- benefits of implementing an EGNOS-based SBAS in Africa
- funding options for an inter-regional SBAS for AFI (ISA)
- EGNOS commercial data distribution service;
- EGNOS and maritime IALA DGPS systems;

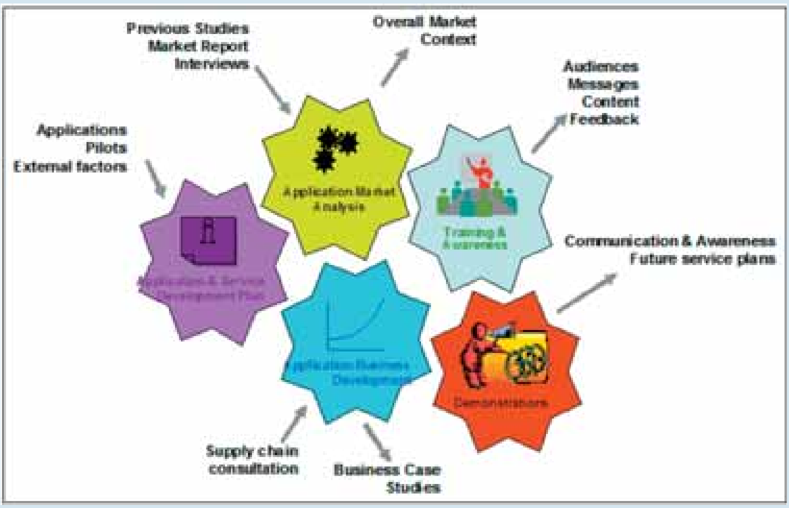
- an EGNOS-based train control system.

6 Organising and participating in 24 events promoting Galileo and/or representing the Galileo Joint Undertaking (GJU).

Results

The main results of the project were:

1 The Application and Service Development Plan (ASDP) document offered the GJU strategic guidance and recommendations for applications, areas



and different geographical regions to improve the markets for EGNOS and Galileo.

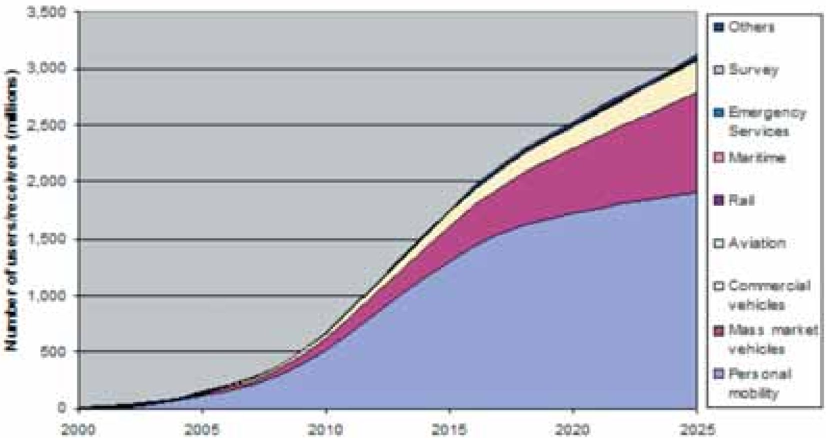
2 Addressable market size, GNSS-penetrated markets and revenues for each application were measured or estimated in each of the 10 global regions to 2025 (Figure 2).

3 The overall GNSS market was forecast to be 3.1 billion receivers in 2025, with 1.9 billion and 1.1 billion from mobile phones and road transport markets respectively. Worldwide revenues from GNSS products and services are estimated to exceed € 450 billion from 3.1 billion users by 2025. These market results remain the current benchmark for the evaluation of market opportunities for the upstream and downstream industry.

4 Successful demonstrations were attended by around 200 attendees outside the 'normal' European navigation community and generated hundreds of news stories on the web.

5 Five detailed business case studies examined the viability of potential new services.

6 The ProDDAGE team organised or participated in 24 events promoting Galileo. An EGNOS brochure was produced to raise awareness of its capabilities ahead of the official launch of the fully operational capability.



More information

Acronym:	ProDDAGE
Name of proposal:	Programme for the Development and Demonstration of Applications of Galileo and EGNOS
Contract number:	1006/CTR/FP6/D
Total cost:	€ 1 695 989
EU contribution:	€ 1 695 989
Call:	FP6 1st Call
Starting date:	10/02/2004
Ending date:	18/05/2006
Duration:	27 months
Type:	SUPPORT ACTIVITY
Website:	http://www.esys.co.uk/proddage
Video:	EGNOS and GPS tracking at the World Rally Championship 2005 http://www.esys.co.uk/wrcdemo/mql3d01.wmv
Coordinator:	Dr Nina Costa, ESYS plc 3 Stirling House Stirling Road, Surrey Research Park UK GU2 7RF Guildford
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Fax:	+44 (0)1483 303 878
Project Officer:	Eric Guyader
Keywords:	GNSS, GNSS applications, GNSS markets, business case studies, EGNOS demonstrations, GNSS revenues

Partners		
	Helios Technologies	UK
	ECORYS	PL
	ESSP	BE
	Nottingham Scientific Ltd	UK
	ERTICO	BE
	Bombadier	DE
	Alcatel Espace	FR
	Thales Geosolutions Ltd	UK
	European Maritime Radionavigation Forum (EMRF)	UK

QGN

Quantification of the potential threat to Galileo from man-made Noise sources

With the development of Galileo, there are new frequency allocations. Although there should not be any intentional interference, electronic devices could unintentionally leak into these frequency bands and therefore some investigation is needed. It is important to assess the interference situation early on before Galileo is fully operational.

Background

The development of the Galileo system will significantly improve the already high level of accuracy, availability, reliability and integrity provided by current satellite navigation systems. However, in urban canyon and indoor locations there is a significant performance loss due to high levels of attenuation, signal masking and multipath. Receiver design for positioning in challenging areas like this is dependent on accurate characterisation of the signal and noise environments. Effects of signal propagation into urban canyons and indoors is relatively well known. However, the noise characteristics are largely unknown in the sensitive Galileo bands, especially the effect on the noise floor, from the increasing number of electronic devices.

Objectives

The key objective of the proposed research is to characterise the man-made noise environment at Galileo L1 and E5 frequencies in urban and indoor locations. As GNSS received signal powers are at a very low level in these locations, minor elevations of the noise floor can be of significance.

Two distinct hardware development projects will be initiated. One will provide a high-end measurement device with a spectrum analyser as the key element. The other project will provide a low-cost instrument that is more suited for parallel deployment.

Description of work

The proposed characterisation of the man-made noise environment at Galileo L1 and E5 frequencies will be based upon a combination of analysis and measurements. The analysis component of this effort will characterise the radio frequency interference (RFI) expected within the Galileo frequency band, with a primary focus on the L1 and a secondary focus on the E5 bands. The identification of potential interference sources will be an important aspect of this work. In order to validate the analysis/predictions, measurement hardware will be constructed to enable actual spectral measurements that can be taken to assess the operational environment of GNSS receivers for various locations. Such knowledge will prove invaluable, as

it will provide the necessary corroborate insight into the expected operational environment and the challenges posed by specific environments. The measurements will be thoroughly analysed to provide a detailed characterisation of the representative environments tested. An assessment will also be made of the impact of such noise conditions on a pre-defined Galileo receiver operating in such locations.

Two distinct hardware development efforts will be initiated in this project. The first will provide a high-end measurement device. The key element in this system will be a spectrum analyser. Such a device will be able to be deployed into an environment of interest, recording spectral measurements over a 24-hour period. The benefit of such an instrument will be the rapid development time (less than four months) to provide measurements into the analytic process. The problem with such an instrument will be the high development cost and bulky size, which will prevent rapid parallel deployment.

In order to improve upon these drawbacks, a second instrument will be developed which will provide a low-cost sensor module that can be deployed widely, essentially capable of establishing an RFI monitoring network. There will be an extended development time for this instrument; however the project schedule will still allow it to provide data for the analytic process, validating its performance as an instrument for low-cost, high-performance RFI monitoring.

Results

This project has made accurate measurements of the noise in a range of environments and this data and its interpretation is detailed in the following reports which are freely available to the public:

- Report presenting the interference characteristics and levels required to disrupt the defined indoor Galileo receiver;
- Report describing the expected man-made noise sources likely to impact

the performance of Galileo receivers indoors;

- Results from SA-based measurement campaign;
- Results from front-end-based measurement campaign;
- Galileo man made noise characterisation report.

Additionally, small, cheap, easily deployable, monitoring equipment resulting from the project is available to users.

More information

Acronym:	QGN
Name of proposal:	Quantification of the potential threat to Galileo from man-made Noise sources. (QGN)
Contract number:	QGN001
Total cost:	€ 304 611
EU contribution:	€ 304 611
Call:	FP6 3rd Call
Starting date:	27/04/2006
Ending date:	31/08/0007
Duration:	16 months
Type:	SYSTEM INFRASTRUCTURE & EVOLUTION
Website:	http://www.engineering.leeds.ac.uk/i3s/research/Sat_Nav_wire/qgn_project.shtml
Coordinator:	Dr Andy Kemp, University of Leeds School of Electronic & Electrical Engineering Woodhouse Lane UK LS2 9JT Leeds
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Project Officer:	Eric Guyader
Keywords:	Man-made noise, interference, quantification of noise threat
Partners	Luleå University of Technology SE

SARHA

Sensor-Augmented EGNOS/Galileo Receiver for Handheld Applications in urban and indoor environments

The purpose SARHA is to combine a modern satellite navigation receiver with augmentation sensors and to develop an optimised hybrid navigation software for the system. While satellite navigation reaches technological limits in urban canyons or indoors, the SARHA system bridges GPS outages with autonomous sensor technology.

Background

In the personal mobility sector in dense urban, indoor and outdoor environments, nearly all of the current applications rely on satellite navigation, sometimes also exploiting regional or local augmentations to improve positioning accuracy.

As applications move into safety-critical and other domains, where service reliability is a major concern, users and service providers are becoming aware of the importance of positioning accuracy, availability and service quality. In pedestrian user environments, like dense urban canyons or indoors, the GNSS (Global Navigation Satellite System) positioning performance reaches well-known technological limits. These limitations can be overcome by adding additional sources of information to the system.

Imagine a fire fighter in a building full of heavy smoke, unable to find his way back outdoors. A positioning and communication unit providing reliable position information and instructions from outside can help to save his life. This scenario or similar ones can be seen as the main motivation for the SARHA project.

Objectives

In the near future, small and portable devices will assemble seamless communication, navigation and geo-information capabilities in a highly integrated hardware. This will be offered at reasonable costs and with high positioning performance.

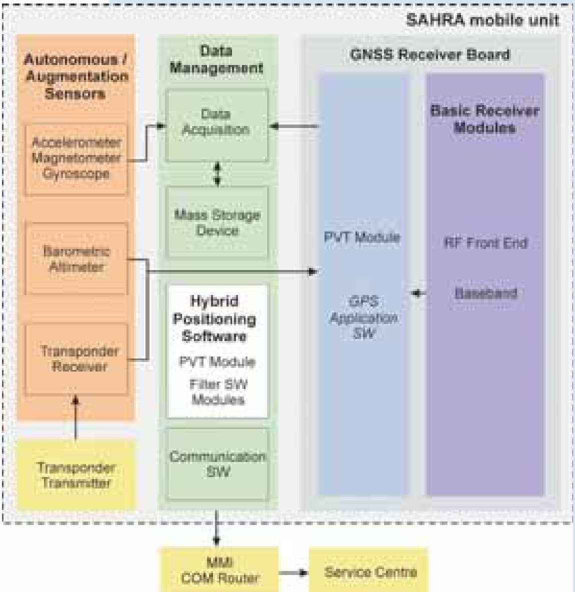
The SARHA positioning device, focusing on safety-of-life operations aims to increase accuracy, availability, reliability and integrity compared to stand-alone GNSS receivers. Therefore a hybrid navigation system architecture has been chosen which will allow indoor and outdoor navigation.

The SARHA system integrates state-of-the-art sensors to provide higher availability and accuracy of positioning solutions, greater robustness, and a miniaturisation and simplification of system complexity at reasonable cost. Furthermore, the interaction between a mobile device and a service centre via communication enhances security and affords additional services.

An accompanying study analyses the benefits of the Galileo system and signals in target handheld applications.

Description of work

The SARHA system architecture follows the concept of integrated pedestrian navigation systems combining GNSS with a dead-reckoning approach, by measuring the walking velocity and the heading. Thus, in case of GPS/EGNOS outages in, for example, urban canyons or indoors, the dead-reckoning component will deliver position information.



To increase positioning accuracy and availability, especially in difficult environments, the SARHA system incorporates, besides a u-blox GNSS receiver, a magnetic compass and gyroscopes for obtaining heading information, and accelerometers for velocity determination based on the principle of step detection and speed modelling. Also the system is enhanced by a transponder system for absolute indoor positioning updates. For 3D positioning, the system contains a barometric altimeter which provides pressure and temperature information. In addition to the different sensor types, the SARHA system contains a single-board computer for the overall data and interface management.

For user interaction and visualisation purposes, the mobile unit provides a man-machine interface (MMI), which can be useful for navigating in cities and buildings or for route guidance. Furthermore, a communication link provides access from the mobile unit to a service centre, which also supports visualisation and communication capabilities. This is especially important for safety-of-life operations (e.g. fire fighters) or search and rescue applications. While the pedestrian navigation unit and the MMI communicate via Bluetooth, the MMI and the service centre are connected via cellular communication networks, such as GPRS or UMTS.

Results

The SARHA system is designed to meet the stringent requirements of fire fighters, rescue services, police, special task forces, solitary and lone workers for handheld applications in environments with unfavourable satellite signals, whilst providing maximum reliability and robustness with a hybrid navigation system architecture.

The hybridisation of complementary sensors allows seamless indoor/outdoor navigation and maximises security, availability and accurate performance

even under severe environments. Furthermore, the interaction with communication enhances security and affords additional services.

Besides the system development, the SARHA project incorporated a technical study analysing the impact of Galileo on the SARHA design for future developments. Influences of Galileo and assisted Galileo on the SARHA system performance and the system design have been further analysed.

More information

Acronym:	SARHA
Name of proposal:	Sensor-Augmented EGNOS/Galileo Receiver for Handheld Applications in urban and indoor environments
Contract number:	GJU/06/2423/CTR/SARHA
Total cost:	€ 412 894
EU contribution:	€ 294 241
Call:	FP6 2nd Call
Starting date:	08/02/2006
Ending date:	30/04/2007
Duration:	15 months
Type:	USER TECHNOLOGY
Website:	http://www.sarha-project.info
Coordinator:	Mr Franz Weimann, TeleConsult Austria GmbH Schwarzbauerweg 3 AT 8043 Graz
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Fax:	+43 (0)316 38 10 15 55
Project Officer:	Eric Guyader
Keywords:	GNSS, GPS, EGNOS, Galileo, pedestrian navigation, autonomous sensors, transponder

Partners	OECON GmbH	DE
	u-blox AG	CH
	Dynatronics AG	CH
	Ecole Polytechnique Fédérale de Lausanne	CH

SCORE

Service of Coordinated Operational emergency and Rescue using EGNOS

In the context of GNSS and E112, SCORE developed an E112 service, which boosts the growth of other LBS using EGNOS and Galileo. It consists of user assistance during emergency calls (automatic location) and support to operations coordination thanks to the supervision and guidance of the teams (civil protection, fire brigades, medical services, etc.).

Background

Europe has been offering global navigation satellite systems since the availability of EGNOS, paving the way for improved location-based services.

In parallel, the emergency handling encounters a new improvement phase. After the establishment of a unique 112 emergency number 15 years ago, the EU asked the telecom operators in 2003 to provide the location of the emergency call. This recommendation should cope with both the growing number of emergency calls (more than several million) that suffered from lack of wrong or inaccurate localisation information as well as multiple calls referring to the same accident or disaster.

As emergency services concern safety of life, the user community requires a very good location performance, not only in terms of location accuracy but also in terms of integrity (i.e. service guarantee) and availability. Such requirements can only be reached with the help of EGNOS and soon Galileo, providing real-time integrity, together with other techniques offering better availability, accuracy and latency. GPS or ground techniques based on GSM-cell triangulation, which are less accurate, and differential GPS, which requires costly ground reference stations and doesn't work properly in indoor and in urban environments, will soon be dispensed with.

Objectives

SCORE aimed to bring the following items to reality:

- an end-to-end solution, with applications dedicated to the selected test case;
- a universal and easily customisable system with hardware and software ready to be widely re-used for other services;
- demonstrating the relevance of LBS services using EGNOS and Galileo when compared with other solutions. (Cell-ID location, GPS, etc.);
- involving the industrial partners, assessing that the service provision value chain is well identified and provides proven benefits for all the actors.

Description of work

The project activities were divided into two phases:

Phase A, during the first six months, covered:

- analysis of user needs, application definition and service differentiators;
- current solutions for the application, analysis of the service provision value-chain;
- preliminary design of the system architecture and its constituent elements;

- definition and preliminary design of the service prototype;
- steps towards the operational introduction of the application in a commercial and/or regulated context.

Phase B, for the remainder of the project time, covered:

- detailed design of the service prototype architecture;
- implementation of the service prototype architecture, including the systems development or procurement, integration and system validation;
- definition of operations for the service prototype and refinement of the exploitation plan;
- operation of the service prototype, trials and test campaign;
- analysis of the results and dissemination.

Results

This competitive research and development project developed a prototype and validated its results during a field trial in Portugal. It has been operated by SNBPC (National Service for Civil Protection and Fire) in both rural and urban environments. The user scenario focuses on the highly accurate localisation of citizens calling from a mobile phone equipped with enhanced A-GPS (i.e. assisted-GPS improved by EGNOS).

The results from the project were:

- an end to end solution, with applications dedicated to the selected test case;
- a universal and easily customisable system, with hardware and software ready to be widely re-used for other services;
- a demonstration of the relevance of LBS services using EGNOS and Galileo when compared with other solutions. (cell-ID location, GPS, etc.);
- involving the industrial partners, and assessing that the service provision value chain is well identified with proven benefits for all actors;
- disseminating E112 accurate solutions using EA-GPS are technically feasible and as a consequence must be implemented as soon as possible by telecom operators and be used by PSAP (Public Safety Answering Points) according to European directives.

More information

Acronym:	SCORE
Name of proposal:	Service of Coordinated Operational emergency and Rescue using EGNOS
Contract number:	GJU/03/118/Issue2/OM/ms -- 8332401
Total cost:	€ 2 114 220
EU contribution:	€ 1 161 152
Call:	FP6 1st Call
Starting date:	18/02/2004
Ending date:	04/04/2006
Duration:	25 months
Website:	http://www.score112.org
Coordinator:	Mr Simon Accarier, Thales Alenia Space 26 avenue J.-F. Champollion B.P. 33787 FR 31037 Toulouse Cedex 1
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Tel:	+33 (0)5 34 35 43 69
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Project Officer:	Stefano Scarda
Keywords:	E112, civil protection, telecom, EA-GPS, LBS, rescue team coordination, GNSS, Galileo, EGNOS

Partners

EDISOFT – Empresa de Serviços e Desenvolvimento de Software	PT
VARS BRNO a.s.	CZ
ICE	CZ
KLPD - Netherlands's National Police Agency	NL
SNBPC - Portuguese National Service for Fire and Civil Protection	PT
HiTEC - Vereinigung High Tech Marketing	AT
Grupo Technologico e Industrial GMV S.A.	ES
STM - STMicroelectronics s.r.l.	IT

SOPHA

Software Receiver with Enhanced Integrity Concept on PDA for Safety Critical Hand-held Applications

The central objective of SOHPA was to develop a GNSS software receiver, including WLAN positioning technology, to be integrated within a mobile hand-held device. The positioning element was extended using an innovative integrity concept. The system was designed to meet requirements for personal mobility applications in special niche market domains and for operation in difficult terrains such as mountains, industrial zones, high-rise urban areas and inside buildings.

Background

GALILEO/EGNOS opens up new possibilities for personal mobility applications in special niche market domains. The SOPHA project aimed to develop a state-of-the-art hand-held mobile positioning device integrating the new capabilities offered. Hybrid GPS/Galileo receivers will be of great interest to users, as GPS combined with Galileo will greatly increase the availability of satellite navigation services in weak signal environments (rivers, canyons), and increases the integrity of positioning information.

Objectives

The objective of SOPHA was to integrate an innovative GNSS software receiver on a modern lightweight PC platform (PDA) and to demonstrate the capabilities of the new device for personal mobility applications in difficult environments such as urban canyons, mountainous regions, and indoors. The project was driven by a perceived application-driven need for improved handheld positioning devices.

Description of work

The technical approach of the SOPHA project was based on state-of-the-art and innovative emerging technologies from European SME companies which were adapted, upgraded and modified to satisfy the user requirements for new Galileo technologies and future navigation needs for personal mobility. Augmentation sensors (EGNOS) were used to improve the integrity and accuracy of the navigation solution. A feasibility study on WLAN positioning technology was also carried out.

Results

SOPHA successfully developed a functional receiver prototype on PDA/Portable PC, including PVT and integrity computation, as well as a communication module for data transmission to a Service Center. The device was tested in Evry, France in 2006. It has successfully demonstrated its capabilities for personal mobility applications in unfavorable environments. Potential markets are expected, for example, in mountain rescue applications, safety and rescue forces (fire brigade, police); and private security companies. Functional results included: integration of GPS and EGNOS for positioning; WLAN position updates (indoor environment); data provision to third party application software.

More information

Acronym:	SOPHA
Name of proposal:	Software Receiver with Enhanced Integrity Concept on PDA for Safety Critical Hand-held Applications
Contract number:	GJU/05/2423/CTR/SOPHA
Total cost:	€ 415 818
EU contribution:	€ 296 072
Call:	FP6 2nd Call
Starting date:	07.10.2005
Ending date:	30.11.2006
Duration:	14 months
Type:	USER TECHNOLOGY
Website:	http://www.sopha.info
Coordinator Title:	Mr Per-Ludvig Normark, Cambridge Silicon Radio (CSR) (formerly NordNav Technologies AB) Stadsgarden 10, 116 45 – Stockholm
E-mail:	perludvig.normark@csr.com
Tel:	+46 8 39 0000
Fax:	+46 8 412 4740
EC Officer:	Eric Guyader

Partners		
	Teleconsult Austria GmbH	AT
	OECON GmbH	DE
	INT	FR

SPESSS

SPecial Event Support by Satellite System

SPESSS develops innovative applications and services based on EGNOS in the 'special events' management domain, with a special focus on security, safety and emergency management.

Background

A 'special event' means an event in which a well defined, large area becomes for a few days the focal point for a very important performance (e.g. sporting event, meeting, concert, etc.) during which thousands of people are concentrated in one place.

In big cities or in densely populated areas the concentration of further thousands of people for a few days means a stress on all the infrastructure and services supporting the everyday mobility, security, emergency services, etc. Moreover the management of the visitors requires ad-hoc solutions that, in some cases, go against the direct needs and interests of the residents who perceive the visitors as invaders.

A seamless interaction with existing systems installed at the different corporations and organisations is one of the key points that can enhance the quality of the services provided and decrease the impact of the event on the hosting community.

The convergence between wireless communications means, mobile distributed systems and precise satellite positioning systems allows the delivery of innovative solutions that give an answer to this emerging need. SPESSS develops innovative applications and services based on EGNOS in the special events management domain, with special focus on the security, safety and emergency management.

Objectives

The main technical objectives of the project are:

- the design and integration of the components necessary for a mobile user terminal to provide an EGNOS-based navigation and positioning service integrated with 2.5/third-generation cellular communications, and a smart and capable interface to reach a high level of usability in the domain of personal security applications;
- the design and development of an IT centralised infrastructure, composed of a security and service control centre capable of managing mobile equipment under critical alerting constraints and serving a dynamic push model management for emergency controls;
- the integration of an artificial intelligence system to enhance the foresight and analytical capabilities;

- the assessment of an EGNOS signal in the area of Turin.

The system supports new applications that enhance the efficiency of the security, safety and emergency management, optimising the reaction time of the staff to recover emergency situations and, working both in push (unsolicited by the user but coherent with its profile location and emergency) and pull (upon request) modes, the capability distribution of geo-referenced, multimedia, personalised and heterogeneous information, which reach the security and emergency staff on their mobile user terminals, taking into account their actual reliable location and their specific 'role'.

Description of work

The SPESSS project is divided into three phases:

- analysis phase: 4 months
- implementation phase: 10 months
- technology transfer phase: from month 11 to month 12: 2 months.

The first two phases, analysis and implementation, have been repeatedly performed during the first ten months of the project. The first iteration was focused on the identification and implementation of the specific requests expressed by TOROC, which fully endorsed the project, to perform the demonstration activity in Turin during the 2006 Winter Olympic Games from 10-24 February. Thanks to this collaboration, the consortium delivered a system which was able to support the management of crucial aspects during the event.

The second iteration began with the results of the demonstration campaign to deliver the design and development of a detailed example of SPESSS system architecture, assessing the inputs obtained during the first stage of the project, together with the system requirements that limit the whole system architecture.

In parallel, the foreseen development of the new components and the refinement and customisation of the existing ones were carried out in order to validate the architecture and to perform the necessary tests.

The implementation of the system was completed with the integration of the new components in the existing framework for the provision of the expected services.

Results

The demonstration during the 2006 Turin Olympic Winter Games validated the developed system.

The developed system relies on an advanced infrastructure, specifically focused on info-mobility services, whose main components are the service control centres and the user terminals, supported by an artificial intelligence module.

List of deliverables:

Project management plan: the managerial processes to be used in the project;

Requirements analysis: the user, system and functional requirements of the SPESSS system;

Preliminary system design: the system developed for the demonstration activities at the 2006 Turin Winter Olympic Games;

Detailed system design: the architecture design for the final SPESSS system, including a detailed description of all the sub-systems;

Technology transfer plan: sets up the guidelines of activities to exploit the results in the market;

Dissemination plan;

Results analysis and recommendations;

Software prototype: details the processes in the development stages;

State of the art: assesses the main technological options available with potential impact;

Analysis phase review report, mid-term report and final review: these reports provide a synthesis of the different results obtained by the consortium in the different areas of work at the three different stages of the project.

More information

Acronym:	SPESSS	
Name of proposal:	SPecial Event Support by Satellite System	
Contract number:	GJU/05/2423/CTR/SPESSS	
Total cost:	€ 405 804	
EU contribution:	€ 284 063	
Call:	FP6 3rd Call	
Starting date:	26/01/2006	
Ending date:	30/03/2007	
Duration:	14 months	
Type:	APPLICATION	
Website:	http://www.spesss-project.com	
Coordinator:	Mr. Luigi Mazzucchelli, Next Ingegneria dei Sistemi S.p.A. Via Noale 345/b IT 00155 Rome	
E-mail:	luigi.mazzucchelli@next.it	
Tel:	+39 06 22 45 41 01	
Project Officer:	Eric Guyader	
Partners	Rigel SA	ES

SWIRLS

Galileo professional receiver development

The SWIRLS project is a complete receiver development programme: starting from user requirements for specific applications generated by experienced client partners, a full capability receiver prototype is designed, implemented and tested in its entirety. Parallel research and development activities in the course of the project investigate new receiver technologies for GPS/Galileo receiver applications in a professional market.

Background

SWIRLS is one of the projects that began under the second call of the Sixth Framework Programme for Galileo Research and Development. It is coordinated by Septentrio and is partially funded by the European GNSS Supervisory Authority. SWIRLS consists of a consortium of nine European partners:

- Coordinator: Septentrio Satellite Navigation (BE)
- Partners: Orban Microwave Technology (BE), GMV (ES), Skysoft (PT), Technische Universiteit Delft (NL), E.ON-Ruhrgas (DE), Allsat (DE), VUGTK (CZ) and Satimo (FR).

Objectives

The objective of SWIRLS is to build the first GPS/Galileo receiver for professional users (RTK, surveying, geodesy, etc.). As a criterion for the most relevant applications, the consortium has selected applications where the receiver performance benefits mostly from an increased number of SV simultaneously in view, which is obtained by combining GPS and Galileo while offering integrity services to ensure a correct operation of the application. Two applications have been targeted by the consortium:

- (permanent) control networks for geodetic/geodynamics/research applications;
- reference stations/rovers for applications such as RTK, DGPS, etc.

The ultimate goal is to realise a prototype receiver for these two applications.

The SWIRLS project has three main objectives:

- investigate and research receiver core technologies relevant to professional users (including antenna technology, interference and multipath mitigation, etc.). The goal is also to identify new techniques or algorithms for the professional receivers (for both targeted applications).
- development of the hardware/software components. Although based on tested technology, it is done in parallel with core technology studies in order to try to implement the findings made in the core technology investigations.
- development of a simulator, test and validation tools.

Description of work

Prototype development

First the user requirements are defined based on end-user experiences and general market knowledge of the partners.

The derived specifications serve as input for the architectural and research activities, after which the prototype is developed. The prototype is then integrated, internally tested and validated. Finally, the market partners subject the receiver prototype to application testing.

The following phases are not part of the project but the next goal is to realise a

commercial product. The prototype will be upgraded with the necessary modifications resulting from the test results, a pre-series will be produced and finally the product will be commercialised.

Results

The expected results are:

- Dual-frequency L1/E5a code/carrier tracking of GPS and Galileo signals;
- Differential GNSS and RTK capabilities;
- EGNOS and WAAS compatible;
- Three serial and one full-speed USB port;
- Available as an OEM board or, for ready-to-use solutions, in a waterproof IP65 rugged enclosure;
- Base station antenna and rover antenna;
- Intuitive GUI for its configuration, logging and remote control.

More information

Acronym:	SWIRLS
Name of proposal:	Galileo professional receiver development
Contract number:	GJU/05/2414/CTR/SWIRLS
Total cost:	€ 4 499 236
EU contribution:	€ 2 392 028
Call:	FP6 2nd Call
Starting date:	22/10/2005
Type:	USER TECHNOLOGY
Website:	http://www.swirls-gju.com/index.htm
Coordinator:	Ir. Alain Suskind, Septentrio Ubicenter, Philipssite 5 BE 3001 Leuven
E-mail:	alain.suskind@septentrio.com
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Project Officer:	Eric Guyader
Keywords:	Dual-frequency receiver

Partners		
	Orban Microwave Technology	BE
	GMV	ES
	Skysoft	PT
	Technische Universiteit Delft	NL
	E.ON-Ruhrgas	DE
	Allsat	DE
	VUGTK	CZ
	Satimo	FR

TGR

Application of Turbo Techniques to GNSS Receivers

TGR will perform an algorithm study on how iterative turbo techniques can be applied in the Galileo receiver design in order to improve its performance, in terms of 'time to first fix' and the positioning precision in a severe multipath environment.

Background

'Turbo' techniques represent a class of digital processing algorithms that involve iterative and collaborative processing between several receiver components that exchange probabilities or likelihood information. In various fields of data transmission (satellite, wireless, etc.), embodiments of this paradigm, such as turbo error correction, turbo equalisation, turbo synchronisation, turbo interference cancellation and turbo multi-user detection, prove to be very powerful in solving various problems such as noise, multipath, interference, code and carrier acquisition, and synchronisation. They have brought outstanding performance gains, often approaching theoretical limits.

The project team has an excellent background in iterative turbo algorithms and implementation in the communications fields (satellite and wireless). One major challenge of the project is to assess the applicability of these advanced techniques to GNSS receivers.

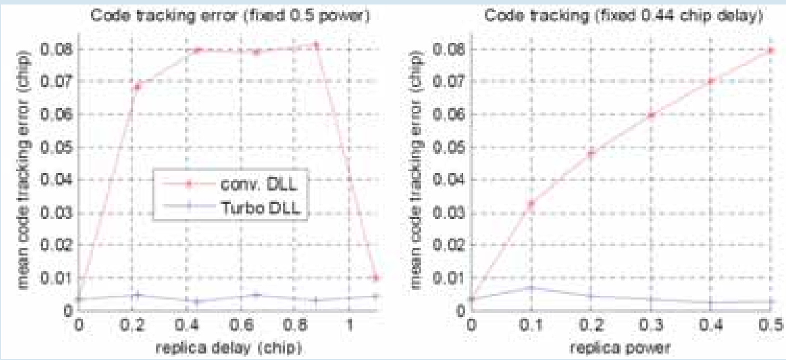
Objectives

The project aims at devising innovative algorithms inspired from the partners' knowledge in turbo techniques to address the issues of 'time to first fix' and the positioning precision in a severe multipath environment. The implementation aspects are also part of the project – in the form of a detailed hardware architectural study – in order to lead to solutions that can be implemented in today's receiver hardware technologies.

Description of work

The TGR project considers the study of advanced signal processing techniques applied to GNSS receivers, particularly those applied to code synchronisation and tracking.

A pre-study phase considered several techniques (both existing and original algorithm proposals have been considered) and selected two of them based



upon their technical and industrial potentialities. The following two techniques were selected for deep algorithm refinement and performance characterisation:

- the turbo DLL receiver, achieving excellent multipath mitigation;
- the coarse self synchronisation (CSS), an original algorithm aiming at rapid code acquisition.

Intensive algorithm investigations and performance assessment have been carried out by the project partners. Receiver models have been developed and integrated in the Granada environment. A large number of simulations has been carried out to optimise both algorithms parameters.

Results

The outcomes of the project are very positive in terms of innovation and performance results.

The turbo DLL receiver has been significantly improved and augmented by an original scheduling algorithm reaching optimal performance without prior channel estimation (see figure 1), and adapts automatically to multipath channel conditions. An advanced receiver architecture has also been proposed.

The coarse self synchronisation technique is an original algorithm proposed by project partners. It aims at fast acquisition of the code, and can be implemented with reduced (low-cost) hardware. The proposed algorithm has been simulated and its principles have been validated in several realistic conditions.

More information

Acronym:	TGR	
Name of proposal:	Application of Turbo Techniques to GNSS Receivers	
Contract number:	2423	
Total cost:	€ 404 198	
EU contribution:	€ 296 490	
Call:	FP6 2nd Call	
Starting date:	21/02/2006	
Ending date:	25/05/2007	
Duration:	14 months	
Type:	USER TECHNOLOGY	
Coordinator:	Mr Jacky Tousch, Turbo Concept 40 rue Joseph Fourier FR 29280 Plouzane	
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Project Officer:	Eric Guyader	
Keywords:	Turbo DLL, code synchronisation, multipath mitigation	
Partners	Universite de Bretagne Sud	FR
	TTTC	HU
	CSEM	CH
	Eclexsys	CH

TWIST

Tourist-Wide Infrastructure supported by Satellite Technology

TWIST aims at satisfying needs related to the fruition of cultural heritage (in cities, museums, archaeological areas, etc.), demonstrating innovative applications and services based on EGNOS and Galileo, which are integrated with other emerging technologies such as mobile computing, web services, intelligent agents, RFId and digital watermarking.

Background

Information and communication technologies have become of great importance for many human activities: one of these is represented by tourism, involving millions of people moving around the world every day. EGNOS, and in the near future GALILEO, represent enabling technologies for the implementation of innovative services and applications related to the concept of 'personal info-mobility' where information and data, regarding the territory and its resources, can be efficiently provided on demand to the tourists, taking into account their current position on the ground and their needs.

The fruition of cultural heritage shows evidence of a growing importance in European society, particularly rich in cultural assets and demanding increasing attention.

The European Commission gives high importance to the subject, promoting actions for improving the understanding and dissemination of the culture and history of European citizens, making cultural heritage increasingly available and accessible.

The innovative idea behind this project is to help the tourist on a cultural visit to get the right information easily, at the right time and in the right place.

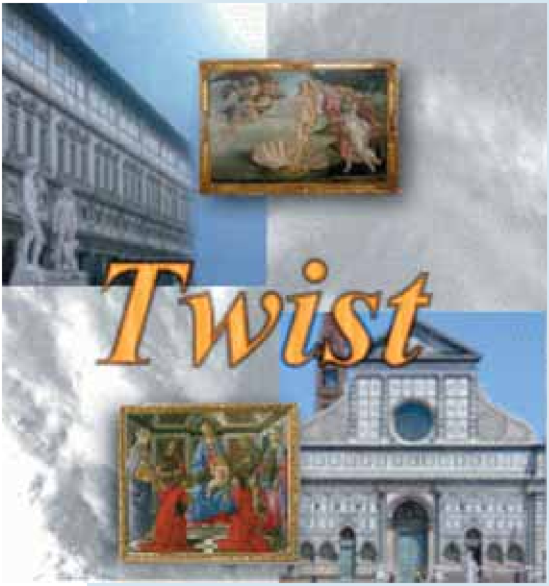
Objectives

The project aims at satisfying needs related to the fruition of cultural heritage in different contexts (indoor and outdoor), both from the point of view of tourists and the owners of cultural assets.

The overall goal was to realise and demonstrate live a proof of concept which validates the exploitation of EGNOS and the other emerging technologies in personal info-mobility applications for cultural tourists, facilitating their transfer into the market.

The most important objectives were:

- to provide the user with information relevant to his/her location in the most reliable way, by means of a proximity function taking efficient advantage of the valuable characteristics of the EGNOS signal;



- to provide the user with information that could be stored locally on a mobile terminal, or remotely on a content provider and provided via the Internet through a web service, thus realising a decoupling between tasks related to data management and data provision, and increasing the amount of information that can be provided on mobile devices connected to the Internet.

As a long-term objective, TWIST intends to facilitate the visit of tourists by providing information on both cultural assets and logistic issues, thus facilitating the user in the deployment of a complete visit to a city, a museum or an archaeological area.

Description of work

The project objectives have been accomplished and demonstrated through the development, integration and demonstration of a system composed of:

- a service control centre: providing messaging functionalities between linked mobile terminals, and providing emergency services for the users;
- a guide: realising the real multimedia guide for the user;
- a web portal: by which the user can register to the service and specify his/her specific preferences;
- a web service: for the provision of information on points of interest via the Internet;
- a specific software solution: providing, via the Internet, images optimised for the visualisation on mobile terminals and representing high definition images of cultural assets.

The system is able to operate transparently both in outdoor and indoor environments, providing the user with a smooth transition between the two, and, in both contexts, providing the user with multimedia information (audio, text, images) related to cultural assets close to the user location, or directly chosen by the user.

Moreover, information on cultural assets and other type of points of interest could be provided via the Internet by a web service, in a transparent way with respect to the user.

Results

The results include the following:

- an overview of the applicative scenario and the reference projects, which shows the end user profile, classifies the user requirements and lists the applicative requirements;
- starting from the assumptions made in relation to user requirements and applicative requirements, a list has been prepared of use cases, logical views of the system, a preliminary architecture design and a deployment view, giving a complete view of the various macro and micro software

components, and of the system in its entire deployment;

- report on the technologies applied in TWIST, on the benefits expected for the tourism market, and on the aspects influencing the transfer of these technologies into the market.
- report on the analysis carried out on the project's results, and compared with the project's and user's expectations, in terms of service provision and performances, highlighting the improvements with respect to current solutions and benefits brought.

More information

Acronym:	TWIST
Name of proposal:	Tourist-Wide Infrastructure supported by Satellite Technology
Contract number:	GJU/05/2423/CTR/TWIST
Total cost:	€ 406 863
EU contribution:	€ 284 804
Call:	FP6 2nd Call
Duration:	18 months
Website:	http://www.twist-project.com
Coordinator:	Mr. Luigi Mazzucchelli, NEXT Ingegneria dei Sistemi SpA Via Andrea Noale, 345/B IT 00155 Rome
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Project Officer:	Eric Guyader
Keywords:	Tourism, guide, PDA, mobile device, tour, cultural heritage, route guidance, point of interest, multimedia information, agent system, XML, GPS, EGNOS, proximity, web service, infomobility
Partners	ISO Software Systeme Gmbh DE CENTRICA Srl IT Università di Firenze DET IT

VASER

Visual Awarness System for Emergency Response

VASER is addressing novel applications in the emergency management sector which can greatly improve the performance of users in the field. Thus, VASER will provide safety and security enhancements for emergency management.

The ultimate objective is to have the proposed applications ready for operational exploitation in parallel with the introduction of the advanced European navigation satellite infrastructures (EGNOS and Galileo).

Background

Satellite navigation has become an emerging positioning source for a wide range of applications, many of which are going much further than the traditional transport sector, i.e. civil protection including emergency management which is addressed here.

Practically all of the current applications rely on GPS signals, sometimes also exploiting regional or local augmentations for better accuracy. As applications also move into safety-critical or other areas where service reliability is of concern, users and service providers alike are becoming aware of the importance of service qualities and, ultimately, guarantees. As a first step, an integrity signal is ready to be provided with the EGNOS service. After the Galileo system deployment, full-scale service guarantees will be possible with Galileo on certain signals.

Along with the performance evaluation, the potential for revenue-generation will be analysed.

Objectives

The main goal of the VASER project is to provide a solution to be used by users in the field of disaster management activities.

The VASER consortium proposes a system that brings together EGNOS/Galileo navigation technologies and the most advanced visualisation technologies to support the tasks performed in a disaster mission control centre. These tasks include the provision of important information to the teams in the field regarding their location, those of surrounding teams, dangers and victims, and support means.

The architecture of VASER serves the location-sensitive information exchange. The architecture relies on the integration of four elements: navigation, communication, GIS and multimedia.

Description of work

The targeted applications are in the area of safety critical personal mobility, like civil protection, police and security, and fire fighting. The feedback from the users was extremely positive and motivated the consortium to continue to invest in the improvement of the prototype and in the direction of commercial solutions based on the project outputs.

A quick assessment of the project activities is compiled below:

- six demonstrations;
- one television presentation;
- more than six appearances in news websites and magazines with global coverage;
- participation in international events (Seville, Torres Vedras, Madrid and Brussels);
- more than 1 000 emails generated;
- project website and promotional material;
- one nomination for an international award – 2007 Telematics Awards for the Best Portable Navigation System.

DigiUtopikA Lda. has been presented with an Innovation and Technology award given by the Portuguese President of the Republic for their involvement and development work in projects like VASER.

Results

Six demonstration campaigns were successfully performed to test the VASER system and to present it to the public.

The VASER mission centre (VMC) software provided a 3D model of four different scenarios. The user communities welcomed the concept of visualisation of the scenario in the service centre. They also agreed to exchange information with the mobile units, but depending on the application, different information will be exchanged. Several enhancements for the VMC software and hardware have been identified.

The position accuracy is satisfactory, although there are a number of effects which should be taken into account during future developments.

The VASER architecture proved to be feasible for security relevant applications. The concept of visualisation in the service centre was followed by the user community with interest and the capabilities of a pedestrian navigation prototype acknowledged.

More information

Acronym:	VASER
Name of proposal:	Visual Awarness System for Emergency Response
Contract number:	GJU/06/2423/CTR/VASER
Total cost:	€ 438 968
EU contribution:	€ 299 866
Call:	FP6 2nd Call
Starting date:	07/03/2006
Ending date:	31/03/2007
Duration:	13 months
Website:	http://www.vaser-project.com
Coordinator:	Mr Pedro Branco, DigiUtopikA Lda. Rua do Moinho, Lote 30 Casal Labrusque, Areia Branca PT 2530-065 Lourinhã
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Project Officer:	Eric Guyader
Keywords:	3D navigation, GIS, civil protection, portable data fusion
Partners	PS Testware BE Servicios de Assistenza ES

VeRT

Vehicular Remote Tolling

The VeRT project examined ways of exploiting the new capabilities offered by the EGNOS and GALILEO to provide enhanced applications in the road sector. In particular, it looked at the development of an extended service concept of road tolling, referred to as 'remote tolling'. The concept covered basic road tolling services, but also additional 'pay-per-use' services both on motorways and in the urban environment (e.g. parking, access to restricted zones). Among other things, VeRT examined the possibilities for harmonisation of national Electronic Fee Collection (EFC) systems.

Background

The road sector is one of the major potential markets for GNSS applications and therefore for EGNOS/GALILEO. GPS satellite navigation systems are now commonly installed in cars, providing advanced services for drivers, such as route guidance, remote assistance, theft protection and fleet management. The availability of EGNOS has extended the possibilities in this area to enable further services, such as: electronic charging, real time traffic information, or emergency calls.

The VeRT project worked on the development of a prototype architecture, including advanced user terminals and a service control centre, to provide specific remote road tolling and pay-per-use services.

In the EU, each country has its own EFC (Electronic Fee Collection) system. The lack of compatibility between these systems can pose serious problems. EGNOS/GALILEO provided the possibility of creating a single European EFC system, which, in addition to eliminating the compatibility problems, would facilitate the introduction of new payment schemes, taking into account the real-time information. VeRT examined the possbilities opened up in this direction.

Objectives

The objective of the VeRT project was to examine ways of exploiting the capabilities offered by EGNOS (in the near term) and GALILEO (in medium long term) to provide new applications for the road sector; specifically, an extended service concept of road tolling - remote tolling - and additional 'pay-per-use' services on motorways, as well as in urban environment (parking and access to restricted zones).

Its aim was to assess the applicability of the GALILEO system to traffic charging systems (motorway tolls and payed parking), vehicle tracking systems (management of commercial fleets, control of access to restricted areas), and satellite navigation systems for private and business users and local public transport.

Description of work

The project was divided into two phases.

The first phase involved the definition of user requirements for the development of services to be provided through the satellite tracking system;

The second phase, involved the identification of pilot projects and the development of the necessary software to implement the projects.

VeRT also studied the possibility of extending the EGNOS/GALILEO technology to LTZ (Limited Traffic Zone) access, 'pay-per-use insurance, and emergency services, creating a multi-functional platform integrated within a single (on-board unit (OBU), and introducing the 'single contract/single invoice' concept.

Results

Two demonstration trials were carried out in the urban area of Torino (Italy) and on the Italian motorways. Results from these were fed into the later GIROADS project, which aimed to establish a reference platform for the development of EGNOS/Galileo applications for the road community as a whole.

More information

Acronym:	VeRT
Name of proposal:	Vehicular Remote Tolling
Total cost:	€ 1 773 326
EU contribution:	€ 886 663
Call:	FP6 1st Call
Starting date:	01.09.2004
Ending date:	31.07.2006
Duration:	22 months
Website:	http://www.vert-project.com
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	Aalborg University	DK
	Renault Trucks	FR
	NEXT Ingegneria dei Sistemi SpA	IT
	Comune di Torino	IT
	BAIN & Company	IT
	Societa Autostrada Ligure Toscana (SALT)	IT
	Parcheggi Italia	IT
	Pagnanielli Risk Solution	UK
	AAT Ltd	UK
	Unitra	IT
	Autosped	IT
	Edisoft	IT
	University of Rome 'Tor Vergata'	IT
	Autostrada dei Fiori	IT
	ASTM TLC	IT
	MTA SZATAKI	HU

WARTK-EGAL

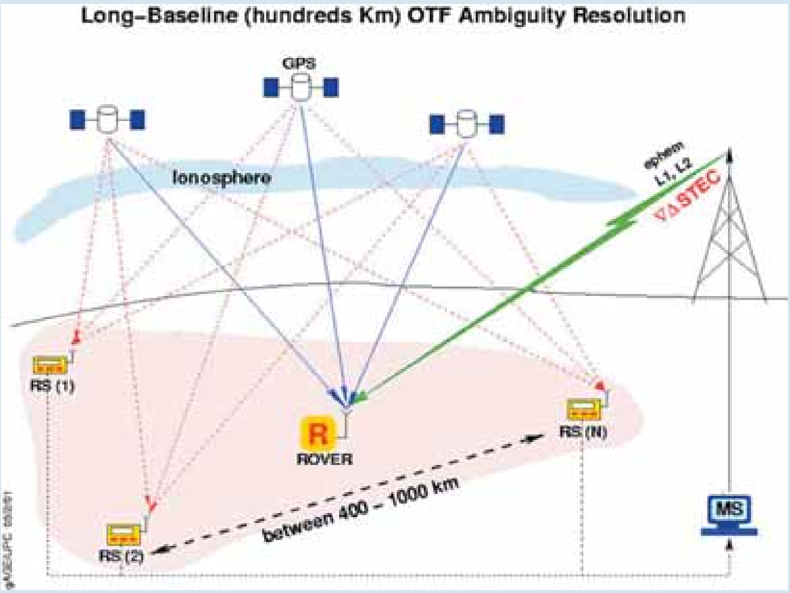
WARTK based on EGNOS and Galileo: technical feasibility study

The WARTK technique has been invented by the Research Group of Astronomy and Geomatics (gAGE) from the Technical University of Catalonia (UPC), in collaboration with GSFC/NASA. In this project, it has been shown that a precise GNSS navigation service (with typical errors below 10 cm) is feasible based on a wide-area network of reference receivers by using the above mentioned WARTK technique.

Background

During the last few years, gAGE/UPC has developed and tested new techniques, which allow the extension of local services based on the real-time carrier phase ambiguity resolution to wide-area scale (i.e. baselines between the rover and reference stations greater than 100 km), for both dual-frequency (GPS) and 3-frequency systems (Galileo and modernised GPS). These are the so-called Wide-Area Real-Time Kinematics (WARTK) technique for dual and 3-frequency systems that are based on an optimal combination of accurate ionospheric and geodetic models in a permanent reference stations network.

The main factor limiting the range extension of the real-time kinematics technique beyond a few tens of kilometres is the differential ionospheric correction between the roving and the nearest reference GNSS station. Such ionospheric correction impedes the real-time ambiguity fixing, and therefore the corresponding accurate navigation at sub-decimetre level. The ionosphere



produces ambiguity biases and correlations whose mitigation becomes the main problem to sort out. Even with the aid of multi-reference-station techniques, due to the baseline limitation (←20 km), several thousands would be required to cover such a service to the whole European region, obviously unaffordable from a logistic and economic point of view.

Objectives

The main goal of the WARTK-EGAL project is to show the capability of using the EGNOS reference station network for supporting wide-area sub-decimetre error level navigation over the EGNOS service area with GPS/Galileo signals. The main techniques supporting this new approach are related to an accurate real-time computation of ionospheric corrections, combined with an optimal processing of GNSS observables (carrier phases in particular) in both 2 and 3-frequency systems. This is the so-called WARTK technique, previously developed by gAGE/UPC and protected by two patents.

Description of work

The main working methods and approaches were:

- analysis of the ionospheric climatology in the EGNOS service area, and its impact on the expected accuracy of the ionospheric corrections and the ambiguity resolution success;
- computation of a set of true reference ionospheric values to evaluate the ionospheric models;
- analysis of tropospheric refraction characteristics for roving receivers;
- use of state-of-the-art methods to mitigate tropospheric propagation delay errors in a wide-area differential positioning service;
- assessment of the impact of tropospheric propagation delay errors (systematic and stochastic), satellite orbit and clock errors on the WARTK user with respect to ambiguity resolution and positioning performance;
- study of the potential use of EGNOS corrections in the frame of the WARTK service.
- design of the WARTK ionospheric model and network architecture;
- solve the communications aspect on the WARTK service, including communications between permanent receivers and also the links with the WARTK users;
- testing the stabilised WARTK algorithm during more than one month of continuous reference and roving GNSS receiver's data stream;
- re-evaluation of the WARTK algorithm for 3-frequency systems in the specific geometry of the EGNOS RIMS;
- study and assessment of applications and markets for a potential WARTK-EGAL service provider.

Results

Considering that WARTK-based applications provide the highest accuracy under the worst environmental conditions and that the required infrastructure is limited, there should be a clear place in the market for these applications. However, present GNSS applications perform quite well with the existing systems. Therefore, the target market should be a market line where the enhancement provided by the WARTK technique is needed, such as sub-decimetre accuracy, orientation and wide-area service coverage. It would be mandatory to have institutional support due to the extended RIMS network involved to perform such techniques. The EGNOS RIMS network would be a feasible possibility and it would diminish the initial investment for the prototype. The time-to-market should be reduced to the minimum since the current GNSS systems, already on the market, could

evolve in the direction of WARTK. The present price of dual-frequency receivers could be a barrier for mass-market uses but hardware developers foresee lowering it in the medium term.

The following markets have been identified as the most suitable for the three different applications that WARTK is able to provide at this stage of development: accurate navigation in deep seas, tsunami detection, instant meteorology, civil construction, precision farming, orientation, cadastral coverage, real-time wide-area mapping and auto-piloting.

More information

Acronym:	WARTK-EGAL
Name of proposal:	WARTK based on EGNOS and Galileo: technical feasibility study
Contract number:	GJU/05/2423/CTR/WARTK-EGAL
Total cost:	€ 421 923
EU contribution:	€ 295 344
Call:	FP6 2nd Call
Starting date:	04/10/2005
Ending date:	03/11/2006
Duration:	12 months
Type:	SUPPORT ACTIVITY
Website:	http://www.gage.es
Coordinator:	Mr. Manuel Hernandez Pajares, Technical University of Catalonia Jordi Girona, 1-3. Mod C3 ES 08034 Barcelona
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Project Officer:	Eric Guyader

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	Pildo Labs	ES
	Ifen	DE
	ICC	ES

European Commission

**European Union 6th Research Framework Programme
2002 — 2006 Project Synopsis**

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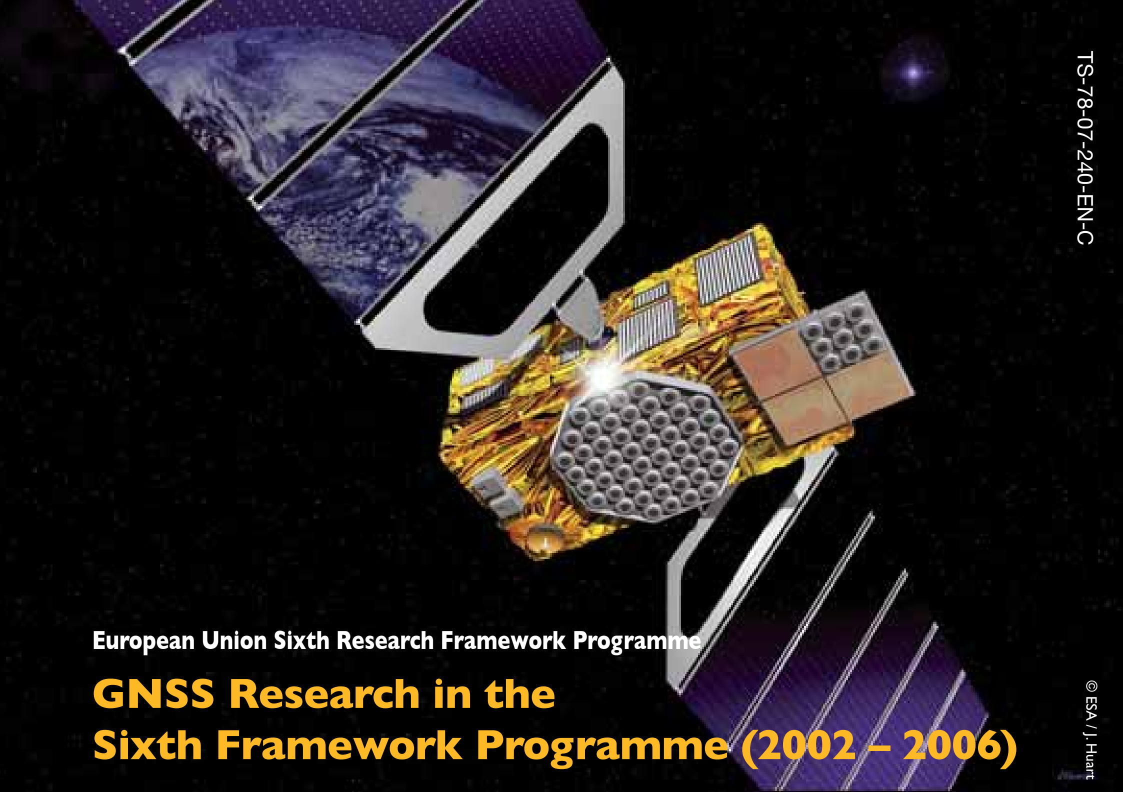

TS-78-07-240-EN-C

European Union Sixth Research Framework Programme

GNSS Research in the Sixth Framework Programme (2002 – 2006)

This Project Synopsis represents Global Navigation Satellite System (GNSS) research projects from the Sixth European Research Framework Programme.

Grouped alphabetically and by project category, the projects are detailed according to their objectives, methodologies and results. Administrative information is also provided, including project participants.

European GNSS Supervisory Authority

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