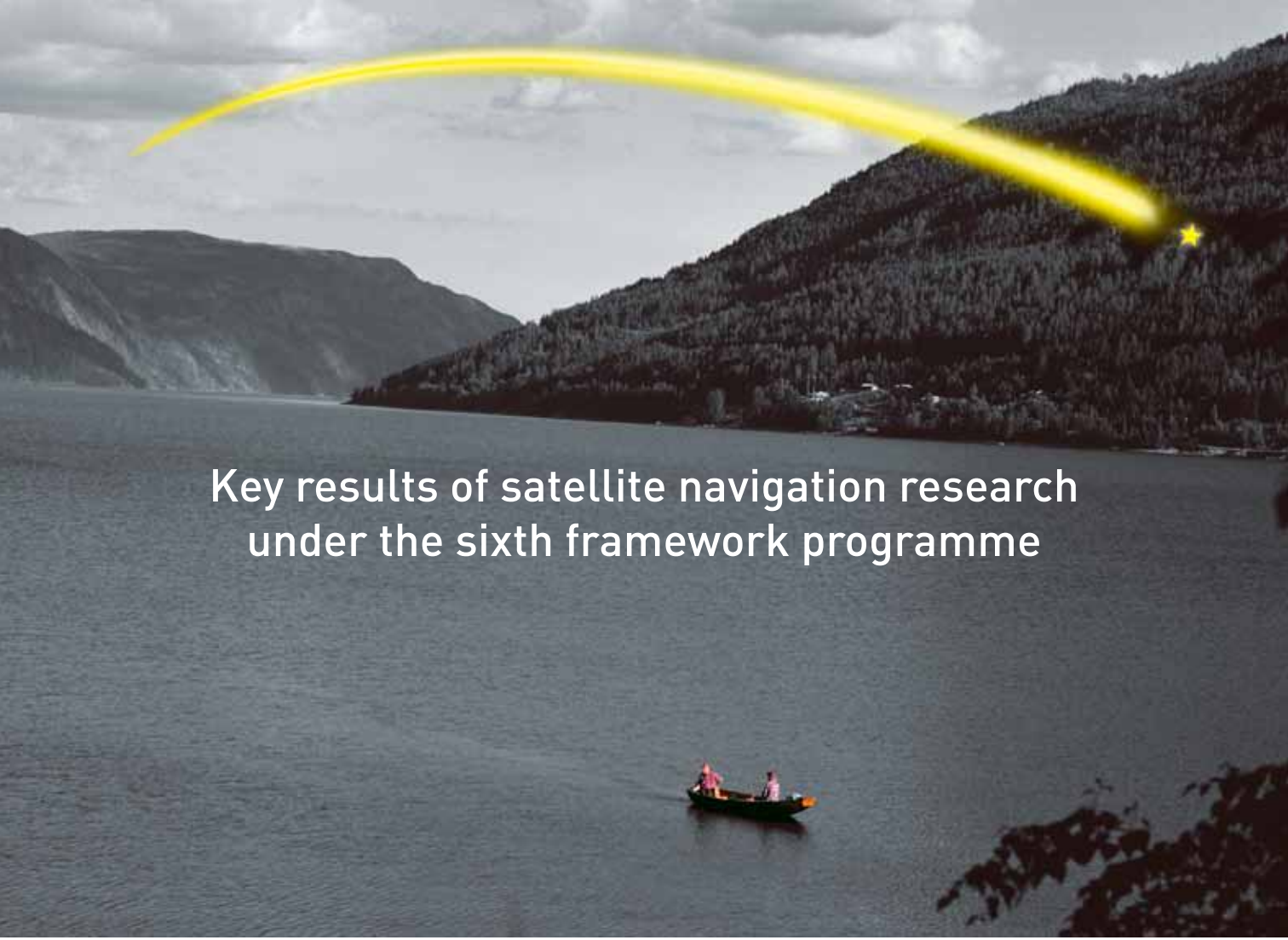


Key results of satellite navigation research under the sixth framework programme

GALILEO

EGNOS

Navigation solutions powered by Europe

FIGURES

Galileo research and development activities under the sixth framework programme for research and technological development (FP6) launched in 2003

There were **three calls**

2003	EUR 18 million	8 projects
2004	EUR 80 million	56 projects
2005	EUR 15 million	5 projects
	Total	69 projects

In the applications field, **20 projects** were financed:

Service prototypes	4 projects
User communities	16 projects

KEY RESULTS OF GNSS RESEARCH IN FP6

HeliCity
Precision helicopter guidance for cities and emergency support, *4*

GIANT
GNSS introduction in the aviation sector, *5*

ALIS
A proposal for the development of an at-sea location information service, *7*

MARUSE
GNSS introduction in the maritime sector, *8*

GIROADS
GNSS introduction in the road sector, *9*

MENTORE
Implementation of GNSS tracking and tracing technologies for EU-regulated domains, *11*

M-TRADE
Multimodal transportation supported by EGNOS, *12*

CUSPIS
Cultural heritage space identification system, *13*

HARMLESS
Humanitarian aid, emergency management and law enforcement support applications, *15*

FieldFact
Introduction and promotion of GNSS in the agricultural sector, *17*

GISAR
Galileo implementation of search and rescue interfaces – and MEOLUT – Medium earth orbit local user terminal, *19*

Aviation

Maritime

Road transport

Multimodal transport

Social activities

Agriculture

Infrastructure

Innovation

The projects revealed an impressive number of innovative ideas for new satellite navigation applications. They paved the way for GNSS (global navigation satellite system) introduction in the aviation, maritime and road sectors, clearly demonstrating the added value that GNSS applications could provide to these sectors by increasing the safety, efficiency and reliability of the activities performed. A clear focus was on applications enabled by the specific features of EGNOS (the European Geostationary Navigation Overlay Service) and Galileo, and which could not be implemented with GPS alone with the same results, due to the higher accuracy and service availability that the European GNSS systems provide.

Two examples of activities in different research domains are described below.

(1) In **road transport**, FP6 projects have studied the advantage of EGNOS and Galileo in road-pricing, and the value of integrity for liability-critical applications. Also a comprehensive service portfolio has been tested for vehicle applications (comprising road charging, parking management, traffic management, insurance services, fleet management, emergency call, as well as other location-based services and route guidance).

(2) Industry developed ideas on **receivers** for different requirements, as well as **tools for simulation and testing**. Several projects achieved substantial progress towards a marketable satellite navigation receiver with full support for Galileo. The first Galileo software receiver ever developed was financed by FP6 with the objective to offer it to the widest community involved in the development of Galileo-related technology. Several patents have been registered.

A Galileo-enabled chipset is now marketed by one of the project participants, and another participant is already offering the second generation of Galileo-enabled receivers. Other projects resulted in advanced concepts that require further development before products are ready for market.

Each project had to find the balance between innovation and market readiness. There is no question about applications for EGNOS, which is currently running, but the delay in the Galileo infrastructure development made the balance more difficult to find, as any technological solution would be obsolete by the time Galileo is operational. Therefore, projects oriented towards Galileo generally aimed at using compatible GPS and Galileo receivers to perform their demonstrations with GPS.

Commercialisation and time to market

Many companies are already exploiting the impressive potential offered by GPS, and the market for satellite navigation is reacting quickly. While industry is slowly picking up space-based augmentation systems (including EGNOS in Europe and the wide area augmentation system (WAAS) in North America), the potential of Galileo will stimulate new developments. The projects conducted with FP6 funds were not aimed at developing directly marketable solutions. Market conditions and product lives are rather different in the various market segments. However, every project has highlighted the potential of Galileo to respective user communities in dissemination activities. To this end, conferences, workshops and demonstrations were organised. There was a large user involvement in the design and presentation of prototypes.

A remarkable success, announced in August 2007, is a contract for the European semiconductor manufacturer STMicro to deliver satellite navigation chipsets to the world market leader GARMIN from the United States. A direct effect of the FP6 R&D funding is that these devices support not only GPS, WAAS and EGNOS, but are also 'Galileo-enabled', a fact well noted in media coverage. This will certainly drive other (non-European) manufacturers to build Galileo capability into their products.

STMicro was part of the GARDA project and the TESEO chipset now in production is assumed to contain elements developed in this framework.

The overall conclusion is that some of the FP6 technology projects have led to the developments of Galileo-enabled products which are on the market today, for both European and international use.

Contribution to international standardisation and market preparation

Many projects have contributed to the standardisation processes, including GIROADS for road transport, GRAIL for rail transport and AGILE for location-based services (LBSs). Some projects also conducted other Galileo and EGNOS market preparation activities such as: certification and accreditation, technology demonstrations, requirements' analysis, definition of a market introduction roadmap and action plan, and consolidation and awareness-raising.

HeliCity

Precision helicopter guidance for cities and emergency support

HeliCity aimed to develop a support system for helicopters using EGNOS (and Galileo in the future) for precise positioning with an adequate level of accuracy, integrity and improved positioning performance in terms of continuity. It was aimed at emergency and rescue operations, under critical conditions and primarily with helicopters.

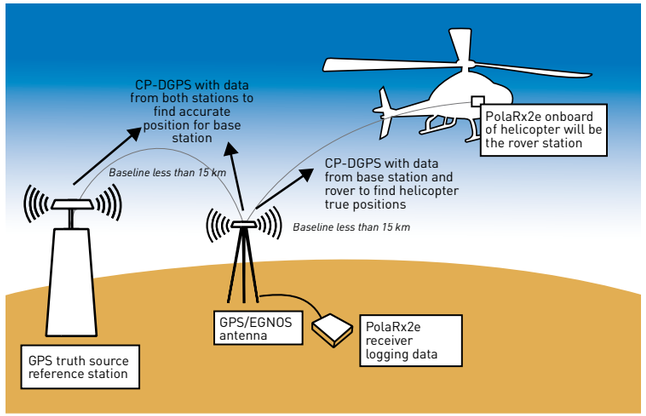
The main success of HeliCity was the demonstration carried out in Lisbon (summer 2006), when a helicopter flew using only EGNOS signals, thus demonstrating the improved positioning system performance, not only in terms of accuracy, but also of safety (integrity of the position) and continuity. The team integrated the HeliCity prototype — a GPS/space-based augmentation systems' (SBAS) receiver together with a cockpit display unit — on a helicopter.

Main achievements

- The HeliCity system was designed to assist helicopter visual flight rules (VFRs) (not instrument flight rules (IFRs)).
- Pilots reported that the HeliCity system was helpful and reliable, without additional workload.
- The level of results are already deemed sufficient to improve the safety level of VFR flights.
- The outcome demonstrates the viability of such positioning solutions for aircraft operators.

Next steps

- Exploitation of further opportunities in both the multi-function display and receiver markets.
- Development of a new product line meeting RTCA-DO-229D standards.
- Development of a certifiable receiver component.
- Commercialisation.



GIANT

GNSS introduction in the aviation sector

The final aim of the GIANT project is to **support the introduction of EGNOS and Galileo services in the aviation market**. The realisation of this project is being coordinated with Eurocontrol (the European Organisation for the Safety of Air Navigation).

GIANT will put the emphasis on the GNSS long-term vision for aviation and the introduction of combined EGNOS/Galileo/GPS services. However, GIANT demonstrated to the airline operators the immediate benefits that can be obtained by implementing GNSS, through two operational scenarios based on EGNOS.

Aircraft: APV approaches (those with vertical guidance) in European airports using Bombardier aircraft (Dash-8 and CRJ200) operated by a regional airline (Air Nostrum)

Rotorcraft: Helicopter IFR approaches to hospitals in Switzerland and North Sea oil rigs

The key added value of these trials is that, for the first time in Europe, the flights will use the actual EGNOS signal as the main navigation tool.

Partners carried out demonstrations in Bologna (Italy) on 27 September 2008 with an Air Nostrum CRJ-200 aircraft.

The flight time was 1 hour 7 minutes, executing five LPV (localiser performance with vertical guidance) approaches, and flight demo included all IAFs (initial approach fix), a missed approach as well as an extended final approach segment with EGNOS vertical guidance.

Outcomes of this trial

- The aircraft guidance was positive.
- Reduced pilot workload.
- The flight path was always extremely close to the expected path including altitude, upon IAFs/IF interception and at turns.
- Increased flexibility in the use of airspace (e.g. multiple options of IAFs in case of adverse weather).
- The flight operations (flight demo) were integrated with the current complex scenario.
- Accurate transition and track-keeping of LPV segment, even better than ILS (instrument landing system).
- Required transition to navigational aids in case of failure (including the chart).
- Required information about EGNOS status.
- Required appropriate layout on radar displays.

A helicopter landed on a hospital platform at another demonstration in Lausanne in June 2007. Simulations of offshore landing on platforms have been successfully performed as well.

ALIS

A proposal for the development of an at-sea location information service

ALIS is an exciting new service concept designed to provide yachtsmen with useful services and important safety information based on their location. ALIS uses the positioning capabilities of GPS and the even more accurate Galileo system to automatically receive information and services relevant to the vessel and where it is at a particular time.

Demonstrations carried out within ALIS have showed the added value of EGNOS and Galileo in port operations (e.g. optimising routes) and inland waterways' navigation. Users and data suppliers responded positively to the fact that Galileo is a European, non-military system, and have also appreciated:

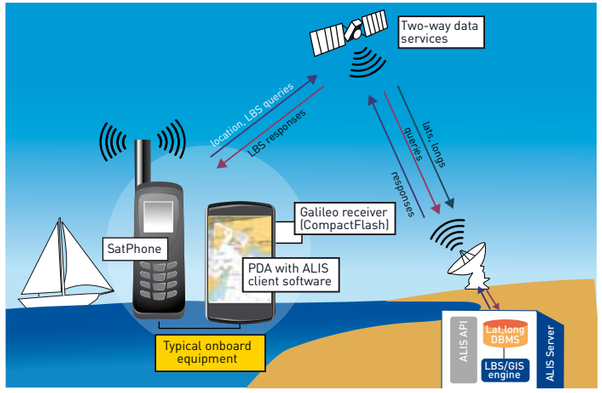
- that having both Galileo and GPS means that users have a back-up in case one system fails;
- that position errors due to satellite problems are less likely;
- the improved accuracy of the free-to-use open service: ~ 4 metres (compared with GPS at ~10 metres).

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 tells a mariner who and what is in their vicinity, be it the nearest marina or a weather warning so they can react accordingly. ALIS uses a range of current GNSS, satcom and terrestrial data communication services and complements other onboard navigation systems.

ALIS will operate in a market where high positional accuracies are not required, meaning that ALIS will function based on Galileo 'open service'. However, there are other synergies between ALIS and Galileo, and ALIS services could make use of Galileo-specific functionality, including the following:

- make search and rescue (SAR) downlink (i.e. distress calls) and uplink (i.e. acknowledgment messages) available to provide a 'complete information picture' to people at sea;
- pass receiver correction data to users' Galileo receivers and pass on Galileo mission status information;
- provide information on Galileo mission status to users;
- pass information on Galileo signal integrity from users' Galileo receivers and make Galileo signal authentication information available;
- develop a Galileo local service: determination of sea height.

This service 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.



MARUSE

GNSS introduction in the maritime sector

MARUSE focuses on future requirements for maritime navigation, expressed formally by the International Maritime Organisation (IMO) and other authorities. It addresses topics like security and safety, integrity, continuity, availability and accuracy where the future Galileo system is a vital part.

The main objective of the MARUSE project was to demonstrate Galileo differentiators and the benefits of using Galileo and EGNOS in maritime and inland waterways' applications. It aimed to:

- focus on future maritime navigation;
- provide a seamless, efficient and harmonised end-to-end service;
- improve navigation performance in terms of accuracy, integrity, continuity and availability.

There were four demonstrations during the project:

1. multimodal port operations;
2. operations in inland waterways (Danube River);
3. coastal and port navigation;
4. high accuracy telemetry.

Conclusion

MARUSE identified a number of EGNOS and Galileo differentiators of importance to the maritime community. Four demonstrations highlighted these to users and provided a good platform for further engagement. The project developed maritime Galileo pseudolites, a Galileo/GNSS receiver prototype capable of tracking a GIOVE-A signal, Galileo pseudolites and an integrated maritime user terminal.

GIROADS

GNSS introduction in the road sector

GIROADS aimed to facilitate the introduction of GNSS (EGNOS and 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 act as a reference for the development of EGNOS/Galileo applications to the road community as a whole.

Field trials

- Electronic fee collection and road charging — Odivelas Toll Plaza, BRISA motorway network.
- Pay-per-use insurance — Rome and neighbouring highways.
- Traffic information generation using floating car data and provision — Madrid.
- Livestock tracking — livestock transport journey, Spain.
- Urban fleet monitoring — ATAC bus route, Rome.

MENTORE

Implementation of GNSS tracking and tracing technologies for EU-regulated domains

The key objective of MENTORE is to demonstrate the added value of EGNOS and Galileo in tracking and tracing applications (T&T), with a long-term view to:

- supporting the application of national and European regulations already in place;
- accelerating the set-up process of regulations;
- triggering the development of a new European regulatory framework that integrates national trends and strategies.

MENTORE implemented five live demonstrations using the EGNOS signal for T&T services for:

- nuclear material transport;
- livestock transport;
- dependent persons;
- multimodal freight transport;
- city logistics.

On completion, MENTORE issued a set of recommendations to the European Union, the Member States and other stakeholders, to promote GNSS development especially through the ITS action plan, the action plan on urban mobility and the GNSS action plan of the European Commission.

Example

Two priority actions shall be implemented in the short term to foster EGNOS/Galileo use in the domain of dangerous goods tracking and tracing:

- evolution of technology and services from prototype to standardised products;
- preparation of a legislative framework including rules for liability data exchange/sharing, operations and procedures.

The role of national authorities is to facilitate and accelerate the regulatory process.

MENTORE also played a key role in the decision of the Italian company ENI to track and trace in real time its fuel transporting vehicles with EGNOS rather than with GPS alone.

M-TRADE

Multimodal transportation supported by EGNOS

M-TRADE's main goal is to explore and promote the capabilities of GNSS (EGNOS/Galileo) in multimodal freight transport markets for applications such as the tracking and tracing of goods, risk management, support to customs and border control.

M-TRADE developed an end-to-end solution that combines EGNOS with short-range transponders (RFID) and GPRS commercial off-the-shelf components, demonstrated it in real-life operations, and evaluated its introduction.

Demonstration cases

PILOT 1 **Bologna Freight Village:** included the use of EGNOS for remote monitoring of locomotives' position and manoeuvres during shunting operations.

PILOT 2 **Rail (Brescia–Verona–Bologna) and road (Bologna–Modena) chain**: demonstrated the use of EGNOS for tracking and tracing and temperature monitoring of a refrigerating container carrying perishable goods.

PILOT 3 **Danube River (Vienna–Budapest round trip)**: demonstrated the use of EGNOS for tracking and tracing of a river vessel loaded with petrol, through three European countries (Austria, Slovakia, Hungary).

PILOT 4 **Rail chain Genoa–Ferrandina–Dordrecht Zeehaven**: demonstrated the use of EGNOS for tracking and tracing of a tank rail wagon loaded with oil products, through four European countries (Italy, Switzerland, Germany, the Netherlands). The demonstration aimed to validate the EGNOS commercial service provisioning architectures and schemes in freight transport application domains, towards operative use in professional and regulated markets. M-TRADE identified business and service models. They demonstrated the benefits of EGNOS and Galileo to improve the efficiency and reliability of the processes, reducing administrative operations and delays at borders, improving also the security in transport operations.

A roadmap supporting the progressive introduction of EGNOS/Galileo in the freight transport community has been defined, including a concrete exploitation plan and an action plan in the short (2010) and medium–long (2015–20) terms.

Next developments will be:

- the consolidation of business models and the service provisioning schemes;
- supporting the definition of standard architectures and regulatory drivers;
- a wider experimentation in other transport markets;
- the introduction of EGNOS- and Galileo-certified products and services.

CUSPIS

Cultural heritage space identification system

CUSPIS aims to use EGNOS and Galileo capabilities to enhance the protection, understanding and dissemination of European culture and history, making heritage more accessible. It is unique within the cultural heritage user community in merging GNSS aspects, authentication capabilities and info-mobility services in a single solution.

Trials of CUSPIS clearly demonstrated the advantages of EGNOS/Galileo in the transport of secure assets in open archaeological areas.

Demonstrations

1.The CUSPIS **cultural asset fruition** (**CAF**) system allows a tourist to organise a cultural tour, to be safely assisted in the tour, to be tracked and monitored in case of emergency and to promote the interest of the relevant assets in an archaeological site. It was successfully demonstrated at Villa Adriana (Rome, 28 November 2006) involving three groups of visits (around 50 people) with three user terminals. Each group had:

- one CUSPIS user terminal with EGNOS BT receiver;
- a guided tour;
- one official expert guide;
- one representative from NEXT (the consortium which developed the project);
- full functionalities at client and server levels, which were demonstrated during visits;
- good visibility of EGNOS the whole day.

2. The CUSPIS solution also allows the secure transportation of cultural assets while they are moved between different locations. It was demonstrated on 31 January 2007 between Villa Adriana and the Quirinale in Rome, allowing a safe and secured tracking of the transported items.

CUSPIS technologies are based on GPS/EGNOS and in future Galileo precise position with integrity, secured communications and a command and

control centre with tracking and tracing, remote commands.

The safe-box developed by the project is equipped with RFID for asset identification and sensor devices.

CUSPIS terminals allow controllers (e.g. police forces) to authenticate assets, containers and trucks.

The CUSPIS web portal allows a secured and certified process to involve all actors (e.g. authorities, insurance companies, museums and exhibitions), to control and manage the authorisation and transportation process.

HARMLESS

Humanitarian aid, emergency management and law enforcement support applications

HARMLESS aimed to promote the use of the applications of the European navigation satellite systems in the areas of 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.

The HARMLESS project encouraged dialogue between two different worlds: the GNSS sector and the user communities of emergency management, humanitarian aid and law enforcement. The project established a platform that can serve as a future reference.

Demonstrations looked at:

- damage assessment for humanitarian aid;
- people tracking, covert surveillance and as legal evidence for law enforcement;
- flood and fire management and resource management for the emergency management community.

The project followed various steps:

- analysis of different missions where GNSS can play a relevant role;
- identification of the use of GNSS applications (in combination with other technologies) for these missions;
- analysis of the added value of EGNOS and Galileo;
- demonstration of some applications in the fields of emergency management, humanitarian aid and law enforcement.

Results

- Better knowledge of the user communities, based on the participation of a wide range of members of these communities.
- In-depth analysis of applications that were identified as the most promising for these user communities, including requirements, architecture, market assessment, cost benefit analysis, standardisation and regulation aspects.
- A demonstration of the benefits of EGNOS and Galileo for some of the most relevant applications for the three user communities:
  - support to damage assessment for humanitarian aid;
  - people tracking, covert surveillance and as legal evidence for law enforcement;

— support for 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.
- 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.

Recommendations for the next generation of Galileo services

- Alert dissemination service (ADS): One of the main needs identified during the project is the use of GNSS systems to ensure the rapid dissemination of alerts, with many benefits for emergency management.
- Emergency coordination communication service (ECCS): The use of GNSS could also allow the dissemination of other information related to disasters or emergency situations, such as identifying evacuation routes. At the moment, the Galileo search and rescue support service does not include this kind of service.

FIELDFACT

Introduction and promotion of GNSS in the agricultural sector

FieldFact aimed at investigating the potential and applications of Galileo for agriculture.

The project approached the agricultural user community by means of demonstrations and business cases to show the benefits of new GNSS technology to farmers and other actors including government, contractors and food processors, in order to improve awareness and use of EGNOS.

Typical agricultural applications of EGNOS:

- parcel area measurement;
- parcel and farm geo-coding and identification;
- livestock and product logistics management;
- soil and crop sampling;
- variable rate application of water, crop protection and fertiliser;
- guided steering;
- animal disease management;
- individual animal tracking.

FieldFact focuses on two different demonstrators:

- an application of mass-market (handheld) receivers to reach the largest part of the user community;
- an application of dedicated receivers integrated with sensors and machine monitoring, which serve a smaller market segment but seem very attractive for farmers.

Precies 2007 – 5 July 2007
Lelystad, Netherlands
National event on precision agriculture, focusing on arable farmers in the Netherlands and stakeholders themselves.

GISAR
Galileo implementation of search and rescue interfaces

MEOLUT
Medium earth orbit local user terminal

Both projects paved the way towards the implementation of the Galileo search and rescue service (SAR).

GISAR developed the ground segment of the SAR service, a part of it being **MEOLUT**, the prototype station in charge of receiving distress alerts, recovering beacon messages and locating people in distress. MEOLUT is able to provide fully autonomous localisation of 'Cospas-Sarsat' distress beacons. Within the Galileo fully operational capacity (FOC) programme, additional MEOLUT stations will be deployed in order to ensure full European coverage of the SAR/Galileo service.

The on-site acceptance of MEOLUT after the installation and testing phase was successfully performed at the end of April 2009.

The MEOLUT prototype

The MEOLUT prototype station developed under the FP6 GISAR contract was installed at the French CNES site in Toulouse. When receiving the search and rescue signals, it detects and localises distress events, then delivers information to the mission control centres (MCCs) in order to activate rescue operations. The European MEOLUT is equipped with monitoring and control equipment aimed at supervising its complete functionality and even allowing for remote operation.

On-site installations

The MEOLUT stations will be able to handle different constellations of SAR satellites (Galileo, DASS, Glonass SAR). The whole system will have worldwide coverage, and will handle not only maritime rescue but also aviation and personal uses (for example, hikers, skiers or climbers). The use of GNSS will improve the accuracy of current systems to a few metres, thus enabling faster rescue.

MEOLUT prototype antenna being installed

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