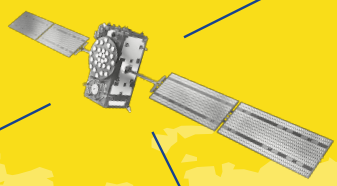
EUSPA
European Union Agency for the Space Programme

Fundamental Elements



The Fundamental Elements catalogue

2014-2020

Developing chipsets, antennas and receivers to close the gaps between Galileo satellites and users

Fiammetta Diani

Head of Market, Downstream and Innovation, EUSPA

Dear Reader,

It is with great enthusiasm that I share with you the first Research & Development catalogue dedicated to Fundamental Elements, an initiative supporting the development of EGNSS-enabled chipsets, antennas and receiver technologies.

For some time now, EUSPA has been working on a series of initiatives to create a stronger, more competitive and united European Space Programme. While striving to strengthen existing European Union space assets and services is an important objective of the European Space Programme, a dedicated team made up of EU professionals is continuously working on writing the future of EU-space applications and products for European citizens and businesses. In recent years, we have witnessed profound changes in the way space business is conceived by European SMEs, start-ups and entrepreneurs. Our mission at the European Union Agency for the Space Programme (EUSPA) is to encourage these important business players to use and transform space data and services into tangible benefits to end users.

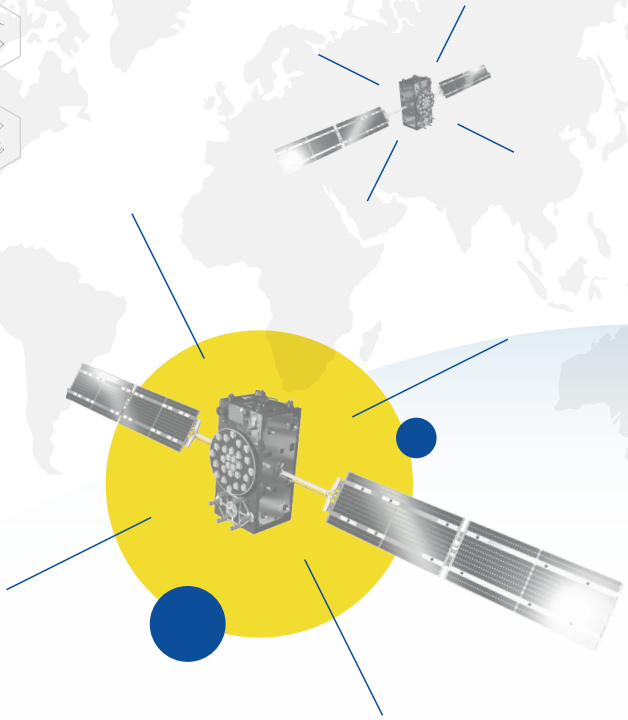
Aiming at closing the gaps between Galileo satellites and users, Fundamental Elements initiative accelerates the integration of Galileo and EGNOS into market-ready devices. Spanning all vertical segments, from Automotive to Aviation, Fundamental Elements initiative plays a pivotal role in increasing the maturity of those foundational technologies that will define the future of EGNSS. This initiative has been key to the development of Galileo as the leading GNSS constellation we know today.

It was enabling many applications that European citizens benefit from every day Fundamental Elements is also playing an essential role in the introduction of Galileo unique differentiators in the market. As EUSPA is working to foster the synergies between satellite navigation (EGNOS & Galileo), Earth Observation (Copernicus) and secure telecommunications (GOVSATCOM), the integration of the other EU Space technologies in end users products is always encouraged.

I am confident that this catalogue will not only showcase the success of the initiative, but will also give you an overview of the opportunities for the space downstream industry. Looking at what the future holds, it is clear that Fundamental Elements will allow end-users from all segments, including Aviation, Rail, Infrastructure, Energy and Space to be part of a more competitive and strong EU space landscape.

Fiammetta Diani
Head of Market, Downstream and Innovation

European Union Agency
for the Space Programme (EUSPA)
Prague, July 2022



The European Global Navigation Satellite System (GNSS) allows users with compatible devices to determine their position, velocity and time by processing signals from satellites. It consists of two elements: Galileo; and the European Geostationary Navigation Overlay Service (EGNOS).

Galileo is the first global satellite navigation and positioning system designed specifically for civilian purposes, which can be used by a variety of public and private actors worldwide. It provides Europe with independence from the other GNSSs but remains interoperable with them, in order to facilitate GNSS combined use and offer better performance.

EGNOS is Europe's regional Satellite-Based Augmentation System (SBAS). It improves the quality of open signals from the US Global Positioning System (GPS) and (soon) Galileo.

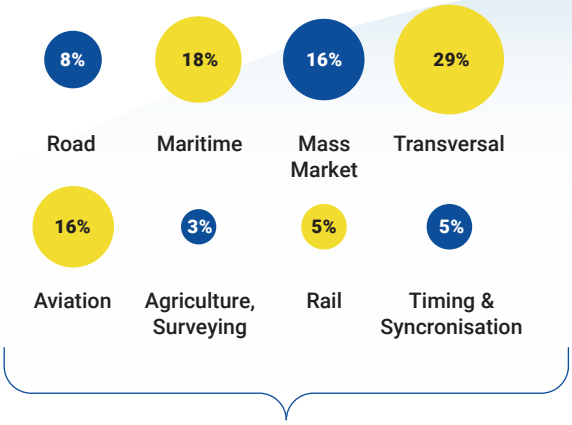
The EU's Fundamental Elements (FE) R&D initiative is supporting the design, development, and production of EGNSS-enabled receivers, chipsets, antennas, and devices. The FE initiative is a part of the overall European GNSS strategy for market uptake, led by EUSPA, which aims to:

1. Boost the adoption of European GNSS and its differentiators
2. Improve EU industry competitiveness
3. Address user needs in priority market segments
4. Maximise benefits to European citizens

The 43 projects covering nine different topics have been funded with an EU contribution of around 70 M€ between 2014 and 2020.

The projects aim to develop market-ready end-products for end-users in all segments, ranging from aviation, automotive and critical infrastructures to agriculture. FE projects are essential in advancing the maturity of the concerned technologies and encourage their pursuit or adoption.

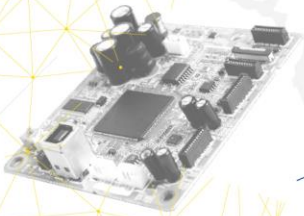
The following R&D catalogue focuses on the 38 research projects funded within the initiative.



38 FE Projects cover 9 topics (2014-2020)

FANTASTIC

Field **A**ware **N**avigation and **T**iming **A**uthentication **S**ensor for **T**iming **I**nfrastructure and **C**entimeter level positioning



Key facts

Full name
Field **A**ware **N**avigation and **T**iming **A**uthentication **S**ensor for **T**iming **I**nfrastructure and **C**entimeter level positioning

Project call number
GSA/GRANT/01/2016

Project call
Development of high-end professional receivers and corresponding antennas

Funding
1 738 744,78 EUR

EU contribution
1 043 246,87 EUR

Topic
Agriculture, Surveying

Market segment
Agriculture

Project start/end
01/03/2017 – 31/08/2019

Galileo differentiators
Galileo OSNMA
Galileo HAS
Multi-frequency (E1 - E5 - E6) GNSS

Context and motivation

Precise Point Positioning (PPP) is the preferred positioning technique in many applications such as precision agriculture, offshore applications, and scientific applications, particularly at remote locations where augmentation signals can be received via satellite link. However, there are **availability limitations for current commercial services,** which are based on geostationary satellites and thus experience visibility problems.
The FANTASTIC project was conceived to substantially broaden the scope of professional GNSS applications, making them work in harsher conditions, where they can't today.

FANTASTIC developed the technology for the **optimal exploitation of the PPP data provided by the Galileo High Accuracy Service.** It shall be a key component in professional positioning and timing applications. Based on an innovative "field aware" antenna technology combined with a multi-frequency receiver, leveraging Galileo-specific features such as the Commercial Service, pilot channels and frequency diversity, FANTASTIC aims to **substantially broaden the scope of professional GNSS applications** and improve current PPP performance.

Targeted GNSS innovation
GNSS/INS, OSNMA, Antenna techs

Targeted Product
GNSS receiver

Scope

Innovations introduced in this project is based on the processing of the **Galileo E6 Commercial Service**, which is expected to improve current PPP performance with its enhanced navigation message. Furthermore, a **new antenna and receiver design** is conceived to maximise the advantages provided by Galileo, enabling the selection of the best signals and the mitigation of interference.

Challenge & technical solution

The biggest challenge was to **address spoofing attacks** based on a perfect, or nearly perfect, signal replica. In fact, in the verification of a spoofing attack, the spoofed satellite signals all have the same polarisation. Hence, the idea was to exploit this property to detect and reject the spoofing signals with the help of a newly developed **dual-polar E1/L2/E5/E6 antenna optimised for polarisation purity**, avoiding antenna-induced spill-over from one polarisation into the other.

Septentrio, BE **Fraunhofer, DE** **GMV Aerospace and Defence, ES**
Istituto Superiore Mario Boella sulle Tecnologie dell'informazione e delle telecomunicazioni, IT **Universitat Autonoma de Barcelona, ES**

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@GNSSfantastic
FANTASTIC project

ESCAPE

European **S**afety-**C**ritical **A**pplications **P**ositioning **E**ngine

Key facts

Full name
European **S**afety-**C**ritical **A**pplications **P**ositioning **E**ngine

Project call number
GSA/GRANT/02/2015

Project call
Development of E-GNSS engine for safety-critical multi-applications in road transportation

Funding
5 452 739,80 EUR

EU contribution
3 271 643,88 EUR

Topic
Road

Market segment
Road

Project start/end
01/10/2016 – 31/12/2019

Galileo differentiators
Multi-frequency GNSS
Galileo high-accuracy through PPP

Context and motivation

With the declaration of Galileo Initial Services in 2016, companies, service providers and developers can now take full advantage of the more precise positioning and better performance that Galileo provides. All one needs is a Galileo-enabled chipset and/or receiver.

In the road transportation sector, the ESCAPE project targeted just that: using Galileo to provide users with better positioning and performance. The project developed **an innovative positioning engine that exploits the newly available capabilities of Galileo.**

The **solution proved critical in the advancement of the connected vehicle and autonomous driving,** both of which require accurate and reliable positioning information for safety-critical applications.

Traditionally positioning information is provided via multiple sources of sensor data, that require the use of expensive radar/Lidar-based sensors and cameras not specifically designed for road transport use. ESCAPE and its solution offer both a cost-effective and safe solution for autonomous vehicles.

Targeted GNSS innovation

PPP, GNSS Fusion/Data

Targeted Product

EGNSS Engine

Scope

The project developed **the first multi-constellation Galileo chipset receiver offering multi-frequency capability adapted to road applications** – and in particular autonomous vehicles. The chipset is integrated in an onboard positioning unit with unique localisation features that are tailored to the needs expressed by the applications of autonomous driving.

Challenge & technical solution

The ESCAPE positioning engine is built on two core innovations:

- The **engine integrates different localisation data sources**, including multi-constellation/ multi-frequency GNSS, intelligent cameras, inertial units, vehicle odometer and advanced navigation maps
- The **integrity level provided measures the trust associated with the real-time location estimates**.

This degree of trust is crucial for its use in safety-critical applications involving high levels of automation.

Advanced Automotive Antennas, ES

Institut francais des sciences et technologies des transports, de l'amenagement et des reseaux, FR

STMicroelectronics, CH

GMV Aerospace and Defence, ES

Renault, FR

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MAREC

MAREC

Key facts

Full name
MAREC

Project call number
GSA/GRANT/03/2017

Project call
Development of SBAS-enabled Shipborne Receivers

Funding
714 285,71 EUR

EU contribution
500 000,00 EUR

Topic
Maritime

Market segment
Maritime

Project start/end
01/03/2018 – 31/12/2020

Context and motivation

The Global Navigation Satellite System (GNSS) has become the primary means of obtaining Position, Navigation, and Timing (PNT) information at sea.
The current existing capabilities of the Global Positioning System (GPS) constellation, although adequate for ocean navigation, have some shortfalls for coastal navigation: some user communities have a need for enhanced performance, and they can benefit from the available "augmentation" techniques, resulting in improved GPS performance.
Nowadays, the users can take advantage of Satellite-Based Augmentation Systems (SBASs). The maritime domain has been using SBAS for several years and it is supported by GNSS receivers used in the recreational and professional sectors.
The SBAS/European Geostationary Navigation Overlay Service (EGNOS) can be used to complement the differential GNSS (DGNSS) for the provision of enhanced accuracy and integrity information with additional benefits.
However, the equipment standards are not yet available for using SBAS for navigation under the International Convention for the Safety of Life at Sea (SOLAS) rules.
In this context, the MAREC project comes into play, with the objective of supporting **SBAS standardisation for the maritime domain.**

Targeted GNSS innovation

SBAS

Targeted Product

SBAS guidelines for SOLAS and non-SOLAS applications and AIS

Scope

The MAREC project contributes to the ongoing work with **SBAS standardisation for SOLAS and non-SOLAS applications both for navigation equipment and for AIS.** Among the achievements of the MAREC project it is worth mentioning the **guidelines for the implementation of SBAS in the maritime domain and** contribution to the work on **test specifications.**
The project also raised awareness of the benefits of using SBAS.

Challenge & technical solution

In the project, the **SBAS functionality was added to existing GPS and DGPS navigation receivers** from Kongsberg Seatex. The **implementation was carried out in compliance with the SBAS guidelines**, foreseeing possible modifications to solve issues arising during implementation.
As a result, three prototype receivers were achieved, i.e.,:

- EGNOS-enabled Shipborne Receiver for navigation in SOLAS vessels
- EGNOS-enabled Shipborne Receiver for navigation in non-SOLAS vessels
- EGNOS-enabled Shipborne (AIS) Automatic Identification System mobile station.

GLAD

GLobal **A**RAIM for **D**ual-Constellation

Key facts

Full name
GLobal **A**RAIM for **D**ual-**C**onstellation

Project call number
GSA/GRANT/01/2017

Project call
Development of an Advanced RAIM Multi-constellation Receiver

Funding
1 194 649,41 EUR

EU contribution
836 254,58 EUR

Topic
Aviation

Market segment
Aviation

Project start/end
01/06/2018 – 30/06/2020

Galileo differentiators
Multi-frequency GNSS

Context and motivation

The **Advanced RAIM** (ARAIM) concept extends the traditional legacy GPS single frequency Receiver Autonomous Integrity Monitoring (RAIM) by **using multiple GNSS constellations that may include signals from** the same satellite transmitting **more than one frequency**. The Galileo constellation, in addition to GPS, provides a Dual Frequency Multi-Constellation (DFMC) system that allows for robustness and redundancy.
In the aviation sector, when DFMC is supported by a Satellite Based Augmentation System (SBAS) and ARAIM, satellite availability is leveraged with accuracy in position and the associated integrity and continuity elevated in terms of radio navigation performance.
Concept wise, each GNSS Constellation Service Provider (CSP) will transmit an Integrity Support Message (ISM) to broadcast integrity information associated with its own system.
The airborne receiver's ARAIM algorithm processes this information to gain sufficient confidence in the information provided by the specific GNSS constellation in order to meet required safety criteria in terms of lateral and vertical guidance, thereby addressing the requirement for all phases of flight up to Category I (CAT I) precision approach capability/localiser performance with vertical guidance (LPV) 200 approach globally in the future.

Targeted GNSS innovation

ARAIM

Targeted Product

Advanced RAIM , Multi-constellation receiver

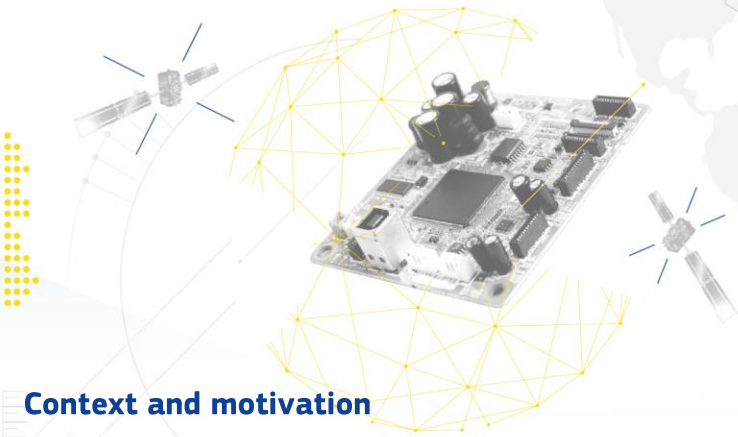
Scope

The GLAD project aims to foster the development of the ARAIM concept by **prototyping the algorithm within critical components of the Collins' GLU-2100 Multi-Mode Receiver (MMR)**, followed by testing and assessing the performance of the algorithm. In addition, the project focuses on concepts of operations (CONOPS) using ARAIM and collaborated with Air Navigation Service Providers (ANSPs) to engage and understand the requirements for airport operations. Standardisation activities within GNSS working groups are also within the scope.

Challenge & technical solution

During the GLAD project timeframe, the team **successfully** conducted ground experiments **demonstrating real-time horizontal and vertical ARAIM performance**, with a horizontal precision of 0.3 NM and vertical precision supporting LPV-200.
This paved the way for future benefits which include significant contributions to **improvements in position integrity**, and to underpinning the economic (e.g., fuel and time), environmental (e.g., CO2), and safety aspects required by the aviation industry.

Rockwell Collins, UK
Airbus Operations, DE
GMV Aerospace and Defence, ES
NATS, DE
Pildo Consulting, ES



H-GEAR

High **p**erformance
Galileo **E**mergency **A**nti-theft and **R**escue

Context and motivation

In recent years, more and more drivers have switched to two-wheelers.
Congested cities, fuel efficiency, lower environmental impact or simply the sense of freedom while riding are some of the reasons why motorcycles are gaining ground as a favourite means of transport. The double-digit spike in motorbike sales in 2020, notwithstanding the crisis in automotive, clearly underlines this preference.
Seeing this shift in transportation patterns and with motorcycles thefts soaring, the "High performance Galileo Emergency Anti-theft and Rescue" (H-Gear) project was conceived.
The project developed a **twofold solution to provide safety and security to motorcycle drivers by relying on EU Space technology**, in particular that of Galileo.
The delivered H-GEAR project output is a motorbike that integrates antitheft and eCall system and introduces in the mass market a unique proposition for the reliability of accuracy in positioning, service continuity, time for acquisition, and data transmission.

Targeted GNSS innovation

GNSS fusion and data integration, OSNMA, PPP

Targeted Product

GNSS receiver, Mobile application

Scope

The H-Gear project targets the development of an **eCall and anti-theft system based on Galileo for small and medium motorcycles**. In case the vehicle is moved, an alert message is sent to the owner of the vehicle via a dedicated mobile application. It is then up to the user to decide whether to call the authorities and intervene. The Galileo based chipset in the device allows users and the authorities to track down the vehicle but also to authenticate the location and identify spoofing attempts, thanks to the unique Galileo Authentication Service (OSNMA). The mobile app offers several features such as parking locator, for forgetful riders, and acts as a dashboard storing information on the vehicle, travel information, and battery status.

Challenge & technical solution

Among the faced challenges, some of the key ones are the **integration of an anti-theft and e-call Galileo based system** into a small/medium-size scooter manageable by the user through a mobile application, battery duration, and the antenna performance in a stressed environment, due to the vibrations and potential accidents. As a result, the system comprises:

- **a fully integrated device**, built into the frame or wiring of the motorcycle
- a software suite for the **monitoring and control of the eCall and anti-theft services**
- a **user mobile application** for the interaction with the end user.

Key facts

Full name
High performance **G**alileo **E**mergency **A**nti-theft and **R**escue

Project call numer
GSA/GRANT/08/2017

Project call
Development of GNSS receiver technologies for Premium and General mass market

Funding
1 117 511,21 EUR

EU contribution
745 000 EUR

Topic
Mass Market

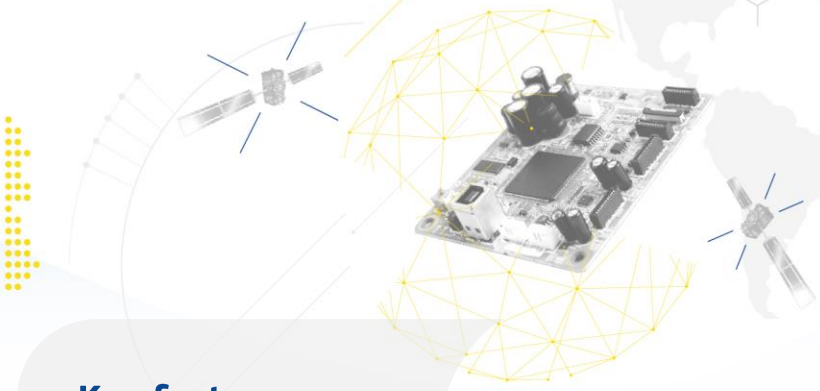
Market segment
Road

Project start/end
01/11/2019 – 31/08/2021

Galileo differentiators
Galileo OSNMA

Vetrociset (Now Telespazio BE) , BE
Antenna Provider Finland Ltd, FI
Honda Italia, IT
SpaceEXE, IT

www.h-gear.eu



AMETRINE

AMETRINE

Key facts

Full name
AMETRINE

Project call number
GSA/GRANT/02/2017

Project call
Development of MEOSAR Beacons (MEOSAR)

Funding
806 834,70 EUR

EU contribution
564 784,29 EUR

Topic
Maritime

Market segment
Maritime, Emergency Response

Project start/end
01/03/2018 - 31/07/2023

Galileo differentiators
Galileo RLS

Context and motivation

Cospas-Sarsat (C/S) is an international satellite communication system that detects and locates activated emergency beacons and transmits distress alerts to Search and Rescue (SAR) authorities.
The role of Global Navigation Satellite Systems (GNSS) in providing precise positioning information will become increasingly central, with **continuous technological improvements and increasing penetration of multi-constellation capabilities in SAR beacons**.

Galileo is providing a SAR Service that, since its beginning of operations in 2020, has contributed to saving an average of five lives per day, with greater benefits provided by the Return Link Service (RLS).
In this context, to foster the uptake of this brand-new Galileo SAR service, the **AMETRINE** project was conceived with the aim to develop an **ultra-compact SAR RLS beacon ready for market**, unleashing the benefits of Galileo RLS in life-saving equipment.

Targeted GNSS innovation

GNSS RLS

Targeted Product

Galileo based MEOSAR Location Protocol beacon

Scope

The AMETRINE project concerns the design, prototyping, and certification of an ultra-compact SAR RLS **first Generation Beacon aimed at the deepest market penetration and dissemination to a large market.**
A key point of this project is the development of an enclosure for the Personal Locator Beacon (PLB) to reduce the risk of accidental alarm triggering, and integrating RLS status to minimise the false alarms rate.

Challenge & technical solution

The main challenge addressed during the AMETRINE project in the development of the PLB solution concerns the **use of the Return Link Message (RLM) sentence to transfer a return link message received** by a RLS compatible GNSS receiver **from C/S recognised Return Link Service Provider (RLSP) to an RLS compliant C/S beacon.**

GIANO

Galileo-based T**I**ming Receiver for Critic**A**l I**N**frastructure R**O**bustness

Key facts

Full name
Galileo-based T**I**ming Receiver for Critic**A**l I**N**frastructure R**O**bustness

Project call number
GSA/GRANT/05/2017

Project call
Development of a Galileo-based timing receiver for critical infrastructures

Funding
2 033 390,56 EUR

EU contribution
1 423 373,39 EUR

Topic
Timing & Synchronisation

Market segment
Timing & Synchronisation

Project start/end
01/02/2019 – 30/09/2021

Galileo differentiators
Galileo OSNMA
Multi-frequency (E1 – E5a – E6) GNSS

Context and motivation

GNSS technology is currently widely used by Timing and Synchronisation user community because capable to provide timing services granting time, phase and frequency network synchronisation.
In an increasingly complex GNSS environment, the unavailability of synchronisation due to unintentional or deliberate interferences and/or spoofing of GNSS signal can cause economic losses due to disruption of the services.
The GIANO project aimed to develop **a technological solution capable to make critical infrastructure more robust against interference, jamming, and spoofing, and increase the accuracy and reliability of the time transfer service**. Thus, by leveraging Galileo and EGNOS-driven innovation, the GIANO project developed a solution that addresses the **need of improved resilience and robustness by the critical infrastructure user community**, especially energy generation and distribution, telecommunications, and financial operators.

Targeted GNSS innovation

OSNMA, EGNOS
T-RAIM

Targeted Product

GNSS timing receiver

Scope

The GIANO project aims to successfully **bring Galileo and EGNOS driven innovation to the GNSS-based timing and synchronisation domain**.
As a result, the GIANO project developed a **multi-GNSS timing receiver fulfilling both the accuracy and robustness needs of several timing applications.**
The resulting Galileo-based timing platform represents a tangible test bench for innovation to be industrialised, by tailoring it towards each specific application and user need.

Challenge & technical solution

The developed **solution exploits state-of-the-art multi-GNSS** (GPS/Galileo & EGNOS), **multi-frequency** (L1/E1, L5/E5a, E6) **with high Radio Frequency flexibility**.
This was achieved through an innovative Direct-Sampling and Digital Down-Conversion approach.
By leveraging Galileo OS authentication and Time-Receiver Autonomous Integrity Monitoring (T-RAIM) algorithms, the **GIANO platform enables resilience and time integrity against Jamming and Spoofing threats.**

Thales Alenia Space, IT
DEIMOS Engenharia, PT
Space Research Centre PAS, PL
Business Integration Partners, IT
Piktime System, PL

gianoproject.eu

TAUCETI

Next generation Survival Emergency Locator Transmitter (ELT-S)

Key facts

Full name
Next generation Survival Emergency Locator Transmitter (ELT-S)

Project call number
GSA/GRANT/02/2017

Project call
Development of MEOSAR Beacons

Funding
1 412 062,13 EUR

EU contribution
988 443,49 EUR

Topic
Aviation

Market segment
Aviation

Project start/end
01/07/2018 – 30/09/2021

Galileo differentiators
Galileo RLS

Context and motivation

The Search & Rescue (SAR) community is at the turn of its history. New satellites have led to the development of the Medium-altitude Earth Orbiting Search And Rescue (MEOSAR) constellation of the COSPAS-SARSAT (C/S) system. Meanwhile EGNOS, Europe's own SBAS, significantly improves localisation performance, introducing capabilities and allowing operations not possible through prior systems. Furthermore, Galileo's Return Link Service (RLS), one of the main differentiators of European GNSS, will contribute to saving more lives at sea and on land.

The SAR community strongly benefits from the performance of such systems, with more and more lives being saved every day.

Survival Emergency Locator Transmitter (ELT-S) beacons, which have been **developed within the TAUCETI project, enabled a new technology to enter the market and finally brought innovations long awaited by the aviation community**.

Targeted GNSS innovation
ELT

Targeted Product
GNSS receiver

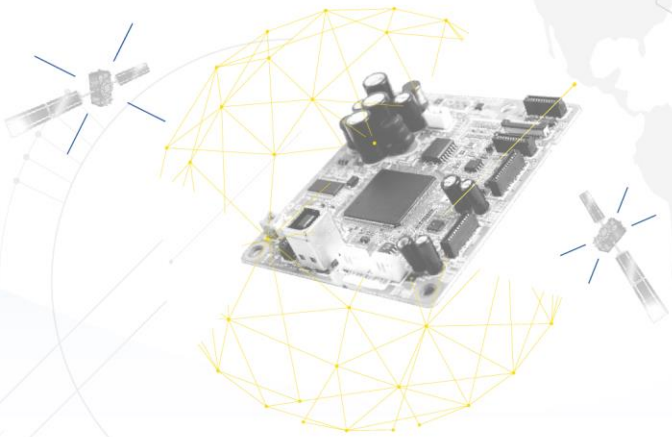
Scope

The goal of the TAUCETI is to provide a new range of Survival ELT (ELT-S):

- **distress beacons** compatible with **multi-constellation GNSS** and meeting the latest needs and requirements of end-users
- GNSS & SAR **system validation on the field**
- **certifications for commercialisation** of the new Ultima-S range, providing **compatibility with** both **MEOSAR C/S** and legacy **LEO- and GEOSAR satellites**, and capable to seamlessly interact with **Galileo's** automatic acknowledgment system **RLS**.

Challenge & technical solution

A **key challenge** for the TAUCETI project was the **provision of a new range of ELT-S beacons** optimised to operate with the new **MEOSAR C/S International Programme** embedded in the GNSS constellation, including Europe's own Galileo.
As a result, the developed innovations provide a new range of S-ELT that brings to the market the advantages of the multi-constellation GNSS receivers, the Galileo RLS to inform the user, an answer to the Lithium batteries regulations, and **a new global commercial product** with a package including the Global Aeronautical Distress and Safety System (GADSS) Distress Tracking ELT and Survival equipment specifically designed for the flight crew.



COBALT

COBALT

Context and motivation

The Galileo Return Link Service (RLS) was declared operational on 21 January 2020. The service, a joint effort between Cospas-Sarsat and the Galileo programme, is free of charge and available to all Cospas-Sarsat RLS-compatible beacons. The Galileo satellites are able to pick up emergency signals emitted from distress beacons at a frequency of 406 MHz and transmit a Return Link Message (RLM) signal back to the beacon through the Galileo Navigation Message (I/NAV E1).

Due to the recent introduction of the Galileo RLS, the number of compatible SAR distress beacons available is still limited. Therefore, efforts have been set in place in order to increase the development and availability of such devices. In this context, the **COBALT project developed and marketed a Cospas-Sarsat compliant 406 MHz Personal Locator Beacon (PLB),** designed addressing maritime and land capacity, and increasing the survival solutions market offering.

Targeted GNSS innovation

ELT/ PLB

Targeted Product

MEOSAR PLB

Scope

COBALT delivers a significant increase in features and benefits to end-users by providing a system improvement through a new technology. This satisfies a developing market requirement and removes the limitations of existing products on the market, both of which have previously been barriers for existing PLB users in adopting the 406 MHz technology and COSPAS-SARSAT system. The **continuous promotion of the sMRT Rescue unit throughout the development and production phases of the project will serve as a platform to increase user awareness of the integration of Galileo into COSPAS-SARSAT and the benefits the system offers**.

Challenge & technical solution

By **integrating the innovative GNSS solution with state-of-the-art radio technology** that maximises the benefits offered by the Galileo MEOSAR system, the sMRT Rescue PLB (i.e., the COBALT prototype) offers unrivalled features and performance for its users.

The resulting PLB is a **compact, lightweight and uniquely designed unit for distressed users in both a maritime and land capacity.** The sMRT Rescue unit will increase chances of location and survival by improving the relay time of the distress alert, increasing the signal location accuracy, improving the signal detection in difficult conditions, and providing user reassurance thank to the return link service.

Key facts

Full name
COBALT

Funding
622 296,86 EUR

Market segment
Maritime

Project call number
GSA/GRANT/02/2017

EU contribution
435 607,80 EUR

Project start/end
01/03/2018 - 31/07/2023

Project call
Development of MEOSAR Beacons (MEOSAR)

Topic
Maritime

Galileo differentiators
Galileo RLS

PHOENIX

PHOENIX MEOSAR PLB

Key facts

Full name
PHOENIX

Project call number
GSA/GRANT/02/2017

Project call
Development of MEOSAR Beacons

Funding
464 378,57 EUR

EU contribution
313 196,68EUR

Topic
Maritime

Market segment
Maritime

Project start/end
01/03/2018 - 31/11/2022

Galileo differentiators
Galileo SAR

Context and motivation

The seas and oceans on the coastlines of the European Union together with the more than 12,000 commercial ports located in EU coastal states play a major role in Europe's economy and security. Its ocean and seas are used to transport goods and people from within and outside the EU, to produce food from fisheries and aquaculture, and to produce energy from both non-renewable (oil and gas) and renewable (wave, wind) energy sources. The use of the seas and coasts has increased as traditional industries grow and as new industries emerge. These industries are essential to the European economy and society with an estimated Gross Value Added (GVA) of at least EUR 460–485 billion and employ at least 6.6–7 million people. In this framework, end-to-end solutions based on Galileo's SAR service and leveraging its Return Link have multiplied in order **to improve safety and security of operations at sea.**

Among these solutions, the **PHOENIX project** developed a new core **beacon platform for global and local rescue**. The beacon combines a Personal Locator Beacon (PLB) with built-in Automatic Identification Service (AIS), for maritime applications, integrating the Return Link feature utilising LED indicators to confirm receipt of a SAR distress call, thus delivering the lowest cost PLB available, the smallest possible form factor and an easy programming solution.

Targeted GNSS innovation

ELT/PLB, SAR/Galileo

Targeted Product

MEOSAR Personal Locator Beacon

Scope

The PHOENIX project focuses on the development of a **406MHz MEOSAR Personal Locator Beacon** incorporating the **'First Generation' COSPAS-SARSAT 406MHz waveform**; accessing the benefits of the **Galileo** Global Navigation Satellite Systems and more specifically of the **Return Link Service** (RLS)/Return Link Message (RLM) data encoded in the Galileo Ephemeris downlink.

Challenge & technical solution

The ambitions of the PHOENIX project were reached by developing a 406 MHz Personal Locator Beacon with AIS man overboard (MOB) capable of instant detection by nearby vessels. When activated, the rescueME PLB3 transmits one's position and ID using satellite link for global rescue. The device features a blue LED RLS indicator and AIS for local rescue. The **combination of integrated features and the high level of precision allows** for a **wider level of protection and ultimately higher probability of rescue**.

Ocean Signal Limited, GB

GoT

Galileo **o**f **T**hings

Key facts

Full name
Galileo of **T**hings

Project call number
GSA/GRANT/08/2017

Project call
Development of GNSS receiver technologies for Premium and General mass market

Funding
1 272 498, 00 EUR

EU contribution
890, 748,60 EUR

Topic
Mass Market

Market segment
Location Based Services

Project start/end
01/11/2019 – 30/04/2022

Context and motivation

The Internet of Things (IoT) is one of the world's largest application markets for Global Navigation Satellite Systems (GNSS). Real-time geolocation and timing information are crucial for IoT applications to connect physical objects to the network and improve the lifecycle in a sustainable, efficient way.
In this context, the **Galileo of Things (GoT) project proposes an innovative approach to enforce Galileo for IoT trackers by developing a low-power and cost-efficient semiconductor-IP core** that mates with Narrow Band – Internet of Things (NB-IoT) Internet Protocol (IP) for low-power consumption solutions. As a result, the GoT project delivers a breakthrough solution, **making Galileo's benefits affordable for the mass-market.**

Targeted GNSS innovation

GNSS LPWA

Targeted Product

GNSS and NB-IoT tracking device

Scope

The GoT project aims to support general mass-market reach for **Galileo-enabled IoT trackers by delivering a breakthrough combination of GNSS and Low-Power Wide-Area network (LPWA) connectivity.** As an output of the project, the final developed product is a single-chip Galileo+NB-IoT tracking device. The target usages cover **location trackers for consumer applications**, such as people safety, goods protection, connected sport devices and/or pet tracking; furthermore, they also include **professional markets**, such as smart cities and smart farming.

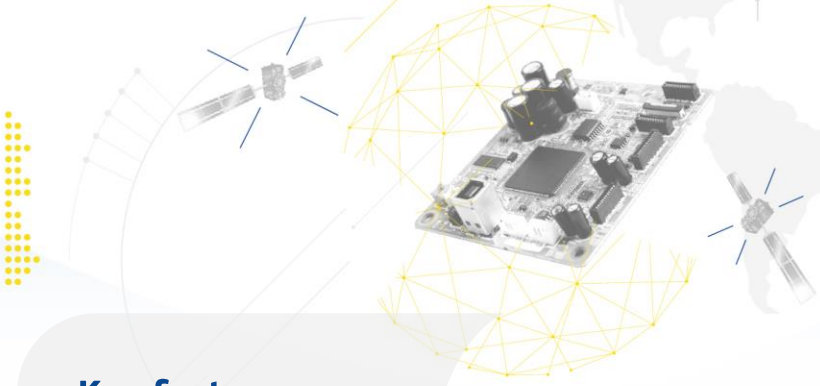
Challenge & technical solution

In the IoT domain, size and affordable costs often pose key challenges.
The **solution developed with the GoT project was especially thought and tailored for those IoT applications where power consumption and cost are the main design drivers.**
The GoT developed solution enables **next-generation System-On-Chip, including Galileo capability with the NB-IoT connectivity,** empowering a plethora of applications in the mass-market.

Ubiscale, FR

CEVA Ireland, IE

https://ubiscale.com/gnss-ip-core-galileo-of-things/



DARP

DARP

Key facts

Full name
DARP

Project call number
GSA/GRANT/01/2017

Project call
Development of an Advanced RAIM Multi-constellation Receiver

Funding
1 678 255,88 EUR

EU contribution
1 155 291,46 EUR

Topic
Aviation

Market segment
Aviation

Project start/end
01/09/2018 – 30/04/2022

Context and motivation

EGNSS plays a key role in Safety of Life (SoL) applications providing precise, reliable, and robust services.
In this setting, integrity is one of the essential qualities of service to be provided to the users of SoL applications. The Advanced Receiver Autonomous Integrity Monitoring (ARAIM) is a concept to which much effort is being devoted: the intention is to provide a global integrity service based on multiple satellite constellations, including Galileo which, with its features, can substantially contribute to ARAIM.

In this context, the DARP project comes into play, in the attempt of **improving the achievable performance and of extending the application domain of the legacy RAIM concept**, a technique extensively used in aviation to determine the integrity of GNSS position solutions.
The **ambition of the DARP project is to enable a double constellation for worldwide air navigation**, able to support en-route and terminal-area flight, and lateral and vertical guidance during airport approach operations.

Targeted GNSS innovation

EGNSS ARAIM/TRAIM

Targeted Product

ARAIM prototype receiver

Scope

The DARP project developed **a GNSS receiver prototype that integrates the ARAIM algorithm**.
In order to achieve this result, three main tasks were performed.

- **Definition of requirements and specifications**, targeting the design, implementation, and test of an ARAIM prototype
- **Assessment of the performance** that can be achieved with the prototype, taking into account the error model defining both laboratory and real scenarios in which the ARAIM prototype will be tested
- **Standardisation, dissemination,** and support to EUSPA/EC.

Challenge & technical solution

The prototype is composed by a core **GNSS Receiver and a Navigation Processing Unit,** enabling a suite of functionalities: searching visible Galileo/GPS/SBAS Space Vehicles (SVs), allocating HW Channels on the basis of predefined strategies; acquiring and tracking Galileo/GPS/SBAS signals; maintaining Code Lock and Carrier Lock, demodulating and decoding data messages, and recovering navigation data from connected GNSS satellites; performing position, time, and velocity calculation with GPS and Galileo SVs in view; performing ARAIM/RAIM and integrity related calculations to alert the user in case of integrity risks; providing raw measurements data for GNSS satellites in lock; monitoring receiver status; allowing receiver control by the user through its Command and Control interface.

Deimos Space, ES
Thales Alenia Space Italia, IT
Entidad Publica Empresarial ENAIRE, ES
Thales AVS France, FR
Thales Alenia Space France, FR
DLR. DE

eMAPS

eMAPS

Key facts

Full name
eMAPS

Project call number
GSA/GRANT/08/2017

Project call
Development of GNSS receiver technologies for Premium and General mass market

Funding
749 677,61 EUR

EU contribution
524 774,32 EUR

Topic
Mass Market

Market segment
Road, Agriculture

Project start/end
01/08/2019 – 31/05/2022

Galileo differentiators
Multi-frequency GNSS

Context and motivation

Positioning and navigation are key pillars of the GNSS market, being at the basis of PNT (positioning, navigation and timing) service provision. It is also worth highlighting how the requirements in terms of accuracy and reliability for PNT applications have become increasingly stringent.
The eMAPS project set out to tackle the expected challenges inherent to smartcities and autonomous mobility, as well as those characterising the agriculture sector. Within the scope of the former macro-area, solutions such as smart navigation for connected car users, real time fleet management for city public transport, and infrastructure maintenance monitoring for city planners were developed. On the other hand, eMAPS targeted agriculture-oriented solutions with applications such as yield forecast, and detection of plant sickness and anomalies.
By developing **an innovative, low-cost, compact, high-performance premium receiver combined with cutting-edge algorithms,** eMAPS provides **high accuracy positioning** and **high-definition mapping**, both of which are extremely beneficial to all involved stakeholder groups.

Targeted GNSS innovation

High-accuracy positioning and high-definition mapping

Targeted Product

GNSS receiver, Mobile application

Scope

The main objective of eMAPS is the development of a **low-cost, cloud-based multi-sensor premium mass market platform** which hybridises data generated by a multi-frequency multi-constellation GNSS receiver, an Inertial Measurement Unit (IMU) sensor, and cameras.
As a result, eMAPS provides a targeted **30cm vehicle's 2D position accuracy (95%) and high-definition urban maps** enabling benefits for the cross-urban community, as well as **enhanced maps for smart viticulture** applications.

Challenge & technical solution

High accuracy and map definition posed key challenges to eMAPS. To overcome these issues, through the deployment of the eMAPS platforms, **the accuracy and the definition of the maps are continuously improved by the amount of real environment data collected by the fleet of equipped vehicles**.
In addition, eMAPS is not only a passive user of these open license platforms but also an active player and contributor to them, in order to optimise the dissemination of results to the European citizens.

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APOLLO

Accurate GNSS **PO**sitioning for **L**ow power and **L**ow-cost **O**bjects

Key facts

Full name
Accurate GNSS **PO**sitioning for **L**ow power and **L**ow-cost **O**bjects

Project call number
GSA/GRANT/08/2017

Project call
Development of GNSS receiver technologies for Premium and General mass market

Funding
1 294 090,29 EUR

EU contribution
905 863,20 EUR

Topic
Mass Market

Market segment
LBS

Project start/end
01/10/2019 – 30/09/2021

Context and motivation

The IoT is a rapidly growing market able to capture vast amounts of data from fixed and moving sensors. The processing of such data—whether in real time or on data-at-rest—allows to derive key **value adding information, which instigate in turn the creation of a large range of private or public services**.
In this context, the autonomy of the IoT device is critical to keep a continuity in the service and minimise maintenance needs. Indeed, since IoT devices are typically untethered, they must survive either on a battery or on power harvested from their environment.
Minimising the energy consumption of IoT devices is thus a major challenge for their manufacturers: while larger systems can afford microwatt – milliwatt average power, millimeter-sized devices must survive on nanowatt power budgets. Moreover, the ability to calculate the GNSS position of IoT objects with a very small energy footprint will pave the way for a market of tens of millions of moving objects each year. This is where the APOLLO project comes into play.

Targeted GNSS innovation

Galileo-based geolocation for IoT

Targeted Product

GNSS receiver

Scope

The APOLLO project aims at providing a **low consumption Galileo-based geolocation solution for the IoT market**, dividing the bill of materials of the GNSS function by 4 and by dividing its energy balance by a factor comprised between 10 and 300.
To reach such performance, the consortium developed **a 100% software GNSS receiver able to run on any IoT application processor** implementing powerful Cloud distribution methods to host most of the location processing on a remote server.

Challenge & technical solution

A **low-cost and low-power GNSS-based software location solution** that can be installed and run on generic low-cost IoT Microcontroller (MCU), such as STMicro STM32 or NXP K80 (both using a CORTEX M4 core) and that can be easily optimised depending on the application (e.g., configurable trade-off between energy consumption & accuracy).
The APOLLO System offers unique performance in terms of cost and energy consumption, while providing significant robustness and accuracy, enabling its use in mass-market IoT.

SYNTONY, DE

SIGFOX, DE

LDL Technology, FR

apollo-project-gsa.eu

GEARS

GalilEo Authenticated Robust timing System

Context and motivation

Precise timing is critical for a wide variety of economic activities around the world. Communication systems, electric power grids, and financial networks all rely on accurate and reliable timing for synchronisation and operational efficiency. In order **to protect residents and strengthen economic security and resilience**, a systematic process has been put in place to identify Critical Infrastructure and improve their protection.

In this context, the **GalilEo Authenticated Robust timing System** (GEARS) project **aims at providing** a **Galileo-based timing receiver for critical infrastructure,** using Galileo's open service navigation message authentication (OSNMA) system, **to protect the receiver against jamming and spoofing attacks.**

The prototype developed and validated (at TRL7) within the GEAR project **embedded relevant new technologies and innovations already identified as crucial candidates by the GNSS community to reach the desired levels of security and robustness.**

Targeted GNSS innovation

GNSS timing and navigation message authentication

Targeted Product

GNSS timing receiver for critical infrastructure

Scope

The key objectives of the GEARS project involve:

- **improving performance and resilience** of Galileo and GNSS timing receivers
- **developing and demonstrating** to operators the **effectiveness of Galileo services** and its differentiators
- **strengthening market adoption** through **standardisation** activities.

Thanks to performance and economic criteria shared along the project between the GEARS consortium and a large committee of stakeholders, a **new mature timing receiver** has been developed. The desired objective is to industrialise and market the GEARS project output, making it available to operators: a Galileo robust timing receiver, **tremendously enhancing confidence** of operators **in the timing and synchronisation service offered by Galileo**.

Challenge & technical solution

The engineers of the GEARS project scrutinised a considerable set of hardware options to optimise both hardware and software, with the goal to provide the required solutions to reach resilience and robustness to potential GNSS threats. A fundamental advantage of the developed design, when compared to other GNSS timing receivers, is **the inclusion of the OSNMA capability of the unique Galileo system**.

Great care has been put in defining and designing the hardware and software to address the security and safety aspects. The definition design identifies the different hardware components and software components, as well as the data processing required to achieve a high level of resilience and robustness. The combination of all these different components constitute a **significant step forward in terms of resilience and robustness to current GNSS timing systems**.

Key facts

Full name
GalilEo Authenticated Robust timing System

Funding
2 459 639,30 EUR

Market segment
Timing & Sychronisation, Critical Infrastructure

Project call number
GSA/GRANT/05/2017

EU contribution
1 721 747,51 EUR

Project start/end
01/07/2019 – 31/12/2021

Project call
Development of a Galileo-based timing receiver for critical infrastructures

Topic
Timing & Synchronisation

Galileo differentiators
Galileo OSNMA

Orolia, FR

FDC, FR

NAVCERT,DE

Maanmittauslaitos - National Land Survey of Finland, Finnish Geospatial Research Institute, FI

Stichting Nationaall Lucht-en Ruimtevaartlaboratoriuim, NL

gears-gsa-project.eu

iSSAR

Innovative System for Search And Rescue

Key facts

Full name
Innovative System for Search And Rescue

Project call number
GSA/GRANT/02/2017

Project call
Development of MEOSAR Beacons

Funding
1 491 562,09 EUR

EU contribution
978 901,82EUR

Topic
Aviation

Market segment
Aviation, Search and Rescue

Project start/end
01/03/2018 - 31/07/2023

Galileo differentiators
Galileo SAR

Context and motivation

Global Search and Rescue (SAR) operations quickly locate and help people in distress. Thanks to the SAR/Galileo service, it is possible to do so in a very fast and efficient way, making the position of people in distress known to relevant authorities in the shortest time possible.
Since January 2020, when the **Return Link Service (RLS)** was declared operational, SAR/Galileo has enabled the provision, on top of the distressed-user's location information, of **a fully automatic acknowledgement message back to the user informing them that their request for help has been received.**

As a consequence, efforts have been set in place to develop solutions, illustrating the benefits and stimulating the investment in such Galileo differentiators, consequently increasing the European industry knowledge, innovation capacity and market positioning in this field.
Within this context, the Innovative System for Search and Rescue (**iSSAR**) **project** was set into place, with the final goal of developing of a unique **Distress tracking Emergency Locator Transmitter (ELT-DT) beacon,** ready to be **certified** by the International Civil Aviation Organization (ICAO).

Targeted GNSS innovation
GNSS ELT

Targeted Product
ELT-DT beacon

Scope

The iSSAR project developed a **first-generation ELT-DT beacon that implements Galileo's Return Link Service for SAR.**
The automatic activation functionalities and whose design were partly based on "ELITE", the proprietary Survival ELT beacon which has been in September 2017.
The output of the project was the delivery of the first and unique market-ready ELT beacon with built-in GNSS device (Galileo/GPS) ready for certification and commercialisation.

Challenge & technical solution

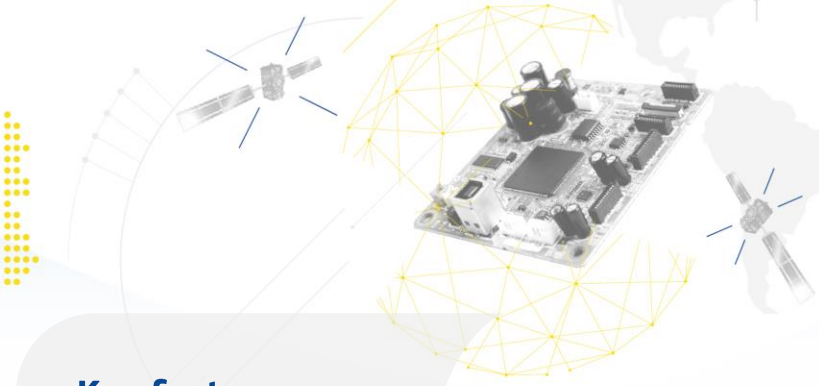
The prototype developed within the iSSAR project **integrates a First-Generation Beacon (FBG) signal modulation, with a dual-frequency transmitter** (406 MHz for the distress signal/121.5 MHz for the location of the beacon during the rescue operations). As a result, the **iSSAR beacon** enables to offer a set of features that **enhance reliability, cost-efficiency, and safety,** as well as **compliant to the ICAO requirements** for certification.

ECA Aerospace, FR

Thales Alenia Space France, FR

PROLONG

Portable **R**eceiver to improve **O**lder adults' safety through gait ana**L**ysis using **O**pportunistic **N**etworking and very high accuracy **G**alileo-based location



Key facts

Full name
Portable **R**eceiver to improve **O**lder adults' safety through gait ana**L**ysis using **O**pportunistic **N**etworking and very high accuracy **G**alileo-based location

Project call number
GSA/GRANT/08/2017

Project call
Development of GNSS receiver technologies for Premium and General mass market

Funding
938 329,80 EUR

EU contribution
499 704,80 EUR

Topic
Mass Market

Market segment
Location Based Services

Project start/end
01/02/2020 - 05/02/2023

Context and motivation

Europe has one of the fastest ageing population worldwide. Today, one-eleventh of the world's population (809 million) is over the age of 60 and this number is expected to grow to one-fifth (2 billion) by 2050.
Such a profound change in demographics calls for development of technologies to help elderly people remain independent, ensuring their safety and security.
The technology market tries to respond to such needs but there are still market gaps between the rapidly growing demand for Active and Healthy Aging (AHA) products and services.

In this context, the Global Navigation Satellite System (**GNSS) user technology** is of help as it is widely available in mass market devices including personal devices, connected vehicles, Internet of Things (IoT) objects, etc. With Galileo, wearable GNSS location devices are more accurate and reliable, particularly in urban environments.
In this context, PROLONG - "**Portable Receiver to improve Older adults' safety through gait analysis using Opportunistic Networking and very high accuracy Galileo-based location**" is an innovative project that aims **to improve the safety of active and healthy elderly users.**

Targeted GNSS innovation

PPP, PNT, GNSS security and authentication

Targeted Product

Portable GNSS-IoT tracker

Scope

The PROLONG project achieved to design and manufacture a prototype of a **portable device that can be carried in a pocket** as a key-chain **or worn** as a belt, bracelet or necklace attachment.
The resulting device, **by performing gait analysis** (i.e., analysis of locomotion) **based** on very accurate Positioning, Navigation and Timing (**PNT) data**, **enables to improve the safety of elderly users** by detecting conditions of possible danger (e.g., unstable walking pattern, wandering, fall) and then generating an alert (e.g., playing a loud beeping sound and sending an alert to caregivers).

Challenge & technical solution

Six innovations are combined in the PROLONG portable device:

- use of **authentication and security** mechanisms to secure users' privacy
- use of GNSS/Galileo with **IoT networking**
- optimized **"plug & play" algorithms** to ensure real-time detection and high accuracy
- specialised algorithms for the **gait analysis to detect conditions of risk** related to gait patterns of older adults when outside their homes
- seamless **indoor/outdoor monitoring** of elderly people
- ubiquitous prevention of risks related to analysis of locomotion of users, ready to be integrated in a **close-to-market device**.

Centre National de la Recherche Scientifique, FR
Aristotelio Panepistimio Thessalonikis, GR
INI-Novation, DE
DICEA, IT
WITA, IT

prolong-gsa.eu

MAGICA

Multi-frequency **A**utomotive **G**NSS Integrated **A**ntenna

Key facts

Full name
Multi-frequency **A**utomotive **G**NSS **I**ntegrated **C**ost-effective **A**ntenna

Project call number
GSA/GRANT/01/2018

Project call
Multi-frequency Multipurpose Antenna for Galileo

Funding
1 987 883,08 EUR

EU contribution
1 391 518,15 EUR

Topic
Transversal

Market segment
Automotive

Project start/end
01/08/2020 – 31/03/2023

Galileo differentiators
Multi-frequency GNSS

Context and motivation

Automated vehicles are becoming a reality, with the promise of safer and more efficient roads. GNSS plays a large role in providing accurate information for automated vehicles. In this context, the automotive market demands make the implementation of high-performance GNSS receivers very difficult. On the one hand, the size and silicon consumption must be significantly reduced while, on the other, the cost of the devices must be limited.
The need of cost-effective solutions maintaining high standards of technical performance is the main driver leading to the MAGICA – "Multi-frequency Automotive GNSS Integrated Cost-effective Antenna" project.
The **new antenna** built within the frame of the project is meant to **increase the frequency bands that are offered to the vehicles' GNSS receivers and to lead to a greater balance between performance and cost** of the GNSS high-accuracy systems.
The target application is autonomous driving where centimetre-level accuracy is a mandatory requirement to meet safety and reliability requirements.

Targeted GNSS innovation

Multi-frequency GNSS

Targeted Product

Multi-frequency GNSS antenna

Scope

The MAGICA project outcomes include a new antenna that is intended to go beyond the state of the art: the development of **a cost-effective, high precision positioning antenna,** capable to provide multi-frequency characteristics and phase stability as the most relevant performance features. The resulting product aims to be **commercially ready**, in order to be integrated on a vehicle for Autonomous Driving operation.

Challenge & technical solution

The development of the new antenna posed several challenges such as design definition, electrical performance and reliability, the Radio frequency amplification scheme and components definition. In this context, different scenarios were considered "**antenna on free-space**", "**antenna integrated on a vehicle**" and "**antenna connected to high precision GNSS receivers**" to test different operational environments for the component.

IDNEO Technologies, ES
Rhode & Schwarz, DE
SEAT, ES

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@GNSS MAGICA Project

ACCURATE

ACCURATE

Key facts

Full name
ACCURATE

Project call number
GSA/GRANT/03/2018

Project call
Enhanced Receiver for autonomous driving/navigation

Funding
2 857 120,30 EUR

EU contribution
1 999 984,21 EUR

Topic
Road

Market segment
Road

Project start/end
01/09/2020 – 31/08/2022

Galileo differentiators
Multi-frequency (E5a – E5b) GNSS

Context and motivation

During the last five years, Autonomous Driving (AD) has moved from "maybe possible" to "now commercially available". Every significant automaker is pursuing the technology, eager to rebuild itself and not to lose the opportunity of the new autonomous market.
In recent years, driverless technology has progressed from needing driver assistance to having full autonomy. Driverless cars are looking more likely to become a reality. With this come significant benefits, including increased personal safety, time saved for drivers, mobility for nondrivers, decreased environmental harm, and reduced transportation costs.
Overall, driverless technology is expected to add more than €7 trillion to the global economy by 2050 and to save hundreds of thousands of lives in the next few decades. Simultaneously, it will cause wholesale upheaval in the automotive industry by increasing efficiency in the logistics chain.
In this framework, the **ACCURATE project represents the next generation positioning on board unit that enables highly automated driving.**

Targeted GNSS innovation

High-precision positioning for autonomous driving

Targeted Product

High-precision positioning automotive system

Scope

The objective of the ACCURATE project is to **maximise the Operational Design Domain** to go beyond the current limiting factors, such as weather and/or road conditions.
The project intends to develop **a high-precision positioning automotive system for enabling the development and deployment of complex automated driving functions**.
Also, within this context, ACCURATE has tested the inclusion of GNSS technologies in L4 and L5 validation and certification pipelines.

Challenge & technical solution

Enhancing situational awareness by combining high-precision positioning approach with camera, lidar, and radar perception systems posed key challenges.
In fact, the challenges that roads provide are numerous, such as pedestrians, uneven roads, variable surface materials, and changing weather conditions or blockage of GNSS signals. Thus, the **key to automated functionalities lies principally within the vehicles' sensor suite** which comprises a combination (determined by the vehicle manufacturers) of radar, camera, lidar, inertial systems, and GNSS, with GNSS being the only data source to provide absolute position, velocity, and time.

Vicomtech Fundacion Centro de Tecnologias de Interaccion Visual y Comunicaciones, ES
FDC, FR
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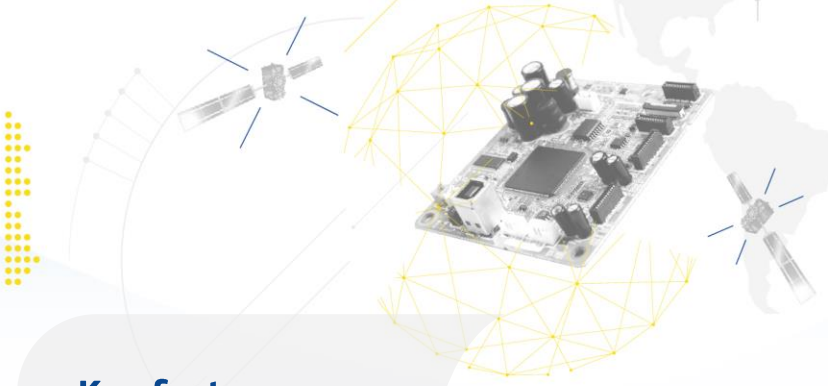
GAMMA

GAlileo-based **M**ultifrequency **M**ultipurpose **A**ntenna



Key facts

Full name
GAlileo-based **M**ultifrequency **M**ultipurpose **A**ntenna

Project call number
GSA/GRANT/01/2018

Project call
Multi-frequency Multipurpose Antenna for Galileo

Funding
2 000 000,21 EUR

EU contribution
1 400 000,15 EUR

Topic
Transversal

Market segment
Mapping & Surveying

Project start/end
01/09/2020 – 31/08/2022

Galileo differentiators
Multi-frequency GNSS

Context and motivation

The modernisation of existing GNSS constellations and the arrival of new GNSS systems have increased the number of bands to be covered by GNSS antennas.
Both the **mass market and professional applications will benefit from the improvement in positioning and navigation performance derived from this multifrequency concept, driving the need for antennas that can support a wider bandwidth**. Recent advances in GNSS antenna technology enable higher flexibility and adaptability and a future trend is to develop antennas that can be used in different platforms and applications (hence multi-purpose).
In this framework, the unavailability of signal together with its potential discontinuity due to both unintentional and intentional interference, disturbance or attacks to the GNSS signal can cause loss of data integrity, disruption of service, and economic losses. Here is where **the GAMMA project** comes into play, with the development of an **antenna** solution, **powered by Galileo signal availability, that enables providing benefits to operators by increasing the robustness of the system,** using GNSS technologies.

Targeted GNSS innovation

Multi-frequency GNSS

Targeted Product

Multi-frequency, multi-purpose GNSS antenna

Scope

The main goal of the **GAMMA project is to develop a new beam-forming antenna product based on Galileo signal**, able to operate in a multi-frequency and multi-constellation mode, reaching Technology Readiness Level 7 (TRL7) and to cope with external threats such as jamming (i.e., interference) and spoofing (i.e., the malicious provision of fake positioning and timing information to a target GNSS device).

Challenge & technical solution

GAMMA makes **use of the Galileo GNSS constellation to provide a more reliable service**, exploiting its inherent and defining features. The GAMMA antenna is able to mitigate interference effects that may emerge from the external environment, acting as an anti-spoofing/jamming detection and mitigation device. Also, the GAMMA antenna presents three distinct interfaces:

- the RF-OUT for professional users with high-end GNSS receiver,
- Data Serial for professional users to receive and process data, and
- Bluetooth interface for mass-market applications, exploiting the potential of raw data processing.

KE Elektronik, DE
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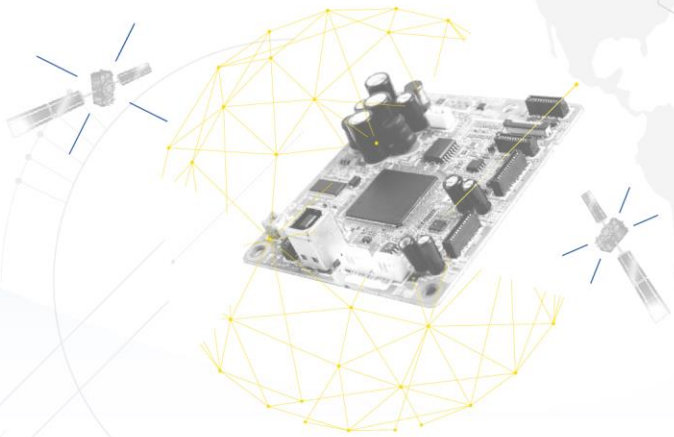
@Gamma Project



ARGOS

Anti-theft **R**obust **G**alileo-based **O**perational **S**ystem

Context and motivation

The ARGOS **project provides a technology and a system to protect valuable transport means from theft, which can be used in a wide set of applications** (e.g., autonomous driving, boats, tracking of goods and citizens when natural disasters take place, elderly people assistance, smart-agriculture, citizens security and control).

Targeted GNSS innovation

LBS/ Gaileo OSNMA

Targeted Product

GNSS User terminal

Scope

The aim of the ARGOS project is to **implement new Galileo features in tracking for anti-theft protection and develop an innovative board/device** with the following objectives:

- Become a reference **low-cost** solution to achieve **high level anti-theft protection** functions
- Develop an **innovative technology in vehicle tracking** that will benefit from Galileo Open Service – Navigation Message Authentication (OSNMA) feature to improve the robustness against spoofing attacks, Galileo E1b I/NAV Improvement to increase the accuracy and availability of the position information that is key for the needs of the ARGOS users, embedded encryption capabilities, easy-to-use interface to CAN-Bus for monitoring critical sensors data, and autonomous anomalies detection capabilities (through embedded Machine Learning techniques) to improve accuracy and availability of position information
- **Increase Safe Communications Reliability** exploiting OSNMA capabilities paired with embedded low-power Encryption Algorithms patented by GEA Space.

Challenge & Technical solution

The ARGOS solution answers the needs and requirements of users whose **leisure vessels are subject to potential theft attempts**. Two scenarios were considered:

- Vessel's protection from the potential movement outside the Mooring at Anchor Radius – MAR (potential risk of both theft attempt or anchor sliding) and from the potential movement outside a Safe Distance (SD) determined by the distance from rocks or dangerous elements.
- Vessel's Protection against theft attempts determined by movements outside a Safe Distance (SD). Vessels unable to communicate with the Control Centre are considered in Alarm condition and the user is therefore notified.

Based on these scenarios, **the ARGOS core algorithm implemented in the Device elaborates the data coming from the GNSS Receiver and other sensors in order to provide the position information with the highest accuracy and availability**. Position information, compared in the Control Centre with the alarm conditions defined by the user, determines the safe/unsafe message to be sent to the end user.

Key facts

Full name
Anti-theft **R**obust **G**alileo-based **O**perational **S**ystem

Funding
1 267 588,34 EUR

Market segment
Maritime

Project call number
GSA/GRANT/03/2019

EU contribution
887 311,84 EUR

Project start/end
01/10/2020 – 30/09/2022

Project call
Enhanced GNSS User Terminal

Topic
Transversal

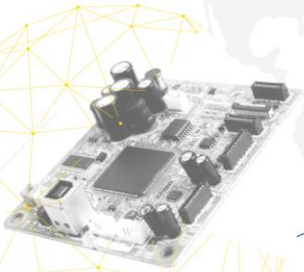
Galileo differentiators
Galileo OSNMA

Modis Consulting, IT
PerMare, IT
GEA Space, CZ
Aria United, RO
ChipCraft, PL

argos-project.eu

PHOENIX

PPP enabled by **H**igh Accuracy Service in **O**pen-Sky **E**nvironment for **N**av**I**gation E**X**cellence



Key facts

Full name
PPP enabled by **H**igh Accuracy Service in **O**pen-Sky **E**nvironment for **N**av**I**gation E**X**cellence

Project call number
GSA/GRANT/04/2019

Project call
Filling the gaps and emerging E-GNSS receivers technologies

Funding
938 329,80 EUR

EU contribution
656 830,86 EUR

Topic
Transversal

Market segment
Mapping & Surveying

Project start/end
01/01/2021 - 30/11/2023

Galileo differentiators
Galileo HAS
Multi-frequency (E1 – E5 – E6) GNSS

Context and motivation

With the **Galileo High Accuracy Service (HAS)** expected to be in-place in the next few years, the gap between large farms using the expensive high-end GNSS network-RTK (Real Time Kinematic) technology towards a 'Digital Farm 4.0' approach and the entry level farmer using mass-market receiver offering in best case SBAS capability can be bridged. HAS, with **accuracy and precision from 10-20 cm, has to compete with RTK but has the advantage of global availability, no operations cost and no need for a communications link**. Galileo HAS could be the cheap upgrade path for current SBAS users (and non-GNSS users) to better performance at lower cost, enabling many small-hold farmers to take advantage of 'Precision Agriculture 3.0'. HAS is considered also an alternative for current RTK-users, looking for a more operational-cost effective alternative to RTK, but with similar performance. For most agriculture applications, Precise Point Positioning (PPP) is considered sufficient. With the low-entry barriers when using Galileo HAS-based PPP, it is expected that the huge market of small-hold farmers can be efficiently addressed.
In this context, the **PHOENIX** (PPP enabled by High Accuracy Service in Open-Sky Environment for NavIgation Excellence) **project aims to meet the needs of the Agriculture market providing a low cost, close to market receiver**.

Targeted GNSS innovation
PPP

Targeted Product
GNSS receiver

Scope

The PHOENIX project aims to develop a prototype **receiver using the Galileo differentiator on the E6B signal, the 'High Accuracy service'**. The HA service promotes the 'Precise Point Positioning' (PPP) approach, being globally available at no cost for the users.
The prototype receiver is a **close-to-market** TRL (Technology Readiness Level) 7 device, designed to meet the **application requirements for the large community of small-hold farmers**.

Challenge & technical solution

The **main challenges addressed by PHOENIX were the major drawbacks of PPP** concerning the long convergence time and having uninterrupted reception of the satellite signals as of no relevance for 'open-sky' agriculture applications. Thanks to Galileo HAS, using triple-frequency (E1/E5/E6), these flaws were overcome.
To minimise development risk, time-to-market and cost, the development was based on an existing TRL6 prototype (called 'SRX-P1'). The proper integration of the new PHOENIX prototype OEM-board in suited housing and smart antenna allowed an additional step for a close-to-market device, enabling to demonstrate the capabilities and advantages to relevant stakeholders.

Fundamental Elements

OSNMA+

OSNMA+

Key facts

Full name
OSNMA+

Project call number
GSA/GRANT/03/2019

Project call
Enhanced GNSS User Terminal

Funding
1 207 908,79 EUR

EU contribution
845 536,00 EUR

Topic
Transversal

Market segment
Location Based Services

Project start/end
01/12/2020 - 30/11/2023

Galileo differentiators
Galileo OSNMA

Context and motivation

Position, Velocity and Time (PVT) based on GNSS, and in particular on Galileo, is used by many critical applications in several factors such as transportation, finance, telecommunications, information technology, energy, utilities, manufacturing, health services, emergency services, defense and law enforcement. However, accessibility to spoofing and jamming and relevant knowledge is increasing, resulting in disruption or denial incidents being more frequently observed.
The Galileo Open Service Navigation Message Authentication (OSNMA) comes to aid as it provides a **data authentication function for Galileo Open Service global users, freely accessible to all.** OSNMA provides receivers with the **assurance that the received Galileo navigation message is coming from the system itself and has not been modified.**
Within this framework, **addressing the needs of the market and the related user communities**, the **OSNMA+ project supported the development of an OSNMA receiver and service** able to target several market applications, from consumer applications to critical infrastructure.

Targeted GNSS innovation

OSNMA, I/NAV

Targeted Product

OSNMA+ Service, OSNMA+ Software Application and OSNMA+ Receiver

Scope

The OSNMA+ project aimed at the **development of enhanced user terminals,** targeting key market segments such as consumer solutions, road transportation and automotive, critical infrastructure (timing), and drones. As a result, the following was delivered:

- **OSNMA+ receiver**, which targets all applications requiring secure and robust positioning
- **OSNMA+ application software and OSNMA+ service**, which targets all existing applications that do not desire to modify the hardware but aim to advance OSNMA services as well as smartphones and consumer applications that do not use GNSS data from satellites

Challenge & technical solution

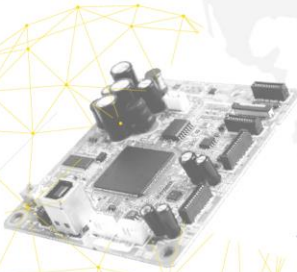
The solution proposes a more robust use of the OSNMA service and of the new I/NAV data. In particular:

- The OSNMA+ receiver **targets the most demanding levels of security, availability, accuracy and connectivity** leveraging an ecosystem of technologies, where GNSS has a primary role with the support of PNT data to the user, and information assurance is achieved with multiple positioning services and sensors.
- The OSNMA+ application software supports applications or the use of connected services
- The OSNMA+ service supporting OSNMA service specifically for smartphones and consumer products.

Qascom, IT

UAV Navigation, ES

Universitat Autonoma de Barcelona, ES



BANSHEE

Hybridization of E-GNSS and WiFi ranging for LBS and automotive Accurate Navigation in Smart city

Key facts

Full name
Hybridization of E-GNSS and WiFi ranging for LBS and automotive Accurate Navigation in Smart city

Project call number
GSA/GRANT/04/2019

Project call
Filling the gaps and emerging EGNSS receivers technologies

Funding
1 420 539,43 EUR

EU contribution
994 377,59 EUR

Topic
LBS and automotive

Market segment
Location Based Services (LBS)

Project start/end
01/01/2021 - 28/02/2023

Context and motivation

The GNSS market and technology is rapidly evolving, following on the one hand the push of increasingly sophisticated technologies and employing of complementary techniques and, on the other hand, the pull from the users who **have growing demands in terms of positioning accuracy, continuity, availability and interoperability** with other systems. Additionally, the price of the GNSS user equipment is decreasing.
Within this framework, by filling the gaps and addressing the market needs, the **BANSHEE project** was conceived with the aim to develop a **hybrid technology combining WiFi ranging and satellite navigation (GNSS)** that allows an accurate, **seamless indoor-outdoor navigation**.
The BANSHEE project's outcome is a **market-driven solution for Smart City environments,** as the applications for this technology are extensive (e.g., improved smartphone connection between indoor and outdoor environments, fleet management, monitoring the flux of people in large infrastructures and/or warehouses).

Targeted GNSS innovation

GNSS and Wi-Fi ranging

Targeted Product

Indoor-outdoor positioning solution

Scope

The BANSHEE project was set up with the ambition to **deliver a market-ready, accurate, ubiquitous, and scalable navigation solution for urban environments** that intends to **hybridise GNSS and WiFi** ranging to enhance navigation performance in urban scenarios.
The scope of work included the demonstration of the technology in two key market segments: **consumer solutions** (smartphones) and **road & automotive** (vehicle navigation units).

Challenge & technical solution

The BANSHEE team designed, developed and validated an indoor-outdoor positioning solution for mass-market services **targeting a meter level accuracy**, promoting its findings and developments through dissemination activities.
In detail, the BANSHEE **solution combines GNSS and Wi-Fi ranging in a new positioning engine adopting Wi-Fi ranging based on Time-of-arrival** (the new 802.11mc protocol) assuring seamless indoor-outdoor navigation.

Rokubun, ES
DAE Engineering, ES
IDNEO Technologies, ES
Innoquant Strategic Analytics – MOCA, ES
Universitat Politecnica de Catalunya, ES

banshee-navigation.eu @BansheeGSA

ASGARD

Advanced **S**hipborne **GA**lileo **R**eceiver **D**ouble Frequency

Key facts

Full name
Advanced **S**hipborne **GA**lileo **R**eceiver **D**ouble Frequency

Project call number
GSA/GRANT/02/2019

Project call
Shipborne double frequency multi-constellation receiver (E1/E5)

Funding
1 428 551.71 EUR

EU contribution
999 986,20 EUR

Topic
Maritime

Market segment
Maritime

Project start/end
01/01/2021 - 30/06/2023

Galileo differentiators
Multi-frequency GNSS
Galileo OSNMA

Context and motivation

Galileo Open Service Navigation Message Authentication (OSNMA) allows the assessment of the authenticity of the data provided through the signal in space to detect spoofing attempts and it will contribute to improving the robustness of GNSS for applications in which safety and security are concerned. In the maritime domain, taking advantage of advanced data is crucial for better performance in a plethora activities.

In the context of addressing the users needs in the maritime sector, targeting the development of shipborne double-frequency receivers, **the ASGARD project was conceived to take advantage of all the benefit of Galileo OS features** (i.e., improved performance and robustness thanks to dual-frequency and OSNMA capabilities).

The project's outcome is **a complete, close-to-market shipborne integrated equipment, compliant with regulatory standards** for Vessel Monitoring Devices as defined by the European Fisheries Control Agency - EFCA and national regulations.

Moreover, the ASGARD solution intends to disrupt current market solutions through the **first use of anti-spoofing cybersecurity protection technology and improved accuracy with dual frequency, enhancing the fishery Vessel Monitoring Systems with EGNSS Galileo Open Service (OS).**

Targeted GNSS innovation

Multi-frequency GNSS

Targeted Product

Advanced shipborne Galileo Receiver

Scope

The ASGARD project is divided into a set of objectives that define the complete scope of the project:

- **Development of Dual Frequency Multi-Constellation Galileo shipborne receiver**
- Type **approval** IEC 61108-3. Static and dynamic laboratory test campaign in the laboratory following IEC 61108-3 (Galileo) and IEC-61108-1 (GPS)
- **Galileo OSNMA implementation** for verifying the authenticity of the Galileo navigation message

The receiver is **based on two already existing products**: PRESENCE2 (GMV product) and R5 (SAAB equipment)

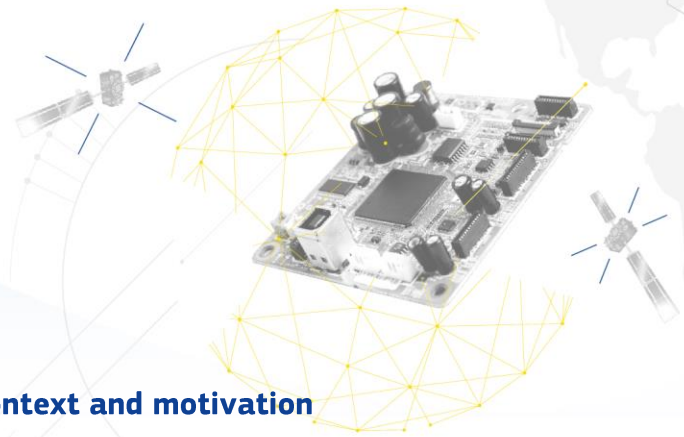
Challenge & technical solution

The project focused **on developing a multi-constellation and double frequency (E1/E5) maritime receiver that uses Galileo and that complies with European and International specifications**, i.e., IEC 61108-3 under the European MED WheelMark and International Maritime Organization MSC 401 (95) and MSC 432 (98).

Likewise, the receiver implemented the required algorithms to process Galileo OSNMA according to the specifications set by the European Commission for this service. The use of Galileo OSNMA functionality will ease the use of the ResilientPNT concept in maritime navigation.

GMV Aerospace and Defence, ES
SAAB, SE

Fundamental Elements



SEGRA

Shipborne receiver **EG**NOS **R**elated **A**ctivities

Context and motivation

The European Geostationary Navigation Overlay Service (EGNOS) will soon launch a new maritime solution that will make legacy and costly coastal ground-based augmentation systems redundant. Meanwhile, the **next generation EGNOS V3, featuring dual-frequency, multi-constellation (DFMC) services, is set to come online by 2028**, once GPS L5 is declared operational.

Maritime transportation remains the backbone of worldwide economic activity, with Europe being one of the world's leading maritime hubs. Shipping around the extensive European coastline relies on differential GNSS (DGNSS) signals for navigation and safety. These signals depend on a network of fixed, ground-based reference stations to broadcast the difference between the positions indicated by GNSS and known fixed positions. Today, almost all commercial GPS receivers, even hand-held units, allow DGNSS data inputs, and DGNSS is commonly used in maritime settings. However, the cost of maintaining this aging infrastructure is high, and the long-standing debate over what to do with this service is unresolved. Hence, the demand for cost-effective solutions.

SEGRA (Shipborne receiver EGNOS Related Activities) aims to support manufacturers with specific guidelines for new SBAS DFMC receivers.

Targeted GNSS innovation

SBAS DFMC

Targeted Product

SBAS DFMC shipborne receiver

Scope

The **SEGRA project proposed a set of Guidelines for Manufacturers for the implementation of SBAS Dual-Frequency Multi-Constellation (DFMC)** open service in shipborne receivers, **including augmentation to GPS and Galileo constellations for L1 and L5 frequencies.**

These guidelines include the minimum receiver requirements for SBAS DFMC processing, along with the required testing to validate the safe use of SBAS for maritime applications, hence **supporting the firmware development (for both the SOLAS and non-SOLAS)** installed in a shipborne receiver to process SBAS DFMC guidelines and used to test and verify them.

Challenge & technical solution

Building on the results and the experience of past projects (i.e., the MAREC project), the main issues addressed by SEGRA concerned the

- **compliance to IMO Res. A. 1046 operational requirements** for harbour entrances, harbour approaches and coastal waters.
- **Receiver and firmware requirements specifications, starting from existing products** already available in the market
- **IEC 61108 test standards** for GPS, Galileo and DGPS receiver requirements
- **Current non-availability of SBAS DFMC service from EGNOS**, which led to sound simulations in order to enable testing.

Key facts

Full name
Shipborne receiver **EG**NOS **R**elated **A**ctivities

Funding
714 285,72 EUR

Market segment
Maritime

Project call number
GSA/GRANT/02/2019

EU contribution
500 000,00 EUR

Project start/end
01/01/2021 - 31/12/2023

Project call
Filling the gaps and emerging E-GNSS receivers technologies

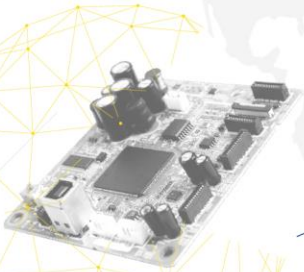
Topic
Maritime

Galileo differentiators
Multi-frequency GNSS

Kongsberg Seatex, NO

Blue Box Porbeagle VMS

Blue Box Porbeagle dual frequency VMS shipborne equipment



Key facts

Full name
Blue Box Porbeagle dual frequency VMS ("Vessel Management System") shipborne equipment

Project call number
GSA/GRANT/02/2019

Project call
Shipborne double frequency multi-constellation receiver (E1/E5)

Funding
1 191 888,52 EUR

EU contribution
834 321,96 EUR

Topic
Maritime

Market segment
Maritime

Project start/end
01/01/2021 - 30/06/2023

Galileo differentiators
Deal-frequency (E1 - E5a) GNSS
Galileo OSNMA

Context and motivation

Blue Box Porbeagle VMS ("Vessel Management System") was born with the goal to develop a **complete shipborne integrated equipment** (TRL 7), compliant with regulatory standards for Vessel Monitoring Devices and to reach TRL 7.
Its key features of **anti-spoofing cybersecurity protection** technology and **improved accuracy with dual frequency** target upending the market, leveraging EGNSS Galileo Open Service to outperform current solutions.

Scope

The **Blue Box Porbeagle project aims to create a close-to-market trusted dual-frequency VMS as a cost-effective line-replaceable unit (LRU)**. The Blue Box Porbeagle VMS shipborne equipment decodes dual frequency position, velocity, and time (PVT) information from E1/E5a E-GNSS signals and performs autonomous GNSS data messages authentication based on Galileo OSNMA.

Targeted GNSS innovation

Multi-frequency GNSS

Targeted Product

Dual Frequency VMS shipborne equipment

Challenge & technical solution

The Blue Box Porbeagle project has addressed numerous challenges posed by the maritime regulatory and specifications environment. Among the activities aiming to overcome such challenges it is worth highlighting:

- completion of VMS shipborne following identified functional and regulatory requirements
- dissemination of expected impact and activities among main fisheries policy stakeholders
- development shipborne equipment architecture and allocate requirements to internal circuit boards.
- manufacture efficient prototypes
- validation campaign installing devices in fishing vessels.
- deep dissemination of technical results.

Arxitec Critical Systems, ES

ARVI – Coop de Armadores de Pesca de Puerto de Vigo, ES

GEYSER

Galil**E**o c**Y**ber **S**pac**E** **R**eceiver

Key facts

Full name
Galil**E**o c**Y**ber **S**pac**E** **R**eceiver

Project call number
GSA/GRANT/04/2019

Project call
Filling the gaps and emerging E-GNSS receivers technologies

Funding
801 540,21 EUR

EU contribution
561 077,20 EUR

Topic
Transversal

Market segment
Aviation

Project start/end
01/01/2021 – 31/10/2023

Galileo differentiators
Galileo OSNMA

Context and motivation

During the last decade, the **space industry has experienced a profound transformation. Driven by technological advancements and a new entrepreneurial spirit**, the space environment is now hosting an increasing number of platforms and has therefore become a new playground for GNSS technologies. Whatever the mission-type (e.g., telecommunication, Earth observation, or navigation), **providing reliable real-time GNSS data to Earth-orbiting satellites can bring many financial, technical and societal benefits** such as reduced mission costs, improved navigation performance and the provision of trustworthy EO data.
From using real-time GNSS data for absolute and relative spacecraft navigation, to deriving Earth Observation measurements from it, GNSS has proven its worth for in-space applications. Driven by the NewSpace paradigm, the diversification and proliferation of space users has led to an increasing need for spaceborne GNSS-based solutions. It is in this framework, **targeting** the **new emerging GNSS Space applications and Space Economy trends, that the GEYSER (GalilEo cYber SpacE Receiver) project was conceived.**

Targeted GNSS innovation

OSNMA

Targeted Product

Hardware and software solutions for GNSS receiver

Scope

The project aims at the development of two new solutions:

- **GEYSER Hardware Solution**, a **medium-grade space receiver for robust and high-accuracy positioning, addressing emerging satellite markets** (mega constellations and Low Earth Orbit PNT) and launchers
- **GEYSER Software Solution**, based on the same Software Core of the hardware product. This solution will be compatible with commercially available SDR ("Software Defined Radio") boards for CubeSats. The current plan foresees to offer the SW product for experimental missions or in-orbit demonstrators of Space Agencies or other institutions

Challenge & technical solution

The GEYSER receiver brought diverse novelties and innovations addressing:

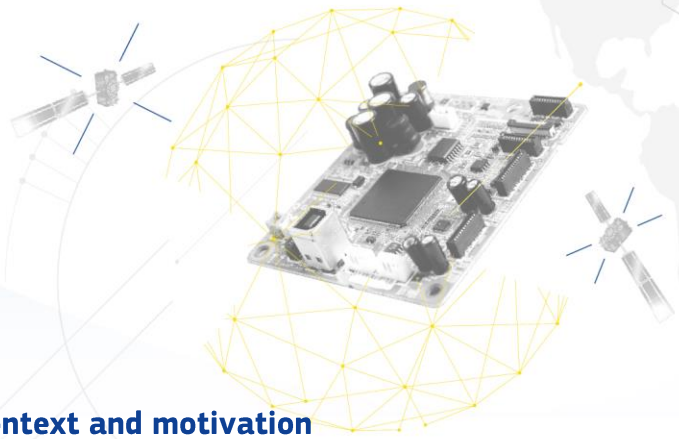
- New Satellite Markets, as the receiver is designed according to Small Satellite plarform requirements
- Emerging GNSS applications in space, with **robust PNT Cybersecurity and Authentication (OSNMA) in Space and real time High Accuracy Precise Orbit Determination (POD) for Space Debris collision avoidance and "Station Keeping" maneuvering**
- **Processing and Plugin Software Upgrades**, supporting the L5/E5a frequency and the development of plugins for Cybersecurity, High Accuracy POD and High Dynamics Navigation

Qascom, IT

GEA Space, CZ

Campera Electronic Systems, IT

Fundamental Elements



GREAT

Next Generation **G**NSS **RE**ference st**AT**ions

Context and motivation

Currently, GNSS reference networks are expensive infrastructures requiring specialised equipment and high installation and maintenance costs. For this reason, most of the public and private GNSS networks are not very dense in the European territory and even less so worldwide. At the same time, a large number of new applications, demanding in terms of positioning accuracy, need to receive real-time differential corrections from reference stations that are 15 km or less far away. In this context, the density of GNSS networks is becoming a key factor for the development of innovative services, ranging from mass market (e.g., for high precision positioning/navigation on new generation smartphones where raw GNSS measurements are available) to more specialised application domains (e.g., for GNSS-based real-time structural and geophysical monitoring).

Also, new safe-sensitive applications such as autonomous driving and drones' navigation need reliable networks of reference stations that shall be redundant and resilient not only to local spoofing and jamming attacks, but also to cyber-attacks and emergency situations (e.g., natural disasters).

Addressing such needs, the **GREAT** (Next Generation GNSS REference stATions) **project developed low-cost GNSS reference stations.**

Targeted GNSS innovation

OSNMA

Targeted Product

GNSS reference station & GNSS receiver

Scope

The purpose of the GREAT project is the development, test and demonstration of the next generation of **low-cost GNSS reference stations, which guarantee performance comparable to the ones of current geodetic grade receivers** but with costs - in terms of equipment, setup and maintenance - up to one order of magnitude lower than the present standards.

The final goal of the project is the **realisation of infrastructure bringing the advantages of differential GNSS processing** (both real-time and post-processing), **in terms of precision and accuracy ranging from sub-metre** (DGNSS technique) up **to millimetre level** (static differential processing), to the widest community of end-users as possible.

Challenge & technical solution

Among the key challenges addressed in the GREAT project are:

- **Cost-effectiveness of components**, combining good performance and a highly competitive price
- **Fully autonomous and infrastructure-less solution,** with no need of wired power and/or wired communication
- **OSNMA anti spoofing capabilities** in the receiver
- **Blockchain-based secure and traceable data flow**
- **IMU hybridisation for the detection of abnormal movements**, the monitoring of vibration and to further **improve anti-spoofing capabilities**.

Key facts

Full name
Next Generation **G**NSS **RE**ference st**AT**ions

Funding
1 106 130,25 EUR

Market segment
Location Based Services

Project call number
GSA/GRANT/04/2019

EU contribution
749 99,25 EUR

Project start/end
01/01/2021 - 31/05/2023

Project call
Filling the gaps and emerging E-GNSS receivers technologies

Topic
Transversal

Galileo differentiators
Galileo OSNMA

SpaceEXE, IT

M3SYSTEMS, FR

EXAGONE, FR

YetitMoves, IT

www.greatgnss.eu

NEWSPAPER

NEWSPAce **P**PP Receiv**ER**

Key facts

Full name
NEWSPAce **P**PP Receiv**ER**

Project call number
GSA/GRANT/04/2019

Project call
Filling the gaps and emerging EGNSS receivers technologies

Funding
1 533 004,89 EUR

EU contribution
1 000 000,00 EUR

Topic
Transversal

Market segment
Aviation

Project start/end
01/01/2021 – 31/12/2022

Galileo differentiators
Galileo HAS

Context and motivation

The GNSS market is rapidly evolving, together with its underlying technologies. The main drivers of this development can be traced on the one hand to the push of increasingly sophisticated technologies and employment of complementary techniques and, on the other hand, to the pull from the users who **have growing demands in terms of positioning accuracy, continuity, availability and interoperability** with other systems.
In this framework, new needs are arising in the market, driven by the NewSpace momentum. Indeed, Space users are becoming increasingly diverse, both in the public and private sectors. The rapid diversification of the space ecosystem, made possible through innovative geo-information business models and significant private capital investment, is therefore propelling space activities into the commercial realm. Also, it led to the major trend in space to move away from large, expensive satellites to constellations of smaller, cost-optimised satellites (e.g., Oneweb, Telesat, Amazon's Kuiper and SpaceX Starlink).
Hence, there is an **arising need to gear together GNSS with the NewSpace market**. The NEWSPAPER project does exactly this, by developing a GNSS receiving system capable of using Precise Point Positioning (PPP) technique utilizing Galileo's High Accuracy Service (HAS) transmitted on the Galileo E6 signal.

Targeted GNSS innovation

PPP

Targeted Product

GNSS spaceborne receiver

Scope

The goal of the NEWSPAPER project focuses on the development of a **spaceborne GNSS receiver for NewSpace**, capable of Precise Point Positioning based on Galileo's E6 signal.

The receiver supports high accuracy timing, autonomous electrical thruster control and collision avoidance, and is targeted for applications on (mega) constellations of LEO satellites requiring most precise navigation in the area of telecommunication, earth observation, climate research, and environmental data collection.

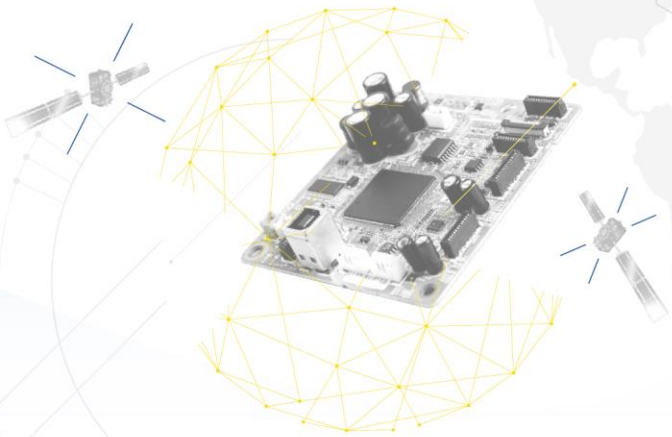
Challenge & technical solution

The NEWSPAPER project intends to **close a significant technology gap** for GNSS receivers through:

- leveraging the unique **Galileo High Accuracy Service**
- **precise positioning and robust timing** using wide bandwidth E-GNSS signals
- **dual and triple frequency operation** of the GNSS receiver
- **satellite-based real-time Precise Point Positioning** without commercial correction service

Ruag Space, AT

https://www.ruag.com/en/newspaper



REMOT

The **R**eal **E**nvironment **MO**vement **T**racker

Context and motivation

Advances in global navigation satellite system (GNSS) technology have resulted in smaller and more accurate GNSS receivers, which have become increasingly suitable for instantaneous calculations of key performance parameters during sports competitions, as well as in physiotherapy applications.
In this context, the **REMOT project** comes into play as it was **conceived to facilitate the professional's interpretation of the patient and/or athlete state of health or performance capacity.**

Scope

The main idea behind the REMOT project is the **development of a low-cost wearable device suitable to provide accurate measurements** of the kinematic of the human gait and, more in general, of the **human movement in a real-life environment** and under **normotype condition**.
According to the current state-of-the-art, such measurements are already available but only in indoor laboratory environment or in outdoor normal life condition for a short lapse of time. The goal of REMOT is to overcome all these limitations providing an **innovative device to physiotherapists and sport trainers**.
Indeed, such professionals are interested in knowing how the "range of movements" of the joints involved in the activity changes (e.g., a fitness activity or a shift of worker who works outdoors with repetitive gestures). By measuring the position and variations in positions of the joints and the articular segments involved in the movements, REMOT can relate the overall movement with efficiency, fatigue, muscle work, physiological functions (e.g., heart rate), facilitating the professional's interpretation of the person' state of health or performance capacity.

Targeted GNSS innovation

GNSS fusion/
Data integration

Targeted Product

GNSS-based wearable device

Challenge & Technical solution

The enabling technology of REMOT innovative capabilities is **based on GNSS and Inertial Measurement Unit (IMU) sensor fusion.**
In the gait analysis such an approach, extensively and successfully tested in precise navigation application, allows to synchronise lots of wearable sensors.
Thus, the adopted technology supports accurate measurements in terms of 3D position in real environmental conditions and for the whole duration of the physical activity, increasing the reliability and usefulness of gathered data.

Key facts

Full name
The **R**eal **E**nvironment **MO**vement **T**racker

Funding
1 040 182,00 EUR

Market segment
Location Based Services (LBS)

Project call number
GSA/GRANT/04/2019

EU contribution
728 127,40 EUR

Project start/end
01/01/2021 - 30/06/2023

Project call
Filling the gaps and emerging E-GNSS receivers technologies

Topic
Transversal

Stonex, IT

Gter, IT

remotproject.eu

OSCAR

OSCAR

Key facts

Full name
OSCAR

Project call number
GSA/GRANT/08/2017

Project call
Development of GNSS receiver technologies for Premium and General mass market

Funding
1 022 213, 62 EUR

EU contribution
715, 259, 00 EUR

Topic
Mass Market

Market segment
Location Based Services

Project start/end
01/12/2019 - 31/03/2022

Context and motivation

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.
Among the existent gaps, one is the **cooperative navigation assisted by Ultra-Wide Band (UWB) ranging** for cooperative navigation.
Responding to the needs of Premium Mass Market receivers, and to specific markets, the OSCAR project comes into place **as a development enabler for a family of advanced Galileo receivers not existing today.** The project specifically addressed cooperative navigation for **rescue and emergency response services** (e.g., firefighting). This sparked from the fact that there are providers of smart solutions for rescue services but **a universal solution for positioning in all conditions**, for example inside buildings without additional proprietary beacons, **does not exist**.
The developed **Galileo receiver** is designed to **work cooperatively from the beginning, with a solution based entirely on the space constellation and thus defining a new GNSS standard**.

Targeted GNSS innovation

ARM processors and FPGA technology

Targeted Product

Open-source, hardware-based GNSS receiver

Scope

The goal of the OSCAR project was the development of an **open source / open hardware Galileo receiver** in a **small form factor that is modular and targeted to premium mass market applications** that require additional features.
Particular emphasis of the project is on **flexibility and modular design**: the receiver consists of dedicated components with well defined interfaces.
The receiver is based on a massively parallel **microkernel architecture and ready for integration with other sources of information like inertial sensors and ultra-wideband radio** for cooperative navigation.

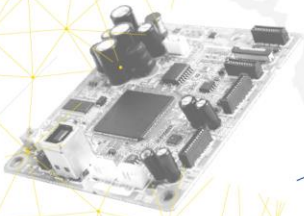
Challenge & technical solution

A **standalone open-source / open hardware GNSS/Galileo receiver** in a small form factor, which could find its place in practical commercial products, is currently unavailable and challenging to develop. The GNSS/Galileo receiver build in OSCAR addresses the main point as it offers:

- **Open-source hardware-based receiver**, highly configurable and modifiable, with the possibility to access and visualise various internal data series
- **Advanced signal processing architectures** based on vector tracking approach
- **Software-based, real-time hardware architecture**
- Multisystem and multicarrier processing
- **Robustness** against various GNSS attacks

UNION

Undifferenced and **UN**combI**n**ed Positi**O**ning Engi**N**e



Key facts

Full name
Undifferenced and **UN**combI**n**ed Positi**O**ning Engi**N**e

Project call number
GSA/GRANT/06/2019

Project call
Receiver technologies for high-precision in mass-market

Funding
431 728,25 EUR

EU contribution
302 209,77 EUR

Topic
Transversal

Market segment
Road, Location Based Services

Project start/end
01/03/2021 –28/02/2023

Galileo differentiators
Galileo HAS
Multi-frequency GNSS

Context and motivation

As shown in the latest technology trends and in EUSPA's Users Technology Report, the **need of increased accuracy levels** has grown steadily and is required **by users operating in several mass-market applications**, such as but not limited to augmented reality, mapping and GIS, Geocaching, sport tracking and navigation (both for automotive and/or smartphones).
Within this framework, the **UNION project** comes into play and aims towards the development of a satellite positioning technology for **accurate and real-time navigation for mass-market devices**, such as smartphones and vehicle navigation units. This goal is to be achieved through the development of two key elements:

Targeted GNSS innovation

Multi-frequency GNSS, RTK, PPP

- **Location Stack** (User end): UNION will be based on a **new navigation filter for mass-market GNSS** which will allow going beyond a smart combination of PPP - RTK techniques.
- **Permanent VRS ("Virtual Reference Stations") Network** (Server end): A new concept based on the creation and operation of a permanent network of VRS will enable proper area coverage and one-way operation of GNSS CORS networks, thus **ensuring service scalability**. This server end will include HAS corrections rebroadcast (via Internet) so that non-E6b receivers can benefit from it.

Targeted Product

Satellite positioning engine

Scope

The goal of the UNION project focuses on the development of a technology that **provides accurate and real-time navigation** for mass-market devices such as, among others, vehicles, drones, or smartphones.
UNION, as a precise positioning solution, improves:

- **continuity**, especially in navigation sessions spanning hundreds of kilometres.
- **accuracy**. UNION will represent a major breakthrough in mass-market oriented navigation solutions, reaching meter–level accuracy.
- **availability** of precise navigation any time in broad geographical areas.

Challenge & technical solution

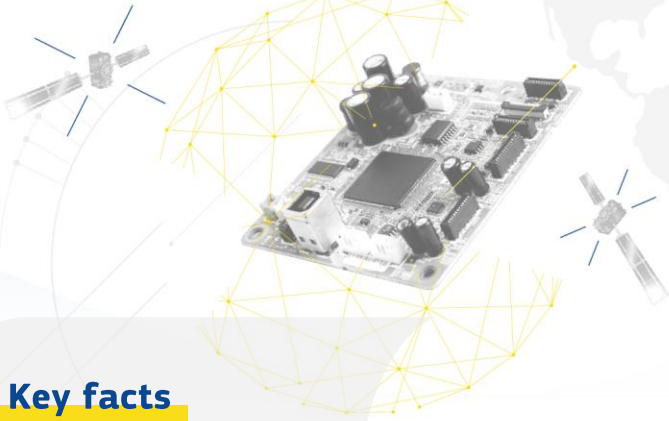
The satellite positioning technology developed during the UNION project provides **platform-agnostic, accurate, and scalable navigation for mass-market devices**, blending **Real-Time Kinematics** (RTK) and **Precise Point Positioning** (PPP) benefits.
The technology utilised within the UNION project is developed and validated for two relevant market segments: **consumer solutions** (smartphones) and **road & automotive** (vehicle navigation units), although it can be used in **other market segments such as Aviation and drones** (drones)

Rokubun, ES

Institut Cartografic I Geologic de Catalunya, ES

DEGREE

DronEborne Galileo RecEivEr



Key facts

Full name
DronEborne Galileo RecEivEr

Project call number
GSA/GRANT/07/2019

Project call
Development of a drone-borne double frequency Galileo receiver

Funding
833 863,24 EUR

EU contribution
583 703,96 EUR

Topic
Aviation

Market segment
Aviation

Project start/end
01/09/2021 – 31/08/2023

Galileo differentiators
Multi-frequency GNSS
Galileo OSNMA

Context and motivation

Drones represent a global phenomenon and one of the first pervasive platforms in which multiple PNT technologies are integrated, including GNSS, Inertial Navigation Systems (INS), Vision-Based Systems and Signals of Opportunity. To date, multiple GNSS receiver manufactures offer chipsets and OEM receiver boards for drones in a wide range of performance, grade and price.
In this context, European GNSS (EGNSS) is at the core of the drone revolution and future U-space services. EGNSS provides significant added value to drone navigation, positioning and related applications, and the use of their differentiators will be instrumental in developing new business opportunities.

Receiver manufacturers are well aware of the benefits that EGNSS can bring and are eager to pass on these advantages to their users.
In order **to improve security and safety of navigation subsystems**, technology development and EU investments on GNSS receivers are now focusing on the requirements related to the Specific Category of UAS operation. The development of the **DronEborne Galileo RecEivEr** (DEGREE) supports this strategy with high flexibility and adaptability to Risk Assessment processes, to allow safe flight operations.

Targeted GNSS innovation

Multi-frequency GNSS, INS

Targeted Product

Dual GNSS Receiver & Dual Antenna Hardware architecture

Scope

The objective of DEGREE project is the development an **innovative Galileo Dual-Frequency receiver** with target Technology Readiness Level (TRL) 7 and a **competitive cost** for the launch in the market.
The integration of the DEGREE receiver in a UAV Flight Control System enables the validation of the algorithms and navigation solution in a representative environment. Multiple test flights were conducted in real conditions, both in Galileo-only mode and in multi-constellation mode. For a proper assessment and test, the **procedures used** for flight testing fully **comply with EASA regulation for UAV operations.**

Challenge & technical solution

The new DEGREE solution was built addressing the following key differentiators:

- **Innovative Dual GNSS Receiver and Dual Antenna HW architecture**, embedding a state-of-the-art chipset GNSS receiver supporting all GNSS constellations
- **Assured Navigation Engine**, powered by a smart and highly multi-constellation and multi-frequency navigation software.
- **Support to robust PNT and** Open Service Navigation Message Authentication (**OSNMA**) for cybersecurity threats
- Support to **High-Accuracy services** and **L1/L5 SBAS**
- Signals of Opportunity, with capability to **support non-GNSS signals**.

Qascom, IT
Acorde Technologies, ES
UAV Navigation, ES
EuroUSC Italia, IT

GEODESY

Galileo **E**nhanced **O**peration **D**rone **SY**stem

Key facts

Full name
Galileo **E**nhanced **O**peration **D**rone **Sy**stem

Project call number
GSA/GRANT/07/2019

Project call
Development of a drone-borne double frequency Galileo receiver

Funding
983 808,67 EUR

EU contribution
688 666,07 EUR

Topic
Aviation

Market segment
Aviation

Project start/end
01/07/2021 - 30/06/2023

Galileo differentiators
Multi-frequency GNSS
Galileo OSNMA

Context and motivation

The **drone market is booming and is set to outstrip any other GNSS user base in aviation and open up new business opportunities** for application developers. GNSS is no longer just an option for drones, but a necessary asset. **GNSS is essential for the safe and reliable navigation of drones,** and GNSS receivers are implemented on almost all new commercial drones as standard. With increasing demand for BVLOS (Beyond Visual Line of Sight) operations, GNSS (possibly with various augmentations) is the most obvious technology choice for navigation, although it is not the only one.

European GNSS (EGNSS) provides significant added value to drone navigation, positioning and related applications, with respect to other systems. To this end, several drone navigation receiver manufacturers already offer EGNSS capabilities in a multi-constellation suite, and the number of models is increasing continuously.
In this context, the GEODESY Project (Galileo Enhanced Operation for Drone Systems) comes into play, with the development of a **navigation solution for drones, based on a Galileo multi-constellation / multi-frequency receiver.**

Targeted GNSS innovation

Multi-constellation, INS

Targeted Product

Multi-constellation/Multi-frequency GNSS receiver

Scope

The GEODESY Project aims to develop **a navigation solution for drones, based on a Galileo multi-constellation/multi-frequency receiver**, which could **support drones achieve robust navigation performance** and enable them to meet stringent technical and operational requirements.
The solution is **integrated with INS (Inertial Navigation System) and other sensors, in order to achieve a sufficient technology level of maturity** (TRL 7), validated within flight tests in a real operational environment

Challenge & technical solution

The starting point was the elaboration of a common understanding of UAV operational environment challenges as key to validate the GEODESY navigation algorithms.
This enabled the **validation of the prototype for different Unmanned aerial platform types. The result is the consolidation of the added value brought by the use of Galileo and its differentiators for the performance of aerial drones.** Furthermore, it highlights the features of integrity, authentication and reliability given by OSNMA and EGNOS corrections.

Aertec Solutions, ES

Centre Technologic de Telecomunicacions de Catalunya, ES

Fundacion Andaluza para desarollo Aeroespacial, ES

Pildo Consulting, ES

GALITS

GAlileo **L**ocalization **I**n **T**rain **S**ignalling

Key facts

Full name
GAlileo **L**ocalization **I**n **T**rain **S**ignalling

Project call number
GSA/GRANT/05/2019

Project call
Receiver for localization in train signalling

Funding
1 788 378,50 EUR

EU contribution
1 251 864,94 EUR

Topic
Rail

Market segment
Rail

Project start/end
01/06/2021 - 31/05/2023

Galileo differentiators
Galileo HAS
Galileo OSNMA

Context and motivation

The **GNSS rail market is a very promising market** which is expected to follow a trend similar to that of the aviation sector, **with every single train equipped with a GNSS receiver.**
In this framework, European GNSS serves the rail sector in various ways as GNSS enabled signalling applications provide increased safety and reduce costs of infrastructure management and operations compared to legacy signalling solutions.
Therefore, **GNSS plays a key role in the rail segment, in particular by offering multi-constellation services with increased robustness and accuracy.**

Manufacturers of GNSS receivers and antennas from different countries across the globe are (and will continue to) competing in the rail market. **Safety, security and rail certification will be fundamental enablers, playing a strong decision factor for the competition.**
Building on consolidated experience and expertise in this domain, **GALITS** (GAlileo Localization In Train Signalling) **aims to innovate GNSS technologies, making them ready for standardisation and entering the market.**

Targeted GNSS innovation
GNSS for ERTM

Targeted Product
GNSS Receiver and antenna

Scope

The objective of GALITS is to **develop an innovative, flexible and customisable Dual-frequency Multi-constellation (DFMC) GNSS receiver and antenna suitable for safety-related railway applications**. This project – optimised to offer a high degree of flexibility for responding to global market needs – provides a cost-efficient solution for train control system integrators.
The built receiver and antenna were first tested in Italy, targeting the European market as an entry point. Currently, other business opportunities are being assessed given the rapidly evolving scenarios in Asian markets.

Challenge & technical solution

GALITS mission and operational analysis started with consolidated knowledge acquired in previous activities and evaluated the applicability of new Galileo services, including HAS and OSNMA. The solution involves:

- A **GNSS receiver,** developed considering applicable railway safety standards. It includes a navigation filter enabling Virtual Baseline Detection in European Rail Traffic Management System (ERTMS) powered by a PVT engine. At its core are innovative integrity approaches, able to detect and mitigate local faults, such as multipath and interferences occurring in challenging rail environments.
- A fully operational, DFMC-certified **GNSS antenna**.

Qascom, IT
Bureu Veritas Italia, IT
RadioLabs, IT
HUBER+SUHNER, CH
QA System, DE

TRENI

Train **RE**ceiver for **N**avigation and **I**ntegrity

Key facts

Full name
Train **RE**ceiver for **N**avigation and **I**ntegrity

Project call number
GSA/GRANT/05/2019

Project call
Receiver for localisation in train signalling

Funding
2 250 648,70 EUR

EU contribution
1 575 454,09 EUR

Topic
Rail

Market segment
Rail

Project start/end
01/07/2021 - 30/06/2023

Galileo differentiators
Multi-frequency (E1 – E5a) GNSS

Context and motivation

Global Navigation Satellite Systems (GNSS) are already widely used for non-safety relevant applications in Rail. Yet, since a few years, safety-relevant applications based on GNSS have also emerged. GNSS-based solutions can indeed offer safety at a lower cost. However, Rail is a highly regulated domain in which the introduction of new technologies can take time. Nevertheless, in the coming years, safety-relevant applications (signalling and train control) based on GNSS will be increasingly developed, complementing and replacing traditional systems.

Taking on the challenge of the Rail scenario - which represents a dynamic vehicle scenario moving in different environments from rural to urban, with different visibility conditions of the GNSS signals and with different and varying Radio Frequency (RF) environment conditions – the TRENI project was conceived. TRENI Project, that stands for Train Receiver for Navigation & Integrity, has as objective the **development of a railway GNSS receiver and antenna** (TRL7) **for use within a safe train positioning platform suitable for railway safety related applications**.

Targeted GNSS innovation

SBAS
Multi-frequency GNSS

Targeted Product

Railway GNSS receiver and antenna

Scope

The TRENI project targets the development of **a railway GNSS receiver and antenna for use within a safe train positioning platform suitable for railway safety-related applications**.
The GNSS receiver resulting from the frame of the project will either be used directly or integrated in a multi-sensor positioning platform in order to fulfil the requirements of specific safety-related railway applications. Nevertheless, to achieve maximum benefit from GNSS in such difficult environments as the railways, the solution is based on a multi-frequency and multi-constellation capable receiver.

Challenge & technical solution

To achieve maximum benefit from GNSS in such difficult environments as the railways, the TRENI solution is deemed to be **based on a multi-frequency (L1/E1 + L5/E5a) and multi-constellation (GPS and Galileo)** capable **receiver**. Implementation of **SBAS corrections and Galileo signals jointly** with interference detection and mitigation, as well as anti-spoofing techniques, will bring **improved performance and robustness**. Furthermore, the product specifically targets harsh and challenging environments thanks to its **null-steering-capable antenna**.

Thales Alenia Space Italia, IT
Thales Alenia Space France, FR
Telespazio, IT
Mermec, IT
Saphyrion, CH

Treniproject.eu
@TreniProject
Treni Project

ERASMO

Enhanced **R**eceiver for **A**utonomouS **MO**bility

Key facts

Full name
Enhanced **R**eceiver for **A**utonomouS **MO**bility

Project call number
GSA/GRANT/03/2018

Project call
Enhanced Receiver for autonomous driving/navigation

Funding
3 465 593.10 EUR

EU contribution
2 000 015,79 EUR

Topic
Road

Market segment
Road

Project start/end
01/06/2021 – 31/05/2024

Galileo differentiators
Multi-frequency GNSS

Context and motivation

Autonomous Driving is transforming the mobility concept enhancing road safety, reducing traffic and, as a consequence, pollution from vehicle exhaust, and will increase comfort for both drivers and passengers. Indeed, the 'Autonomous Driving' concept aims to transfer the vehicle control function from the human driver to the automated system, which has to be aware of its location, sense the surrounding environment, and navigate making decisions without human input. This application belongs to the demanding category of Safety Critical applications, as its failure may have serious consequences for people, properties, and the environment. Therefore, autonomous cars need highly performing positioning engines making optimal use of a complete set of sensors complementing each other in a tightly hybridised solution, necessarily based on GNSS technology, due to its unique capacity of providing accurate absolute positioning and precise timing information.
Within this context, the ERASMO project was conceived with the aim to develop an **innovative engine to provide localisation estimates for the navigation of automated vehicles with precision, integrity and high availability**, by leveraging the information being broadcasted by the Galileo GNSS as well as the combination of absolute and relative localisation methods.

Targeted GNSS innovation

GNSS for autonomous driving

Targeted Product

GNSS-based On Board Unit (OBU)

Scope

ERASMO focuses on the development of an **innovative positioning On-Board-Unit (OBU) that will enable fully automated driving**.
To meet the required performance targets, the proposed OBU makes use of a dedicated communication channel in order to take advantage of the cooperative positioning concept. The output of the ERASMO project is a OBU receiver close-to-market prototype, which corresponds to reaching a Technology Readiness Level (TRL) of at least 7, and is deemed to be **cost-efficient.**

Challenge & technical solution

Localisation estimates for the navigation of automated vehicles **with the highest level of precision, integrity, and availability** are among the key challenges in ERASMO.
To overcome them, the OBU **leverages Galileo GNSS broadcasted information as well as the combination of absolute and relative localisation methods.**
The ERASMO solution allows as well to determine the relative localisation of the vehicle equipped with such OBU by leveraging the perception sensors available for autonomous driving as well as a priori information stored in navigation maps.

IDNEO Technologies, ES
GMV Aerospace and Defence, ES
Grupo Mecanica del Vuelo Sistemas, ES
Renault, FR
VVA Brussels, BE
Septentrio, ES
Artisense, DE
Centre National de la Recherche Scientifique, FR

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