



European
Global Navigation
Satellite Systems
Agency

EGNOS and Galileo services and applications



GALILEO **EGNOS**

NAVIGATION SOLUTIONS
POWERED BY EUROPE

Carmen Aguilera, Daniel Lopour. Market Development, GSA

Vienna, 8th October 2019

Every aspects of our lives leverage GNSS



European GNSS helps us move.....



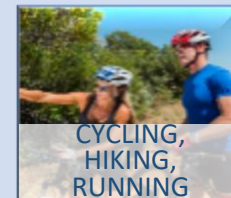
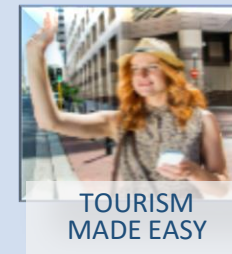
- **80,000 flight** delays and **20,000** diversions avoided in Europe
- Galileo saves at least **15M tonnes of CO₂**
- At least **3.5 billion litres** of fuel saved

European GNSS helps us work.....



- **4,500 tonnes of pesticides** and **1.5mln tonnes of fertiliser** saved
- At least **800mln hours** saved for Europe's consumers and professionals
- Nearly **50,000 annual jobs supported** in the downstream GNSS industry in Europe

European GNSS helps us play.....



EXAMPLES

Integrated approach towards EGNSS adoption



For each market segments



At all levels of the value chain



Market & User Knowledge



Market and technology monitoring and forecasting (i.e. market and tech reports)

User and industry consultations (i.e. user consultation platform, receiver workshops)

User satisfaction monitoring (i.e. EGNOS and Galileo surveys)

Demand Support



Definition of roadmaps with key stakeholders

Cooperation with receivers and apps developers

Technical support to EC to ensure EGNSS use in regulated applications

Offer Creation



Creation of new “made in Europe” products and services

HORIZON 2020

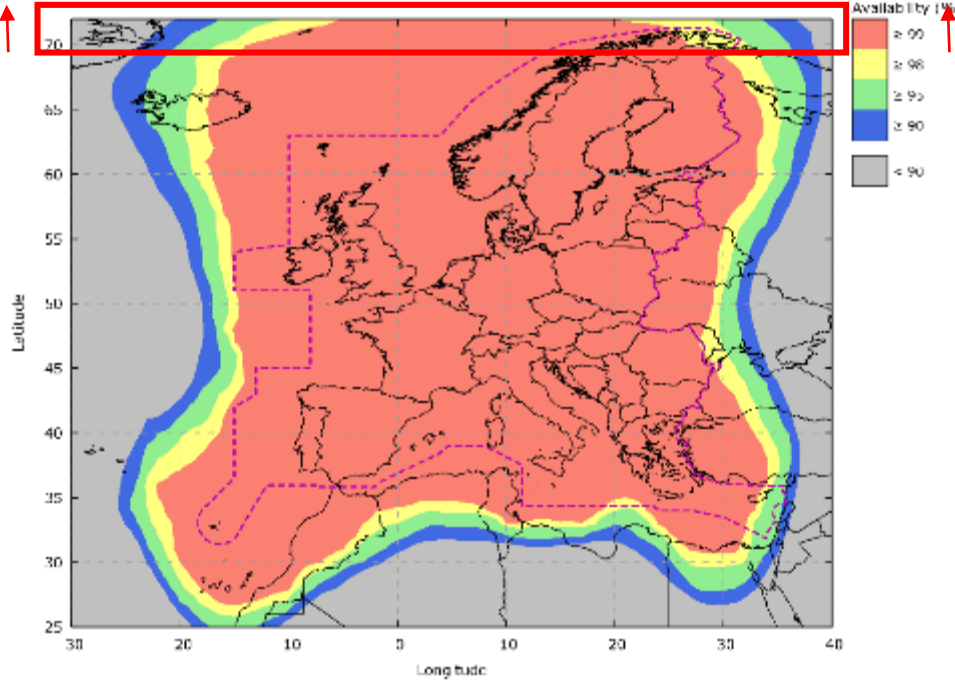


EGNOS SoL Service coverage – SDD 3.3

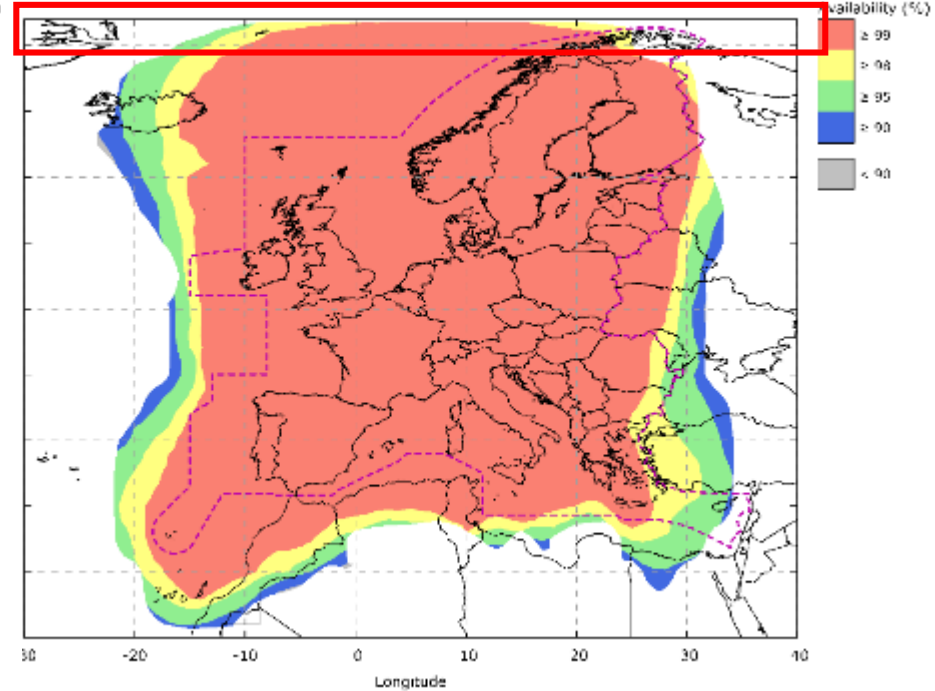


Publication
March '19

APV-I Availability Map



LPV200 Availability Map



Galileo is the European GNSS offering a wide range of services



Open Service (OS)

Galileo open and free of charge service set up for positioning and timing services

High Accuracy Service (HAS)



A service complementing the OS by providing an additional navigation signal and added-value services in a different frequency band. The HAS signal can be encrypted in order to control the access to the Galileo HAS services



Search and Rescue Service (SAR)

Europe's contribution to COSPAS-SARSAT, an international satellite-based search and rescue distress alert detection system

Public Regulated Service (PRS)

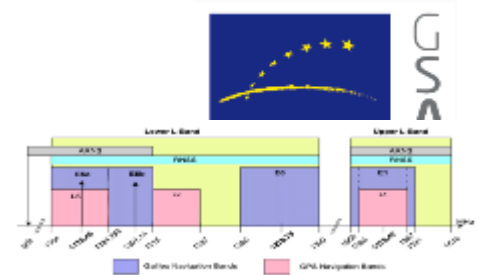


Service restricted to government-authorised users, for sensitive applications that require a high level of service continuity

Galileo and EGNOS differentiators enable innovative applications. Examples

- Dual frequency, with E5 as second frequency

- E5 especially effective in urban areas, bringing new levels of accuracy (sub-meter level) and robustness. Now available in smartphones (see Xiaomi Mi8) and automotive



- Authentication

- Data level: [Open Service Navigation Message Authentication \(OSNMA\)](#)

Integrated in the E1-B band for OS. Aimed at mass market users and offered for free. Already prototyped and under testing.



- Range level: [Signal Authentication](#)

Based on the E6-C Spreading Code Encryption to protect against more sophisticated attacks.



- High Accuracy Service (HAS)

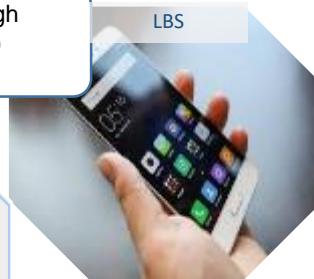
- Provision of PPP corrections via E6B (and terrestrial link tbc), offering high accuracy (decimeter level) for mass market and profesional users
- FREE provision of service



GALILEO & EGNOS ADOPTION OVERVIEW



- +600 M smartphones with Galileo (major high level brands including Apple, Samsung,)
- 1 billion users



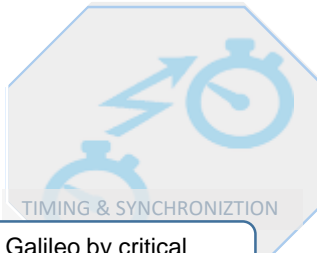
GNSS technology has been included in the European Railway Traffic Management System roadmap in view of its expected operational and safety benefits



MARITIME



Increasing interest towards Galileo by critical infrastructures owners



- Galileo recognized by the IMO as a "World Wide Radio Navigation System" for the use in regulated domains

50% of GNSS receivers are Galileo capable
EGNOS within 85% of farmers using GNSS



>50% of RTK network providers upgraded
or being upgrading to Galileo



- >630 EGNOS based approach procedures in 360 airports in 19 EU countries
- 60 drone receiver models with EGNOS/Galileo available in the market

- 72% of EU tolled roads are GNSS-based.
- Regulated applications: eCall and Digital Tachograph regulations leveraging EGNSS



Galileo is used today on majority of professional devices and consumer platforms



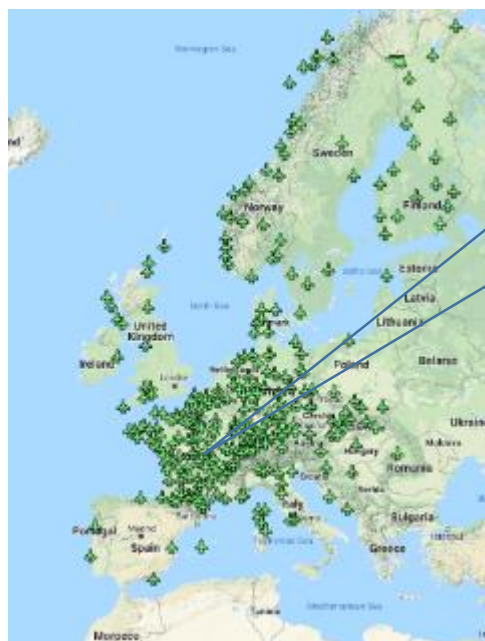
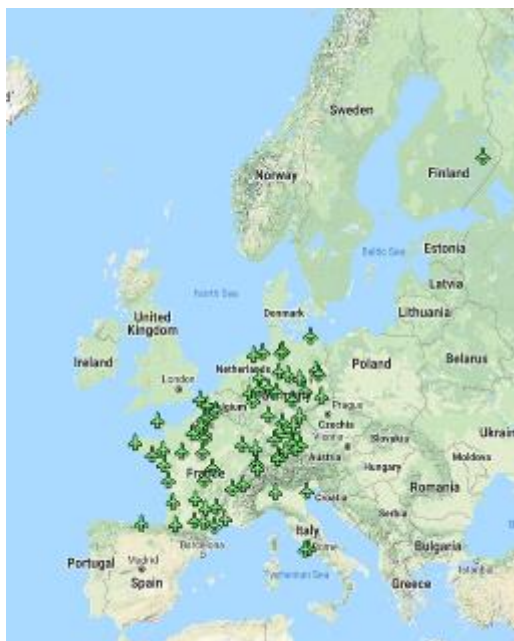
	Chipsets adoption	Devices	Applications & Solutions
LBS	<p>Good compatibility achieved</p>	<p>More than 750 millions phones use Galileo now!</p> <p>First dual frequency smartphone launched in May 2018</p>	<p>GSA hackathons organised to develop Galileo-based applications for smartphones</p>
IoT	<p>More than 50 different IoT chipsets manufacturers already include Galileo, like:</p> <p>...and many more!</p>	<p>Plenty of IoT devices already using Galileo:</p> <ul style="list-style-type: none">- Huawei locator- TWIG Protector- Taival tracking solution- Statsports tracker...	<p>IoT solutions using Galileo:</p> <ul style="list-style-type: none">- Assets tracking- Sports tracking- People tracking- Lone workers protection- Pets tracking

Aviation

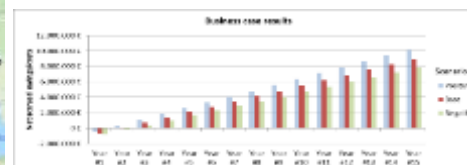




EGNOS approaches for all EU airports and airspace users



Dedicated funding
22 M€



Cost Benefit
Analysis



Regulation

Boom of EGNOS solutions coming to the market



Airbus



Customer Option in A350

Available since EIS



Baseline in A220

48 units in service in EU;

83 orders

Under development

A319/20/21 (Q2 2020)

>1700 in-service in EU

à 5,700 NEO worldwide orders

Boeing



B777X

Customer option. Available by EIS
(mid-2020)

325 orders



737MAX

Customer option (Q3 2020)

à 4,600 orders

Embraer



ERJ-135/140/145

Customer Option



E-170/175/190/195

Customer Option, STC developed

ATR 42, 72



-600 series

Customer Option, STC developed

Bombardier



Q series / CRJ

Customer Options

- + STCs for Avro RJ85/100
- + STCs for Fokker 50
- + Baseline in most business jets: Cessna Citation, Dassault Falcon, Gulfstream G's, Bombardier Globals, Challengers...



EGNOS and Galileo enable safe drone operations



Availability

Accuracy

Integrity

Security



Airbus commercial parcel delivery drone
Skyways



Lillium air taxi

Urban environment



GNSS: Centimetre level accuracy, high update rate
Connectivity: High bandwidth important, range might be compromised

Suburban environment

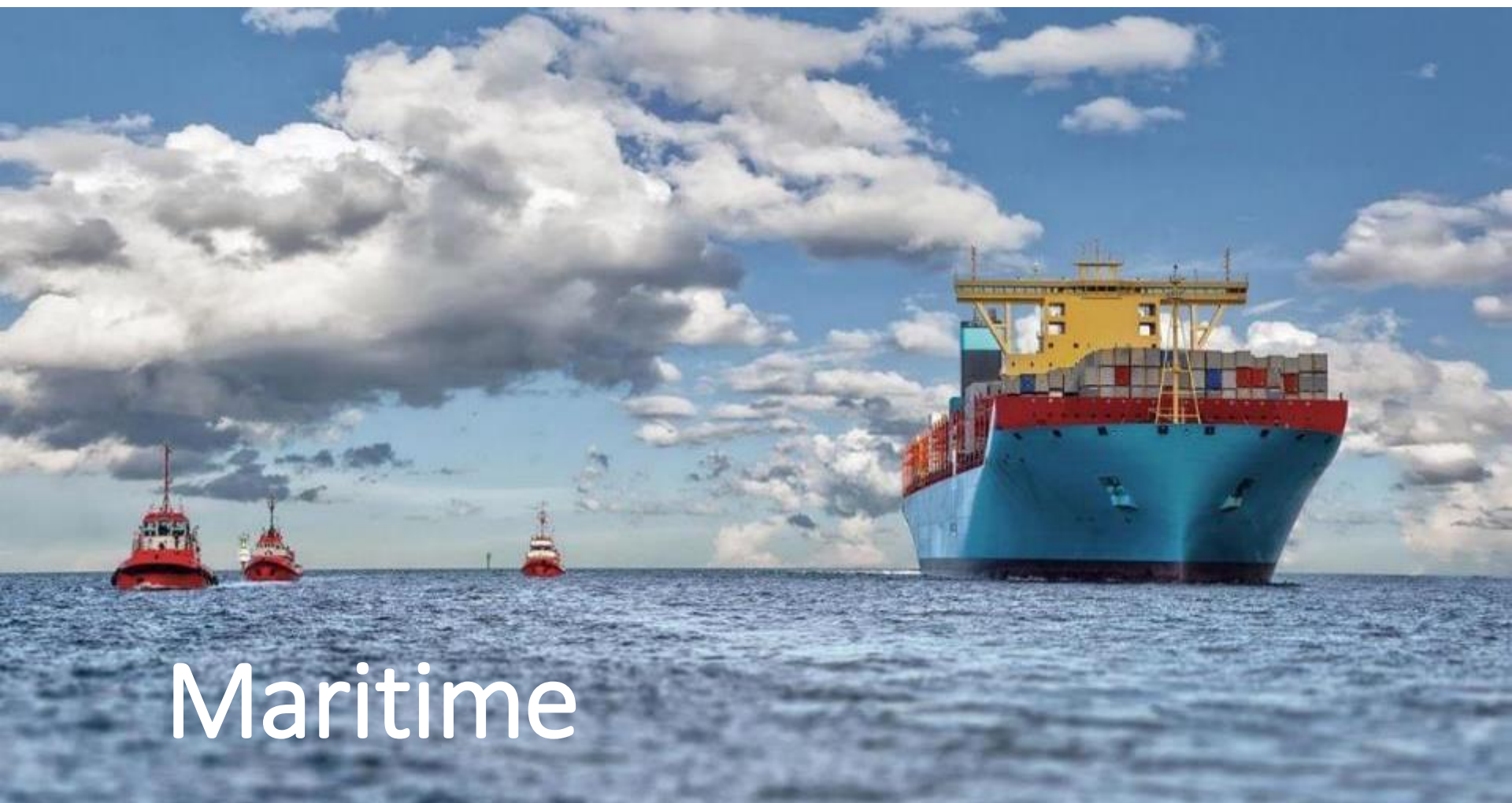


Rural environment



GNSS: Metre level accuracy, update rate can be compromised
Connectivity: Long range connectivity, bandwidth might be compromised

Galileo already present in more than 27% of receiver models suitable for UAV integration



Maritime



Maritime

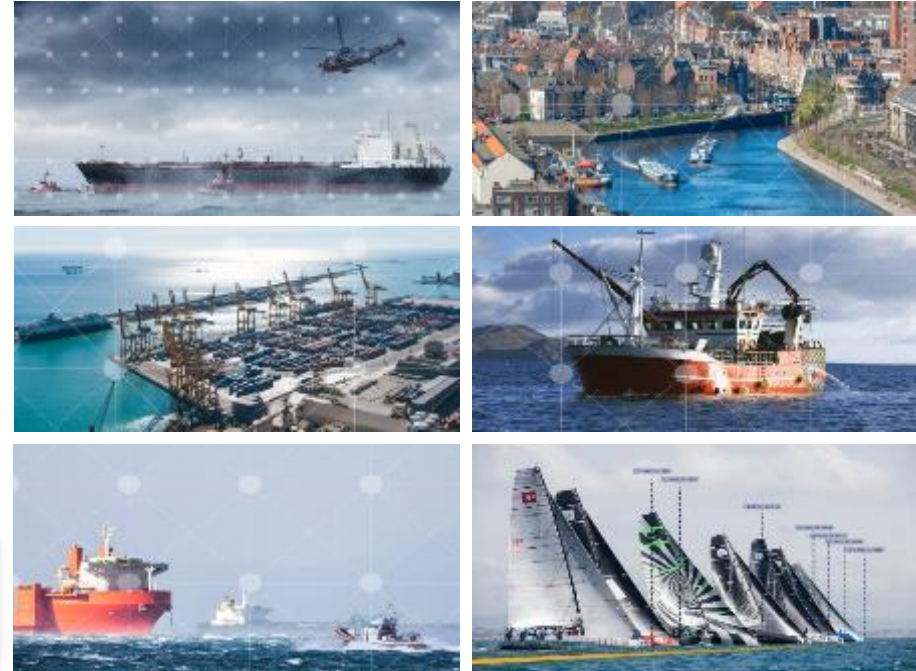


Navigation

- SOLAS/Non-SOLAS vessels
- Inland Waterways (IWW)

Positioning

- Search and Rescue (SAR)
- Traffic management and surveillance
- Port Operations
- Marine Engineering



Navigation and SAR are the applications with more GNSS Rx Shipments

- GNSS is the primary means of obtaining PNT information at sea.
- SAR beacon manufacturers are ready for the Return Link Service.

MARITIME ORGANIZATIONS

COMPONENT
MANUFACTURERS
(RECEIVERS AND
OTHERS)

SYSTEM INTEGRATORS

USERS

SURVEILLANCE
AUTHORITIES



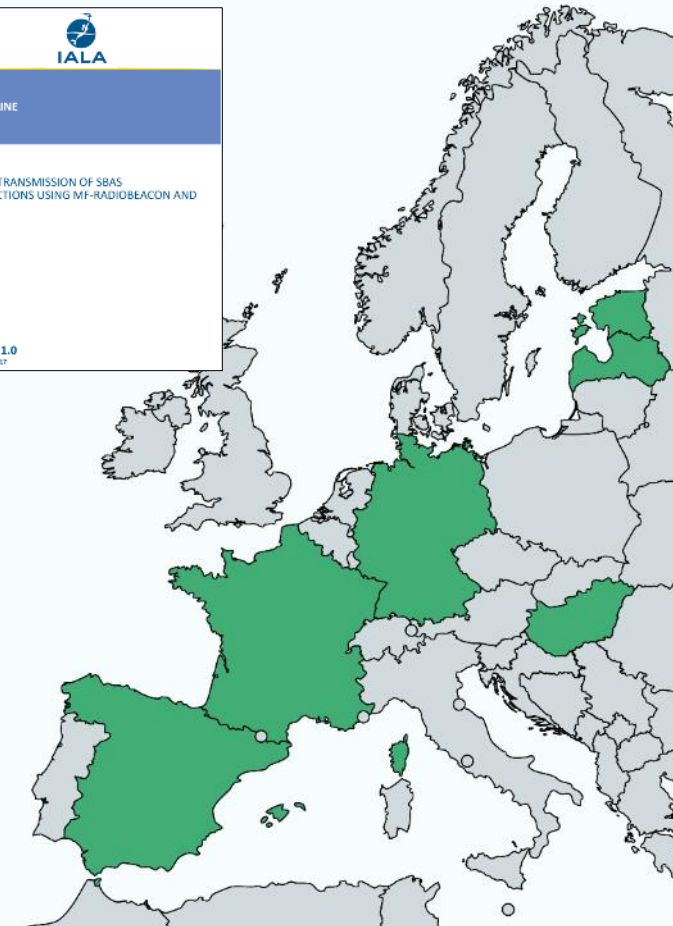
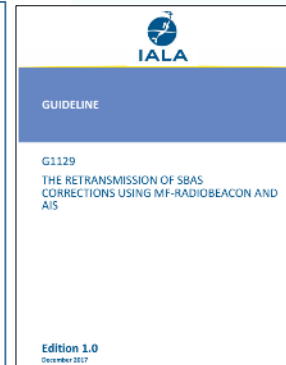
EGNOS in Maritime and Inland Waterways:

EGNOS contributes to resilient PNT, by providing a source of differential corrections



- ✓ IALA, with GSA contribution, published Guidelines for the use of SBAS as a source of differential corrections in IALA beacons and AIS stations to provide a DGNSS service.
- ✓ **6 Countries** have implemented this solution
- ✓ **All SOLAS vessels** in their waters can benefit from this service, with an IALA beacon Rx or a AIS Rx on board
- ✓ [Pilot Project website → egnosforaton.eu](http://egnosforaton.eu)

- ✓ 90% of manufacturers have a SBAS-enabled product
- ✓ **85% of GNSS receivers** are EGNOS enabled (not following specific standard for the use of integrity)





EGNOS as an enabler of resilient navigation: a stepwise approach



EGNOS complementing Differential GNSS shore infrastructure for inland and coastal waters (L1/2019)



EGNOS complementing Differential GNSS infrastructure providing integrity information for inland and coastal waters (compliant with IMO Res. A1046)

- Successful test campaign in Norway
- Ongoing test campaign in Finland

EGNOS enabled in shipborne receivers' models with integrity (L1/2022)

- SBAS Guidelines for shipborne receivers including tests specifications acknowledged by manufacturers and maritime authorities at RTCM.
- Ongoing proposal for standardization at IEC
- Kongsberg is implementing the guidelines in 2 commercial receivers



IALA DGNSS Stations in Europe

DFMC SBAS enabling safety of life applications and maneuvering in ports

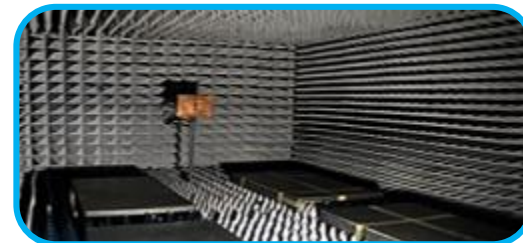




Galileo support to Navigaiton



- Galileo contributes to resilient PNT in a multiconstellation approach
 - ✓ *Galileo is recognised by IMO as part of the World Wide Radionavigation System, which allows its use in merchant shipping.*
 - ✓ *Galileo is available in 15% of receivers following a multiconstellation implementation with GPS at least. Most of them non-SOLAS.*
 - ✓ *IMO performance standards for SOLAS vessels Rx are published*
 - ✓ *IEC test standards for type approval for SOLAS vessels Rx are published*
 - ✓ *Testing Campaign with JRC with 5 manufacturers on-going to verify their readiness to get the type approval following IEC tests.*
- ✓ Galileo support to resilient navigation: Galileo shipborne receivers with authentication (DF/2023)





Rail



E-GNSS value proposition for rail applications

Safety relevant applications

Combination of E-GNSS with sensors for precise train positioning for use within ETCS Level 2 and Level 3 or with conventional communication technologies for other, non-safety relevant applications.

Non-safety relevant applications

Low traffic lines



Improve safety and reduce the cost of signalling (requires very few or no lineside infrastructure components)

Main lines



Reduce the number of physical balises and to improve the odometry accuracy

Asset/Traffic management



Improve monitoring of the railway assets both for operators and infrastructure managers

Improve the availability and accuracy of vehicle tracking

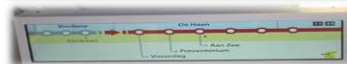
Cargo monitoring



Improve availability of the supply chain visibility information to the LSP/LSC:

- Georeferenced cargo status monitoring
- Corridor
- Geofencing

Passenger information systems



Improve accuracy and availability of positioning for on board passenger information systems



Galileo ramping up in traffic/asset management applications



- **250 TGV units** equipped by January 2019 in France with Galileo enabled receivers
- E-GNSS already supports SNCF passenger information traffic management within daily operations
- It is foreseen that the same system will be rolled out also beyond the core TGV high-speed network, reaching out to the main and low density lines





...and also in cargo tracking/logistics solutions

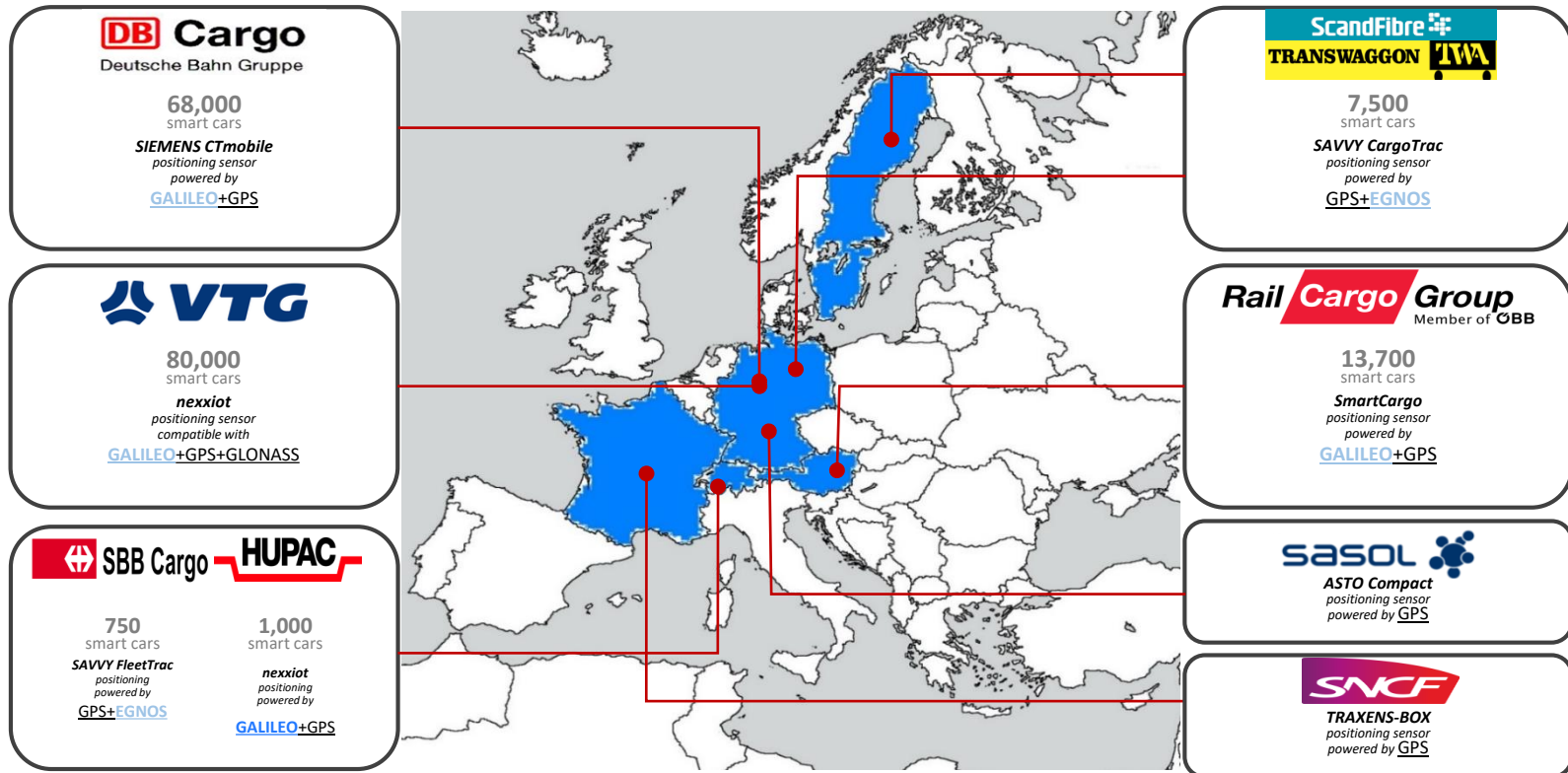


- **DB Cargo AG rail car fleet will be equipped** with smart sensors tracking on a continuous basis the rail car location and provide additional information about the load conditions
- **Galileo enabled chipsets will be used** to support the localization function of the telematics solution provided, improving availability and accuracy of the solution
- **Siemens Mobility AG** as supplier of the solution confirmed this to be so far the largest order for digitalization of rail car fleet (>30 000 **Galileo enabled receivers** already provided)
- Other providers like RailCargo Austria with approximately 13 000 wagons or wagonkeepers like TWR, VTG etc follow with Galileo functionality ready for the FOC





GNSS enabled cargo tracking overview





In rail signalling applications, the common objectives shared between GSA and Shift2Rail are to:



To coordinate the R&D and associated stakeholder initiatives leading towards **inclusion of European GNSS within ERTMS achieving:**

- end user satisfaction by providing the best possible, fully interoperable and stable solution
- overall reduction of ERTMS capital and operational expenditures
- improvement of flexibility and attractiveness of ERTMS for users in Europe and abroad



E-GNSS IN RAIL SIGNALLING ROADMAP



GNSS performance analysis

- Rail environment characterised and possibilities of European GNSS contribution to ERTMS evolution identified
- First set of requirements agreed by industry

Ongoing

System Architecture Definition

- Common agreed architecture of the GNSS based train positioning subsystem for ERTMS evolution delivered
- Independent cost benefit analysis performed

Launched in August 2019

System Deployment Definition

- Certification aspects of GNSS solution for low density lines analysed
- Demonstrator of the agreed architecture in preparation

Certification process for the Pinerolo/Sangone line opened within the H2020 ERSAT GGC project

2018

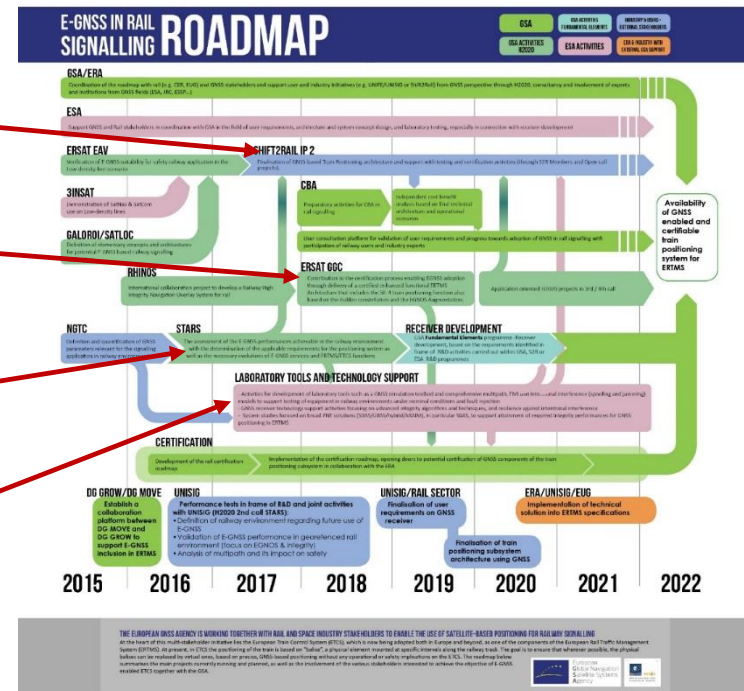
2019

2020

THE EUROPEAN GNSS AGENCY IS WORKING TOGETHER WITH RAIL AND SPACE INDUSTRY STAKEHOLDERS TO ENABLE THE USE OF SATELLITE-BASED POSITIONING FOR RAILWAY SIGNALLING

At the heart of this multi-stakeholder initiative lies the European Train Control System (ETCS), which is now being adopted both in Europe and beyond, as one of the components of the European Rail Traffic Management System (ERTMS). At present, in ETCS the positioning of the train is based on "balise", a physical element mounted at specific intervals along the railway track. The goal is to ensure that wherever possible, the physical balises can be replaced by virtual ones, based on precise, GNSS-based positioning without any operational or safety implications on the ETCS. The roadmap below the main projects currently running and planned, as well as the involvement of the various stakeholders interested to achieve the objective of E-GNSS enabled ETCS together with the GSA.







Public Transport



GNSS applications in public transport



ITS: Fleet management

Provides a clear overview of all buses and where they are located throughout the city/bus routes.

ITS: Passenger information

Provides real-time information to the passengers concerning the transport location and the estimated time of arrival at designated stops.

Driver advisory systems

Provides real-time information to the driver regarding the external and/or internal conditions of the vehicle to facilitate the decision-making regarding the optimal driving control of the vehicle.

Traffic signal prioritization

The system provides public transportation with green lights in order to keep the operations/traffic smooth-running and according to the schedule.

In-vehicle signage

A static or dynamic sign information is displayed to the driver without infrastructure interaction, just taking into account the localization and direction of the vehicle.

Floating vehicle data

Collection of localization, speed and time information produced by the vehicle's onboard devices to be used by service providers and infrastructure operators to produce traffic information.

• **GNSS application tasks**

- **Coordination of public transport fleet/traffic**
- **Provision of passenger information**
- **Gas emission reduction**
- **Scheduling and optimization of passenger travel**
- **React to real-time information**



E-GNSS value proposition for public transport applications



- Thanks to its **superior performance in urban environments** (improved accuracy, faster positioning fix) EGNSS fulfils urban transport requirements
- Being **interoperable and compatible** with GPS and most other technologies, EGNSS can be seamlessly integrated into the foreseen service offering
- Multi-constellation, EGNSS-enabled receivers (to be used on board buses, trams, cars, bicycles) are widely available in the market for **no or marginal extra cost**

Measurement campaign recently conducted by Faculty of electrical engineering - CTU in Prague



Importance of field testing:

Most important is the **continuous availability**
of a **sufficiently accurate** positioning
under **typical operating conditions**.



- Actual performance is never found in literature.
- Lab testing cannot cover all aspects.
Vehicle characteristics and environmental aspects affect the performance.
- The goal is to find the simplest and the most cost-effective solution for the particular problem.
- Results provide a sample of real operation performance.



Operational conditions are key influencing factor for GNSS success in urban conditions



Performance:

In the receiver datasheet:

- Open sky conditions
- Stationary receiver
- No interference
- Accuracy mostly specified as CEP
(50% is worse than the specified value)

In the public transport:

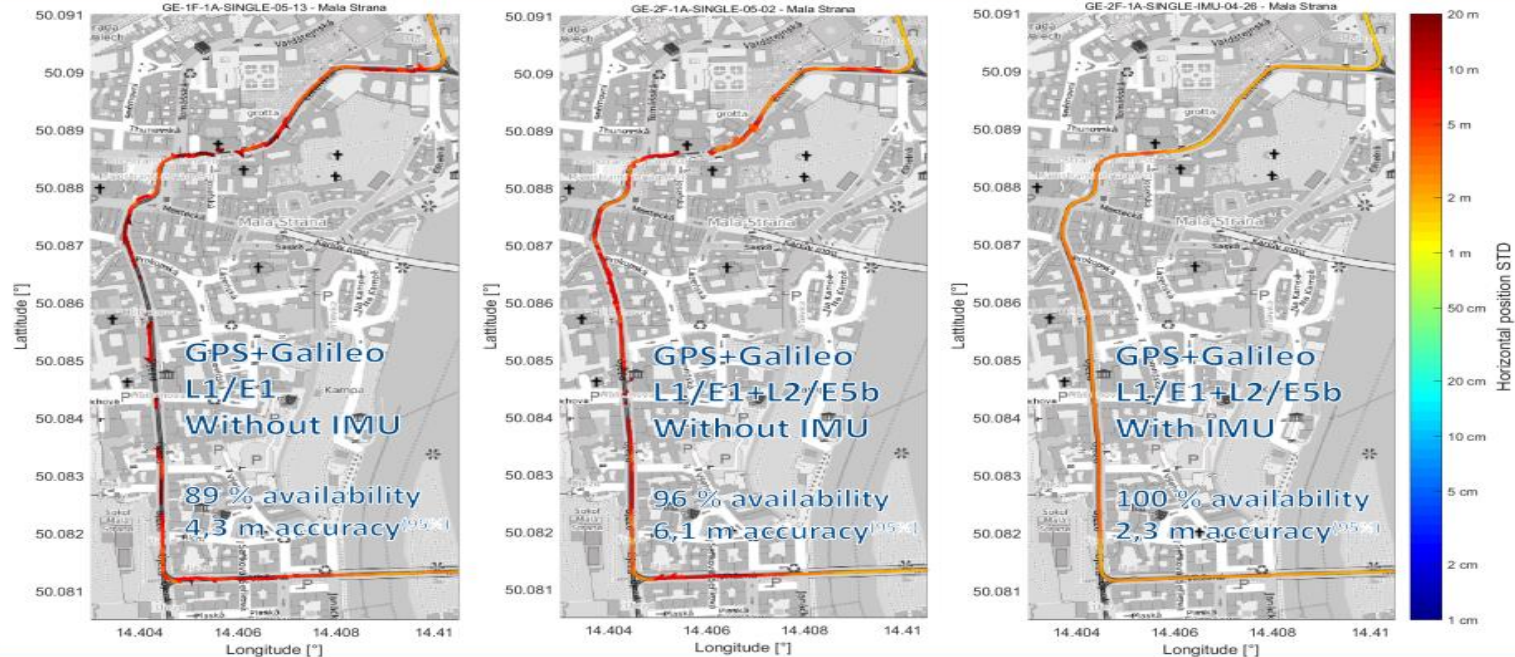
- Obstructed sky:
 - Not enough satellites
 - Multipath errors
- Moving receiver
- Vulnerable to interference
 - Interference from vehicle systems
 - Jamming (illegal, but possible)
- At least 95% confidence of the information is required



Multi-constellation combined with IMU provided so far best results fit for purpose



Performance in dense urban area



Prague; 2019/06/25

V. Navrátil, F. Vejražka, J. Svatoň
Tests of GNSS performance on trams in Prague public transport



How to improve applications performance within public transport



Public transport operators need to ask from the solution providers:



- **Multi-constellation receivers supporting GPS L1 and Galileo E1 as a minimum** to achieve improvements in positioning availability and accuracy
- **Dual frequency support GPS+Galileo L1/E1/L5/E5** (optional - in case of need for further improvement of positioning accuracy, especially with regards to multipath)
- **SBAS L1: EGNOS** in case of increased requirements towards positioning integrity and accuracy



- Tailored position paper from GSA available for public transport authorities and operators
- Possibility of consultations with GNSS experts

Road



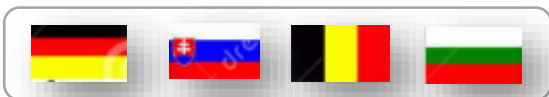


Galileo is used today in the majority of professional devices and consumer platforms



Commercial vehicles

72% from the EU total tolled roads (+79,000 Km) correspond to a GNSS-based scheme



Soon: Bulgaria, Czech Republic, Sweden, Greece, Poland...



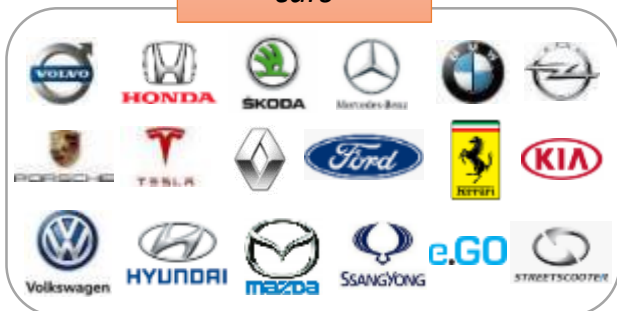
EU Regulations

Smart Tachograph regulation mandates EGNOS and Galileo to control driving time **from Jun.2019**

Updated EETS Directive mandates EGNOS and Galileo in free-flow tolling using satellite positioning in EU **from Oct.2021**

- **1.48 Million EGNOS** (71% of total GNSS)
- **1.28 Million Galileo** (62% of total GNSS)

Passenger cars



eCall regulation (EU) mandates EGNOS and Galileo in every new type of car/van sold in Europe **from Apr.2018**

18 car brands, +25 models

- **3 Million vehicles** (end-2019)

Soon: Galileo being tested in 25 Autonomous Vehicle's prototypes worldwide



Galileo new features are crucial for Autonomous Driving



- GNSS is crucial **to get decimetre/centimetre-level** absolute location and **timing synchronization** in combination with inertial navigation, odometry, HD maps, Machine-Learning and Artificial Intelligence.



High Accuracy service will bring a decimeter level error ($\approx 20\text{cm}$):

- *based on the Galileo E6b signal*



- The UN World Forum for automotive regulations declared the need of clear **cybersecurity rules**, and GNSS authenticated messages are recommended.



Authentication service will detect interference (spoofing) attacks:

- *Galileo E1 Navigation Message Authentication*
- *Galileo E6 Spreading Code Authentication*



BMW and General Motors/Cadillac autonomous vehicles models expected in 2021 will be Galileo compatible



... and the key European car makers (Mercedes-Benz, Fiat-Chrysler, Scania, Renault, Volkswagen, Volvo...) confirmed the interest to test the Galileo High Accuracy and Authentication once available

Horizon 2020 Framework Programme for Research & Innovation



New Call: EGNSS market uptake 2020

H2020-SPACE-EGNSS-2020



Type of Action	Topic	Indicative budget (EUR mln)	Funding rate
IA	EGNSS applications fostering green, safe and smart mobility	10	70% (except for non-profit legal entities, where a rate of 100% applies)
IA	EGNSS applications fostering digitisation	4	
IA	EGNSS applications fostering societal resilience and protecting the environment	4	
PCP	EGNSS applications for public authorities' pilot	3	90%

Special PCP session tomorrow

Opening: 05 November 2019
Deadline: 05 March 2020

Overall ind. budget: 21 mln EUR

IA: activities aimed at producing plans and arrangements or designs for new, altered or improved products, processes or services
PCP: Pre-Commercial Procurement actions aim to encourage public procurement of research, development and validation of new solutions that can bring significant quality and efficiency improvements in areas of public interest, whilst opening market opportunities for industry and researchers active in Europe. It provides EU funding for a group of procurers ('buyers group') to undertake together one joint PCP procurement, so that there is one joint call for tender, one joint evaluation of offers, and a lead procurer³ awarding the R&D service contracts in the name and on behalf of the buyers group.

LC-SPACE-EGNSS-1-2019-2020:

EGNSS applications fostering green, safe and smart mobility



Scope: Proposals should contribute to **efficient, climate and environmentally friendly transport** that will be **safe and seamless for all citizens**

Aviation

Advanced navigation



CNS



Air Traffic Management



Unmanned vehicles



Road

Connected and autonomous vehicles



eCall



Cooperative ITS



Mobility as a Service



Maritime

Vessel navigation & Traffic Management



Port operations



Fisheries



Autonomous vessels



Rail

Train signalling/control



Passenger-crew services



Autonomous trains



Multimodal logistics



Innovation Action

Project Indicative funding: 1 to 3 MEur - Total 10 MEur

Previous projects: have a look on GSA Web Site

Linking space to user needs



Get in touch:



www.GSA.europa.eu



EGNOS-portal.eu



GALILEO

GSC-europa.eu



UseGalileo.eu



The European GNSS Agency is hiring!

Apply today and help shape the future of satellite navigation!

