E-GNSS enabled market opportunities in transport

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IGAW 2017, June 21st 2017, Rome

This presentation can be interpreted only together with the oral comments accompanying it.
E-GNSS Management structure

Political Oversight

Programme Oversight and Programme management

European Council and Parliament

European Commission

GNSS Programme Committee; H2020 Programme Committee

European Space Agency (ESA)

European GNSS Agency (GSA)

Ensuring the Security of the EGNSS

Exploitation of Galileo

Exploitation of EGNOS

Market Development: supporting the use of EGNSS

Execution

IOV Contracts

FOC Contracts

Upstream (space) industry

Downstream (applications) industry
GSA integrated market development continues...

**DOWNSTREAM VALUE CHAIN**

**MARKET SEGMENTS**
- Road
- LBS
- Aviation
- Rail
- Maritime
- Agriculture
- Surveying & Mapping
- Timing & Synchronization
- Governmental

**Bodies influencing the market**

**Navigation Signal Providers**

**Chipset, receiver**

**Devices**

**Content & Apps**

**Service providers**

**Understand market and user needs and satisfaction**

**Stimulate**

**DEMAND & ADOPTION**

- EGNSS added Value
- Cooperate with receivers and apps developers
- Roadmaps with stakeholders
- Support EC policies

**Support EU**

**COMPETITIVE OFFER**

- of Services, applications
- and receivers

**Fundamental Elements**

**User Satisfaction**

**E-GNSS USER ADOPTION**

**EU PUBLIC BENEFITS**
Overall User Satisfaction improved vs. 2015:

- **EGNOS support services** satisfaction of **81.30%** (76.91% in 2015)
- **EGNOS services** satisfaction of **81.01%** (77.15% in 2015)

### Yearly EGNOS User Satisfaction survey objectives:

- Monitor perceived User Satisfaction
- Identify areas for improvement and possible new user requirements

### Overall representativeness of respondents:

- **186** unique respondents from **35** countries
- From all market segments:
  - Aviation, Road, Maritime, Rail, LBS, Agriculture and Surveying
  - Aviation users are the majority since they are the primary target

### RESULTS

**User support improvement process**

**Preparation for 2017 survey**
...and targeting Galileo User satisfaction

2016 Galileo Service Center User Satisfaction Survey results

- Responses from 18 countries, more than tripled vs. prior survey
- Good general feedback: average score 7.2/10.
- Room for improvement: Web Portal contents
- Next survey expanded focus: Galileo Initial Services

Scores follow the convention: very good corresponds to 10; good corresponds to 7.5; average corresponds to 5; poor corresponds to 2.5; and very poor corresponds to 0
Agenda

Where we are today
…in E-GNSS Transport market segments and applications

**Rail**
- Train signalling/control
- Passenger information
- Asset management
- Multimodal logistics

**Aviation**
- Advanced navigation
- CNS and ATS
- Unmanned vehicles
- Search and rescue

**Road**
- Autonomous vehicles
- eCall
- Connected Cars
- Digital tacograph
The GNSS Rail market has an attractive growth ahead

KEY MARKET AND TECHNOLOGY TRENDS

- Growing interest in GNSS use for rail applications
- Combination of GNSS and other technologies is starting to offer the required performance
- OPEX savings in comparison with legacy systems will play a major role in driving future demand for GNSS
- GNSS systems are predominantly used for non-safety related applications

- Safety related GNSS systems are expected to complement traditional rail technologies
- The use of GNSS for signalling and train control will generate benefits for the whole rail industry (e.g. PTC is already starting to influence the industry core revenue)
- Emerging applications combining Positioning and Navigation with Earth Observation data
The GNSS Aviation market is growing especially in GA and BA

**KEY MARKET AND TECHNOLOGY TRENDS**

- **Performance Based Navigation** is driving transition from traditional routing to GNSS navigation
- **SBAS based procedures availability** is growing in Europe
- **Multiconstellation/ Multifrequency GNSS solutions and ARAIM** are enabling advanced required navigation performance, aerodrome manoeuvring, GBAS CATII/III and space based ADS-B
- **GNSS is increasingly being used in surveillance applications** through technologies like ADS-B, complementing radar technology
- **GNSS enabled ELTs/ PLBs are becoming essential for the COSPAS-SARSAT Search & Rescue system**
- **GNSS** is supporting **recreational pilots** using VFR with moving maps, infringements alarms and increasing also their operational awareness
- **Unmanned Vehicles Systems**: an emerging and promising market estimated CAGR of 52%, thanks to their need for precise positioning and orientation

*RUC = Road User Charging** *The Core Revenues, for multi-function devices such as smartphones, include the value of GNSS functionality only and service revenues directly attributable to GNSS functionality, The Enabled Revenues represent the revenue from services and devices enabled by GNSS*
The GNSS Road market shows different dynamics by application

**Worldwide GNSS Market in 2017**
- **Installed base by Application:**
  - 376 M.units
  - Core Revenue: 49.5 €B
- **Core Revenue by Application:**
  - North America: 25%
  - Asia-Pacific: 33%
  - Middle East + Africa: 3%
  - EU28: 30%
- **Core Revenue by Region:**
  - Europe: 52%
  - North America: 41%
  - Middle East + Africa: 7%
  - Asia-Pacific: 27%
  - South America: 15%
  - Non-EU28 Europe: 3%
  - North America: 5%

**Worldwide GNSS Installed Base Evol. '17-'21**
- **Installed base by Application:**
  - 376 M.units
  - 610 M.units
- **Core Revenue by Application:**
  - Core Revenue: 49.5 €B (2017) to 68.6 €B (2021)
- **Compound Annual Growth Rate:** 12.9%

**Key Market and Technology Trends**
- **Personal Navigation Devices** are going out of market
- **Publicly managed applications** (e.g. eCall, Digital Tachograph) will bring communication and positioning platform on all vehicles, enabling connectivity
- **In-vehicle systems** are growing due to more affordable prices and increasing demand for infotainment services
- **Automation / Assisted driving** will grow but based on existing platforms, first step toward autonomous vehicles
- In the near future, an architectural convergence is expected among In-Vehicle Systems, that will need more **reliable and accurate positioning** to serve new applications
- Emerging apps. combing Navigation and Telco. (e.g. 5G, Cooperative ITS)

**Legend**
- In-Vehicle System (IVS)
- RUC
- ADAS
- Smart Tachograph
- Connected vehicles
- Map software updates
- Personal Navigation Device (PND)
- Insurance telematics
- eCall
- Fleet Management Systems
- Smartphone navigation apps
Key trends in transport applications call for a significant E-GNSS contribution

**Rail**
- GNSS is becoming a generic system widely used in non-safety relevant applications
- GNSS begins to be implemented also for safety relevant applications with different maturity depending on the region, e.g. in India, China and the Middle East

**Aviation**
- The aviation market continues to grow worldwide with reliance on GNSS increasing
- Rotorcraft operations are currently rapidly expanding their use of SBAS
- Galileo SAR is going to play a key role in aircraft distress tracking and will enable increased performance through use of multi-constellation

**Road**
- E-GNSS, together with other technologies, is a key answer to Autonomous Vehicles’ need of accurate positioning combined with reliability of localisation
- EU legislations such as eCall is expected to boost shipments of GNSS devices
- New business models are emerging within Mobility as a Service concept
2017 objectives in Transport

**Aviation:**
- Reach 470 EGNOS-based approach procedures in 250 airports
- Coordination with SAR beacons manufacturers to meet ICAO requirements for flight tracking based on Galileo

**Road:**
- Understand the technical requirements and potential scenarios in autonomous driving
- Accelerate E-GNSS adoption before eCall regulation entry into force

**Rail:**
- Results of E-GNSS performance tests endorsed by the rail signalling European suppliers
- Requirements on E-GNSS receivers defined
- Roadmap for E-GNSS adoption in safety relevant applications updated
The future Mobility: E-GNSS addressing emerging market needs

Emerging market needs

- Development of autonomous driving will require better accuracy and reliability, possibly authentication
- Emergency services will bring another GNSS platform in the car
- Car connectivity will decrease the importance of reducing time to first fix, since assistance data will be provided via the network
- Regulated transport will strongly influence the evolution of GNSS, being in the centre of the navigation and positioning solutions on the route, demanding high integrity and robustness
- Multimodal transport applications will continue using GNSS as main source of geolocation, supported by indoor means for relative positioning

E-GNSS challenges

- Accuracy would have to be improved to decimetre level to enable full autonomous driving
- Better continuity in urban canyons would have to be ensured
- Integrity level of E-GNSS, not meeting today the required level for many safety-critical applications such as train positioning, would need to be improved
FE on-going receiver project ESCAPE: E-GNSS engine for safety-critical automotive functions

Aligns ESCAPE with Renault's Autonomous Vehicle project integrating GNSS + Cameras + CANBUS

Advanced Galileo Rx and Roadmap for multifrequency

Additional Key Assets: Standardization, Safety, Engineering + Business model

ESCAPE: European Safety Critical Applications Positioning Engine

Consortium

ST Microelectronics

IFSTTAR + Renault + GMV...

Industrialization +

Advanced Galileo Rx +

Advanced Telematic Unit (TCU)

Advanced GNSS technology: PPP + Integrity (KIPL) + ...

FICOSA

Renault + UTC + Prof. Quddus

Autonomous Vehicle +

Autonomous Vehicle integrating GNSS + Cameras + CANBUS

Fundamental Elements

http://www.gnss-escape.eu/
H2020 applications are backbone of GSA integrated market approach

ERSAT EAV
Verification of E-GNSS suitability for low density line train positioning

The main ERSAT EAV objective is to verify the suitability of EGNSS as the enabler of cost-efficient and economically sustainable ERTMS signalling solutions for safety railway applications.

ERSAT EAV project delivered:
- Solution for low density line signalling based on virtual balise concept
- Operational demonstration at test line in Sardinia
- EGNOS / TAAN based integrity solution for ensuring applicability of the GNSS based positioning in rail from the safety perspective

Successful demonstration with participation of key institutional stakeholders – EUAR, UIC, RFI, ESA, S2R, and GSA
H2020 applications are backbone of GSA integrated market approach

**INLANE**

Low Cost GNSS and Computer Vision Fusion for Accurate Lane Level Navigation and Enhanced Automatic Map Generation

*InLane* is working on the fusion between computer vision and GNSS technologies in order to achieve the required level of positioning that **allows the safe operation of autonomous vehicles.**

InLane is a solution for **mass market** towards:

- Lane Level Navigation in public roads
- Local Dynamic Map generation
- High Precision Cartography generation
- Crowdsourced map updates

**PROTOTYPES- developments ongoing:**

- **In-vehicle computer:** navigation system / driver assistance / Autonomous Driving
- **Aftermarket device:** navigation system / driver assistance
- **Smartphone:** navigation system / driver assistance
Agenda

Where we want to be and why
E-GNSS targets by 2020

**Rail**
- EGNSS adopted in ERTMS specifications
- EGNSS based solutions for railway signalling available on low density lines

**Aviation**
- EGNOS-based LPV to all non precision approach runway ends
- GNSS devices to reach 90% penetration in worldwide installed base (76% today)

**Road**
- E-GNSS enabled in all new vehicles models sold in Europe
- E-GNSS enabled in 2 million heavy trucks (e.g. Smart Tachograph, RUC)

*RUC = Road User Charging**

The Core Revenues, for multi-function devices such as smartphones, include the value of GNSS functionality only and service revenues directly attributable to GNSS functionality. The Enabled Revenues represent the revenue from services and devices enabled by GNSS.
Monitoring technology....

Multi-constellation for more availability of the signals

Multi-frequency for better accuracy of the position

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Supported constellations by GNSS receivers

- All
- GPS + Galileo + GLONASS
- GPS + Galileo
- GPS + Beidou
- GPS + Galileo + Beidou
- GPS + GLONASS

- Shows percentage of receivers capable of tracking 1, 2, 3 or all the 4 GNSS constellations

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Supported frequencies by GNSS receivers

- All
- L1/E1 + L5/ES
- L1/E1 Only
- L1/E1 + L2 + L5/ES
- L1/E1 Only

- Shows percentage of receivers capable of tracking 1, 2, 3 or all the 4 frequencies
...riding the wave of market and technology drivers...

GNSS contributes to a rapidly diversifying range of technologies and applications

**Internet of Things**
- Locating objects
- Synchronising networks

**Big Data**
- Geo-referencing data

**mHealth**
- Disability assistance
- Patient monitoring

**Augmented Reality**
- Link between surrounding reality and digital objects

**Smart Cities**
- Supporting infrastructure design and mobility

**Multimodal Logistics**
- Asset monitoring
- Theft risk reduction
... in order to provide E-GNSS answers to priority positioning needs

1) Ubiquitous positioning
The ability to choose the optimal combination of sensors and networks to become environment-independent

2) Automation & ambient intelligence
Sufficient reliability to enable autonomous operations* by sensing the environment and adapting to it in real time
* driving, sailing, parking, landing

3) Security
If the positioning system knows where you and your assets are at all times, it better keep this information to itself

Security is also understood as robustness and resistance to external interferences.
Agenda

How to get there
In Rail, the accent will stay on safety relevant applications

• Work with key stakeholders **within the agreed roadmap for E-GNSS adoption within ERTMS:**
  • to define requirements on E-GNSS receivers in the challenging railway environment support design of train positioning system architecture, leveraging work with UNIFE (results by 2017)
  • cooperate with EC and associations to **foster the role of E-GNSS in the evolutions of ERTMS**

• Support EC in the **certification of E-GNSS receivers** as a component of the **train positioning subsystem**: a study was launched in Jan 2016

• Support the definition of service provisioning scheme for rail safety relevant applications

• **Support the establishment of E-GNSS enabled asset and cargo tracking solutions** for positioning of rail as a key player in the future European multimodal transport

The timing is dependant also on factors not completely under GSA control
Rail: E-GNSS adoption roadmap in Signalling

Rail roadmap developed with active involvement of main stakeholders interested in European GNSS potential in railway signalling applications is leading towards inclusion of E-GNSS into ERTMS.

Stakeholders currently involved in the process are:

- EC (DG MOVE, DG GROW)
- ERA
- UNIFE
- UNISIG
- CER
- ESA
- ESSP

Roadmap is available for download at the GSA Rail segment website.

The timing is dependant also on factors not completely under GSA control.
### Aviation: continued support to user communities and regulatory framework development

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<tr>
<th>User needs collection and sharing</th>
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<tr>
<td>• Partnership with <strong>user communities</strong> to address user needs</td>
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<tr>
<td>o Business Aviation user fora to guarantee EGNOS wide use for PBN at regional airports in Europe</td>
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<tr>
<td>o Rotorcraft working group to harmonize implementation of EGNOS based rotorcraft operations</td>
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<th>Towards the value chain</th>
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<tr>
<td>• Preparation and dissemination of <strong>Cost/Benefit Analysis for Operators and Airports (navigation and surveillance)</strong></td>
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<th>Support to regulation</th>
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<tr>
<td>• <strong>Contribution to regulation</strong> (e.g. PBN in the European Air Traffic Management Network; LPV to non instrument runways; pilot training; surveillance performance and interoperability requirements…)</td>
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<tr>
<td>• Contribution to the <strong>development of the regulatory framework for the drones operations</strong></td>
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<th>Funding for adoption &amp; R&amp;D</th>
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<tr>
<td>• <strong>Funding</strong> for EGNOS based approach procedure/operators (2 calls of 6 million € each 60% of eligible costs are ongoing)</td>
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<tr>
<td>• <strong>New applications development and validation via R&amp;D</strong></td>
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<tr>
<td>• <strong>DFMC SBAS receiver prototyping</strong> and contribution to standardization</td>
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<tr>
<td>• ELT-DT (Emergency location transmitter – distress tracking) using GALILEO SAR RLS prototyping and contribution to standardization</td>
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*The timing is dependant also on factors not completely under GSA control*
Road: facilitate further adoption through legislation and focus on liability critical applications

1. **E-GNSS enabled in all new vehicles sold in Europe**
   - All cars and vans equipped with EGNOS and Galileo from 2018:
     - 2017: Support policy driven applications by designing technical specifications and test plans
     - 2018: Support industry for the implementation (pre-testing, experts groups to discuss tests procedure and results, etc.)
   - All trucks will be equipped with EGNOS and Galileo from 2019:
     - 2017: Design technical architecture and specifications in relation to Galileo differentiators
     - 2019: Understand stakeholders needs and fine tune accordingly regulated technical req.

2. **European GNSS as the core element for navigation**
   - Create a E-GNSS based “certified” engine (receiver + software/firmware + vehicle interfaces) for liability/payment critical and for safety critical applications:
     - 2019: Work with stakeholders to understand the performance and certification needs

3. **New businesses in Europe**
   - 2017: Coach and leverage results from FP7 and H2020
   - 2018: H2020 projects: 9.5M€ from 1st and 2nd calls
   - 2019: Safety critical apps: 5M€ Fundamental Elements project

The timing is dependant also on factors not completely under GSA control.
Thank you

Gian Gherardo Calini, Head of Market Development
The European GNSS Agency (GSA) today:

- Staff: about **145**
- Nationalities: **21**
- Headquarters: **Prague**
  (since September 2012)
- Other Locations: St Germain en Laye, Toulouse, Swanwick, and Torrejon