Developing GNSS for the rail industry
GNSS? What are we talking about?

- Global Navigation Satellite System

https://www.gsa.europa.eu/galileo-your-pocket
What are their uses in operational rail today?
Challenges & EU context

With GNSS

- Reduce costs
- Boost competitiveness
- Increase safety
The ERTMS framework

Positioning in ERTMS

1. ETCS
   European Transport Control System
   Signalling – automatic brake – speed control

2. GSM-R network
   Communication system
   track vs. train

**ERTMS**
European Rail Traffic Management System

**Balise ETCS @Infrabel**

\[ X_{\text{balise}} \]
\[ X_{\text{balise}} + d \]

\[ \text{odometry} \]

\[ \text{error} \]

\[ \text{distance} \]
The virtual balise concept

Virtual balises positions

Picture source: NGTC Network of End Users, Prague 7.7.2016
What are the expected benefits?
Expected benefits

“The ERSAT Galileo Game Changer”, Presentation from RFI, Trenitalia, Ansaldo STS, Milan March 2018

**Technical benefits**

- **Availability** of the on-board Signalling System (eliminate failures of balises, problems with the on-board antenna, cable connections...)

- **Reliability** of Signalling System on-board odometry (slipping/sliding wheel)

**Trenitalia long term expectations from ERSAT GGC**

- **Reduction of** investment and maintenance costs. (removal of track based train detection systems)

- Modernise signalling system at **lower costs** to **ensure sustainability**, according to the European scale numbers.

- Guarantee a real and **long-term interoperable European standard**.

- **Improve capacity** of transportation networks extending ERTMS system on **secondary lines and urban nodes**.

- **Minimize Impact** on Operational Rules.
What are the challenges?
What kind of issues with GNSS?

Local phenomena

- Lower service availability
- Decreased accuracy
- Local error models, that differ from aeronautics and make complex transferability of the concepts (integrity monitoring)

Local effects have not been addressed so far by the aviation community
GNSS Quality criteria

Identify GNSS SIS quality criteria, qualify, quantify…

Interferences

States of reception

Satellite visibility

Geometry of visible satellites…
In a « moving » environment (train, satellites, time)…

- Interferences?
- Reflected signals?
- multipath?
- masking
- Optimal conditions of SIS reception
Where are we?
Where are we?

Past EU projects, since the 2000s

E-GNSS IN RAIL ROADMAP

- **GSA/CRA**
  - Support for #GNSS and Rail stakeholders in coordination with GSA in the field of user requirements, architectures and system concept design, and laboratory testing, especially in connection with receiver development

- **EUTELSAT**
  - Demonstration of #Satellite & #SatCom use on Low-density lines

- **ERSAT**
  - Verification of #GNSS reliability for safety rail applications in the #Emergency for #Europe,

- **E/NIR**
  - Development of #GNSS satellite positioning architecture

- **SNCF**
  - Demonstration of the #GNSS performance in the railway environment with the determination of the applicable requirements for the positioning system, as well as the necessary evolution of #GNSS services and #GNSS/RTK#satellite

- **B/ER/ES**
  - Development of an infrastructure to support #GNSS receiver development

- **C/ER/US**
  - Certification of the rail #GNSS receiver development

- **G/ER**
  - Implementation of the certification roadmap, opening doors to potential certification of #GNSS components of the train positioning subsystem in collaboration with the #GNSS

- **E/ER/US**
  - Implementation of #GNSS technical solution into #GNSS specifications

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**2015**
- **UNIG**
  - Performance tests in frame of #R&D and #Joint activities with #UNIG (#GNSS and #Civil$^*$)
    - Definition of railway environment regarding future use of #GNSS
    - Validation of #GNSS performance in geographical specific environment (focus on #GNSS $^*$ integrity)
    - Analysis of multipath and its impact on safety

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**2016**
- **UNIR/RAIL SECTOR**
  - Finalization of # user requirements on #GNSS receiver

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**2020**
- **E/ER/US**
  - Implementation of #GNSS technical solution into #GNSS specifications

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www.ifsttar.fr
GNSS-related issues

**Evaluate**
- Develop the tools
- Prepare standards and certification framework

**Characterize**
- Experiment
- Model
- Simulate

**Develop**
- Mitigate local effects
- Mitigate interferences

**S2R Target:** « zero on-site testing »

**Definition of certified standard process, methodology and toolset for classifying track areas for locating VB**

**DB4RAIL SBSRail-2**
GALILEO will be operational

- STARS
- ERSAT GGC

2016

2018

2020

2022

2017

2019

2021

ERTMS L3

WP3: FAIL SAFE TRAIN POSITIONING (INCLUDING SATELLITE TECHNOLOGY)

Operational line by 2020 (ERTMS L2)
Pinerolo – Sangone (It)
GNSS is becoming a game-changer in safety and non-safety critical applications.

SIA project (2018-2021) → information about the health status of the railway’s most demanding assets in terms of maintenance costs (wheel, rail, pantograph and catenary)

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SNCF ambition for 2023

Enhanced odometry
Full GNSS-based-signalling capabilities (with cost savings) for LDL
Conclusions

Cumulative Revenue 2015-2025 by segment

- LBS: 43.4%
- Road: 50.0%
- Other: 6.6%
- Agriculture: 1.3%
- Surveying: 2.6%
- Aviation: 0.7%
- Maritime: 0.7%
- Drones: 0.5%

Rail: 0.1%

Publication 2017

https://www.gsa.europa.eu/2017-gnss-market-report

« Fail-safe positioning solution »
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