# ERSAT GGC

## ERTMS on Satellite
## Galileo Game Changer

# FOREWORD

The deployment of ERTMS in Europe is a priority and commitment of the rail community having guaranteed since its inception the highest safety levels and the interoperability of the railways across Europe. The ERSAT-GGC (ERtms + SATellite Galileo Game Changer) innovation project represents a fundamental contribution for improving the economical sustainability of the ERTMS system and to incentivizing the deployment on the local and regional lines. The proposed innovation changing steps along the roadmap for the evolution of the ERTMS are the train positioning by using the Global Navigation Satellite Systems (GPS and Galileo) and the multi-bearer public telecom services.

ERSAT-GGC, H2020 funded project from European GNSS Agency (GSA), is executed by 14 partners across Europe, representing the whole value chain: railway infrastructure managers, railway undertakers, notify bodies, GNSS research centres, ERTMS manufacturers and ERTMS test laboratories. The goals are to consolidate the Enhanced ERTMS Functional Architecture capable of using the GNSS Positioning and Public Radio TLC Technologies, already defined in the previous European R&D projects, and to pave the way for the certification process for a first operational deployment on the Pinerolo Sangone line selected by RFI. The project tasks include the Hazard Analysis, a test suite to validate the new systems implementing the Enhanced Architecture, and the definition and implementation of a process to classify the track areas as suitable for locating Virtual Balises with respect to the critical railway local phenomena (e.g. NLOS, multipath, Radio Frequency Interferences). A final independent assessment by the notify bodies is performed on all the outcomes of the project, to guarantee their full compliance with all applicable standards and norms and to lay the foundations for the certification process.

ERSAT-GGC will lead to significant economic benefits for the Railways Infrastructure Managers and Train Operators, spanning from a reduction of trackside equipment and maintenance costs to an increase of availability and performance of the functional operation scenarios, i.e. commercial service.

This leaflet summarizes the ERSAT GGC achievements and proposals for further activities along the roadmap of future linked R&D projects to provide a contribution into the large-scale deployment of the ERTMS with satellite positioning and, possibly, public TLC networks.

## MAIN RESULTS

**1** The Enhanced ERTMS Functional Architecture, suitable for the introduction of the GNSS Positioning technology and of the IP based Public Mobile Radio Networks, has been consolidated confirming the Virtual Balise as a cost-effective and low-impact solution for the introduction of the GNSS positioning in the railway environment through the ERTMS framework

**2** The specification of the related Functional and Non Functional Tests have been defined. It allows the validation of the new ERTMS systems obtained by the instantiation of the Enhanced ERTMS Architecture

**3** The safety of the Enhanced ERTMS Functional Architecture has been confirmed by both a qualitative and a quantitative Hazard Analysis

**4** The local hazard causes impacting on the GNSS positioning in the railway environment have been investigated, and a procedure for the classification of track areas as suitable or not suitable for the Virtual Balise placement has been defined

**5** A toolset for the classification of the railway lines in terms of hazard causes impacting the GNSS positioning has been implemented

**6** The Enhanced ERTMS Functional Architecture, the related Hazard Analysis, and the toolset for the track areas classification have been assessed by the Notified Bodies. The architecture and toolset will lead to the release in operational service of the first RFI railway line by RFI

**7** A demonstrator for the classification process to locate virtual balises has been produced in the Cagliari – San Gavino

**8** Three test campaigns have been completed in representative lines (Italy, France and Spain) to get the data that feeds the classification tool.

## EXPORTED ISSUES

The ERSAT-GGC project has proposed an extension of the ERTMS functional architecture suitable for the Virtual Balise implementation that minimizes the modification to the existing ERTMS principles. The results of the ERSAT-GGC project play an important role both in the implementation of the Rete Ferroviaria Italiana (RFI) ERSAT Program and in providing qualitative and quantitative feedbacks in the ERTMS roadmap evolution. The ERSAT Program aims at putting into commercial service the first SIL 4 railway signaling ERTMS solution that will use Virtual Balises; on the other side, the experience obtained throughout the V&V activities on such a new solution will accelerate the completeness and the robustness of the ERTMS roadmap specification evolution. Therefore, ongoing and future R&D projects related to the use of the GNSS positioning for performing the SIL 4 ERTMS Train Function can get benefits from the ERSAT-GGC results.

# MAIN ACHIEVEMENTS

## WP2 Enhanced ERTMS Specification and Architecture

- Review and consolidation of the Enhanced ERTMS Functional Architecture, suitable for the introduction of the GNSS Positioning technology and of the IP based Public Mobile Radio Networks, as defined in the previous R&D European projects

- Detailed analysis of the Virtual Balise concept, in particular its analogy with the ERTMS Physical Balise

- Systematic description of the ERTMS Operational Scenarios affected by the introduction of GNSS.

- Specification of the Functional and NotFunctional Tests necessary to validate the new ERTMS systems obtained by the instantiation of the proposed Enhanced ERTMS Functional Architecture

## WP3 Safety and Hazard Analysis of the Enhanced ERTMS Architecture

- Systematic identification of possible functional deviations in the specific Operational Scenario for ERSAT-GGC Enhanced Reference architecture;

- Definition of technical and procedural safety measures to ensure an acceptable risk level;

- Development of Fault Tree Analysis to support the technical Interoperability verification

- Derivations of Tolerable Hazard Rates for the Virtual Balise Information Points hazards, and preliminary Integrity targets for EGNSS.

In addition, ERSAT-GGG has also proposed a process, based on survey field campaigns and simulations, for classifying railway track areas as suitable or not-suitable for placing Virtual Balises. The process addresses the consequences that GNSS phenomena such as multipath, NLOS, and radio frequency inferences can have on the GNSS Position Domain in some specific track areas due to the local environment; such consequences might potentially lead to unbounded Virtual Balise location errors. The use of this classification process can thus be seen as another enabling measure for introducing the GNSS positioning into the ERTMS specification road map evolution.
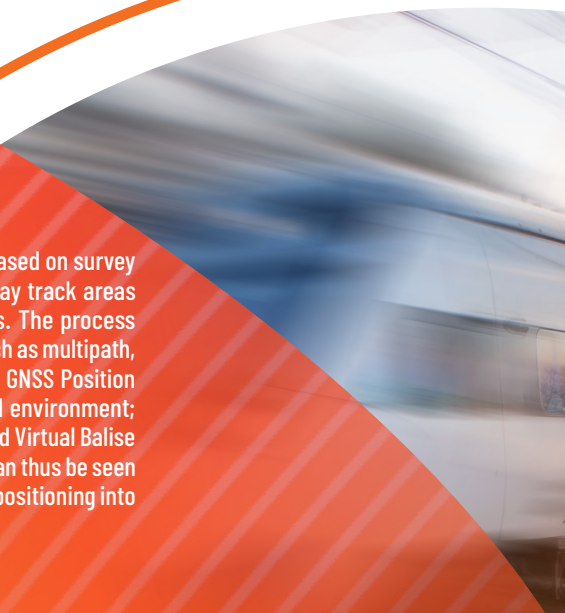
**WP4 Track Survey and Track Classification**

- Contextualization of the importance of a track survey process for the use of Virtual Balise based on GNSS for ERTMS Signaling

- Study of GNSS threats in the Railway context and identification of suitable detection techniques based on COTS measurement components.

- Definition of the track area classification process based on the presence of GNSS threats along the railway line. ERSAT-GGC is the first project that addresses this important aspect.

- Development of a Software Toolset to classify railway lines based on multiple and diverse GNSS measurement data (field data and simulated data)

- Execution of measurement campaigns in three different countries (Spain, Italy and France) to support and validate the classification process.

- First study of the inclusion of GNSS classification process in the Railway laboratories.

**WP5 Assessment of the Enhanced ERTMS architecture and of the Survey process and related toolset**

- Contribution to the certification process of the RFI ERSAT program

- Process assessment for Track Survey and Track Classification

- Assessment of the toolset, for the Track Survey and Track Classification, to provide valid results in different situations and environmental context

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