

1. FINAL PUBLISHABLE SUMMARY REPORT

1.1 EXECUTIVE SUMMARY

EATS project aimed at progressing on the ETCS on-board equipment laboratory testing and on the use satellite positioning technologies together with other technologies into ERTMS. The main research paths of the EATS project were aligned with the two main objectives. On the one hand it was the improvement of the laboratory testing for the on-board ETCS equipment. The ETCS on-board equipment testing laboratory research path was referred as EATS_LAB. EATS_LAB helped to define the required tools to further test the system focusing on safety and including more realistic tests for the wireless links. On the other hand, there was the definition of the Smart Train Positioning System (STPS) to be integrated into the ETCS on-board equipment. The research path related to Smart Train Positioning System (STPS) was also referred as EATS_STPS. The STPS is based on satellite positioning and wireless technologies employed as Location-Based Services (LBS) that provides a step forward to overcome current limitations of the migration to ETCS level 3. In this context the technical results achieved at the EATS project have covered the objectives set in the project as it can be seen in the following tables and figures

EATS_LAB ETCS TESTING		
Objectives	Main outcomes (see Figure 1)	Exploitation
<u>HIGH LEVEL TECHNICAL OBJECTIVES</u> Advancing in testing for reducing time and effort in the verification and certification process. <u>SPECIFIC OBJECTIVES</u> 1. On-board ERTMS Reference Model for ETCS level 1, 2 & 3. 2. Inclusion of air-gap effects in the test setup to generate a realistic environment. 3. Inclusion of fault injection techniques in test setup to assess safety performance.	- ETCS on-board unit virtual laboratory with realistic scenarios - ETCS on-board unit reference model (BTM, LTM, ODO, KERNEL, ...) - Wireless Comm. Emulators for BTM and LTM lab. testing - Saboteur for Fault Injection in ETCS on-board unit interfaces	Three levels are foreseen for the exploitation depending on the nature and maturity of the project outcome: - Standardisation proposals: ETCS reference model, Wireless Comm. Emulators, saboteurs, scenario definition. - Follow up research projects: Zero on-site testing in the frame of Shift2Rail and national projects. - Direct or derived products into the market: Balise maintenance and testing
EATS_STPS ON-BOARD POSITIONING		
Objectives	Main outcomes (see Figure 2)	Exploitation
<u>HIGH LEVEL TECHNICAL OBJECTIVES</u> Enhancing safety and availability of the on-board Smart Train Positioning System (STPS). <u>SPECIFIC OBJECTIVES</u> 1. Define the on-board STPS architecture to determine train integrity and train position. 2. Develop required GNSS and communication wireless technologies algorithms for STPS. 3. Improvement of sensitivity and directivity of the STPS for railway. 4. STPS Safety assessment. 5. Integration of the STPS into ERTMS	- STPS architecture definition - STPS positioning algorithms (multi constellation GNSS, WCT and data fusion) - STPS testing simulator including rail track, train, GNSS and WCT. - KPI definition for on-board positioning in rail - STPS RAMS Analysis - AoA determination prototype - Integration of STPS into ETCS on-board unit and laboratory.	Three levels are foreseen for the exploitation depending on the nature and maturity of the project outcome: - Standardisation proposals: KPIs definition, RAMS analysis, - Follow up research projects: on-board positioning and testing, cybersecurity in railways in the frame of Shift2Rail and national projects. - Direct or derived products into the market: positioning system including multiconstellation positioning algorithms.

Table 1. EATS Project main outcomes and exploitation

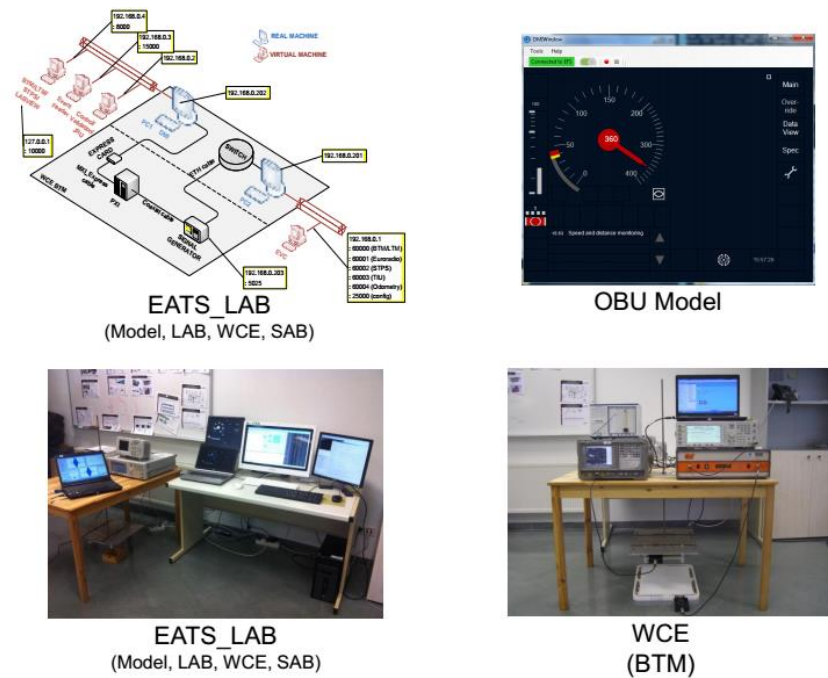


Figure 1. EATS_LAB outcomes

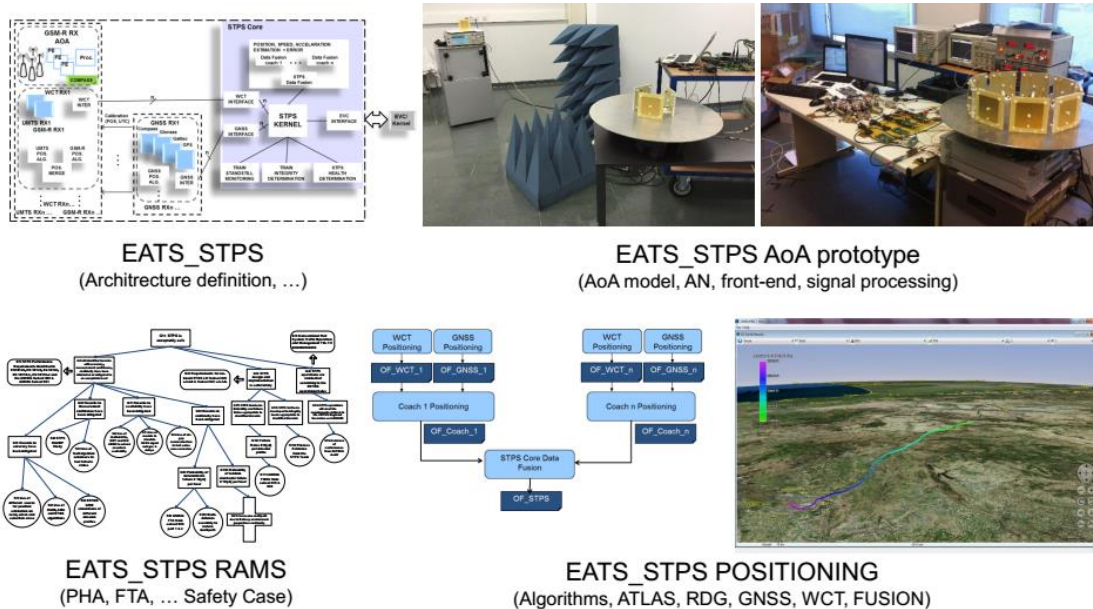


Figure 2. EATS_STPS outcomes

These results have been obtained from both research lines that were connected and also shared the same three phase methodology as follows:

1 – Requirements definition

EATS_LAB was focused on the implementation of the ETCS on-board Reference Model (RM), identification of the wireless communications of the on-board ETCS in order to test the system in a realistic environment, definition of the faults to be injected to the on-board ETCS equipment in order to test its safety level and the development of the testing laboratory model architecture proposal.

EATS_STPS was centred on the requirements definition for STPS, such as functional requirements, RAMS requirements, architecture regarding number of antennas and their location on the train's roof, test setup requirements and finally identification of the required mechanism for standardisations and certification in the field of GNSS and ETCS.

2 – Implementation

EATS_LAB was focused on the implementation and verification of the proposed laboratory tools for ETCS testing, namely, Wireless Communication Emulators that introduced the realistic effect in the air-gaps, Saboteurs that injected faults to the on-board ETCS equipment in order to test its safety level and the required tools for STPS laboratory testing.

EATS_STPS was centred on the implementation and verification of the key parts of the STPS such as the positioning algorithms based on the multi-constellation GNSS and wireless technologies (UMTS, GRM-R) and the information fusion, the prototype to determine AOA by means of GSM-R, the definition of the integration of the STPS within the on-board ETCS and the creation of the scenarios for the STPS positioning algorithms.

3 – Validation

EATS_LAB was focused on the validation of the tools implemented in the previous phase. For that, first the integration of the tools into the ETCS laboratory model developed was carried out. After that, the validation of the Wireless Communications Emulators and the calibration of the saboteurs were covered. Finally, a proposal to contribute to the standards was done.

EATS_STPS was centred on the validation of the positioning algorithms and the AOA determination prototype, as well as the verification of the RAMS requirements of the STPS. Moreover, an analysis of the STPS integration into the on-board ETCS system was carried out. Further, a proposal to contribute to the standards was done.

Finally, dissemination was also a key objective of the project. Dissemination activities were considered across seven levels: Worldwide level with a web page, dissemination to the main stakeholders in railway, dissemination to the industry, courses for professionals and students, contributions to technical journals and international congresses, contribution to the standards and analysis of the commercial exploitation of the outcomes of the project.

List of Beneficiaries

No	Name	Short name	Country	Project entry month	Project exit month
1 (Coordinator)	CENTRO DE ESTUDIOS E INVESTIGACIONES TÉCNICAS	CEIT	Spain	1	42
2	ERTMS SOLUTIONS SPRL	ESOL	Belgium	1	42
3	FRAUNHOFER	FRAUNHOFER IIS	Germany	1	42
4	NOTTINGHAM SCIENTIFIC LTD.	NSL	UK	1	42
5	ASOC. DE ACCION FERROVIARIA	CETREN	Spain	1	42
6	UNIVERSITY OF GLASGOW	UGLA	UK	1	42
7	INTEGRASYS	INTEGRASYS	Spain	1	42
8	PHIDANI SOFTWARE SPRL	PHIDANI	Belgium	1	42

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Project logo and website



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