



Project Results

# openETCS

Paving the way to a pan-European uniform train control command system

## Executive summary

The ITEA 2 openETCS project has developed an integrated modelling, development, validation and testing framework to leverage the cost-efficient and reliable implementation of ETCS (European Train Control System). This thereby realizes the 'Open Proofs' concept for ETCS on-board systems and so signifies a considerable step towards the ambitious target of implementing a pan-European uniform train control command system.

## Project origins

Several challenges exist in developing an ETCS, not least the lack of conformity of pre-existing standards in inherited networks that are not in line with the ETCS guidelines. While the diversity of technical standards of the different European railway lines may present a possibly insurmountable hurdle to a fully unified ETCS, it is nonetheless feasible for a high level of interoperability to be established. In this respect, software solutions are decisive when considering the real core of the global ETCS concept, its unified software. The key to creating unified software lies in an open source solution that is freely accessible to all participants. These were the premises that gave birth to the idea of openETCS.

## Technology applied

The openETCS project made use of open standards on all levels, including hardware and software specification, interface definition, design tools, verification and validation (proofs) procedures, last but not least, embedded control software, and therefore called "open proofs". These technologies and related business concepts provide the framework for the establishment of a holistic tool chain across the whole development process of ETCS software that supports the formal specification and verification of the ETCS system requirements, the automatic and

ETCS compliant code generation and validation, and the model-based test case generation and execution. Furthermore, the open source concept provides for a 'correct' functioning reference device that helps to overcome interoperability problems, supporting manufacturers, infrastructure managers and railway companies alike. By transferring verification and validation activities from the track to the laboratory, scarce resources are preserved and finally the migration phase accelerated. This project is an innovation driver for business: the test phase is always very costly and never reaches guaranteed zero-bug implementation. By focusing on an open

source version of the heart of the signaling software, developers can monitor the code and check for any bad implementation. Moreover, a formalised specification enables vendor-neutral reference implementation and, by making the core functionality software fully transparent, the market for software services in equipment, which tends to last between 20 and 40 years, is opened up.

## Making the difference

openETCS has an impact on rail operators, manufacturers, software service and tool providers. First and foremost, the reduced system development costs due to



Photo: LEA Railergy GmbH

OpenETCS demonstrator connected to a production type DMI (Driver Machine Interface: Bachleitner & Heugel Elektronik OHG

open source components improve both the interoperability of ETCS equipped vehicles and the maintenance of ETCS on-board equipment as well as reduce the impact and time to market of hardware changes, resulting in greater flexibility in relation to the different hardware platforms. For instance, project partners ALSTOM and GE will benefit from 10-20% cost reduction in acquisition, installation, testing and commissioning from 2020 with a potential fall in software maintenance costs by up to 50% for openETCS functionalities. Open proof concepts will give rail operators improved security and help accelerate innovation in EU signaling. Deutsche Bahn, the leading German railway operator, is expecting to bring procurement and installation cost for ETCS down from 350,000 to 100,000 Euros per On-Board Unit (OBU) by 2020 and reduce annual software maintenance costs down from originally more than 4000 to less than 1000 Euros per OBU from 2020. Service/tool providers can acquire domain and method expertise, which is a competitive advantage,

and open source also enables wide usage and better products at lower development costs. ALL4TEC is expected to have a new product based on the open source tool, ESF (European Safety Framework), by 2017 while TWT will see an augmented service portfolio (methods and tools), a new market in the rail sector (domain expertise) and one new software product based on openETCS results by 2019.

openETCS principles are already being exploited by DB and NS (the Dutch railway operator), for example, in vehicle tendering, and NS is even considering applications beyond ETCS in projects for interference current monitoring, energy metering and STM. Open proofs enable not only a shift in testing from track to laboratory, but also more process control (no vendor lock-in) and in-house system (co)development. Finally, the ETCS equipped network is continuing to grow in Europe and overseas, with new players already having entered the ETCS equipment market – and the likelihood that this number will rise in the future. Which is good news from both a safety and economic perspective.

## Major project outcomes

### Dissemination

- More than 60 publications e.g. ZEV Rail, Signal & Draht (magazine), Science of Computer Programming, ERTSS'14, APSEC Proceedings, SEKE 2014, FORMS/FORMAT 2012 & 2014, etc.
- More than 20 presentations at Conferences and industrial Fairs in Europe, Philadelphia, Bangkok and Vancouver

### Exploitation

- openETCS On-Board Units for Classes 401, 403, 411, 415 ICE train sets for DB
- LEA/Railergy, Germany: openETCS mobile simulation box
- Uni Rostock, Germany: “nanoETCS” simulation model train
- All4Tech, France: ESF “Eclipse Safety Framework” open source safety verification tool
- ERTMS Solutions, Belgian: “ERTMS Formal Specs”
- ERSA, France: openETCS simulation package: TC-SIM (Train Control Simulator)

### Standardisation

- Numerous inputs to the European Railway Agency (ERA) specification group concerning various issues for the ERTMS subsets (026 etc.) via authorised CER (Community of European Railway) and EUG (ERTMS Users Group) organisations.

### Spin-offs

- openETCS Foundation e.V. maintaining the openETCS.org development platform and forum

ITEA is the EUREKA Cluster programme supporting innovative, industry-driven, pre-competitive R&D projects in the area of Software-intensive Systems & Services (SiSS). ITEA stimulates projects in an open community of large industry, SMEs, universities, research institutes and user organisations. As ITEA is a EUREKA Cluster, the community is founded in Europe based on the EUREKA principles and is open to participants worldwide.

## openETCS 11025

### Partners

#### Belgium

ALSTOM  
ERTMS Solutions

#### France

ALL4TEC  
ALSTOM Transport  
CEA  
LAAS Centre National de la Recherche Scientifique (UPR8001)

#### ERSA

Institut Mines-Télécom  
Institut National Polytechnique de Toulouse (INPT)

Mitsubishi Electric  
SNCF

#### Systemel

#### Germany

AEbt GmbH  
ALSTOM Transport GmbH  
Deutsche Bahn AG  
Deutsches Zentrum für Luft- und Raumfahrt (DLR)  
Eclipse Foundation Europe GmbH  
Formal Mind GmbH  
Fraunhofer Gesellschaft  
Siemens AG  
Technical University Braunschweig (TUBS)  
TWT GmbH Science & Innovation  
Universität Bremen  
University of Rostock

#### Italy

GE Transportation

#### Netherlands

**lloyd's register rail B.V.**  
**NS Nederlandse Spoorwegen**

#### Spain

**Asociación de empresas tecnológicas Innovalia**

**Software Quality Systems S.A.**

#### United Kingdom

### ATOC

### Project start

July 2012

### Project end

December 2015

### Project leader

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### Project website

<http://openetcs.org>