ERTMS compliant interlockings - INESS Project

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Abstract

The European Union is stimulating the further development of railways as environment friendly transport system by standardisation in all relevant fields. Considerable progress has been achieved in the area of rail traffic management by means of the ERTMS programme with its major projects ETCS, GSM-R and Eur-Optirails. The roll-out has been started on high-speed as well as conventional main lines. It is becoming more and more evident that the lack of standardisation in the field of signalling is a serious hindrance which could hamper this process. For filling this gap, railways and the signalling supply industry have initiated jointly a new project: "INESS" which will become part of the 7thEuropean Framework Programme for Research and Development. The standardisation of the operating, maintenance and supply levels of the railway industry will contribute to the opening-up of national markets and the removal of national barriers of protectionism of highly individualised practices on technical, operational and commercial levels.

The INESS work programme is developed around the following work streams:

- Business Model: the entire value chain in the signalling field will be re-engineered in order to gain cost reductions through highly efficient processes and scale effects due to rationalisation and standardisation. In an interactive process, this work stream will deliver the priorities for activities of the whole project.
- System Design: to harmonise data file formats, design tools, data transfer for production, data flows linked with system architecture and to maximise the knowledge base of owned assets within the railway infrastructure.
- Generic Requirements: to produce the requirements data base in a harmonised format and structure, a complete set of functional requirements for interlockings of each of the participating railways, a common kernel of validated standardised future functionalities, including functionalities specially required by ETCS levels 2 and 3. Additionally, common method and tooling for verification and validation of the functional requirements will be developed.
- Functional architecture and Interfaces: to assess the current architecture of signalling installations with regards to their functional configuration in the context of their adjacent and neighbouring sub-systems. To propose an optimal functional architecture for ETCS compliant interlockings. To show the apportionment of functionality between the interlocking and the different sub-systems, identify and describe the relevant functional interfaces between the interlocking and the adjacent subsystems.
- Testing and commissioning: development of an optimised testing and commissioning process with methods and tools to facilitate the efficient integration of ERTMS applications into the various member states.
- Safety Case Process: to identify an efficient way for an interpretation of the safety case process according to CENELEC and develop improvement strategies consistent to the National Safety Authorities.

The INESS consortium consists of all major European railways, either as direct partners or under the umbrella of UIC which is the project co-ordinator together with UNIFE, all major signalling suppliers

and several Universities. All these parties will have an important role during the coming three years in this challenging project.

Introduction

Due to the seamless guidance by rails, the railway system requires a dedicated signalling sub-system, whereby a major part of the functionality must be ensured and controlled on the infrastructure side. This signalling sub-system is highly relevant for the performance and the safety of train operation. Contrary to the other modes of transport, train drivers have no freedom to choose their route and, when running at higher speed, no chance for escaping from a collision, if a route is wrongly set!
The signalling sub-system is part of the rail traffic management system and comprises functions and technical devices for setting and protecting routes, ordering and controlling train movements etc …
Seen from a European perspective, the traditional signalling is one of the most conservative parts of the railway system, as it is still strongly bound to the national traditions by all involved parties. The legislative frameworks, rules and regulations are different from country to country and there is a lack of explicit functional requirements. Within each network, different technologies are in use simultaneously with extremely long life cycles. The procurement markets are *de facto* often restricted, as many railways are closely linked to a few traditional suppliers.

Since 1990 the European Union is promoting the reformation of the Rail Traffic Management System under the ERTMS programme, which is driven by the need for interoperability, opening of procurement markets, increase of efficiency and harmonising of safety in the European railway system. Huge and successful efforts have been made up until now in the field of train control – ETCS - and train communication - GSM-R. However this covers not the whole signalling system with its main component: the interlocking.

Interlockings, including line block systems, are the traditional instrument in the signalling sub-system for interconnecting information about status of elements and commands towards various control devices. Over the decades of years, an evolution took place from manual towards automated functioning with passage from mechanical, electro-mechanical, relay-based to electronic computer based technology. Extremely high safety and reliability have always been key requirements. In many European railway networks, there is a huge potential need for renewal of heritage signalling installations including their interlockings. However, economic analyses of several railways show that a renewal at current cost levels for planning, procurement and implementation is not any more affordable.

INESS in the ERTMS context

The INESS project will fill the gap regarding harmonised specifications within the ERTMS framework as shown in the following figure 1, which outlines the functional structure of the Rail Traffic Management System (left side) and the associated European projects (right side).

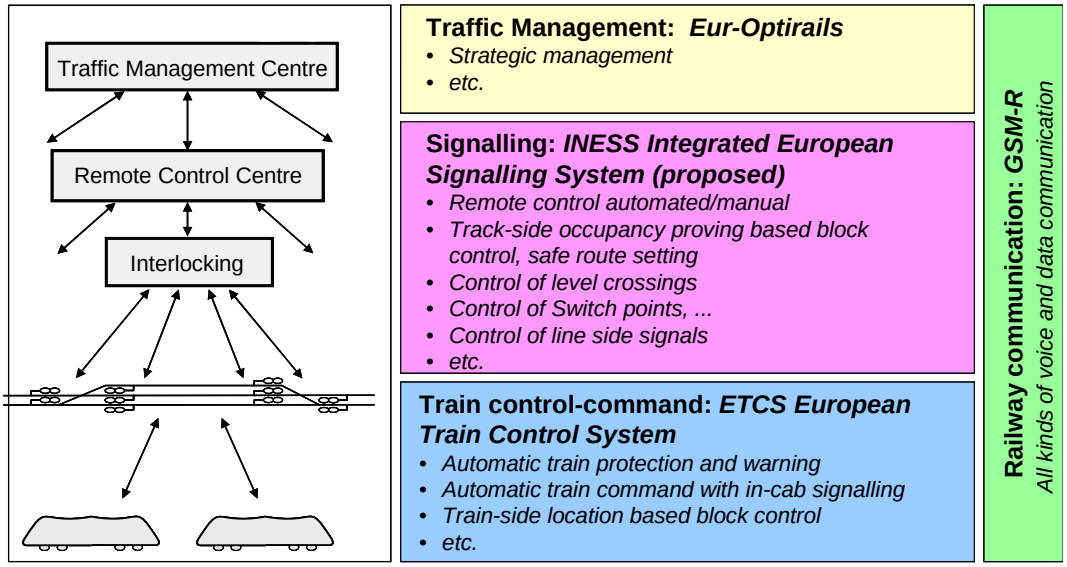

Figure 1: INESS in the ERTMS context

The convergence of the ERTMS vision in the railway sector, with the accompanying ETCS and GSM-R standards, has brought about a degree of cross border co-operation not previously realised. Railways now engage with a united supply industry to achieve the common goal of an interoperable system, within the framework of European legislation, which potentially forms a set of legal obligations all have to comply with. A set of standards have been created within these obligations but, as with any standardisation process, joint efforts are needed from all parties to translate such work into tangible results.

The new TSI Command/Control/Signalling for Conventional Rail foresees that ERTMS will be rolled out over international corridors covering initial inception kernels (as well as on many other projects outside these kernels). The European Commission, the European Railway Associations together with the Railway Supply Industry have agreed to work closely together to define a realisable migration strategy for ERTMS. This unique co-operation has offered the possibility to co-ordinate the implementation of the constituent parts of ERTMS - the traffic-management layer, the train communication and train control system.

Further momentum can be added to this process by ensuring that the underlying systems, such as interlockings, are developed in line with this programme. Therefore, INESS will define and develop specifications for a new generation of interlocking systems with interfaces towards adjacent subsystems such as remote control, neighbour interlocking, outdoor equipment and in particular ETCS.

INESS Objectives

The implementation of ETCS could be hampered, in areas of the conventional European rail network, where interlockings will need to be replaced (particularly installations in old mechanical or electro-mechanical technology - often linked with corresponding obsolete outdoor equipment), if this cannot be carried out in an economically and technically efficient manner. Also the implementation of systems utilising centralised and automated route-setting of trains will be economically constrained.

Therefore Railways are aiming for significantly reduced life-cycle costs of future interlockings and associated outdoor equipment. All possibilities for cost-reduction in the various implementation phases ranging from planning and site-specific engineering, procurement, commissioning (including safety approval) to maintenance (including adaptations to changes of the operational requirements) need to be explored. Standardisation, increased competitive tendering and significant reduction of implementation time are considered to be key requirements for the future. Consequently, railways are aware of the need for well defined strategies to achieve a migration from the present configuration towards a new harmonised Interlocking system with efficient integration with the adjacent systems for Centralised Traffic Control, ERTMS, and other relevant systems. All jointly developed specifications are to be placed in the public domain in the agreed version.

The signalling supply industry acknowledges and supports the railway’s objectives but considers that the underlying signalling equipment cost is not the prime cost driver when viewed against the difficulty in understanding and conforming to different national operational rules and signalling principles (that makes it impossible for a new player to enter a market, in many cases) and complying with national safety approval processes. The signalling supply industry has a lot to gain by the removal of these barriers. In a world where processor-based solutions are now the standard, it has increasingly become clear that the funds and resources required to develop new generations of interlocking products are reaching the limits of the possibilities of a single supplier. Without an approach, similar to that underway for ERTMS-ETCS, many suppliers will run into resource constraints, making it difficult for them to keep up with the many new concurrent developments. It is realised that it is no longer possible to just pass the increased costs of individual developments onto the various customers and therefore some suppliers would simply have to reduce the offering of bespoke systems for certain markets.

Planned structure and INESS work streams

The planned project structure with the constituent work streams (WS) is shown in the following figure 2.

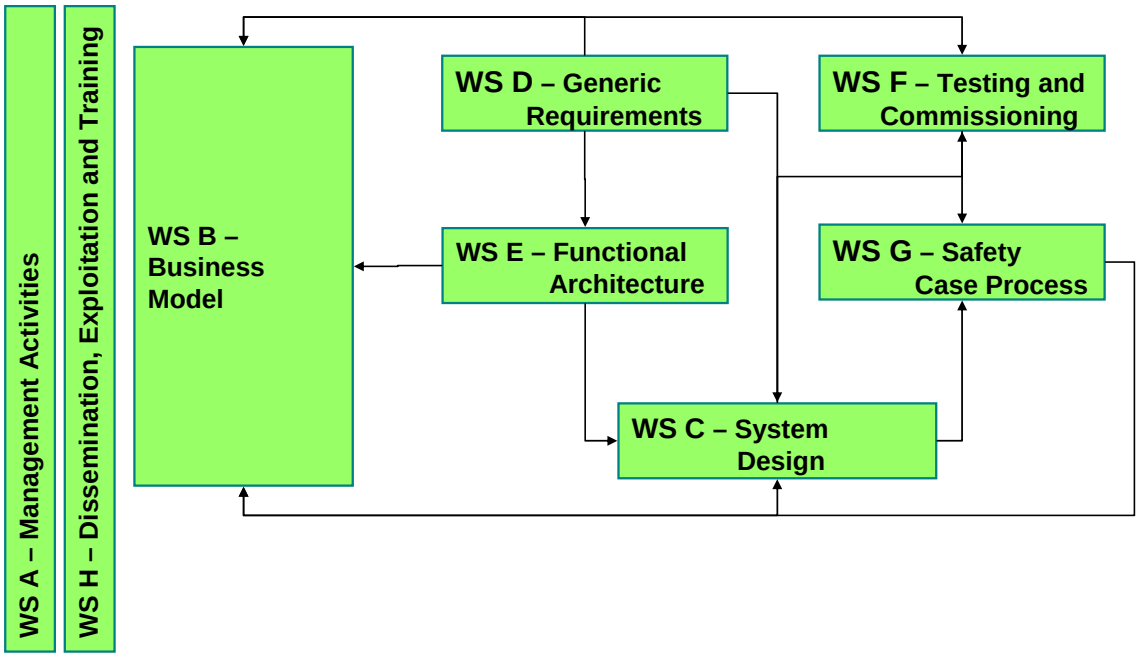

Figure 2: INESS project Structure

WS A relates to *Management Activities.*

WS B Business Model will be highly relevant for the priorities of the project work. To this aim, the entire value chain of the signalling subsystem will be analysed and re-engineered in order to gain cost reduction through highly efficient processes and scale effect due to rationalization and standardization. Within the entire supply chain, business cases and cooperation models will be developed to support intelligent migration strategies for ERTMS and therefore to accelerate the realization of European ETCS corridors. For the interlockings, this work stream will develop a technical road map towards interoperable, standardized platforms.

WS C System Design intends to harmonise data file formats, design tools, data transfer for production, data flows linked with system architectures and to maximise the knowledge base of owned assets within the railway infrastructure.

WS D Generic Requirements will provide fundamental work for the identification and verification of the general and functional requirements. Results from the precursor project Euro-Interlocking will be taken up and further developed. Key activities are the development of a generic core of functionalities and the simulation/verification of the functional requirements by means of modern IT tools. The data flow will be described seamlessly across the relevant subsystems within ERTMS. In order to identify and agree a common core of interlocking functional requirements two complementary mechanisms have been identified as shown in the following figure 3:

1. to extend the current identified core (more functions would be included in the common core; certain functions would be redundant for some railways and then not used);
2. to minimise the individual railway functions (harmonising certain individual functions, thus moving them to the core and removing special individual functions).

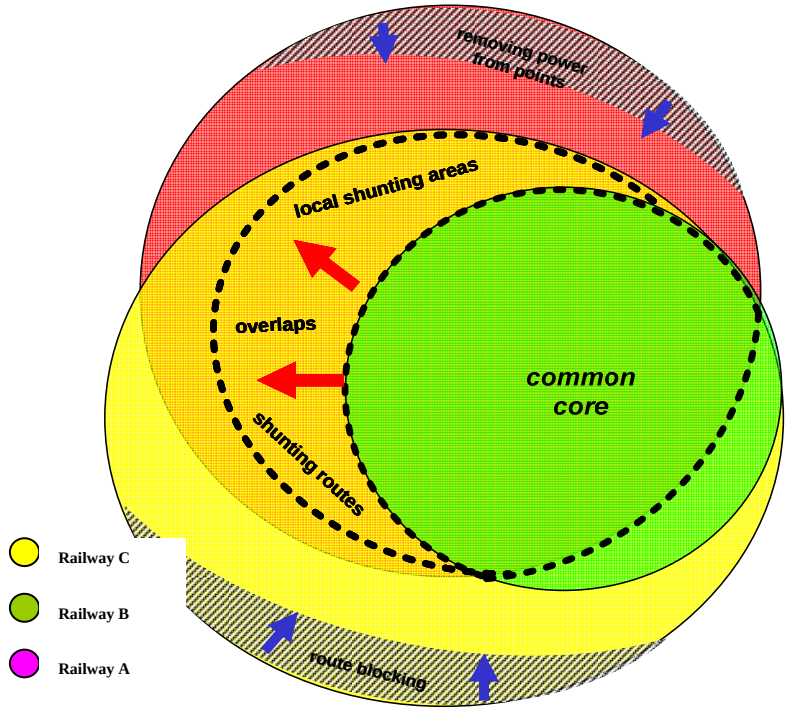

Figure 3: Graphical representation of the common core of Railways A, B, and C

It is important for each railway to be able to experience the functionality of the specified system before tendering and this can best be done through simulation. Towards the modelling and creation of a simulation environment which presents the requirements in a format familiar to the signallers who will be asked to validate them. Refer to the simulation layout reported in figure 4.

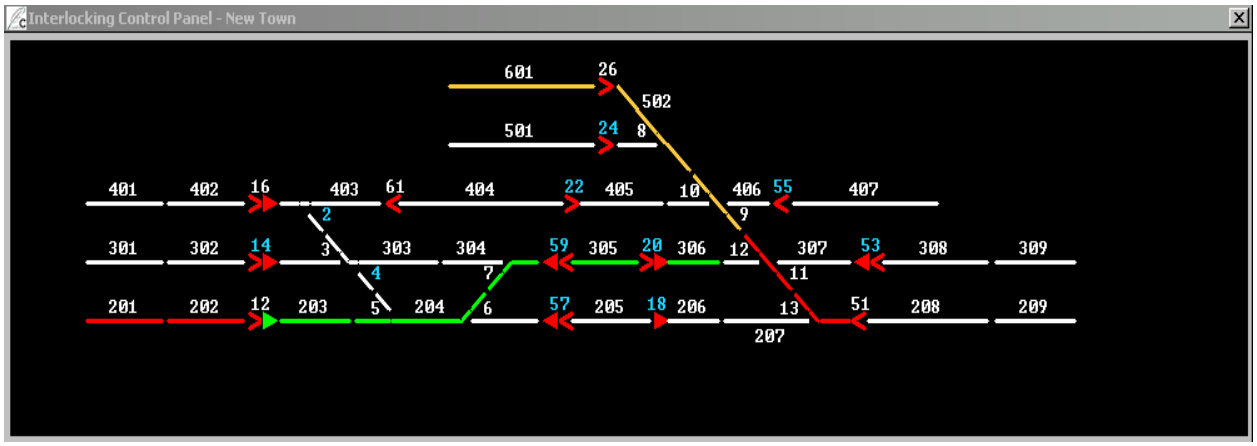

Figure 4: Graphical User Interface of an interactive configurable interlocking requirements simulator

WS E Functional Architecture and Interfaces will develop a standardised functional architecture especially for the interfacing of INESS with ETCS. The functional structure of ETCS shall essentially remain as currently specified with three application levels. Similarly, INESS will also be structured in three application levels as illustrated in the following figure 5.

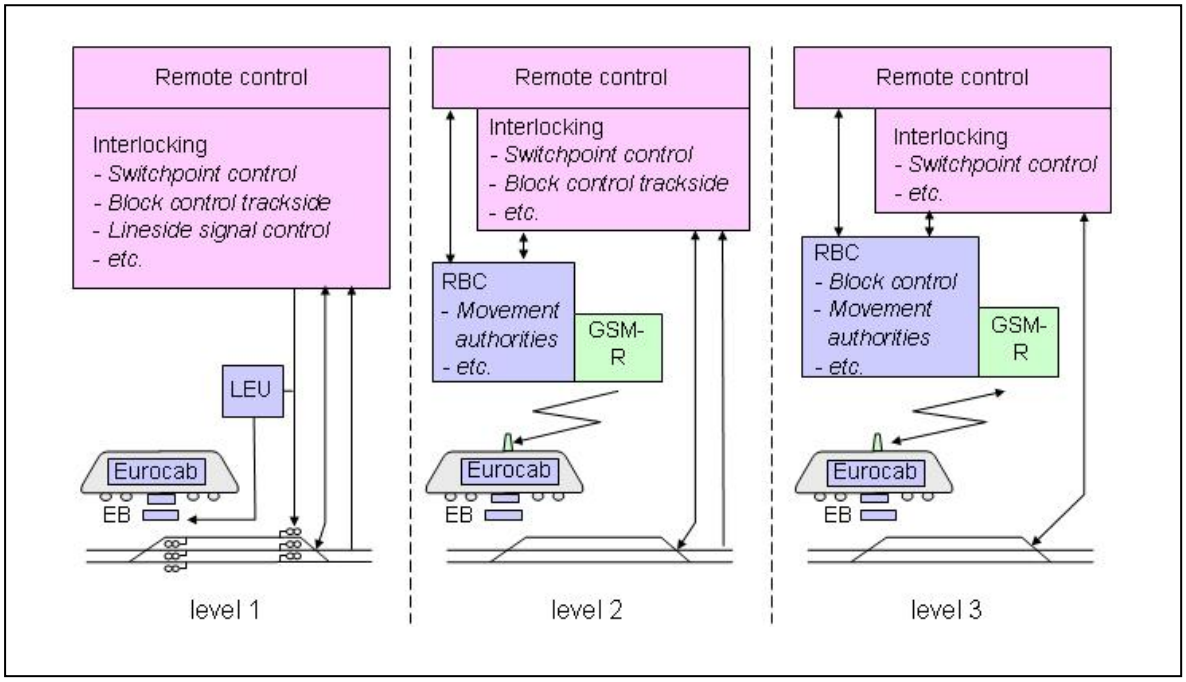

Figure 5: Functional architecture of INESS with 3 application levels

The business model will very likely demonstrate that INESS installations must be upgradeable from lower to higher application levels during their life cycle. This requires a corresponding functional modularity. The functional architecture of INESS will therefore be presented for each of the three application levels as shown in figure 6, whereby level 3 is the target architecture. For levels 1 and 2, the apportionment of functionalities will make it clear which parts can be kept for a later transformation into level 2, 3 respectively. It will also be shown, which parts become superfluous and which extensions are necessary. The corresponding interfaces will be openly specified.

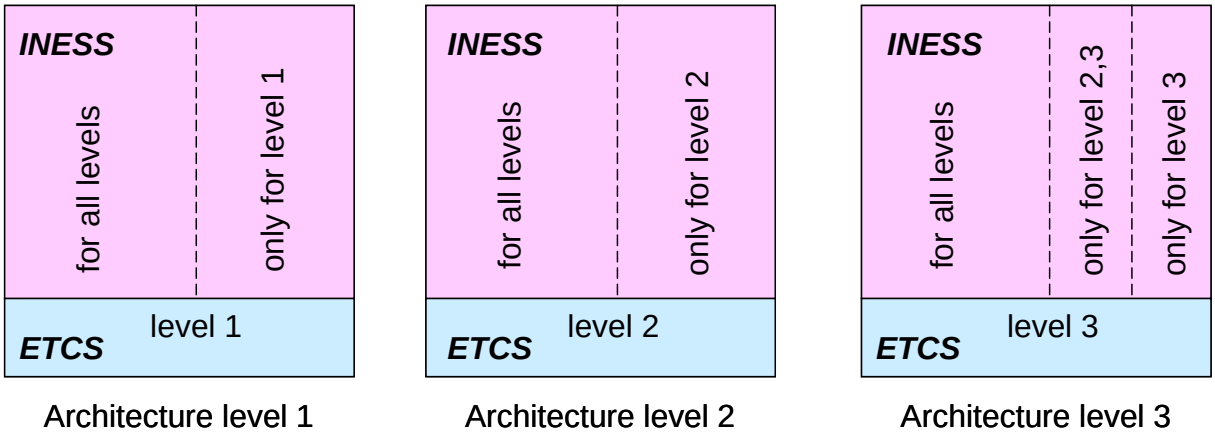

Figure 6: Functional architecture with 3 application levels

WS F Testing and commissioning will elaborate safety-verified test tools and techniques to enable the testing and commissioning of signalling applications, including INESS-compliant products. It foresees also the development of an optimised harmonised testing and commissioning process.

WS G Safety Case Process has the aim to reduce time and money for the Safety Case – at industry level - by avoiding unnecessary or redundant procedures. It will analyse the current status and identify the problem areas in handling the industry safety case process. On the basis of this analysis, it will be proposed an efficient way for an interpretation of the safety case process according to CENELEC and develop improvement strategies consistent with the National Safety Authorities mandate. Furthermore it will develop and provide open source support tools for the safety case process.

WS H comprises activities for the *dissemination, Exploitation and Training.*

INESS and the EU 7 Framework Programme

The INESS project will be developed under the 7th EU Research Framework Programme which was launched end 2006 and covers the period from 2007 to 2013.

The Consortium responsible for developing the project is outlined in the following figure 7.

Railways	Industry	Universities	SMEs	Others
UIC* DB Netz NetworkRail Banverket ADIF ProRail RFI	UNIFE Thales Invensys Ansaldo Alstom Bombardier Siemens Funkwerk IT Scheidt&Bachmann AZD MerMec ELIOP	Uni Aachen Uni Braunschweig Uni York Uni Southampton Polit. Madrid LAQUSO	Railsafe BBR	ALMA CG TIFSA
** including UIC experts from ÖBB, SBB, RHK, PKP, BD, REFER, JBV, SZ*				

Figure 7: INESS Consortium

There are about 30 partners from railways, industry, universities and other institutions. The railways are participating either as full members or under the umbrella of UIC which is the formal coordinator of the project. From industry, UNIFE and eleven suppliers are participating.

References

[1] UIC Report “Global Perspectives for ERTMS - ETCS and GSM-R” – prepared for the UIC ERTMS Annual Conference held in Berne, 11-13 September 2007.

[2] INESS Consortium “INESS Project Proposal” – FP7 218575 – June 2007.

[3] UIC Euro-Interlocking project documents.

Abbreviations

ERTMS	European Rail Traffic Management System
GSM-R	Global System for Mobile Communication for Railways
ETCS	European Train Control System
INESS	Integrated European Signalling System
CENELEC	European Standardisation body for electrical systems
TSI	Technical Specifications for Interoperability