iness

INtegrated European Signalling System

Delivering ERTMS compliant interlockings

Andy Doherty,
Chairman INESS Steering Board,
Network Rail - UK

With the increase in experience at deploying ETCS around the world, it is becoming clear that there are a number of hurdles to overcome to achieve cost effective, interoperable implementations of ETCS. A particular challenge arises in the course of migrating from a national signalling system to ETCS, where it is often necessary for ETCS and that national signalling to co-exist as part of the migration strategy.

Each of the national signalling system solutions have been derived from developments carried out within each country's borders, and which means there is little commonality between different countries' signalling systems in terms of the operating rules, or the signals that train drivers are required to observe.

It is also the case that in many countries, the suppliers of signalling and control systems have also stayed within those national borders, and whilst there is a degree of commonality between the different manufacturers and railways over some aspects of railway signalling systems, and the interlockings within them, the areas of difference are considerably greater than the areas of commonality.

Finally, each of the manufacturers solutions to ETCS also vary from one another, and many of the implementations of ETCS reflect particular national railways' or manufacturer's preferences and sometimes those of the various national safety authorities rather than reflecting a single set of interoperable products, sub-systems and systems, and a common language by which to discuss them and to negotiate contracts to supply them.

The purpose of INESS therefore, is to try to bridge these various differences and challenges in manner that is win-win for railways and manufacturers, leading to more cost-effective procurements of signalling systems, particularly where ETCS is concerned, and optimised ways for railways and suppliers to communicate their needs and requirements in a cost effective and acceptably safe manner, and to foster greater portability of signalling products between different market places.

Andy has spent 25 years in the design, supply and commissioning of railway systems including rolling stock, signalling, power supplies and has been for the last 7 years Director or Railway System Engineering for Network Rail, where he is responsible for Network Rail's arrangements for the introduction of new systems onto the network (including ETCS) and also Network Rail's role in assessing the compatibility of trains with NR's infrastructure. Andy has been a key member of the team in developing the INESS proposals, and seeing them through into their adoption by the European 7th Framework call for funding.

Paolo de Cicco
INESS
Co-ordinator
UIC, Paris,
France

INtegrated European Signalling System Project [INESS] (ERTMS compliant interlockings)

The European Union has been promoting the reformation of the Rail Traffic Management System - since 1990 - 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. 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).

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, 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 no longer affordable.

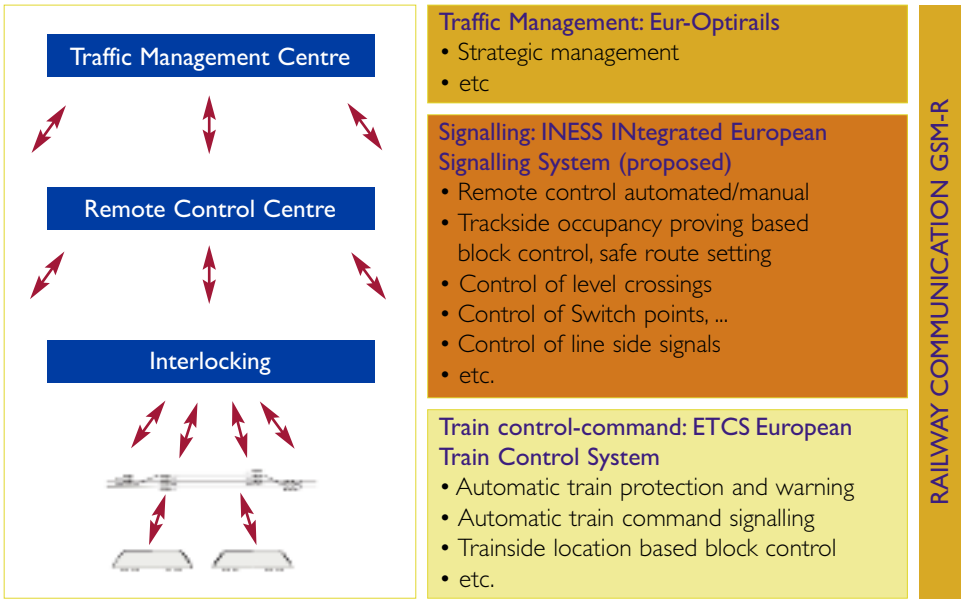


Figure 1: INESS in the ERTMS context

ERTMS vision in the railway sector is converging with the accompanying ETCS and GSM-R standards, it 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. 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.

The INESS work programme is developed around eight work streams (refer to the following figure 2):

- 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.
- Management activities: to deal with the project management from the technical, financial and administrative point of views.
- Dissemination, Exploitation and Training.

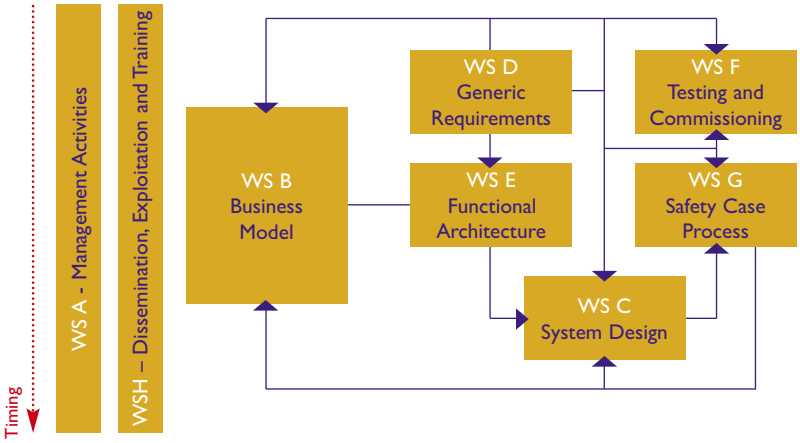


Figure 2: INESS project Structure

The INESS consortium consists of 30 partners: 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.

Emmanuel Buseyne,
Workstream A Leader,
INESS Project Manager,
UIC - France/Belgium

INESS: A Generic View of the Project Manager

A new European Project, INESS (Integrated European Signalling System) has been launched, aiming to accelerate the implementation and use of ERTMS compliant signalling systems within Europe.
With INESS the trains, for example, will be able to cross all the borders in Europe without any trackside compatibility interference, something which has not been possible until now, particularly considering the various different national signalling systems. The communications and protocols between border railway traffic control systems will also be facilitated and secured.
Another key issue for INESS is to take care of/manage the production and installation costs of actual and future signalling installations.
INESS started in October 2008 for a duration of 3 years. In total, 30 partners including Railway Infrastructure Managers, Industries and Universities are taking part in the project for a total of 1060 man months.
The European Commission financed approximately 10 million Euros in subsidies and underlined as a condition that the results of INESS had to be demonstrated and applicable to European countries.

To achieve the goals, INESS will in particular:

- Gather all the financial and technical information emerging from the railway infrastructure signalling market and formalise it in such a way that less money is needed for the further implementation of signalling installations and ETCS and that the performances and safety are simultaneously increased. (WS B – Business Model).
- Harmonise both the future system data flows and design tools (WS C – System Design) of the "ERTMS compliant" Interlockings together with the relevant Functional Architecture & Interfaces (WS E – Functional Architecture & Interfaces) assessed from the different architectures present on market.
- Use state of the art methodologies like formal methods and tools to model the Interlockings requirements and principles taken from more than 10 European Railways and to test and validate this model trough test cases and scenarios (WS D – Generic Requirements).
- Establish, through a better understanding of Testing & Commissioning issues and terms in Railways and Industries, test tools and techniques to facilitate the integration of ERTMS compliant signalling systems and subsystems in Railway Administrations (WS F – Testing & Commissioning).
- Reduce time and money issues for the Safety Case Process in Railways and Industries by developing methods and tools to facilitate the integration of ERTMS applications (WS G – Safety Case Process).

For each WS, financial and business criteria as well as State of the Art techniques and tools will drive the way through the most appropriate and efficient agreed deliverable outcomes for both Railway and Industries.
From the management side, regular meetings, workshops together with a common collaborative platform will be used to build and share the knowledge based on the production of the Deliverables.
A quality assessment of these deliverables will automatically be processed internally at each organizational level structure following before being submitted to the European Commission.

"INESS is the common unique and last way toward and joint integration of the future ERTMS compliant interlocking system for both Industries and Railways".

Workstream B: Business Case
A Life Cycle Model for INESS

Bernd Elsweiler
& Karsten Kamps,
Workstream B Leaders,
DB Netz - Germany

Workstream "Business Model" has started with the definition of an LCC Model which helps other workstreams to evaluate their commercial effects.

Just one week after the INESS Kick Off in Paris, 12 Workstream B (WSB) partners came to the DB Netz headquarters in Frankfurt on October, 27th & 28th 2008 to discuss the objectives and the approach to regard the commercial aspects of interlockings.

All partners agreed that it is a challenging task to get a common understanding on interlockings and costs related to it. In order to come to results in appropriate time, during the second meeting in December partners established three expert groups in order to work in detail on independent sections of the model.

The expert group on "Market Segments & Product Structure" analyses diverse approaches to segment different markets and generates a common definition for the later phase of cost analysis. Furthermore this group started with a product definition for economical considerations on the basis of the Euro-Interlocking Project Context Diagram.

The Life Cycle (LC) Phases of an interlocking and their sub-tasks are part of a second expert group. Each of the defined six LC Phases is described in detail in order to allow similar cost assignment for all partners.

A third group deals with "Cost Categories" and aims to create common INESS Cost Categories (ICC) for the analysis of financial expenses within the LC of an interlocking. The common ICC must on the one hand allow comparability but needs also to be flexible enough to cover all partners' requirements for the data collection.

All expert groups provided first results for the third WS B meeting, which took place in Rome on January, 27th & 28th 2009. With 20 attendants from 14 partners on this meeting good preconditions for constructive discussions were given. While the work is continued in those smaller groups, the results will be approved by all partners on the next meeting, which is scheduled for March, 10th & 11th 2009 in Madrid.

The Life Cycle Cost (LCC) Model is based on EN 60300-3-3 and is the instrument for the cost analysis. After data acquisition in a second phase the model is used to evaluate the commercial effects of other workstreams and gives essential input to the Business Model which is also part of WSB.

Workstream B
Working Group

MEETING TIMETABLE		
DATE	VENUE	HOST
10-11/03/2009	Madrid	ADIF
28-29/04/2009	London	Network Railway
22-23/06/2009	Gotenburg	Banverket
04-05/08/2009	Prague	AZD

Theo Lange,
Workstream C Leader,
Bombardier - Germany

Workstream C: System Design (Bombardier)

Introduction to WS C

Existing railway safety systems within Europe have many variations based on customer and supplier preferences and historical legacy requirements. This large variety is even more increased by another set of variations in defining, preparing and providing the data required to run a safety system for a given infrastructure.
The data typically comprises e.g. object lists (like signals, points, level crossings), infrastructure information (like geographical positions of objects, gradients, track lengths), and operational information (like lists of train routes, speed profiles, signal aspects). As of today, all this information is prepared, documented (and also, to a large extent, implemented) individually for each European railway administration. Technology is available to harmonise the supply and use of supplier and user independent data for safety systems, thus removing the complex situation of today. Therefore, in the context of INESS, Workstream C has been set up to address the issue of "data".

Aims and deliverables of WS C

The complete list of deliverables is defined in the Description of Work, but the main goals and deliverables of this WS are listed below:

- Investigate and define file formats for the exchange of data
  With a common, harmonized file format, the exchange of information between infrastructure managers and suppliers on one hand, and between different suppliers on the other hand, will be simplified to an extent that can be regarded as a "quantum leap". The required activities are managed as work package C1.
- Define interfaces for design tools
  Based on the harmonized architecture specified in another work stream, and the harmonized file formats defined in this work stream, interfaces shall be specified that allow existing or new design tools to be compliant with the INESS approach. The required activities are managed as work package C2.
- User to Supplier Linkage Definition and Asset Management
  The purpose of these linkage definitions is to enable secure transfer of scheme information between user and supplier in the context of the other goals within this Workstream and the INESS project. Additionally, the support of asset management of the final delivered system shall be addressed. The required activities are managed as work package C3.
- Investigate and define data flow requirements
  The data flows within the system as defined by the architecture Workstream shall be analysed and specified, and the data rates determined to support system response times. The required activities are managed as work package C4.

All related activities depend on input from Workstreams D and E, and can be started only after at least draft documents are available from these work streams. Execution of Workstream C is therefore planned mainly for the last 12 months of the INESS project. Consequently, no activities have been formally started so far.

Organization of WS C

The workstream is led by Bombardier.
Workstream leader: Theo Lange, Head of Advanced Engineering Mainline, Bombardier Transportation, Rail Control Solutions.
Mr. Lange has experience with railways (mainly safety and control systems, and operations) for more than 30 years. His current work with Bombardier focuses on interlockings and ERTMS solutions, including their site data preparation, for customers in several countries.
Nearly all INESS project members are planning to contribute to the work stream. In total, 36 man months are planned for work package C1, 26 for work package C2, 70 for work package C3, and 42 for work package C4.

Workstream D: Generic Requirements for ERTMS-compliant interlockings (ProRail)

Wendi Mennen,
Workstream D Leader,
ProRail - Netherlands

The main objectives for the INESS project of Workstream D are:

- to define a common kernel of validated standardized functionalities for future interlockings, including functionalities specially required by ERTMS Level 2 and Level 3 and which will support the common operational requirements of the various railways.
- to define standardized and optimized methods and tools for requirements management and for verification and validation.

This workstream is mainly related to the phase 4 of the CENELEC life cycle.

The functional requirements for interlockings are derived from the various national rules which are not harmonized (Rule Book, Betriebsordnung, Fahrdienstvorschrift, …). In this way, a common understanding and agreement on the expression, presentation (structure, degree of details, formal presentation, etc.) of the requirements is composed.

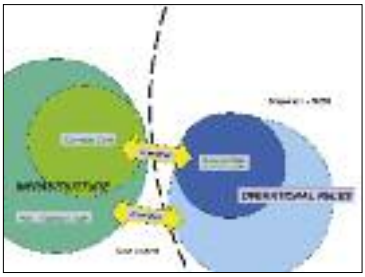
The Euro-Interlocking project offers fundamental dispositions. The set of functional requirements of the Euro-Interlocking project will be extended with requirements concerning railways not yet covered. By using the same method, the experience from railways and industry will be collected to compose ERTMS (especially level 2 and 3) requirements for interlockings. The requirements will be consistent with existing associated ERTMS operational rules and scenarios.

Three basic elements in the railway system must be considered in combination: the infrastructure, the moving trains and the operational rules and regulations. During the course of this workstream the combination of both functional and operational issues will be considered and a link will be established between the INESS requirements and the already existing ERTMS operational rules (the operational rules themselves are not in the scope of INESS).

From this set of requirements a common core of shared requirements will be derived. The common core just includes the basic functions required to operate rail traffic, however it should also represent a high percentage of individual national requirements for each railway. The aim is to maximize the common core, and to minimize the national exceptions. Based on the experience thus far, it is foreseen that on average, the common core will represent around 80% of the essential national requirements, and the remaining part will be made up of individual national functions. With the common core of functional requirements the operational rules that are directly related to these requirements can be identified by the users. These related requirements on their turn are part of the entire set of national rules. A graphical representation is shown in the figures.

In deriving the set of functional requirements the guidelines and environment will be created to standardize and optimise method and tools for requirements management. The workstream shall deliver for this purpose a signalling glossary, a catalogue of commands and statuses, a document of functional interfaces between interlockings and a requirements database.

To be able to retrieve a common method and tooling for verification and validation of the functional requirements a strategy will be documented. All the requirements will be translated to formal expressions by a Unified Modeling Language (UML). Doing this, it must be possible to perform common generic test cases and prove the consistency (for example in safety) of the requirements. In this work package universities have an important role in expression, modeling and simulation, where the railways are responsible for validation.



Jorge Gamelas,
Workstream E Leader,
BV - Sweden

Workstream E: Functional Architecture and Interfaces

Background

Currently no harmonised functional architecture exists for either complete signalling systems or even the integral parts of interlockings. Within ETCS, up until now, only the interfaces needed for interoperability between trackside and onboard equipment have been harmonised; most of the interfaces between the various trackside subsystems are still open.

With the appearance of ETCS there results a combination of existing signalling functions retained with new ones introduced for the new technology. Level 1 will retain the majority of existing signalling functions whilst Level 2 and Level 3 will progressively replace these with new functionality relating to ETCS.

It is important that railways making investments today in conventional signalling systems, can do so with confidence that their outlay will be not be lost when an interlocking needs to be supplemented with ETCS trackside equipment. This makes it crucial to confront the issue of architecture, to enable interlockings to be procured with confidence in the coming years.

Main Objectives of the WS

The main objectives of WS E can be summarized as follows:

- Assess the current architecture of signalling installations with regard to their functional configuration in the context of all their adjacent and neighbouring subsystems.
- Propose an optimal functional architecture for interlockings with ETCS. Show the apportionment of functionality between the interlocking and the different sub-systems and draft all relevant interface specifications between the interlocking and the adjacent subsystems.
- Assess different current migration and fallback methods and make recommendations for migration and fallback strategies.

Work Plan

The WS is divided into the following Work Packages:

WP E1 – The main activity of this WP is to gather information from relevant projects regarding system architecture and interfaces. Information about migration and fallback strategies will also be collected here. The WP will deliver the collected information as a series of reports.

WP E2 – This WP will propose one or several harmonised interlocking structure(s) with corresponding functional architecture and interface definition. It is also the task of this WP to identify a list of relevant interfaces to be harmonised at a functional level.

WP E3 – Based on the work of WP E2, this WP will do an allocation of functionality and safety within the proposed architecture(s) and deliver FIS/FFFIS of the relevant interfaces.

WP E4 – Based on the information collected in WP E1, WP E4 will deliver two reports recommending strategies for migration and fallback.

WS E is planned to start on October 2009 and be active until the end of the project (September 2011).

Participating partners

WS E is being supported with contributions from the following organisations:
UIC, ADIF, ANSALDO, AZD, BV, BT, DB, INVENSYS, MerMec, PR, RFI, S&B, Siemens, TIFSA, Thales, TUBS.

Workstream F: Testing and Commissioning

Ian Harman,
Workstream F Leader,
Network Rail - UK

Railway Systems Engineer, Network Rail, Great Britain (excluding Northern Ireland)

Testing and Commissioning activities are normally essential activities for railway administrations and suppliers when developing, maintaining and renewing railway signalling command and control systems.

This is considered to be the case irrespective of whether an organisation is developing a new product as part of a railway signalling command and control system, or when railway signalling command and control systems are being renewed, updated or replaced.

There are, however, also believed to be a wide range of different requirements that testing and commissioning can be required to fulfil, as well as there being a multiplicity of techniques and methods by which they are carried out, and by whom.

It is also believed to be the case that the use and understanding of the terms varies widely between suppliers, railway administrations and safety regulators.

In many cases, Testing and Commissioning is an expensive activity, often dependent on relatively small groups of specialists, and it is the case for many suppliers and railway administrations that the costs arising are often a significant component of product or project cost.

It is therefore firstly the intention of this Workstream within INESS to gather data leading to an understanding of what is presently "State of the Art" in testing and commissioning, and therefore to establish baseline requirements, terminology and methods for the carrying out testing and commissioning.

The second objective is to take this understanding, and use it to develop cost-effective tools, techniques and competency specifications for Testing and Commissioning to accompany the INESS products. This will, it is believed, lead to the Testing and Commissioning of INESS products being carried out in the most expedient and cost-efficient manner, whilst supporting the safety, legislative and functional requirements that most railway signalling command and control systems are required to meet.

The first 18 months of the programme are related to gathering the information needed to develop the "state of the art" reports. The balance of the 18 months will be applying what has been learnt to the INESS outputs, with a view to being satisfied that the Testing and Commissioning activities for INESS meet the business case requirements.

The workstream is being supported specifically with contributions from the following organisations, whose support I acknowledge with thanks:
UPM, TIFSA, DLR, UIC, Ansaldo, Invensys, AZD, RFI, ADIF, BV

Carsten Trog,
Workstream G Leader,
Funkwerk IT - Germany

Jörg Müller,
Workstream G Leader,
Technical University
Braunschweig - Germany

Workstream G: Safety Case Process

For the approval process of interlocking systems the CENELEC norms EN 50126, 50128 and 50129 are obligatory standard for all European countries. These norms describe the Safety Case Process integrated into the development process.

Though the norms have been published and used for about ten years now there is still a wide range of interpretation possible and this has caused difficulties in the efficient handling of the safety case process.

Therefore, in WS G the safety case processes at the partners' companies have to be analysed and problems have to be identified. Based on the analysis an interpretation of the standards has to be found that allows for an efficient handling of the safety case process according to CENELEC. Improvement strategies consistent to the National Safety Authorities' requirements have to be developed. Finally, open source software tools will be developed which provide support to the staff dealing with safety related tasks. This all will help to reduce time and money spent for the safety case by avoiding unnecessary or redundant procedures.

Of course, the results of WS G will be independently usable for all kinds of projects in the railway sector. But they are essential for the major goal of INESS to develop a universal interlocking system that can be used in all European countries with as few changes as possible. Certainly, the safety case process applied for implementing the necessary changes should be standardised and as efficient as possible.

The safety case process as described in the standards was modelled as a basis for the analysis of the real-life processes. With this model in mind a questionnaire was developed that addresses the major points of the safety case process. For the interviews conducted with most of the partners the questionnaire was used as a guideline for the interview. The results of the interviews have already been gathered and evaluated in a workshop.

Participating partners

Funkwerk, TUBS, DLR, UIC, DB, Banverket, ProRail, BBR, RFI, Ansaldo, Invensys, TIFSA

Workstream H: Dissemination, Exploitation, Training & Coaching

Maria Lafont,
Workstream H Leader,
UIC - France

Communication and dissemination of results are essential for a successful achievement of the project objectives, to protect the participants' interest and exploitation perspectives in order to achieve the overall acceptance and implementation of the project's results. Any intervention into design and maintenance in the railway domain by implementing new products and procedures may have long term effects and very important impacts on costs of railway system.

The Workstream partners are UIC, UNIFE, ProRail and FIR.

Workstream H ensures the take up of knowledge and results that come out of the INESS project by the relevant stakeholders inside and outside the INESS consortium. The main objectives and activities are:

- The dissemination of project results that evolve from the project during its course and a guarantee of the proper diffusion of knowledge using a real platform primarily developed to demonstrate INESS outcomes.

- To ensure the exploitation of the results that will have to take place when the project has finished and to establish interfaces to standardisation bodies in order to introduce the INESS results as draft standard proposals.

- The set up of one or more training and coaching programs for industry as well as railway infrastructure companies to assure the long-term availability of skilled and trained workforce for implementation of INESS results.

Helen Slaney,
Workstream H
& INESS logistics,
UIC - France

During the first months of the project we developed an INESS web-site http://www.iness.eu/. The web-site is regularly updated; it provides information on project organisation and structure, technical information; events and news related to the project. It informs the railway community on basic and detailed information about the project and provides extensive communication material.

Communication Platform is in the process of being set up; it includes the publication of regular articles on INESS in railway journals and international magazines as well as the publication of various dissemination materials.

INESS is also present at other conferences. The events are selected by taking into account the degree of relevance between INESS and the Conference. Such participation provides an excellent opportunity to present INESS and the progress of work on the project First was the UIC ERTMS Malaga Conference, 31 March – 2 April.

The main long-term objectives of the Workstream will be to organise conferences and workshops for disseminating the project results, maintain relationship with relevant people at standard setting bodies, regulatory bodies and national safety bodies for setting Interlocking standards; development of training material, relationship with possible investors and INESS publications.

www.iness.eu

Our partners

UIC (France) • ADIF (Spain) • Alma Consulting Group (France) • ALSTOM (Belgium) • Ansaldo STS (Italy) • AZD (Czech Republic) • Banverket (Sweden) • BBR (Germany) • Bombardier Transportation RCS (United Kingdom) • DB Netz AG (Germany) • Eindhoven University of Technology (Netherlands) • Eliop S.A. (Spain) • Funkwerk IT (Germany) • Invensys (United Kingdom) • MerMec (Italy) • Network Rail (United Kingdom) • ProRail B.V. (Netherlands) • Railsafe Consulting LTD (United Kingdom) • RFI (Italy) • RWTH Aachen (Germany) • Scheidt & Bachmann (Germany) • Siemens AG (Germany) • University of Southampton (United Kingdom) • TIFSA (Spain) • Thales Rail Signalling Solutions GmbH (Germany) • Technical University Braunschweig (Germany) • University Politecnica de Madrid (Spain) • University of York (United Kingdom) • UNIFE (Belgium) • German Aerospace Center (Germany)

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