ETCS
for Engineers

Peter Stanley (Editor)

Eurail press

IRSE
INSTITUTION OF RAILWAY SIGNAL ENGINEERS

ETCS
for Engineers

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Foreword

As a concept, the European Railway Traffic Management System/European Train Control System has been around since the early 1990s, materialising first as prototypes and from 2004 as full commercial systems. This major step change in signalling, where the driver now has a kind of electronic sight of the track ahead of him, will deliver the functionality that modern railway operations require. That includes movement across borders. It is a complex technology.

The main goal of this book is to provide a technical overview of the system during design, implementation and use. That has been achieved. It gives the reader the necessary information, without needing to consult the formal specifications or an expert in the subject. I hope it will help to further the knowledge of ETCS and to facilitate the expansion of ETCS around the world. This will help to establish ERTMS/ETCS as a world-wide standard.

One of my predecessors said that he expected communication-based train control (CBTC) systems to be the future norm. ETCS is the CBTC standard when it comes to main line railways. It is also part of the underlying technology for several mass transit systems. This book will therefore be of value for many if not all working in the signalling field. It does not matter if they are designers, operators, maintainers or simply end users.

This book is the latest of a long line of text books produced by the Institution over many years. Their aim is to explain railway signalling and telecommunications technology to students, technicians and engineers, who are interested in the way trains are controlled. I wish you all an excellent read.

Frans Heijnen, MSc, MBA, FIRSE

President, Institution of Railway Signal Engineers

April 2010

Introduction

The Editor Peter W. Stanley, B.Sc. C.Eng., Hon. FIRSE

The harmonisation of railway control and command systems is an important part of European Commission (EC) transport policy. It is to be achieved through the development of inter-operable systems. These are considered to be a means of increasing supplier competitiveness, reducing costs and eliminating cross-border delays.

Since the early 1990s, there has been a continuous evolution of the specification and technology of the European Rail Traffic Management System/European Traffic Control System (ERTMS/ETCS). Working systems are being introduced widely, not only to achieve efficient cross-border working, but also to allow trains equipped by one supplier to work over infrastructure equipped by another supplier.

ERTMS is the concept of a new generation of train control and signalling, including Advanced Train Protection, by supervising train speed and braking. Trains use data (eg gradients, signal aspects, braking performance) to calculate a safe speed envelope. The system will intervene if the train overspeeds, to bring it back into the envelope. The system stops a train safely if a signal is at danger.

As the name suggests, one aim is to enable the introduction of a common signalling system across Europe, bringing with it greater operational efficiency as well as safety benefits and interoperability.

ETCS is the hardware (and software) which needs to be developed to put the concepts of ERTMS into operation. The ETCS technology has different levels, which offer different combinations of capacity and performance.

The main purpose of this textbook is to provide a comprehensive explanation of how the constituent parts of ETCS work and how these different parts interface and combine to form a complete system. This uses the Global System for Mobile Communication – Railways (GSM-R) as the data bearer between the train and the control centre.

The explanation must be sufficiently detailed to be useful as a point of reference for engineers who are starting a career in railway control systems. It must also be useful for engineers who may be highly experienced in one part of the system, yet need access to information on the interfaces and inter-working of the constituent parts.

When the engineers of the supply industry companies and the railways started work on the project to develop ETCS, each brought to the project a great variety of experience. This covered different types of railway control systems and different technical platforms, together with a good understanding of the need for the various sub-systems serving railway operation and train control to interface and work together. The personal experience was relevant to the country in which the individual had worked, because each country had different requirements, different signalling systems with different functionality, different understanding of safety, safety targets and safety approval procedures. Most importantly, they had different operating rules and practices.

This wide and detailed knowledge of railway operational requirements and lineside signalling, automatic train control, automatic train protection, train detection, remote control, signal interlocking and track-train data transmission was crucial. The work required the definition of a compromise set of ETCS requirements, sub-system boundaries, interfaces and operating procedures that could be applied and accepted throughout the EC.

The timescale of this development work is such that many of the expert engineers are either now retired, or approaching retirement. They will be followed by younger people who will bring welcome knowledge of new technologies and techniques, but will have been less exposed to the system-wide and interface issues.

For railway control system engineers, ETCS presents a completely new situation in that the constituent parts are interdependent, with common data definitions, message structures and message handling processes. The inherent need for integration of the constituent sub-systems, previously regarded as stand-alone, imposes restrictions on sub-systems engineers who must ensure that any proposal for functional or engineering change must be considered in the context of the complete system.

It will also be useful to be clear about what this textbook does not cover. These are the issues of technical or railway operating strategy, economic assessment, legal and enabling processes within the EC, and specific project programmes and implementations. These subjects are dealt with in comprehensive detail in the International Union of Railways (UIC) ERTMS Compendium and many other publications.

The Institution of Railway Signal Engineers (IRSE) is particularly grateful to the many experts who have given their time as authors and reviewers of this textbook and have made their considerable knowledge available for new entrants to the profession.

From a personal point of view I would like to record my thanks to all who have contributed to the work of the textbook committee and to Helmut Uebel and George Nelson who started my involvement with ETCS.

Acknowledgements

The IRSE is most grateful to the Textbook Committee, authors and reviewers; all are engineers who have contributed their time, effort and considerable experience to this textbook; also to those who gave support to its editing and production.

The Editorial Committee

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Born in 1943, Gunnar Hagelin completed a Master of Science degree in Electrical Engineering at the Royal Institute of Technology, Stockholm, in 1967.

He then started work as a software designer in the Ericsson Signalling department. He has remained in that company or its successors (ABB, Adtranz and Bombardier Transportation) for the whole of his working career.

He has held various position as a designer, line manager, project leader and senior advisor. His main interests have been in the areas of Interlockings, Whole System issues and Engineering methods and tools. During the 1980s and 1990s he was involved in the establishment of new markets for the company, especially in the Far East.

He has also worked in the establishment and delivery of signalling education in Swedish technical universities.

He is a member of the International Technical Committee of the IRSE and served as Secretary and Chairman of that committee for a number of years.

Frans Heijnen

After completing his studies for an MSc. in Telecommunications Engineering at the Delft University of Technology in 1974, Frans Heijnen took up employment in Spain with Abengoa S.A and SAINCO in the field of Railway Signaling project management and in 1985 became Product Manager for Robert Bosch Comercial Española, S.A.

In 1986 he moved back to Holland to work in NS Railway Signalling Development, then in 1988 he moved back to Spain firstly as MD of Transmitton S.A., then as a business manager in S&T with ENA Telecomunicaciones and TIFSA before becoming an independent consultant in 1991.

In 1993 he moved back to Holland once more, taking on a consultancy role with the NS Signalling Production Department and then as Project Manager for the Passenger Network Department of Holland Railconsult.

In 1997 he became Director of System Engineering for the ERTMS Users Group, followed in 1999 by experience as Project Manager for sections of the Betuweroute and eventually as Manager of the Project Management Department of Holland Railconsult.

In 2001 he became Vice President, Technology, Invensys Rail Systems, responsible for technical strategy and R&D and then in 2006 became Vice President, Industry Relations, Invensys Rail Group, responsible for liaison with EU institutions and cross sector discussions. He was a member of UNISIG, UNIFE, EEIG, ERA and EU steering Boards and Committees.

Since 2008 he has worked as an independent consultant mainly in the area of ERTMS/ETCS.

Karin Löfstedt

Born in 1945, Karin Löfstedt gained a Master of Science degree at the Royal Institute of Technology in Stockholm in 1969.

After five years as a hardware designer at Philips, she joined Ericsson Signalling department in 1974. She participated in the development of the Automatic Train Control System that began operation in 1979 in Sweden. She had different roles in the company, with experience in technical sales support, project management and line management.

In 1991 she left the signalling business to work as Project and Product Manager at Ericsson Development department ELLEMTEL.

She then returned to the company now named Adtranz Signal in 1995 and was engaged in the Safety Assessment of the Adtranz Interlocking System according to the CENELEC norms. She was one of the Adtranz members of the UNISIG group working on the development of the ERTMS/ETCS standards. Following its release, she worked on the application of Bombardier Transportation ERTMS/ETCS systems in several European countries.

Jacques Poré

Born in 1955, Jacques Poré graduated from Ecole Centrale de Lyon in engineering in 1978. He started his career at Jeumont-Schneider (later part of Alstom) as Project Manager for control centres. This included one of the first TGV lines in France, from Paris to Lyon.

In 1980, he went to Alstom technical department, where he was involved with activities in track circuits and axle counters, point machines, level crossings and interlockings. In the technical/commercial field, he worked as the Project Manager for KVB, the Automatic Train Control system for SNCF. He subsequently transferred to the commercial and then the marketing departments.

From 2003, he was a Director of Alstom Transport Information Solutions in charge of the marketing strategy as well as that for the Regional Trains and for the Train Life Services businesses. In 2006 he took charge of Pre-Tendering Tools and especially training, documentation and tools for the Alstom Transport sales community.

From 1991 to 1998, he was the European Secretary for CENELEC. He has also been a member of the IRSE since 1980. This is the single worldwide signalling Institution, with over 4,000 members. He served as IRSE President in 2005-06.

Peter Stanley

Born 1942 and graduating in Electrical Engineering from Manchester University in 1964, Peter Stanley joined British Rail Signalling and Telecommunications Department. Here he gained experience in planning, design, installation, commissioning and maintenance. In1970 he moved into line management, eventually becoming British Rail's Assistant Director of Signalling in 1989.

From 1992-96 he was Managing Director of BR's engineering services, responsible for BR's IT services Project Management, Signalling Design & Technical Support, Telecommunications, Traction and Rolling Stock testing, maintenance and servicing workshops.

He left BR in 1996, becoming a director of AEA Technology Rail, advising on Signalling and Control systems. Also from 1997 to 2001 he was Project Director ETCS for Eurosig. Here he co-ordinated delivery of specifications and the Emset project.

From 2001 he worked with Virgin Trains as Project Director, Tilting Train Control System, and then with London Underground Ltd, reviewing system requirement specifications and with Metronet/LUL chairing safety approval panels.

He retired in 2009 and is currently supporting on-going tasks with IRSE of which he is a career–long member. He has been a member of its International Technical Committee since 1991 and was President of the Institution in 2002-03. He is the Chairman of the Textbook Committee.

Karl-Heinz Suwe

After studying general electronics technology at the Kiel Engineering College, Karl-Heinz Suwe worked for three years on the planning of signalling systems for the Hamburg Railway Authority.

From 1969 to 1979, he supervised the development of remote control and operational control centres in the former Central Railway Department in Munich, before going to work in the Main Administration Department of the Deutsche Bundesbahn in Frankfurt/Main.

From 1994 to 2001, he was a departmental manager in the National Railways Office, responsible for signalling systems, telecommunications systems and electrical engineering. Since 2001 he has been a consultant to the German Railway Industry Association (VDB).

Patrick Zoetardt

As a Senior Expert in Signalling Systems, Patrick Zoetardt has been working for Alstom Belgium since 1981. He has been involved in the development of electronic interlockings (1984-1988) and in the co-ordination of various train control systems for high speed trains (1989-1993), by which time he was dealing with cross-border transitions at full speed.

He participated as a member of the Eurosig team for testing Eurobalise technologies during the first phases of the ETCS specifications (1994-1996), and was a member of the Alstom teams developing the ETCS system (1996-2000). He was a member of the UNISIG team at the beginning of the "SUBSET" specifications (1998-2001). Design Authority for the Mattstetten-Rothrist ETCS Level 2 project in Switzerland (2002-2007). This covered the designs of the ETCS trackside and on-board sub-systems, together with the integration of the whole system including interlocking and the control centre. He is currently involved as Design Authority for an ETCS on-board project in Austria and is also working for ETCS tenders and for ETCS external trainings.

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1 Introduction to ETCS

1.1 Present and future requirements for Interoperability

Peter W. Stanley

1.1.1 ETCS Background

Unlike earlier legacy systems, ETCS is applicable to all kinds of train services. The key for this universality is the degree of functional autonomy allocated to the on board equipment. It includes all the generic functions necessary for speed monitoring and enforcement.

A big advantage of this concept is the possibility not only for interoperability between different networks, but also for intra-operability between parts of networks. Here, different train control-command and communication systems were used in the past or in some cases there were no such systems.

ERTMS also offers great scope for optimisation of equipment density on the trackside. The possibility of overlaying ETCS in conjunction with existing signalling systems also provides a great deal of flexibility in the planning of migration from old to new systems.

1.1.2 Requirements

The overriding technical requirement is to achieve interoperability. Thus trains with ETCS and GSM-R equipment of any supplier can run on lines equipped with ETCS and GSM-R of the same or any other supplier. They can also cross borders without special stops required specifically by the train control or train communication equipment.

Because it is practically impossible to harmonise the operational rules governing the use of existing lineside signalling systems, the achievement of cross-border interoperability under Level 1 introduces problems that are not met with in Level 2 or Level 3.

Although at all levels the driver is presented with the essential information by the Driver Machine Interface (DMI) and is supervised by the system, there are two additional considerations for Level 1. These relate to National requirements for driver reaction to signal failure conditions. The first consideration is the reaction to a discrepancy between the displayed signal aspect and the DMI information. This may be caused, for example, by a signal lamp failure. The second is a failure of the on board equipment or a Lineside Electronic Unit (LEU)/Eurobalise. To cover such an eventuality, the driver would need to understand the lineside signals and the regulations for movement under signal failure conditions for the administrations on each side of the border.

Cross-border interoperability under Levels 2 or 3 with harmonised fall back systems does not require an in-depth knowledge of operating regulations under failure conditions of heritage signalling systems on each side of the border.

The economic, procurement and life cycle requirements are discussed in UIC ERTMS Compendium, section 8.2.

1.1.3 Future developments – Baseline 3

The current specification baseline (known as 2.3.0.d) is enforced by the Commission Decision 2008/386 dated 23 April 2008. It contains, as described in this book, a defined set of functionality. Additional functions for a broader application have been identified and are under discussion for the next baseline. This new baseline is being referred to as “Baseline 3”. Further discussion and technical description of the additional functions will be made available when the new baseline is adopted formally.

One clear characteristic of the new baseline is the backward compatibility with the previous baseline. As a result, any train with Baseline 3 on board can run on a 2.3.0.d infrastructure. UNISIG Specification Subset 104, System Version Management, describes how this compatibility will be achieved.

In 2008 a Memorandum of Understanding (MOU) was signed between the relevant partners of the sector, including the European Commission. The European Railway Agency (ERA) was not party to the Memorandum, but was asked to prepare the Baseline 3 specifications before the end of 2012. As a first action, the ERA established a list of all new functionalities with the sector, to be defined for Baseline 3, together with a plan for the development of the specification.

The ERA documents in Figure 1.1-1 describe the plan at the time of writing, but are subject to change.

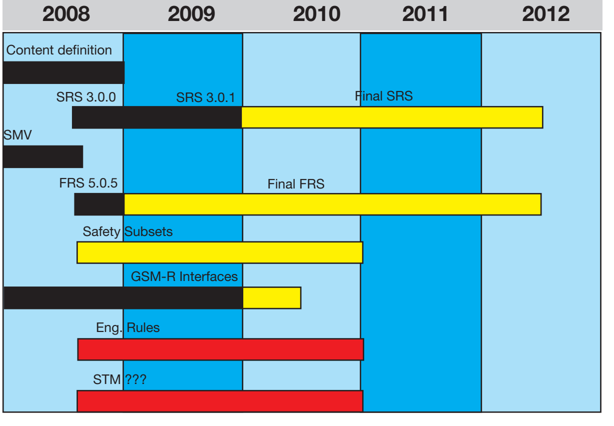

Figure 1.1-1: Baseline 3 timescale

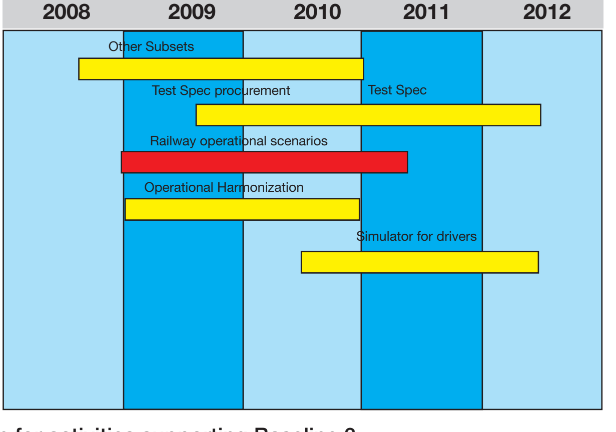

Figure 1.1-2: Plan for activities supporting Baseline 3

The ERA ERTMS Control Group handles discussions with the sector according to this plan, resulting in the publication of the initial release in December 2008. At the end of 2009 the first interim release was published (Version 3.0.1 of subset 026) followed by the first consolidation release 3.1.0 in February 2010.

Release 3.2.0 was discussed at the European level, by the Railway Interoperability Standards Committee (RISC) in spring 2010. This major step then freed the way for the modification of the underlying subsets and other related documents, like DMI Harmonisation and Operational Harmonisation.

The proposed changes include the definition of two additional operating modes and the elimination of the STM European mode, which has not been used. These changes are shown in Figure 1.1-3 below.

The current plan calls for a completion of the specification work in 2012. It will allow the first trains according to Baseline 3 to enter operation in 2015, in time for the start of the first Trans-European Network (TEN) corridors. The progress of the specification development can be followed on the ERA website: www.era.europa.eu.

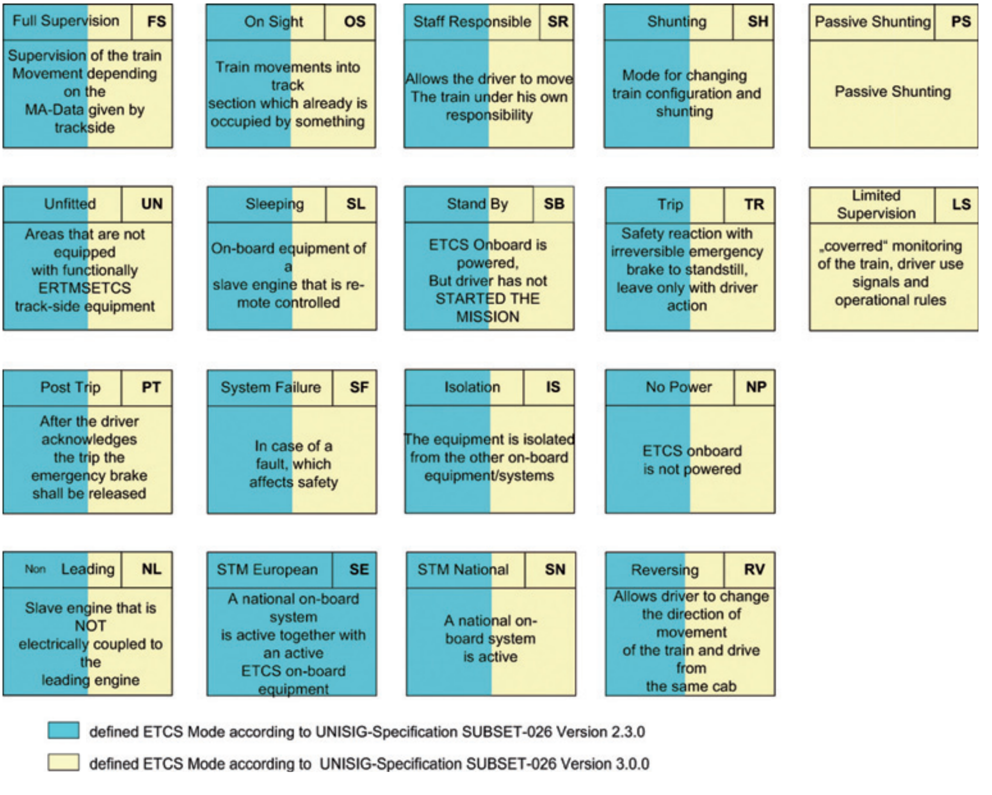

Figure 1.1-3 Baseline 3 changes to ETCS Operating Modes

1.2 Motivating factors for adopting ERTMS/ETCS and Requirements

Jacques Poré

There are several different areas that can be the initial motivators and subsequently the requirements for adopting ERTMS. Sometimes, several may act together to get an ERTMS project started.

The Motivations (the list is not exhaustive) include any Railway Undertaking (RU) or any Infrastructure Manager (IM), and of course any integrated railway administration which has its own priorities.

- The prime motivation is to comply with the EC – European Commission – rules to harmonise the cab-signalling systems throughout Europe and to follow what is now perceived as the future standard solution for main-line railways outside Europe. This approach includes the wish to reduce technical and economic risks.
- In reality, any technology will survive for decades if there are enough customers to buy it. ERTMS aims to reduce the technical risks associated with a multiplicity of cab-signalling and ATP – Automatic Train Protection – systems.
- ERTMS will also much reduce the economic risks associated with the juxtaposition of several ATP systems on board and along the trackside, whilst avoiding a single source solution for the railways.

As far as the Requirements are concerned, these are the most commonly considered. A classification of three sub-sections of economic, technical/operational and political is suggested.

Economic Requirements

- Level of investment.
  What is the level of investment required and, more precisely, what budget is available for a given project?
- Life Cycle Costs
  Some railways will focus only on the capital investment. Others, maybe the more mature railways, would right away consider the global Life Cycle Cost (LCC) i. e. including in their analysis the initial investment + any operational costs + the maintenance and end of life/ replacement costs. For products (or rather a system) such as ERTMS, the required level of interoperability will have also to be considered. Each line or corridor, each series of vehicles or fleet will have its own specifications.
- Liberalisation of the cross-border traffic:
  This is one of the key drivers towards ERTMS, already for freight (e. g. the Trans-European Network (TEN) corridors), later for passenger traffic. Private operators have a strong interest in using ERTMS to help them to become more efficient.

Technical/Operational Requirements

- Operation of non-equipped trains:
  If a line/corridor has, or has not, to be operated by both equipped and non-equipped trains, the issues to manage will not be the same.
- Need for new or existing lines fitment:
  The ease and costs of fitment for a new line are quite different from the upgrade or refurbishment of an existing operational railway.
- Need for High Speed Line fitment:
  More precisely, is there a need for High Speed Line (HSL)/Very High Speed Line (VHSL) fitment only? Or is the railway considering future HSL/VHSL fitment? Or is there no need

for HSL/VHSL fitment at all? This uses the European Rail Industry Association (UNIFE) definitions i.e. a HSL means a line with speeds from 200 to 299 km/h and a VHSL means speeds of 300 km/h and above.

- Need for mixed traffic:
  This refers to the need for only certain categories of rolling stock, or when considering a wider pattern of trains e.g. from freight to suburban, or from regional to intercity and High Speed Trains. Consideration needs to be given not only to the operation of certain types of trains in normal operation, and their performance, but also the possible disturbances. The more types of rolling stock that have to be included, the more complex the tests and approval processes.
- Line capacity/headway:
  Both the present and the planned headway requirements have to be considered. This is linked not only with existing and planned lineside signal spacing, but also with the rolling stock data. Subsequently, how many slots may each type of train use on any specific part of the line? With ETCS Level 2, it is possible to get a signalling system with a higher line capacity than with ETCS Level 1 or any conventional system.
- Safety:
  In some countries without a good existing (legacy) ATP system, ETCS will contribute to increased safety.
- Maintainability:
  Implementing a new system, whatever the type of ATP or Level of ERTMS/ETCS means maintaining it and changing some of the previous maintenance rules and habits. That has to be done on an existing railway that is in operation at an optimal level of reliability. The removal of redundant track equipment reduces maintenance and renewal costs and the chance of failures, and increases the availability of the total system.
- Exposure to vandalism:
  The less track side (visible) equipment there is, the less quantity of cables there is, the better the equipment will be naturally protected against vandalism or theft.
- Ease of implementation on an existing network/signalling system:
  The architecture of the ERTMS/ETCS system to be implemented depends much on the ERTMS/ETCS Level. It is also dependent upon the supplier, the layout of the installation, the quantity of “boxes” and where and how to implement them, and on the interfaces caused by all these items varying significantly from one supplier to another. On some High Speed Lines, ETCS Level 2 is used together with Level 1 as a fall back. The result is a lower level of performance, but maybe with a perception of greater reliability?
- Ease of implementation on an existing rolling stock fleet:
  This is much the same as the network/signalling system) i.e. the architecture depends much on the ERTMS/ETCS level as well as on the supplier, the layout, implementation and the interfaces.

Political Requirements

- EC rules compliance. EC rules are laws for ERTMS/ETCS needs, because they are transferred into national legislation. Depending on the country, inside or outside Europe, with some EC financing possibilities (and to what degree?), or with none at all, the railway will have a different approach to the compliance with EC rules. In some countries, there may be other types of rules with which some compliance may be preferred or be compulsory.
- Separation of network and operation?
  The split between the network and operational parts of a railway, as in the EC, will see new entrants (mainly operators) who will prefer to apply a more uniform standard.

1.2.1 As seen by the Railway Undertakings (RU)

In summary from the above chapter 1.2, the following Requirements concern especially the railway undertakings (RUs):

Economic Requirements

- Level of investment
- Life Cycle Costs:
  Not to be forgotten with RUs, especially the new entrants that are private companies, is the need to be able to easily adapt any piece of rolling stock to its operation on other lines than it is used on today. This extends to the networks of other countries, after three, five or 10 years or more, depending on the operational contracts that they may get.
- Liberalisation of the cross-border traffic

Technical/Operational Requirements

- Operation of non-equipped trains:
  If a line/corridor has, or has not, to be operated by both ETCS-equipped and non-ETCS-equipped trains, the management issues will be different. The question to solve for any RU is: “What to do when I do not have rolling stock fitted for a given line?”
- Need for mixed traffic:
  For RUs, the more types or series of rolling stock, the more the tests and approval processes to undergo. This means costs and time when those vehicles are not available for traffic.
- Maintainability
- Ease of implementation on an existing rolling stock fleet. This depends on the ERTMS/ETCS system and the level to be implemented. There are also other details which vary significantly between suppliers, such as equipment layout possibilities and the quantity and size of equipment modules.

Political Requirements:

- EC rules compliance
- Separation of network and operation?
- Speed of migration/Need (and/or wish) to replace legacy systems:
- No non-equipped trains allowed?

1.2.2 As seen by the Infrastructure Managers (IM)

In summary from the above chapter 1.2, the following Requirements concern especially the Infrastructure Managers:

Economic Requirements:

- Level of investment
- Life Cycle Costs
- Liberalisation of the cross-border traffic

1.3 The Driver's View

Peter W. Stanley

1.3.1 The man–machine Interface

The driver of an ETCS fitted cab has two control panels by which all ERTMS information is received and actions taken. These are usually referred to as the Driver Radio Interface (DRI) and the Driver Machine Interface (DMI). The DRI announces incoming calls or interrupts existing calls with emergency messages. It has single push buttons by which the driver can set up calls without dialling, e. g. to the line controllers/dispatcher and for an emergency call.

The DMI is described in detail in Section 3.5.3; it can be constructed either with soft-touch buttons or touch-screen technology. With these, a driver can input the train and trip specific data needed to start-up the on board ETCS equipment, or change the status during a journey. The driver can also acknowledge information and warnings presented by the system.

The general principle is that all input required from the driver and all information displayed to the driver in the course of train operation under ETCS is made via the DMI and the DRI.

1.3.2 Operating in Level 0

For, the most basic operating level, Level 0, the driver is required to enter basic train data such as maximum train speed at start up. In this Level the train can respond to any level change instruction received from a Eurobalise group. The DMI provides only a speedometer display. The system enforces the maximum permitted speed defined as that entered by the driver and

Figure 1.3-1: DRI and DMI– Swiss ETCS train (Alstom)

Figure 1.3-2: DRI – Napoli (Alstom)

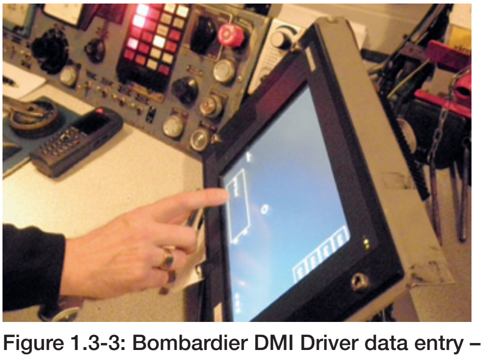

Figure 1.3-3: Bombardier DMI Driver data entry – Switzerland (Bombardier)

Figure 1.3-4: Siemens DMI, Class 102 train, Madrid

the maximum permitted speed defined by the Unfitted mode (UN). The maximum speed in UN mode is either the default National Value or a special value received from trackside in the packet National Values. All other functions, including the observation of lineside signals are the responsibility of the driver as defined in the national operating regulations.

1.3.3 Operating in Level STM (Specific Transmission Module)

For Level STM operation, the driver must enter basic train data, observe lineside signals and obey national operating regulations. The ETCS system will check continuously that its interaction with the STM is working as required, the STM being the on board part of the national train protection system. The STM will supervise and display information on the DMI as required by the information received from the trackside part of the national protection system.

1.3.4 Operating in Level 1

For Level 1 operation, the driver is supported by lineside signalling and the DMI information. ETCS on board will indicate the distance to the end of the current movement authority, will enforce maximum line speed and will generate, indicate and ultimately enforce a speed reduction envelope to prevent the train exceeding the limit of its movement authority. Operating regulations are enforced through the action of the Interlocking and lineside signals and the LEU, lineside Electronic Unit, together with the Eurobalise group in the generation and transmission of the Movement Authority to the train. When approaching a red signal, the driver will stop before the signal and wait for the signal to clear before moving on.

1.3.5 Operating in Level 2 and 3

For Level 2 and 3 operation, the driver will not have to observe lineside signals. Indeed, in most cases there will be none to observe. The ETCS on board will indicate the distance to the end of the current movement authority, will enforce maximum line speed and will generate, indicate and ultimately enforce a speed reduction envelope to prevent the train exceeding the limit of its movement authority. Operating regulations are enforced through the action of the Interlocking and RBC in the generation and transmission of a Movement authority to the train.

Further details can be found in the UIC ERTMS Compendium, section 5.3.

Traditional railway signalling has long been based on the principle of no more than one train, on any one section of track, at any one time.

New technology allows cab-based equipment to replace lineside signals. This gives improved operational performance and better system capacity by redefining the concept of the track section. Using continuous position reporting by the train, the section becomes a safe 'envelope', within which each train operates. The 'envelope' increases or contracts according to the speed of the train, its braking distance and other characteristics. This gives much more flexibility and the closer spacing of trains, without compromising safety principles.

The contents:

- An introduction to the European Train Control System (ETCS).
- A description of how ETCS works and the levels at which it may be employed.
- An exploration of the sub-systems, processes and interfaces.
- The requirements for system testing, commissioning and certification.
- Engineering – the technical, organisational and operational requirements.
- The needs for maintenance, fault-finding and safety monitoring.

System interoperability is a key European Union requirement, and a common approach to signalling in the different countries is a major contributor.

This book was written by experts involved in ECTS development under the leadership of the **Institution of Railway Signal Engineers,** supported by Eurailpress. It is the latest in a series describing railway signalling and telecommunications systems in use throughout the world.

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