

GENERAL DESCRIPTION OF EUROPEAN RAILWAY TRAFFIC MANAGEMENT SYSTEM (ERTMS) AND STRATEGY OF ERTMS IMPLEMENTATION IN VARIOUS RAILWAY MANAGERMENTS

Aldona Jarašūnienė

*Transport Research Institute, Vilnius Gediminas Technical University,
Plytinės G. 27, LT-10105 Vilnius-16, Lithuania
E-mail: Ajarasuniene@Yahoo.Com*

The paper presents the general overview of European railway traffic management system (ERTMS). Subsystems are described ETML, GSM-R with particular attention to ETCS.

The technological progress of application of national railway traffic control equipment, in the case of international trains, has enforced development of a unified ERTMS system. This paper describes the issue of ERTMS system implementation in various railway managements.

Keywords: ERTMS, railway traffic control, railway managements

1. INTRODUCTION

European Railway Traffic Management System (ERTMS) in accordance with the Decision of European Committee 2001/260/EC should ensure railway interoperability.

Railway interoperability means the broadly understood compatibility of infrastructure, power supply, maintenance, control, and rolling stock, traffic. Railway interoperability applies both to existing and newly constructed lines, the existing signalling systems and ERTMS.

Operational interoperability of control ensures international safe train; travel within various European networks and in particular:

1. The train passage through the border without necessity to stop the train;
2. Without change of locomotives;
3. Without change of driver;
4. Using exclusively standard tasks compliant with ERTMS.

Technical interoperability is a component of operational interoperability.

Together with the economical progress of European countries the development of national railway traffic control system took place that are not compatible with each other. As a result, trains passing the border are equipped with various national systems that are extremely costly and have to be installed among other onboard equipment. When passing the border, the train has to change its system in accordance with dictated by the cross border European country. This extends the time of travel and increases maintenance and operating costs.

2. GENERAL DESCRIPTION OF ERTMS SYSTEM

European railway traffic management system (ERTMS) consists of the following:

- European Train Control System (ETCS);
- Radio transmission system GSM-R;
- European Train Management Layer ETML.

General assumptions of ETCS. ETCS is bound to supplement and in the future even suppress the variety of AKJP systems (Automatic Train Travel Control) by one common system. Thus, it has to be fully accepted by all European, and in the future also non-European railway managements. This means that it has to fulfil all functions performed by the presently used system, while certain basic functions will be obligatory for all lines equipped with ETCS, and other will be used on an as needed basis.

At the same time for economical reasons this system will have to ensure a possibility of cooperation with various structures, both on the vehicle and on the infrastructure side. Moreover, the system has to enable management of traffic in accordance with requirements and provisions of all specific railway managements and ensure safety at the high level, but not lower than now.

It is necessary to make possible smooth transition of railway management borders without longer standstills for replacement of locomotive and reduction of investment and operational costs by expansion of market and implementation of market competition principles between control system manufacturers on the railways by making available full documentation of interfaces and functional and system requirements of each module to the potential manufactures.

Thus set, these objectives are reached through a far-reaching modularity of functions and structure of the system, open hardware and software architecture and mechanisms taking into account national and local traffic regulations.

ETCS based is on digital track-car transmission. This transmission may be made by balises, short, average or long loops, digital radio channel or specialized transmission modules. The data describing the track and data describing the vehicle serve the purpose of static and dynamic speed profile calculations. The calculated profile is continuously compared with the present speed in function of a location. Location function, necessary for this purpose is based upon uniquely identifiable (by an unique number) and precisely located devices for pinpoint transmissions (balises or loop end marks).

Functions of control and supervision always operate along the same principles, independently from the channel receiving the information from the track. The basic functions fulfilled by the vehicle and track devices are presented on Figure 1.

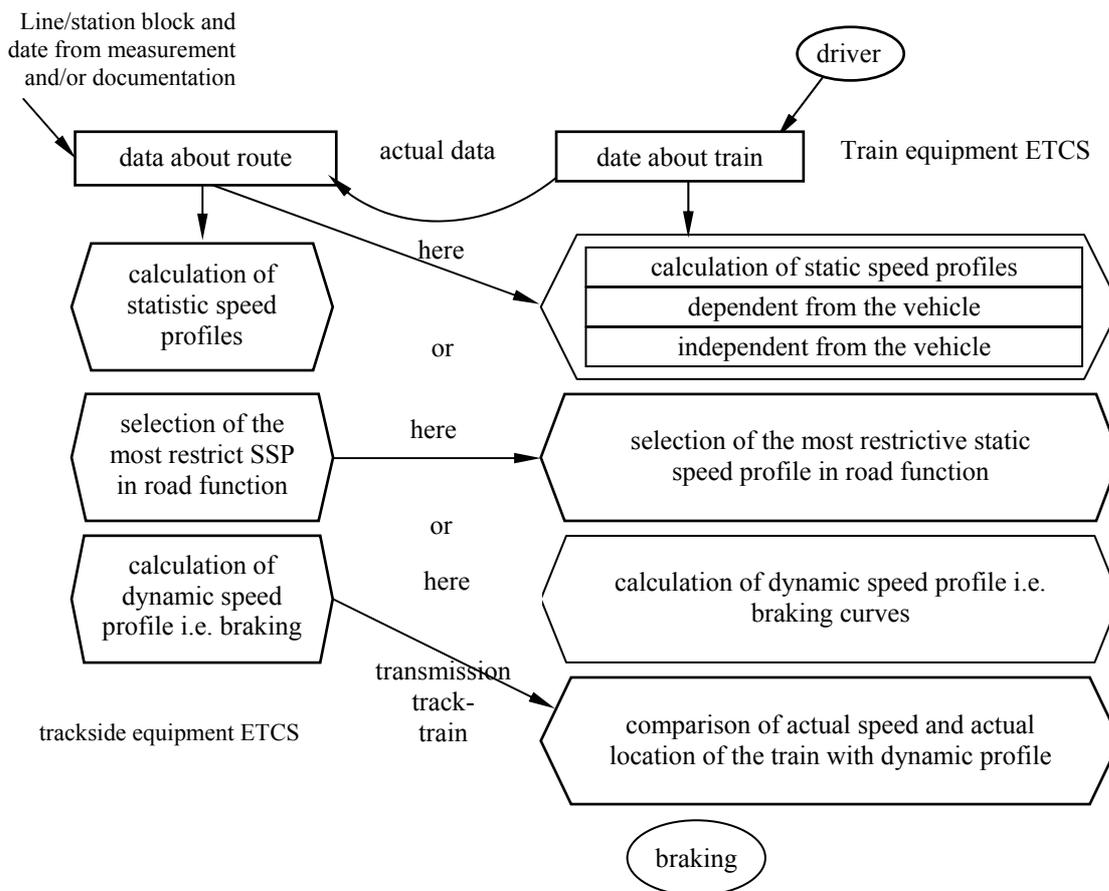


Figure 1. Basic functions of vehicle and track devices ETCS

This drawing shows clearly trackside equipment, transmission track-train and train devices. This division is always appearing in AKJP systems based on train-track transmission. We have to draw attention to the fact that in the case of ETCS both trackside and onboard train devices may realize system the majority of functions.

Each train provided with ETCS devices is able to realize all functions shown at the side of ETCS train on-board equipment as shown on Figure 1. Use or not of each function depends on information received from the track i.e. of level of ETCS application or configuration of trackside devices. This does not mean, however, that each vehicle equipped by ETCS is able to move on any line equipped with ETCS.

Trackside equipment, depending application level and configuration are ready to perform only a predetermined range of functions. This range is determined during designing of line equipping with ETCS taking into account, among others, needs of the line (expressed by, for example, required throughput of the line, speed of the line, required comfort of passengers) as well as cost of investment and operation.

GSM-R. GSM-R is a railway version of GSM (R – Railway) operating in the band of 900 MHz. GSM-R functionally corresponds to GSM 2+ making available to the users, besides talk channel, also a radio channel for data transmission, group calls, determination of call priorities, functional addressing (using for example train numbers) and other specialized functions designed for such services as railways or police. GSM-R constitutes then a transmission carrier whereby drive clearances are sent, issued by Radio Block Centre – RBC to specific trains located within one RBC area. Place of GSM in the ERTMS/ETCS system is shown on Figure 2.

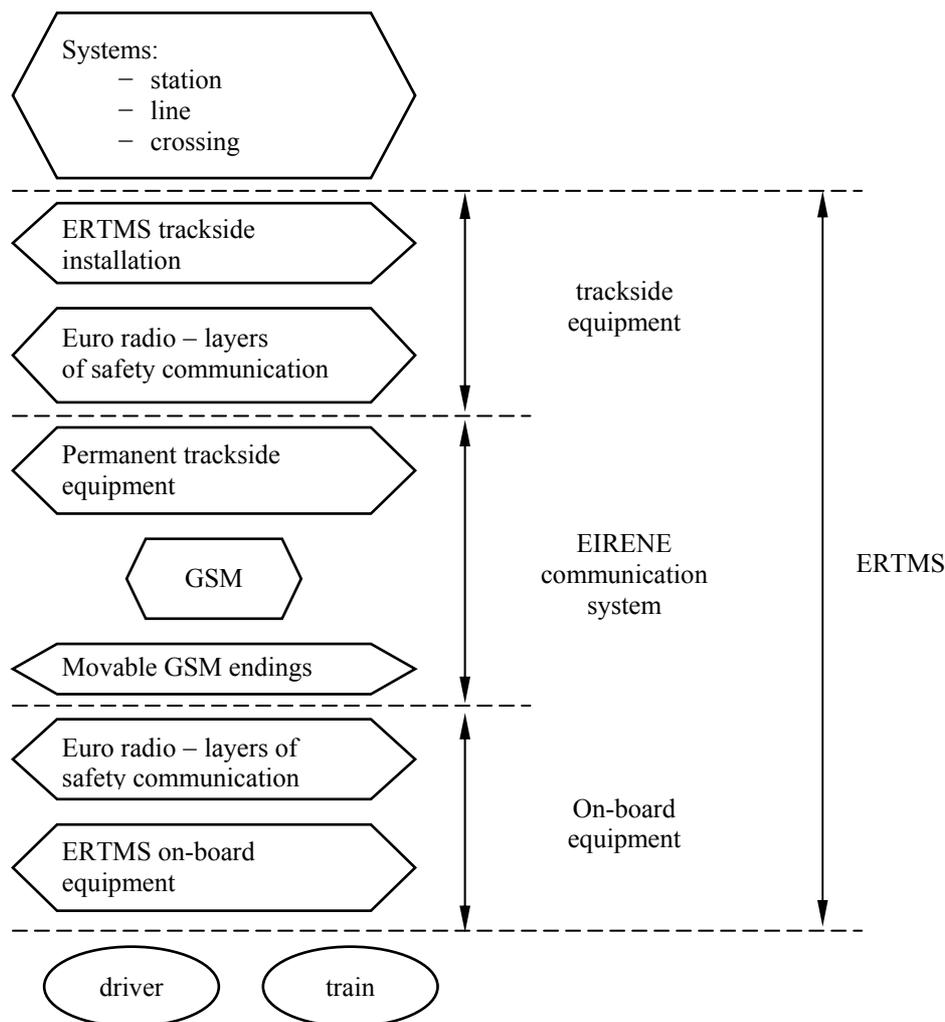


Figure 2. Place of GSM in the ERTMS/ETCS system

Architecture of GSM-R system is a typical GSM cellular network and consists of a main Network Switching Subsystem – NSS and Network Management Subsystem – NMS on the main level Base Station Subsystem – BSS consisting of peripheral groups of Base Station Controllers – BSC and peripheral groups of Base Transceiver Stations – BTS.

GSM-R constitutes the transmission medium not only for ETCS but also for train radio communication, as it makes available also talk channels. At the same time, spreading of GSM-R gives medium for all other applications, related with information transmission for the purposes of maintenance, statistics, travellers information etc.

Train management level – ETML. Even in 1998 it was expected that within the ERTMS system the railway management layer would be introduced. Railways however could not agree upon which functions should have been introduced to the management system and in the meantime the railway managements were creating their own systems. Telematic railway management systems in the specific railway managements developed to such degree that any standardization of the entire management system became impossible. For this reason, at the level of European Committee, a decision was taken that ERTMS should contain an interface enabling the national telematic railway management systems to exchange information using standard connections and standard messages.

The fact, that within the ERTMS only an interface between telematic railway management systems will be developed, means that specific railways need their own railway management systems and should not expect in this respect standardized European solutions.

3. OFFICIAL STATUS OF ETCS IMPLEMENTATION

The discussions held on governmental level and aimed at integration of structures of various countries into a single organism directed according to certain principles with maintained privatisation trends of other transport branches, forces the operators of railways to be more competitive than previously. Railways have to offer increased speeds and more comfort of travel not only in high-speed trains, but also in all trains travelling along trunk lines, Similar criteria have to apply also to the operation of cargo transport.

The governmental discussions concerning integration of specific countries within the European Union (EU) forced the specific national railway operators to begin discussions concerning meeting the challenge of competitiveness of railway transport. An outcome of these discussions was development of an ERTMS system covering the train control and supervision system (ETCS), system of digital transmission channel in the railway band (GSM-R) and traffic management system (ETML). Three basic levels with possible modifications have been proposed to the future users.

Operating possibilities and a possibility of cross-border travel on the lines of neighbour countries results in the fact that this system is provided as basic one (in accordance with EU directive) on the European railway networks (at the high speed tracks and main transport channels) where the trains have to travel in always safe conditions.

Implementation of ETCS in each country requires big initial effort in order to determine specific technical and legal circumstances of ETCS implementation. Definition is required also for conditions of contract and installation realization, conditions of system's implementation approval for regular operation. This process is advanced to a different degree in different countries. Generally, the phase of testing and certification approaches its end and ETCS enters the phase of real commercial application. Pilot applications for both Level 1 and Level 2 are already in day-to-day commercial operation for over a year. Several additional important projects will be implemented in the next two years.

The map below gives a general overview where and to what scale we may expect the ETCS until the end of 2008.

Especially with mentioning in the fact that till today instead the interoperability was the key driving factor for implementation of ETCS, but opening of new lines and improvement of safety. Till today, significantly more kilometres of conventional lines than those of high-speed lines have been assigned for provision with ETCS not later than 2008. Similarly, in relation to rolling stock, more than half of units provided with ETCS will have STM with return information which means that these vehicles will probably run on conventional lines. Of course, in next 2–3 years it is possible and more

than desirable than additional ETCS equipment is ordered for future conventional and high speed railway connections.

Plans of ERTMS/ETCS implementation in certain European countries are shown below.

Belgium. At the end of April 2001 the supervisory board of Belgium Railways made a decision about implementation of ETCS in the Belgium railways.

On the high-speed lines, the system TBL2 will not be developed anymore. For new lines Antwerp – border of Denmark and Liege – border of Germany the system 2 ETCS will be installed till the end of 2006.

For the remaining conventional networks till the end of 2006 the Level 1 ETCS will be installed till 2006 on the 50 % of networks. Priority will be lines and nodes on the international corridors and/or burdened with intense traffic. The main goal is elimination of railway accident risk.

On the lines with fewer burdens it is provided to use Level 1 ETCS with use of travel in the “limited supervision” mode, which is related with time and cost limitations.

The following options are provided for in the area of rolling stock:

- Units supplied in 1980 and later, without TBL2 will be provided with ETCS onboard equipment.

- Units with TBL2 will have reverse STM.

- Units supplied in 1980 but that will remain in use until 2010 (ca 31 % of rolling stock) will have the data transmission equipment (balises/loops) and simplified cabin equipment giving the same scope of functions as TBL1.

- Units with their lifetime expiring till 2010 or earlier will not be provided with ETCS.

France. French Railways are the founding member of ERTMS users. A test centre was established on a section of a high-speed line near Paris, a conventional line joined it. Here, the suppliers such as Alstom and Ansaldo/CSEE have a possibility to test and approve their ETCS products containing STM for Crocodile/KVB and TVM. These tests with combustion wagons as well as interoperability tests of a German train equipped by Siemens will be completed till the end of 2004. In particular in relation to the French STM certain inconsistencies have been discovered in the presently available specifications. Appropriate revision requests have been formulated (Cr).

The French government investigates technical and financial possibilities of realization of a first international commercial application of ETCS on a new high-speed line LGV East European. For this purpose, development of a so-called two-standard cabin device for TVM j and ETCS level 1 and 2 has been ordered at the supplier Ansaldo/CSEE. In this concept, the same central equipment may be used for either realization of an ETCS function for level 1 and 2, or TVM 430 function as a so-called internal or integrated STM – ECS/TVM 430, or as the so-called external STM for TVM. Each application is provided with an odometer. The visualization equipment for the driver (MMI) was designed in accordance with ETCS specifications. Combined equipment ETCS/TVM 430 will be used for the first time in 15 international trains that have been recently ordered. On the infrastructure side, the new high-speed line East will be provided with TVM 430 and in parallel with ETCS Level 2. If the financing decisions were to be taken, it would be purposeful to use both systems in parallel. Whereas the trains provided with TVM 430 will operate according to previous principles, and those provided with new MMI will operate in ETCS mode. This would require harmonization of procedures and regulations (watchdog, temporary speed limitations, drive on sight mode, manoeuvring mode etc).

On condition that all technical and operational issues will be possible to solve, all new TGV trains ordered since the mid-2005 will be marked with a new generation cabin profile ETCS/TVM 430.

For the existing high speed line Paris – Lyon a study is carried out aimed at showing how much the throughput will grow as a result of ETCS installation.

The planned future extension of French high-speed networks where ETCS could be applied, are shown on the drawing below.

For a conventional network studies are carried out concerning implementation of ETCS but no formal decisions have been taken yet.

Italy. Italian Railways are a founding member of ERTMS user group and since very beginning they actively participated in the ETCS development works.

The pilot installation was established between Florence and Arezzo, using 61 km section of a high-speed line Direttissima and a conventional branch connecting it with Arezzo station. Purpose of this pilot installation whose supplier was Alstom was to demonstrate the feasibility of ETCS Level 1 and 2 installations based on ERTMS specifications taking into account the specific interfaces to the Italian signalling and train borne equipment. Trial runs have been performed using specifically equipped train sets Pendolino. Commercial service using ETCS never was planned on this line.

As a next step, the consortium responsible for a new line Roma – Napoli lead by Ansaldo has installed a prototype track equipment designed to the latest specifications on an extension from Arezzo to Rigutino. In 2002 a full program verifying various functions including GSM-R was successfully carried out.

The first commercial application of ETCS will take place in a new line Roma – Napoli. In the developed track part of the system the following main partners are engaged RFI/Direzione Technica, Consortium Saturno, Alstom (RBC, track circuits), Ansaldo (protection equipment and balises) and Sirti (GSM-R radio equipment). ETCS Level 2 will be installed without track signals.

The following rolling stock is provided for this line:

- 60 multi-system trains ETR500 with cabin equipment (combination of ETCS and SCMT) supplied by Alstom.

- 15 multi-system trains ETR 480 with cabin equipment (combination of ETCS and SCMT).

For these systems the supplier will be selected.

- 12 new multi-system trains ETR 480. For these systems the supplier will be selected.

Beginning of commercial services is expected in 2004.

Luxembourg. At the end of 1999 the supervisory board of Luxembourg railways has taken a decision about implementation of ETCS Level 1 on the entire network (ca 250 km with 880 signals) and on the entire rolling stock (36 motor wagons, 20 electric locomotives, 40 combustion locomotives).

In the last two years a bidding procedure took place covering the transformation study. Till the end of 2002 the following contracts were signed:

- With Alcatel for delivery of track equipment. Several sets have been determined, the first one as a pilot application. The most optimistic scenario provides for the entire network to be equipped within 5 years.

- With Alstom for rolling stock equipment. In the first phase the electric locomotives will be equipped (type 3000, identical with type 13 in Belgian railways).

In reference to the transformation, the decision was to maintain in operation the system Memor II+ both in track and in train borne part.

Holland. Pro Rail is a member of ERTMS user group. For testing and validation of ETCS system the specific Dutch environment two independent test centers have been established, equipped by Alstom and Bombardier companies. Expansion of STM for ATB and ATB of new generation has been ordered.

On the Southern High Speed line from Hoofddorp to Rotterdam – West and from Rotterdam – South to the Belgian border, the ETCS Level 2 will be installed. The rolling stock to be used on this line both existing and new will need onboard equipment. The line will be connected to the existing conventional infrastructure near Amsterdam, Rotterdam and Breda. Till now no plans for installation of ETCS on sections of this line exist. Such plans may be developed in the future as a result of implemented national strategy. Project of preparation of such a strategy was recently initiated.

On the new cargo line, Betuwe, connecting several terminals in port of Rotterdam and the marshalling yard Kijfhoek with Zevenaar and Emmerich on the German border, ETCS Level 2 will be installed. Locomotives travelling along this line will need onboard equipment ETCS.

Line Amsterdam – Utrecht is presently modernized and expanded from 2 to 4 tracks. The ETCS Level 2 and first generation national ATB system will be installed on this line, which will enable testing of transition from ATB to ETCS in the onboard equipment. The further transition to ETCS on the Dutch railway lines will depend, among others, on results of these tests. Installation of ETCS on the existing line between Utrecht, Arnhem and German border may be considered as a consequence of the above-mentioned migration. We have to note that in 2001 implementation of GSM-R system on the entire network of Dutch railways has been initiated, to be completed till 2005.

Lithuanian railways are also instead in equipping new lines with ERTMS system equipment.

4. CONCLUSIONS

1. The paper presented the general overview of ERTMS system. Subsystems were described: ETML, GSM-R with particular attention to ETCS.
2. Plans of ERTMS/ETCS implementation in certain European countries were shown.

References

- [1] Bialon A. Trans-border pilot ERTMS sections Katowice–Bohumin–proposal. In: *Railway Scientific and technical Centre, Chlopickiego, III international conference TST'2003*.
- [2] Gradovskij P. Conditioning of initiation ERTMS/ETCS. In: *Railway Scientific and technical Centre, Chlopickiego, III international conference TST'2003*.
- [3] Directive 2001/16/EC of 19 March 2001. On interoperability of Trans-European system of conventional railways.
- [4] Directive 96/48/EC of 23 June 1996. On interoperability of Trans-European system of high-speed railways.
- [5] Decision 2001/260/EC of 21 March 2001. On basic parameters of control system containing specifications ERTMS/ETCS and ERTMS/GSM-R.
- [6] Recommendation 2001/290/EC of 21 March 2001. On basic parameters of Trans-European system of high-speed railways.