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Paweł GRADOWSKI[1]

STRATEGY OF ERTMS IMPLEMENTATION IN VARIOUS RAILWAY MANAGEMENTS

The technological progress of application of national railway traffic control equipment, in the case of international trains, has enforced development of an unified ERTMS system. As per today, the first installations on the lines belonging to specific operators take place. This paper describes the issue of ERTMS system implementation in various railway managements.

STRATEGIA WDRAŻANIA ERTMS W RÓŻNYCH ZARZĄDACH KOLEJOWYCH

Postęp technologiczny stosowanych narodowych urządzeń sterowania ruchem kolejowym, w przypadku pociągów międzynarodowych, wymusił opracowanie jednolitego systemu ERTMS. Na dzień dzisiejszy mają miejsce pierwsze instalacje tego systemu na liniach poszczególnych operatorów. Niniejszy referat przedstawia problematykę wdrażania systemu ERTMS w różnych zarządach kolejowych.

1. INTRODUCTION

Together with the economical progress of European countries the development of national railway traffic control system took place (Fig.1.) 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 that dictated by the cross-border European country. This extends the time of travel and increases maintenance and operating costs.

[1] Railway Scientific and Technical Centre, Chłopickiego 50, 04-275 Warsaw, Poland, pgradowski@cntk.pl

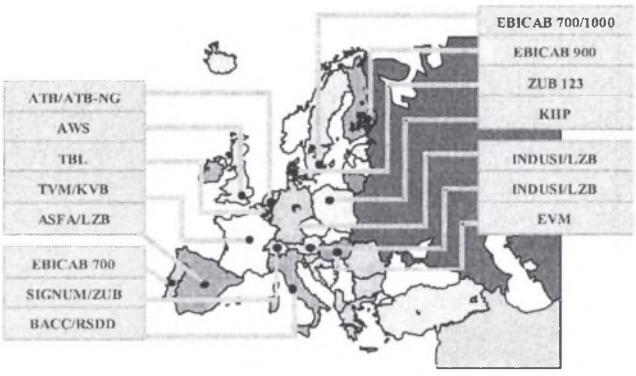

Fig.1. Railway traffic control systems

2. HISTORICAL OUTLINE

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 privatization 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 traveling 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 neighbor 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.

3. OFFICIAL STATUS OF ETCS IMPLEMENTATION

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.

Fig.2. Expected implementations of ETCS till 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 kilometers 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 less burden 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 center 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 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 a ETCS function for level 1 and 2, or TVM 430 function as a so-called internal or integrated STM – ECS/TVM 430, or as 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 are 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, maneuvering 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.

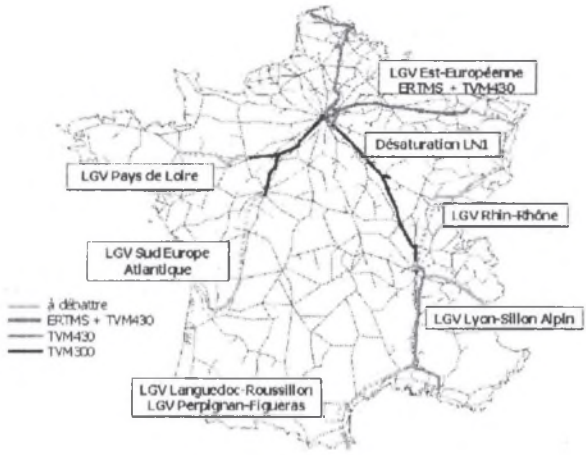

Fig.3. French implementations of ERTMS

Where the radio transmission to the train is concerned, a project was initiated aimed at equipping of high-speed lines and part of a conventional networks in GSM-R that should be completed till the end of 2008 (14 000 km).

Germany

DB is one of founding members of ERTMS user group.

Since several years works are carried out related with implementation of trial ETCS Level 1 and 2 installations on the existing main line between Berlin and Halle and Leipzig for a maximum speed of 200 km/h. Presently ca. 140 passenger and cargo trains travel along this line with a classic signaling and PZB with a maximum speed of 160 km/h. As a target the trial line ETCS has to be 155 km long and consist of three Radio Control Centers. At the rolling stock side, the tests involve 4 locomotives and one measuring motor wagon. Objective of this trial installation is to obtain homologation of the ETCS system in Germany. Siemens and Alcatel/SEL have created a joined consortium for supplies and application of equipment designed in accordance with the last version of ETCS SRS. A Radio Control Center was designed (Alcatel), onboard equipment of Eurocabin (Siemens), trainborne and track radio interface equipment (Siemens), national supplementary equipment such as driver MMI, STM for LZB and PZB (Siemens), interface for electronic interlocks. The beginning of tests with a commercial service of ETCS train is scheduled for spring 2004. Till the end of 2004 the commercial service should begin and the parallel LZB installation should also be ready.

In the last year the DB has undertaken complete tests concerning transformation of German railways. The main attention was concentrated on a high speed networks. In the area of LZB transition to ETCS the parallel equipment with both onboard and tacks systems was taken into consideration. The tests indicated the main problems remaining to be solved in the technical, organizational and political area.

Till present no formal decisions have been taken concerning the further measures in implementation of ETCS.

DB railways are very active in the field of ERTMS/GSM-R implementation. At the side of infrastructure the first phase of equipping 24000 km of line with GSM-R was initiated and

it is to be completed till the end of 2004. At the rolling stock site the transformations (migration) have started at the beginning of 2002 with trial installations of radio cabins. On a new high speed line Frankfurt – Koln the GSM-R is the only used radio system. No other systems as hot reserve were used. Till 2005, 110000 will be equipped. Beginning with this date, the old-fashioned analog radio will be successively eliminated,

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 installation based on ERTMS specifications taking into account the specific interfaces to the Italian signaling and trainborne 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 multisystem trains ETR500 with cabin equipment (combination of ETCS and SCMT) supplied by Alstom
- 15 multisystem trains ETR 480 with cabin equipment (combination of ETCS and SCMT). For these systems the supplier will be selected.
- 12 new multisystem 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 trainborne part.

Holland

Pro Rail is a member of ERTMS user group. For testing and validation of ETCS system in 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 have 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 traveling along this line will need onboard equipment ETCS.

Line Amsterdam - Utrech 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, from 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 2003.

Switzerland

Almost 10 years ago the management of SBB was presented a general strategy of ERTMS/ETCS standardization on the Swiss railway network.

In the meantime, the strategy of migration has become the basic element of Swiss Transport Policy, It was determined by the Federal Bureau of Transportation. The basic intentions of Swiss strategy of transition to ETCS are:

- Utilization of ETCS level 2 (cabin signaling) on the new high speed lines and in the most loaded parts of the existing network.
- Utilization of ETCS level 1 during realization of travels in the „limited supervision" mode on the remaining part of the network.

One third of SBB rolling stock (ca 500 vehicles) has to be equipped with onboard ETCS equipment the remaining rolling stock (ca 1000 vehicles) has to be equipped with "reverse STM" and onboard equipment Signum will be soon entirely replaced by ETCS and no STM module is planned for ZUB or Signum.

From the point of view of such implementation strategy, the following installations have been realized based on public bidding procedures:

- Pilot installation with replacement of ZUB and Signum track equipment by balises and loops with national telegrams; in the rolling stock six units are to be provided with „reverse STM" (by Siemens company)
- The pilot installation of ETCS Level 2 at the 35 km track section on the main line between Olten and Luzern. All vehicles (over 60 units) traveling along this line are equipped with onboard ETCS equipment. This installation (supplied by Bombardier) was

commissioned at the end of April 2002. The pilot line equipped with ETCS level 2 has shown that it is extremely useful for collection of technical and operational experiences with ETCS technology. Since the very beginning, no hazard for safety was present in the conditions of normal operation its functionality was fully satisfactory and the system was accepted especially by the drivers. However, for many months the system was not stable and several interruptions of train travel occurred. Due to the extreme efforts of all interested parties the timeliness was increased to the level of 98,5% which is comparable to the situation before implementation of ETCS.

At the beginning of 2002 Alstom was awarded a contract for equipping the new line between Bern and Olten and 450 vehicles with ETCS Level 2. This system will be set to operation till the end of 2004. Because of preliminary negative experiences with ETCS level 2 on the pilot line, at the end 2002 it was decided to install hot reserve in the form of tracks signals and conventional ZUB ATP using balises on the new high speed lines. With train travel based on hot reserve the velocity will be limited to 160 km/h.

In the meantime, also 750 „reverse STM" have been ordered, supplied to SBB by Siemens. Till the end of March 2003, 550 vehicles have been equipped.

In 2002 year Siemens was awarded a contract for equipping the entire SBB line with GSM -R.

4. ERTMS PROJECTS REALIZED BY PKP

Polish railways are also interested in equipping new lines with ERTMS system equipment. Already in nineties of XX century studies were carried out concerning the future implementation of ERTMS system on E-20 line (Fig.4) Kunowice – Poznań – Warszawa – Terespol. Choice of this line was dictated by the position of this line in the entire PKP network structure – this line is one of the main routes in the railway transport East – West. As a result of works being done among others by Italferr company, a final document was prepared containing a specific description of proposed ERTMS system level. This document, besides detailed time schedule of implementation of the specified tasks, contains collected information concerning E-20 line section Warszawa-Kunowice. They include geometry of the line, railway traffic control equipment installed and planned to be installed as well as transport forecasts developed for this line within an earlier marketing study. This document contains also a technical and economical analysis of possible configurations.

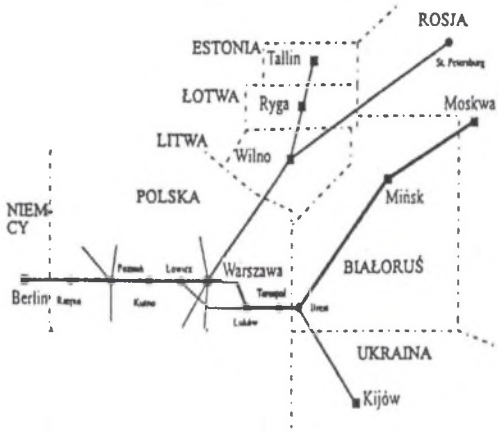

Fig.4. Line E-20

The collected data allowed carrying out of simulation train runs enabling performance of analysis of the line's needs. It was determined which of available levels and configuration of the ERTMS system could be installed on this line. Cost analyses of specific possible configuration have been performed along with the analyses of advantages offered by these configurations. Having in mind both the measurable advantages such as limitation of energy consumption and the advantage whose economical measure is difficult to determine, such as adaptation of the European standard or increased safety.

Analyses cost/advantages also have been carried out for six possible configuration of ERTMS system:

- level 1 ERTMS without update,
- level 1 ERTMS with update with use of additional balises,
- level 1 ERTMS with update through Euroloop (radiating cable),
- level 1 ERTMS with update through STM to the KHP system,
- level 2 ERTMS,
- level 2 and level 1 ERTMS as hot reserve.

Level 3 was not taken into consideration because of mixed character of traffic on this line (vehicles both provided and not provided with onboard ERTMS system equipment).

The comparative economical analyses carried out have yielded a positive result for three fro considered six configurations: level 1 update through Euroloop or through STM to the KHP and level 2 system. Because of the necessity to develop STM for KHP system separately, the configuration was not further on taken into consideration. For the remaining two variants detailed cost analyses and detailed advantage analyses have been carried out. Compared was safety offered by ERTMS system with safety level offered by the Eac line block presently installed on the line. Financial and macro-economical analyses have been performed.

As a result of analyses performed, the configuration consisting of level 1 ERTMS with update through the Euroloop was less expensive than level 2 ERTMS, but the configuration of level 2 has obtained higher advantages/cost ratio and, contrary to the configuration of

Level 1 and in accordance with the calculations should be balanced within ca 17 years (according to the data of 1998). However, in this case the costs of level 2 were considerably overestimated, as they contained also cost of radio transmission system GSM-R installation, including construction of two radio exchanges (MSC – Mobile Switching Centre) for line E-20. Analyses of radio transmission state that the entire PKP network provided with radio GSM-R equipment could be served by 4 such centers.

Another line where it is planned to implement the ERTMS system is a Central Railway Trunk Line (CMK) constituting a part of VI corridor of a trans-European railway network. Presently this line is declared as TINA (Transport Infrastructure Needs Assessment). The requirement of use of an ERTMS system in CMK will enforce adaptation of Polish regulations to the provisions contained in EU documents i.e. Directive 96/48/EC on interoperability for high speed lines. The basic consequence of establishing European standards in the railway sector is imposing the agreed solutions to the industries such as signaling and railway management, under financial penalty. This will apply to the newly constructed and reconstructed lines and not all operated lines. It is a fact that Poland not yet being the member of UE is not obliged to be adapted to the developed standard for formal and legal reasons. However, the presently performed modernization of CMK line with a target raising of speed up to 250 km/h and classification of this line as a high speed one, as well as financial reasons indicate a clear necessity to accept the new railway line standard here.

Presently, adaptation of this line at the present moment will result in the following: first, at the moment of Poland's accession to the European Union the process of Polish transport system integration with those of EU states – with lines grouped in the trans-European high speed railway transport network TEN (TEN – Trans European Network) will be easier; secondly, already today it is possible to use the co-financing for implementation of ERTMS system from European sources, as this system is an European one.

Thus, in accordance with EU documents and other national documents, it is planned to install the ERTMS level 2 on CMK line.

Presently studies are under way, performed by representatives of PKP/ČD/UIC, on implementation of ERTMS on a pilot trans-border section of Katowice – Bohumin. This section is a part of trans-European corridor that is taken into consideration in yet another UIC project ("High Speed Junction Network East – West"). This project is being realized within the UIC East-West task force.

The section under consideration was included also in a „ERTMS Strategic Study for CEEC" with a multi-country reach.

As a result of work being done the implementation possibilities will be indicated based upon functional and technical analysis of possible solutions, as well as advantages and drawbacks of the configurations being considered for application of the ERTMS system on an experiment section (level 1 without update, level 1 with update, level 2).

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