5th INTERNATIONAL CONFERENCE
TRANSPORT SYSTEMS TELEMATICS TST'05

ZESZYTY NAUKOWE
POLITECHNIKI ŚLĄSKIEJ 2005
TRANSPORT z. 59, nr kol. 1691

ERTMS system,
ETCS, GSM-R

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STRATEGIES OF INTEROPERABILITY IMPLEMENTATION IN SRK EQUIPMENT

Development of railway traffic management systems is one of the components aimed at prevention of train accidents. The paper presents a synthetic resume of conditions related with implementation of ERTMS system in Polish railways. These conditions have been shown related to the legislation and technical works carried out in EU in this respect.

STRATEGIE WDRAŻANIA INTEROPERACYJNOŚCI W ZAKRESIE SRK

Rozwój systemów sterowania ruchem kolejowym jest jednym z elementów mających na celu zapobieganie wypadkom pociągów. W artykule przedstawiono w sposób syntetyczny uwarunkowania związane z wdrożeniem systemu ERTMS na kolejach polskich. Uwarunkowania te przedstawione zostały w odniesieniu do aktualnie prowadzonych w UE w tym zakresie prac legislacyjnych i technicznych.

1. PRESENT EQUIPPING WITH SRK SYSTEMS

The present factor of development and implementation of railway traffic management system is a necessity to prevent the train accidents. Very often the selection of operational and technical solutions was made under the political pressure of the State. Implementation of theses systems was taking much time in the past, and the lifetime reached after installation was often almost comparable with the preparatory period. In some countries not only a single railway traffic management system is used, but more than that, a variety of systems with various functionalities and performed in various technologies. In the past there were also some problems on the national level with cooperation of the equipment inside the country as well as problems with the migration of systems.

For the conventional railways several generations of the systems have been adapted for a parallel cooperation of line equipment and rolling stock. This situation has changed after implementation of the dedicated devices for high speed lines. The railway traffic management systems with cab signaling and installed in the rolling stock that matter are these that may be accepted for high speed line travels.

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Table 1 shows an overall overview of types., functions, data transmission techniques of systems operated in the selected countries. Shown is also the scope of application (track length, number of vehicles and basic function of the system). Of course it is possible that these tracks or vehicles are additionally equipped with devices of lesser functionality.

Table 1

Line equipment used in the selected countries and number of vehicles provided with such system

Country	Control-Comand System (status for 2003)	Functionality	Total length of track equipped [km]		Total number of vehicles equipped	
Belgium	Crocodile	Warning	4.000	6.100	1.842	1.974
	TBL1 + Crocodile	Warning / stop	1.000		114	
	TBL2	Cab signalling	150		201	
	TVM	Cab signalling	150		17	
	Not equipped	Lack of protection	800			
Bulgaria	Ebicab	Continuous speed supervision	300	5.200	90	750
	ETCS level 1	Cab signalling	500		130	
	Not equipped	Lack of protection	4.400		540	
Czech	LS	Discrete speed supervision	2.730	16.300	2.700	3.300
	Not equipped	Lack of protection	13.570		600	
Luxembourg	Crocodile	Warning / stop	400	420	116	132
	Not equipped	Lack of protection	20		16	
Germany	PZB	Discrete speed supervision	39.000	54.000	6.900	9.500
	ZUB 122/262 + PZB	I speed supervision	6.010		305	
	LZB + PZB	Cab signalling	3.800		1.800	
	Not equipped	Lack of protection	5.200		500	
Poland	SHP	Warning	17.500	28.900		5.300
	Not equipped	Lack of protection	11.400			
Slovenia	PZB	Discrete speed supervision	996	1.559	271	274
	Not equipped	Lack of protection	561		3	
Hungary	EVM	Discrete speed supervision	2.800	8.100	700	800
	Not equipped	Lack of protection	5.300		100	
Italy	BACC	Discrete speed supervision	6'000	2'250	3'100	3'300
	SCMT + BACC	Continuous speed supervision	2'000		50	
	Not equipped	Lack of protection	14'500		150	

As shown on Fig.1. the existing train management systems differ significantly from the functionality point of view. This scope covers cab signaling (used mainly for high speed trains), continuous speed control, discrete speed control, combined warning/stop function up to simple warning function.

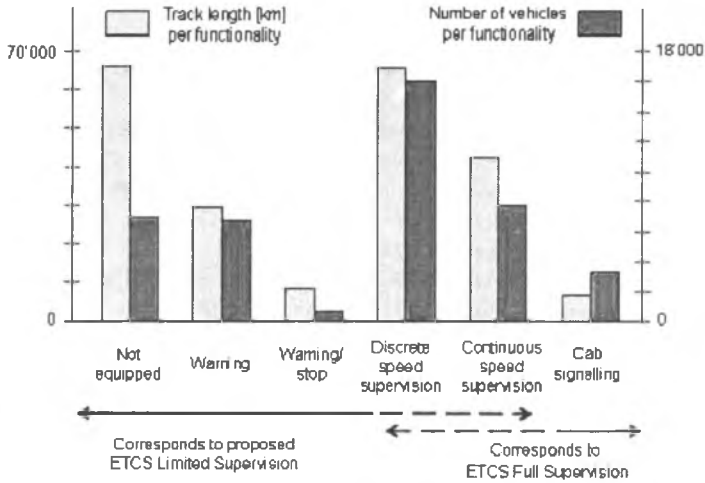

Fig.1. Functionality of SRK systems

An ETCS system with Full Supervision operating mode has its counterpart in the existing systems in a cab signaling with continuous speed control. The major part of tracks is however provided with the existing systems that ensure lower functionality (and thus lower safety) that in the ETCS system corresponds to the "Limited Supervision" mode. Replacement of the existing systems using ETCS installations prepared for train traffic in the Full Supervision mode would result in a significant raising of both functionality and safety. Such raising of safety is not so necessary on all the lines. At the same time, financial expenditures related with ETCS implementation may prove unnecessary, of course assuming that the existing systems have not to be replaced so extensively.

Fig.2 shows the track length where existing systems are installed and number of equipped vehicles.

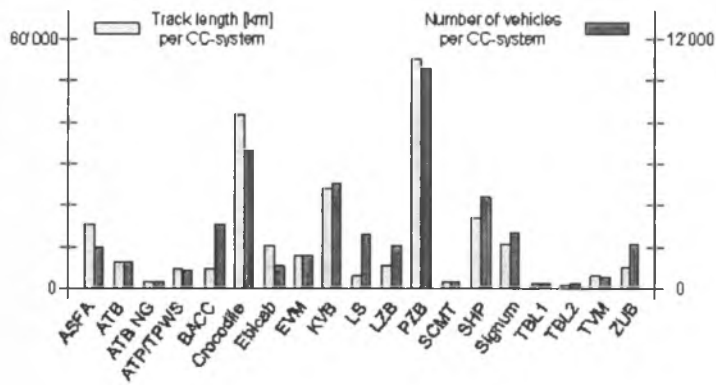

Fig.2. Equipping lines and vehicles with the particular systems

The presented specification shows that the most popular are two systems: PZB/Indus and Crocodile, that have been installed since many years. At the beginning they were installed in Germany and France, and then taken over by other neighbor countries. Thus interoperability was achieved earlier, although not in the full scope.

From the point of view of technology used for transmission of data in the interface between track and train we may discern several groups of the systems:

- Galvanic contacts (Crocodile) or simple induction coils (PZB/Indus, Signup).
- Relay operating in the range of low frequencies (ZUB, TBL, ATB of new generation).
- Balisees KER (KVB, Erickson, RSDD).
- Low frequency track circuits (ATB, BACC).
- Acoustic frequency track circuits (TVM).
- Cable loops (LZB).

Similar solutions may be used for migration of these groups of systems to ETCS, for example a common STM for KER „family".

2. OFFICIAL STATUS OF ETCS IMPLEMENTATION

Implementation of ETCS in each country requires real initial effort to determine specific technical, operational and legal circumstances where the ETCS may be implemented. It is necessary also to determine the conditions of contract and installations realization, conditions of obtaining approvals for implementation of the system to regular operation. This process is at various stages in various countries.

Generally in the EU, the phase of testing and certification is coming to its end and the ETCS enters the phase of real commercial application. Pilot applications both for Level 1 and Level 2 are already in the day-to-day commercial operation since over a year. In the two coming years several other important projects will be set into motion.

The map presented on Fig.3 gives a general overview where and at what scale the ETCS may be expected till the end of 2008.

Fig.3. Lines to be provided with ERTMS till the end of 2008

The most meaningful fact is that till now the opening of new lines and improvement of safety and not the interoperability was the key driving factor in the implementation of ETCS. Till now significantly more kilometers of conventional lines than the high speed ones are assigned for provision with ETCS till 2008 at the latest. Also when it comes to rolling stock, over than a half of units provided with ETCS will receive STM with feedback information which means that these vehicles are basically intended for operation on conventional lines. Of course, it is possible and more than desired

3. STRATEGIES OF INTEROPERABILITY IMPLEMENTATION IN THE TRANSPORT CORRIDORS

Fig.4 presents a general strategy supported by EU (both for high speed and conventional lines) of ERTMS/ETCS implementation and concerning passengers' or cargo for which the ETCS may be used.

Fig.4. Transport corridors planned for priority installation of ERTMS

3.1. STRATEGY OF INTEROPERABILITY IMPLEMENTATION AT PKP

For PKO the strategy assumed was to implement the level appropriate for the expected line requirements. Because of a necessity to apply the rules of economics, the railways carry out implementation studies before the ETCS system installation, in order to determine the most appropriate configuration of equipment. Such studies show that it is much more profitable to select the target ETCS configuration and withdraw from implementation of next levels. The configuration is selected depending of current and forecasted operational needs of each line taking into account its existing and expected infrastructure of basic SRK layer, This strategy is proposed, for example, for E-20 line Warszawa – Kunowice (- Berlin).

This solution is optimum in the present PKP condition i.e. it is the least expensive and the quickest to be implemented.

The optimum level proposed for PKP it is level 2 supplemented with STM for SHP and RADIOSTOP equipment. Detailed issues related with selection of ERTMS level for PKP are described in the CNTK work „Koncepcja wdrażania interoperacyjności w zakresie sterowania

ruchem kolejowym (ERTMS) na PKP" (Concept of interoperability implementation in railway traffic management system (ERTMS) in PKP) (topic No 4035/10 Report from realization of stage II b) [1].

The basic condition of ERTMS/ETCS level 2 implementation is the earlier implementation of ERTMS/GSM-R on PKP lines.

It was assumed that the commercial implementation of ERTMS on PKP lines has to be preceded by pilot installations. The purpose of pilot lines will be:

- Acquiring experience in the installation of ETCS equipment;
- Verification of ETCS devices installed on the locomotives (including STM for Polish national systems of B class contained in the specification for TSI CCS –CR and HS Technical Interoperability Specification – Traffic Management i.e. SHP and RADIOSTOP);
- Verification of assumed solutions (national variables, ETCS functions, GSM-R functions, location of balises, CVMD etc.)
- Acquiring experience in the installation of GSM-R equipment;
- Acquiring experience in the maintenance of ETCS equipment;
- Acquiring experience in the maintenance of GSM-R equipment;

Very important is also that the commercial installation of ERTMS is preceded by construction of a test and training section where besides the above mentioned functions it is possible to test the ERTMS equipment (both trackside and installed on the traction vehicles) before installing it in the operational conditions, and above all, to realize the training programs for PKP employees (drivers, maintenance services, personnel responsible for traffic management).

In the present financial situation PKP is in, it seems that the method of „purchasing" qualified personnel on the market is not feasible. Thus it is necessary to train one's own personnel. While getting to the training should take place simultaneously with the engineering process and even earlier. While getting to the training it should be purposeful to perform a selection of present personnel and select the persons likely to encompass the necessary knowledge and skills for implementation of the project. Getting to the training the two-stage realization variant should be taken into account.

At the first stage a group of „instructors" should be trained that at the second stage would train the next group of the personnel. However, in this case there is a certain danger at the first stage of training realization, namely language barrier. The scope of such training should include training of management staff responsible for project management: technical personnel responsible for planning, engineering, implementation, technical working personnel, maintenance personnel and training of users. It is necessary to make the interested companies of PKP Group to start the training as soon as possible, because training of staff takes at least one year. We have also to remember that the training process, especially for the maintenance personnel, is of continuous character. Introduction of new software versions, new elements of equipment, new functionalities in the existing software etc requires supplementary training of staff dealing with the system.

An important issue is also the method of ERTMS installation financing both for trackside and onboard equipment. Financing sources has been shown in detail in the CNTK's work „Koncepcja wdrażania interoperacyjności w zakresie sterowania ruchem kolejowym (ERTMS) na PKP" (Concept of interoperability implementation in railway traffic management system (ERTMS) in PKP) (topic No 4035/10 Report from realization of stage III p.4) [3]. In addition, attention should be paid to the new EC approach to the ERTMS project financing reduced to the co-financing of on-board equipment in 50% and even in

100% if installed on the traction vehicles "assigned" to the particular corridor. At the same time, the minimum financing level was assumed at 50%

3.2. ORDER OF IMPLEMENTATION

Order (plan) of implementation depends of such factors as:

- Location of the line (transport corridors),
- Traffic loads,
- Speed on the lines,
- Modernization plans of PKP,
- Speed and order of GSM-R implementation,
- Balance of toe line (operating costs - revenues),
- Possibilities of foreign co-financing (outside PKP).

The above- mentioned factors and their impact on the order of implementation were discussed in detail in the report from the stage III p.3. [2]

In accordance with the earlier discussion it is proposed to implement the ERTMS system while keeping the phases as shown below:

Phase 0 – not later than in 2008

Test and training section and pilot sections

Phase I – till 2012

Lines covered by international treaties (ca 5 300 km of line in total) and ca 1000 locomotives and 1000 electrical traction assemblies

Phase II – till 2014

Lines of national importance (ca 12 000 km of line) and ca 2000 locomotives and 1900 electrical traction assemblies

Phase III – after 2014 and after detailed technical and economical analyses

Target system (ca 17 000 km of lines).

Because of a chance of obtaining co-financing from the European Union's budget in the period 2007 – 2013 it is necessary to develop urgently a detailed strategy of ERTMS implementation on PKP in accordance with the EU requirements, i.e. respecting the EU directives and decisions governing the interoperability issues. Such a strategy should be transferred to appropriate EC structures through the Ministry of Infrastructure, in order to enable obtaining co-financing of ERTMS in PKP.

Moreover, such a strategy will enable the PKP S.A. Board to set into motion a quick decision-making process concerning implementation of ERTMS, and will allow the company PKP PLK S.A. and indirectly also transport companies to face an opportunity to obtain European Union's co-financing for pilot installations and priority ERTMS corridors described in Section 7 TSI CCS CR and MoU for stationary and onboard ETCS and GSM-R installations. At the same time we have to remember that not all lines covered by the international treaties are taken into account in the priority corridors.

As indicated before, the pace of ERTMS/ETCS implementation depends greatly from the pace of ERTMS/GSM-R implementation. The implementation of GSM-R in Polish railways is planned first on the lines covered with international treaties.

The order of implementation of the system is also shown on Fig.5.

Fig.5. Order of ERTMS implementation on PKP lines

1. Training section – experimental track Żmigród
2. Pilot sections
3. Group of lines – first order of implementation
4. Group of lines – second order of implementation
5. Group of lines – lines of national significance
6. Number of railway line.

3.3. CONSEQUENCES OF FAILURE TO IMPLEMENT ERTMS

Failure to comply with the decisions contained among others in the Directive 2004/50/EC and decisions 447/2004/EC and 884/2004/EC will cause the following basic repercussions [4]:

- Enforcing implementation of ERTMS by the EU authorities (among others by blocking funds assigned for modernization of infrastructure till the time of beginning of ERTMS implementation). This situation exists already since 2002 in relation to the projects realized within the ISPA fund.
- Transfer of transit passenger and cargo traffic to the railways fulfilling the requirements (for example through the neighbor countries),
- During transports carried out by the foreign forwarders much lower payments for availability of the line;
- Lower safety on PKP lines in relation to other railway managements.

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