ISSUES OF ERTMS IMPLEMENTATION AT THE POLISH RAILWAYS

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Summary Short Description of ERTMS system. Legal conditions of ERTMS system implementation on Polish Railway. Implementation Study of the Pilot ERTMS Installation for E-20 Warszawa-Kunowice. Trans-boundary section of ERTMS on the E-65 line Katowice – Bohumin. Necessity of ERTMS implementation with pilot sections. Proposals of pilot sections at PKP.

1. GENERAL DESCRIPTION OF ERTMS SYSTEM

European Railway Traffic Management System(ERTMS) consists of the subsystems: European Train Control System (ETCS), Radio transmission system GSM-R (and European Train Management Layer ETML).

1.1. ETCS (European train control system)

The basis for development of an ETCS system is a complete set of specifications resulting mainly from social conditions. These specifications ensure interoperability of ETCS equipment manufactured by various suppliers.. They define functions, procedures, performance ratios as well as ETCS system architecture and relations between various subsystems that are important for assurance of the interoperability. Individual suppliers are free to select optimum technical equipment. The ETCS system is characterized by modular structure, which enables engineering, modernization and construction of various modules at any time using the available techniques.

Such definition of the structure makes possible the expansion of ETCS concept. In the future, the management of strict control of revisions to the ETCS specifications shall ensure firstly maintenance of primary interoperation objective and secondly: the possibility of directional development of ETCS system.

1.1.1. Architecture of etcs

The specification of ETCS system requirements is described by a so-called core of European ETCS with its interfaces to: radio system GSM-R, line traffic protection systems, onboard train equipment.

Overall functional structure with links between system core and interfaces is shown on Fig. 1.

The onboard equipment – Eurocab ETCS contains transmission equipment and antennae for data exchange with the trackside: Eurobalise, Euroloop, digital GSM-R device and equipment linking with Euroradio.

The trackside ETCS equipment contains data transmission equipment using balises, loops or GSM-R, as well as additionally various types of interfaces linking with the fixed installations of railway traffic equipment.

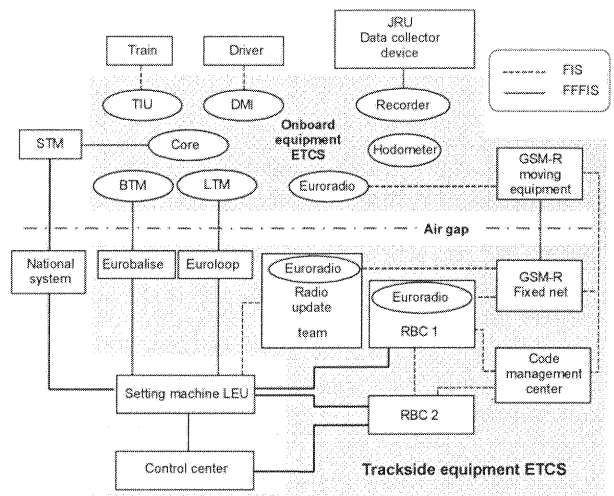

Fig. 1. Functional structure of ETCS.

1.1.2. Available application levels

The ETCS project shows advantages of 3 application levels for ETCS that may be determined using the following features:

- a way to raise the standard, especially in relation to the onboard equipment (it is possible to start the system up using level 1, and subsequently introduce level 2 or even level 3 within the same system specification),
- backwards compatibility (such as train level 2 may also travel on the line level 1, etc.),
- consistent system behavior,
- minimum expenditures.

1.2. 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 the following features:

- a digital 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.

Location of GSM-R in the ERTMS/ETCS system is shown on Fig. 2

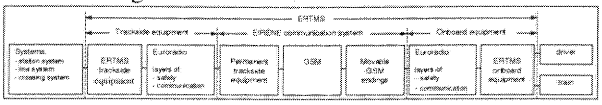

Fig. 2. Place of GSM in the ERTMS/ETCS system.

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 and 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.

2. LEGAL CONDITIONS OF ERTMS IMPLEMENTATION

Implementation of ERTMS (on Polish railways among others) is conditioned by the following acts of European Union:

- Directive 2001/16/EC of 19 March 2001 "On interoperability of Trans-European system of conventional railways",
- Directive 96/48/EC of 23 June 1996 „On interoperability of Trans-European system of high speed railways" and
- Decision 2001/260/EC of 21 March 2001 on basic parameters of control system containing specifications ERTMS/ETCS and ERTMS/GSM-R,
- supplementing the Directive 96/48/EC,
- replaced by decision 2002/731/EC of 30 May 2002 „On technical specification for interoperability for the subsystem of trans-European system of high speed railways"

Directives 96/48/EC and 2001/16/EC impose on railways of EU member countries an obligation to ensure interoperability of railways. This may be achieved, among others, by implementation of ERTMS system on these railways (through implementation of control subsystem interoperability components denied in the decision 2002/731/EC covering the trackside and onboard equipment of ERTMS/ETCS and ERTMS/GSM-R). Detailed specifications concerning ERTMS/ETCS and ERTMS/GSM-R are contained in the documents named in Appendix A to the decision 2002/731/EC.

Important legal acts are also AGC and AGTC contracts signed by RP government.

3. PROJECTS REALIZED FOR PKP

3.1 Implementation study of ertms pilot installation on the line E-20 Kunowice - Warszawa

In the period 1995-1997 an implementation study was made for pilot installation of ERTMS on the line E-20 Kunowice – Warszawa, financed from EU resources.

The advantages were determined in relation with ERTMS implementation, that depend of parameters and characteristic features of the configuration, and namely:

- reduction of border crossing time,
- a possibility to reduce number of drivers working in the train simultaneously, which entails cost reduction,
- reduction of maneuvering costs related with lack of need to change the locomotives at the border,
- shortened travel time on certain sections of the line,
- reduced energy consumption,
- integration of specific features of signaling and control at E-20 line with the EU standards,
- increase of throughput at certain line sections,
- increased traffic safety,
- easier future implementation of the system.

Advantages related with all modernization work on the line also were described (tracks, traction, elimination of turnouts etc.) i.e.:

- transfer from road to railway transport,
- increased traffic safety because of a lesser probability of road accidents,
- reduced travel time and consequently reduced costs of transport,
- improved environment conditions,
- other social and overall advantages,
- specific macroeconomical analysis,
- integration of Polish transport system with Western Europe's one,
- improvement of national economical conditions as a result of new solutions,
- incentive to foreign investors as a result of better organization of public transport,
- larger quantity of high quality and highly processed goods transported along the railway lines.

Table 1 shows the net present values (1997) for configurations taken for calculation.

Tab. 1. Net values taken for calculation.

CONFIGURATION	ADVANTA-GES (ECU)	COSTS (ECU)	NET VALUE (ECU)
1 Level 1 without update	25,007,000	30,408,000	- 5,401,000
2 Level 1 with update through eurobalises	30,017,000	35,835,000	- 5,818,000
3 Level 1 with update through euroloop	70,268,000	59,694,000	+10,574,000
4 Level 1 with update through KHP	63,622,000	33,649,000	+29,973,000
5 Level 2	77,559,000	66,483,000	+11,076,000
6 Level 2 + Level 1	82,342,000	89,669,000	- 7,327,000

A financial analysis was also carried out for two selected configurations (No 3 and No 6). Annual costs and revenues (cash flow) used in the financial model

consists of costs and revenues estimated as a difference between the reference case and the modernization option, taking the costs below into account:
- cost of delivery, installation and maintenance of equipment,
- cost of trackside and onboard equipment maintenance.

The financial assumption was that the railway projects are investment projects to repay themselves in a long-term time horizon, which means that the modernization projects will require financial resources with long-term reimbursement period. For the financial planning purpose it was assumed that the 50% of financial resources necessary for this investment project will be provided by European Union's PHARE fund. Also a possibility of revenues from lease of optical cable to the external operators was taken into consideration. The financial resources with lease and 50% EU contribution in the investment cost (ECU-1997) for the selected configuration is shown below:

EIRR (%) ratio – economical internal rate of return	NPV – net present value	Benefits/cost ratio	Break even year
22.49	21,974,000	1.79	2006

3.2 Bohumin - Katowice project

The first trans-boundary project (Poland – Czech) of ERTMS implementation under partial financing of UIC and UE and railways PKP and ČD.

The preliminary scope of the project included:
- collection of necessary data for the line,
- selection of required functions ERTMS/ETCS,
- technical analysis of feasible ERTMS solutions.

As a result of preliminary project phase realization the following issues were proposed:
- ERTMS functions required by ČD and PKP (in accordance with FRS 4.29),
- impact of ERTMS implementation on railway control system systems,
- impact of ERTMS implementation on traffic management,
- advantages and drawbacks of feasible ERTMS implementations (level 1 without update, level 1 with update, level 2),
- implementation indications based upon the functional and technical analysis of possible solutions not taking into account the economical assessment.

Advantages resulting from project realization:
- implementation of ERTMS/ETCS on the national lines,
- easier performance of analyses and strategic plans,
- installation of ERTMS/ETCS on the line,
- a possibility of testing and collection of experiences from ERTMS/ETCS implementation,
- reaching the indicated international trends.

Till now the technical assumptions for the project have been prepared. Further work to be performed within this project
- economical analysis,
- national requirements:
- determination of national variable values,
- comparison of national variables,
- selection of solutions for cabin signaling,
- preparation of infrastructure register,
- preparation of safety and functional tests,
- installation of equipment and tests on pilot section.

4. PILOT INSTALLATIONS

Within the works of Technical Group for ERTMS at PKP it was stated that the widespread implementation of the system on PKP should be preceded by implementation on the pilot section.

This solution is supported by the following factors:
- all European railways implement their ERTMS/ETCS with pilot installations; This is true also for other railways.
- moreover, this solution is supported by the following argumentation:
  - adaptation of PKP rolling stock (locomotives) to the cooperation with ETCS;
  - a need to check the cooperation of ETCS with the rolling stock remaining on PKP inventory (this applies above all to the locomotive equipment),
  - adaptation and verification of STM for SHP and Radiostop;
- preparation and verification of interfaces between the operating railway control systems and ETCS;

4.1 Proposed pilot sections

The following sections have been taken into consideration for pilot installation:

I. Line E 65 – section State Boundary - Zebrzydowice – Katowice
II. Line E 65 - section Góra Włodowska – Knapówka
III. Line E 30 - section Legnica – Węgliniec
IV. Experimental Track in Żmigród – test and training section.

Table 2 shows specification of certain features of these sections.

Tab. 2. Specification of the sections.

Parameter	Section I	Section II	Section III	Section IV
Length [km]	78.600	46.100	71.000	7.700
Acceptable speed km/h	120/60/120 (target 160)	160 (target 200/250)	65 (target 160)	120
Equipping with railway control system equipment	mechanical, relay, electronic	relay, electronic	mechanical, relay, electronic	mechanical, relay, electronic
Line block	present	present	none	none
Number of stations	15	3	8	1

Sections I - III are planned for equipping with 2 level ERTMS and are provided for:
- gaining experience in operation of trackside equipment ETCS level 2,

- gaining experience in installation of GSM-R,
- gaining experience in maintenance of trackside equipment ETCS,
- gaining experience in maintenance of equipment GSM-R,
- checking the ETCS level 2 equipment installed for PKP,

Section IV would serve the system tests, first of all rolling stock and level 1 equipment. As a target, also additional equipment of the section with level 2 ERTMS equipment. This section would enable the following:

- gaining experience in installation of trackside equipment ETCS level 1,
- gaining experience in maintenance of trackside equipment ETCS level 1,
- check of ETCS level 1 equipment installed on PKP locomotives,
- check of ETCS level 2 equipment installed on PKP locomotives (with exception of digital radio systems),
- checking of cooperation of various level ETCS systems installed on PKP locomotives with level 1 trackside equipment,
- this section could be also used for checking of ERTMS equipment installed on locomotives of other railway management locomotives.

Section IV should also fulfill the training role in ERTMS for PKP workers and other companies. This includes engineers of equipment, system installers, PKP personnel for commissioning of equipment, PKP equipment maintenance personnel as well as – to a certain degree – management of specific PKP units.

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