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SELECTED ASPECTS OF ETCS-L3 DEPLOYMENT

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Abstract. This paper focuses on selected problem areas in the implementation of ETCS L3, analyz-es their impacts and offers a number of possible solutions as a basis for pilot testing. It compares the suitability of each solution and summarizes their advantages and disadvantages.

Keywords: ERTMS, ETCS L3, odometry, ITS-R.

1. Introduction

Control and command systems on the railways have undergone a relatively long development. On the one hand, the development is driven by increasing demands on safety, reliability, smoothness and fuel economy, on the other hand, the development was mainly limited by technical capabilities of the time in the past. The development possibilities of electronics and especially microprocessor technology and computing power have allowed in recent years to increasingly address the question of optimizing the control process quality and minimizing the necessity of the human factor's intervention, which in earlier times was not possible to such an extent. This technical progress, pressure on cost cutting and the European Union requirements for the interoperability of the railway networks have created the need for addressing the management and security of railway services in new ways. Introducing new systems brings the need of identifying and addressing the potential risks and technical challenges associated with the transition to the new system. The aim of this paper is to point out possible problems in the implementation and deployment of ETCS L3 on the conventional railway network and suggest possible solutions to these problems with the specification of advantages and disadvantages of the various options.

2. Requirements

For the full implementation of intelligent transport systems on railways (hereinafter ITS-R) and for the purposes of this article, we consider the target state to be a state in which the following conditions are met:

(1.) there is a bidirectional data connection to the train (between mobile and stationary parts),

(2.) the integrity check of the train using technical means on the vehicle is ensured,

(3.) all locomotives are equipped with an on-board unit (OBU) ETCS.

When projecting these demands while considering the current trend and the commitments of the European Union member states in the field of the railway network interoperability, the ERTMS system on application level 3 (L3) is a suitable candidate for addressing the Command and Control System (CCS).

2.1. Substantiation of the Requirements

Requirements specified in the previous section are based primarily on the overall concept of ITS-R. The need for a data connection to the train is given mainly by the necessity of the existence of such a data transfer connection between the stationary and mobile parts of the ETCS L3 system. However, the data connection can also be used with other subsystems in the ITS-R concept, such as the transmission of data for the ATO system, transmission of diagnostic data, etc. Another requirement – to ensure the train integrity – is another necessary condition for the ETCS L3 system's activity, where the existence of detection devices already disregarded. The third requirement requiring full equipment of the cabin section in all vehicles is again given by application level 3 of the ETCS system, where mixed traffic (such as with L2) is operationally unacceptable after removing the signals. Only the connection and fulfillment of all three requirements above at the same time gives us the opportunity to fully start taking advantage of ETCS L3 âĂŞ primarily to use the opportunity to minimize the infrastructure elements (signals, track circuits, axle counters). Such minimization has several far-reaching impacts – reducing the investment demand compared to the situation where application level 2 (or even one) of the ETCS system is installed to achieve the desired safety parameters; according to [1] by approximately 25% compared with L2. It is necessary to emphasize that ETCS L1 and L2 are "only" an extension of conventional interlocking equipment and block signaling system and track security equipment. In practice this leads to duplication of some functions in RBC and IXL. This delivers increased investment and operating costs for the construction and operation of two parallel systems and also reduces the possibilities of

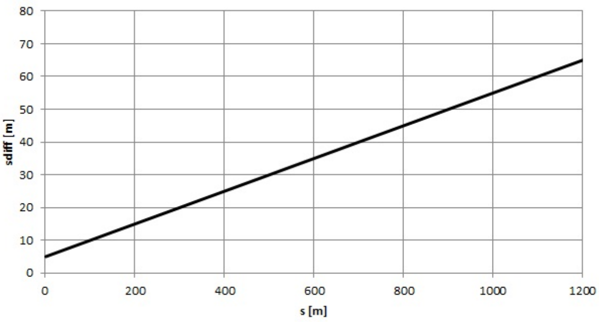

Figure 1. Required odometry accuracy [2]

the system – especially if a link RBC -> IXL is not implemented for L2. Only ETCS L3 is not an extension of the current IXL – it is thus possible to leave out the riding principle in a fixed block and train ride control using the signals.

3. Definition of Problem Areas

3.1. The Accuracy of the Odometer

A key part of the function of determining train location in the ETCS system is an odometer and Doppler radar. Since this is a safety-relevant function, it is necessary to consider a possible error in the given position in a safer direction. According to the specification [2], the required accuracy is expressed by the formula according to the traveled distance s:

$$s_{diff} = 5 + 0.05xs[m]$$

The position is specified (error is null) always after reading a balise group and the error refers to the distance traveled from that point. For the operation of the ETCS system in its current form it is therefore necessary to count with this error in determining the usable length of each track. In addition, the position of the end of the train must be added to this inaccuracy in the case of ETCS L3, e.g. for track length of 600 m it is necessary to consider an error of up to 35 m, and vacate the space behind the railroad switch signal at least by this distance in order for the railroad switch stretch to be regarded as vacant. This again reduces the usable length of the track.

3.2. Train handling

The method for determining train location and sections occupancy in the stretch of ETCS L3 makes it necessary to address potential problems arising from the train handling, such as splitting, joining and shunting of train cars. The simplest situation occurs when joining and separating sets of coherent units, where with regard to the assumed equipment of all driving vehicles it will be possible to locate both parts and detect their integrity after division. However, this does not apply to the movement of parts of the train set and keeping a part of the train on the station track or to the train profiling into multiple parts. In such a situation, the vacancy of the concerned part of the infrastructure cannot be safely determined only with the use of the ETCS L3 system's technical means.

4. Suggested Solution

4.1. The Accuracy of the Odometer

To increase the usable length of the transport rails, it may be necessary to increase the accuracy of the positioning system. With current specifications, this problem can be solved by placing one or more locators inside the balises of a long track section. This will split it into several smaller sections, where the odometer's inaccuracy is proportionately smaller. Another possibility is the gradual tightening of the requirement for maximum permissible error in the ETCS odometer (now 5m + 5%). Similar devices used in the CBTC systems achieved accuracy of about 1% according to [3] already (using e.g. a Doppler radar with multiple antennas).

4.2. Train Handling

The problem with train division, shutting down of train cars, and shifts can be solved in principle several ways, which will be discussed in the following text. The advantages and disadvantages of various options and a comment on the possible applicability are also mentioned.

4.2.1. Confirmation of Occupancy by Human Operators

The occupancy of selected parts of the infrastructure can be confirmed with the participation of the human factor. This principle is used according to [4], e.g. in ERTMS Regional in Sweden. After confirming the section's occupancy with the human factor, the ride through the stretch is possible only in the Staff Responsible mode with speed restrictions. After the first train passes, the stretch is already considered vacant from the point of view of previous manipulation, and the ride of the following trains is no longer restricted. The disadvantages of this solution are obvious – the need for participation of the human factor, the risk of failure is limited by limiting the speed for the next train. This thereby decreases the throughput performance parameter. However, this solution may be suitable for regional routes with limited speed and sporadic shifts.

4.2.2. Partial Equipment with detection resources

In case of frequent handling, using conventional detection devices (track circuits, axle counters) at this point is offered as a solution to the question of detecting the occupancy of the infrastructure's section. The disadvantage regarding the involvement of the human factor on detecting the occupancy of the section is thus eliminated, the disadvantage being the need to install detection devices, albeit to a very limited extent.

5. Evaluation, Conclusion

The article pointed out several questions that will be necessary to address within the preparation of the possible pilot deployment of ETCS L3. The solution's suitability in some cases depends on the local situation and the nature of the track on which the system will be deployed; all possible situations cannot generally always be covered. In the near future it is also possible to expect verification of the related technologies that could help contribute as another alternative to solving open points (e.g. use of satellite positioning systems instead of fixed balises, use of modern communication technology instead of GSM-R, etc.) in the event of a positive outcome.

6. Abbreviation

- ATO ... Automatic Train Operation
- CBTC ... Communication Based Train Control
- CCS ... Command and Control System
- ERTMS ... European Rail Traffic Management System
- ETCS ... European Train Control System
- GSM-R ... Global System for Mobile Communications-Railway
- ITS-R ... Intelligent Transport System-Railway
- IXL ... Interlocking
- OBU ... On-Board Unit
- RBC ... Radio Block Centre

References

[1] W. Coenraad. Level 3 : From High Speed Vision To Rural Implementation [online], 2011. http://www.irse.org/knowledge/publicdocuments/2011_09_29_ERTMS_Level_3_from_High_Speed_Vision_to_Rural_Implementation.pdf.

[2] ERTMS/ETCS Performance Requirements for Interoperability, Subset-041, Issue 3.1.0, 2012, UNISIG [online]. http://www.era.europa.eu/Document-Register/Documents/Set-2-Index014-SUBSET-041%20v310.pdf.

[3] ERTMS Level 3 Risks and Benefits to UK Railways, Final Report; Transport Research La-borator [online], 2010. http://www.trl.co.uk/media/773946/cpr798_-_ertms_level_3_risks_and_benefits_to_uk_railways.pdf.

[4] Ertms regional functional requirements specification, version 03.08, uic, 2009.