ITS-Railway

ITS&S position paper

to the further develop telematics in rail transport

The Czech Intelligent Transport Systems & Services proposes to connect three hitherto separate worlds on the railways: the world of vehicle movement safety, the world of transport logistics processes and an environment that makes traveling in a rail vehicle more attractive to passengers. Everything is motivated by the idea of improving customer service through an intelligent vehicle that moves on an intelligent infrastructure. As a first step, ITS&S proposes to implement a pilot project on an appropriate regional line to validate ERTMS / ETCS L3 technologies, including automatic train control, information and communication systems providing data for traffic management and control, logistics processes and passenger services. More information on this topic is given later in the text of this document.

Current state

At present, modern technologies are applied to the Czech Railways, both traffic management and safety, as well as information systems for traffic management and passenger handling. Electronic systems of safety devices (electronic interlocks, level crossing safety devices, etc.) are being introduced, including remote traffic control systems (Central Dispatching Workplaces). Information systems for operational traffic management make it possible to enter, process and provide comprehensive information needed for operational, direct and strategic traffic management and planning. ICT systems also relatively commonly provide information to passengers through electronic information panels and other electronic applications.

The current approach to ensuring the safety of railway traffic is aimed primarily at infrastructure equipment and the issue of ensuring the control of vehicle movement is not satisfactorily addressed. The vehicles are obligatorily equipped with driver vigilance control systems and, especially on corridor lines, the driver is provided with an LVZ system enabling the transmission of the signal to which the vehicle is approaching. However, the responsibility for respecting the signal and all safe driving conditions remains with the human factor (driver). The LVZ system is equipped with approximately 1,500 km of main (corridor) lines in the Czech Republic. On the remaining part of the railway infrastructure, the control of the driver's activity is ensured only by the control of the periodic pressing of the vigilance button.

This state of infrastructure is similar in all Eastern European countries (Poland, Slovakia, Hungary). In the Czech Republic, some vehicles (especially the complete ČD 471 series) are also equipped with intelligent Automatic Train Control (ATO) technologies (Czech version is AVV), which enable a significant facilitation of the driver's activities and significant automation in the train control process. These systems directly make it possible to reduce direct operating costs, but their deployment is not optimal in the current conditions, mainly due to the failure to provide adequate information from the infrastructure and the absence of a safe level of driving. Despite this significant handicap, the ATO system achieves excellent operating parameters at the top world level.

Currently (11/2014), the ERTMS implementation plan was approved and published, which is a key legislative document defining the strategy for the implementation of the ERTMS system in the Czech Republic. A major change from the current assumption is now a clear strategy for equipping vehicles with ETCS on-board components, assuming that **"On continuous sections of ETCS-equipped lines of hundreds of km in length, trains driven without a functional ETCS on-board component will be prohibited immediately after placing in service."**

The assumption is that by 2020 the ETCS on-board unit will be equipped with approx. 1000 vehicles and by 2024 up to approx. 1500. It can therefore be concluded that most of the rolling stock will soon be equipped with ETCS on-board systems. However, the implementation plan addresses only the TEN-T networks, not the other railway network of the Czech Republic. At present, the Czech railway network has the length of national lines included in the TEN-T network of 1,329 km (3670 km), other national railways included in the TEN-T network 1265 km (3022 km), other national railways 2430 km (3633 km). tracks) and 4,409 km (5,079 km of tracks) of regional railways. European legislation on TSI requirements defines the requirement to extend the scope of the TSI to other national and regional railways outside the TEN-T network and to all vehicles, including work machines. **The question of solving these types of lines, forming approx. 2/3 of the Czech railway network, therefore remains a major challenge for the future.**

The implementation plan prepares a suitable environment for the implementation of ITS-R systems. With regard to the assumed full equipment of traction units, it can be assumed that vehicles that will be equipped with ERTMS / ETCS on-board units must continue to be considered for national and regional lines. The expected equipment of vehicles is a great opportunity to change the scope and type of infrastructure technology. The current "full" infrastructure equipment with conventional signaling equipment (station, line and level crossing equipment, signals, track circuits / axle computers, etc.) on these types of lines is not yet fully widespread and in the case of regional lines in particular its deployment is economically unjustifiable. Therefore, the use of ERTMS / ETCS for these line types can be considered, which allows the application of other levels, such as ETCS - L1 or ETCS - LS.

However, the most promising with regard to the usability of all functions of ITS systems may appear to be the ETCS-L3 system (currently verified as ERTMS / ETCS Regional). The use of new GNSS-based technologies, which are not yet introduced in the TSI specifications, can also be considered for

these systems, but their early introduction can be expected. On these types of lines, and therefore on corridor lines, investment and operating costs can be minimized by choosing a strategy and method of management and operation consisting in minimizing the number of elements in the infrastructure - especially the reduction of signals and vehicle detection means. The use of radio communication between the vehicle and the infrastructure must be considered, taking into account the applicability of ITS technologies. At the same time, the issue of train integrity, especially freight, must be addressed, which should enable the minimization of detection means in the infrastructure.

At present (5/2015), another strategic document of the Ministry of Transport of the Czech Republic, the so-called ITS Action Plan, was also approved and published, which also deals with the implementation of the ITS system on railways. The action plan only refers to the ERTMS / ETCS system and its implementation in the Czech Republic and in principle deals with related technologies (remote traffic control, vehicle control automation, etc.). The concept of an overall ITS system on the railways is missing. In further development, it is therefore expedient to combine the ERTMS / ETCS system, GSM-R and ITS systems into one unit so that it is possible to implement a suitable concept and integration of all systems that are to ensure the functions of the ITS-R system.

European best practices

The countries of Western Europe have been addressing the issue of vehicle equipment since 1950, mainly to ensure the safe movement of vehicles. For example, the German railways have 100% vehicle train control systems (main lines LZB system, side lines PZB). Swiss Railways currently has a very high level of vehicle equipment with ERTMS / ETCS systems (Level LS, Level 2). In the European and global scale, the main direction of equipping vehicles with rail traffic management systems based on ERTMS / ETCS principles can be seen. The ERTMS / ETCS application is promoted by the European Union as one of the subsystems ensuring the interoperability of the entire railway system in Europe. The ERTMS / ETCS system ensures that the requirements of the ITS-R are met, especially in the parameters of ensuring the safety of vehicle movement. Other parameters, such as reliability and operational efficiency, are more dependent on the conditions of application of the system in specific countries.

In the field of intelligent transport systems, similar trends can be seen in developed European countries as in the Czech Republic, ie. centralization of traffic management together with strong support for traffic management information systems. In real traffic, automatic road construction systems are already being used, including control optimization and traffic safety (eg the Swiss RCS system).

However, the comprehensive concept of ITS technology on railways has not yet been defined at European level and is still limited to defining the structure of data exchange in passenger and freight transport (TSI TAF, TAP, Telematics subsystem in freight and passenger transport). TAF and TAP also define processes, objects and communication interfaces that are a prerequisite for mutual dialogues between carriers and infrastructure managers, which largely causes changes in operational

technology, JR, operational management and prospectively one of the largest and most complex changes in railway management since time of its creation.

The vision

The subject of ITS deployment on railways is the creation of an intelligent transport system, the architecture and elements of which will be interconnected in order to optimize and increase the efficiency of the whole process (see Fig. 1). The overall concept of ITS must be focused on increasing the parameters of the railway system, especially safety, reliability, economic efficiency of operation.

The precondition for meeting the ITS objectives on the railways is the equipment of all vehicles, as the main target element of the system that ensures transport (goods, passengers). This concerns in particular the installation of the ERTMS / ETCS system, including the Automatic Train Control system, wireless train data transmission (GSM-R). These basic components enable the implementation of the intelligent vehicle concept, which provides both safe motion control and motion optimization functions. However, for the intelligent vehicle to function properly, it is also necessary to equip an appropriate intelligent infrastructure that will provide the intelligent vehicles with the appropriate information with the least possible economic and technical complexity. A necessary condition is also the coverage of the infrastructure by wireless two-way communication, which can provide information not only for traffic management and safety, but also enable the provision of services for information handling and public services to passengers.

The vision should lead to integration and an overall optimal solution both on the infrastructure and especially on the vehicles in order to use all components to provide ITS-R services. To ensure sufficient functionality and quality of services, ITS-R technologies must be implemented using modern and promising telecommunications technologies.

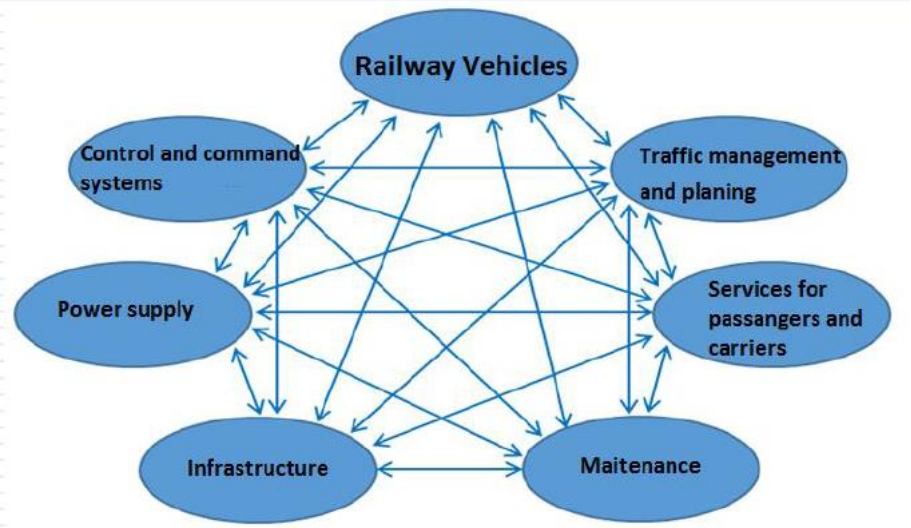

Figure 1. Interconnections of sub-railway subsystems in ITS-R

As a basis for solving the safety function of the system (train movement), the movement of all vehicles must be under the control of the ERTMS / ETCS signaling system (drawn in black in Figure 2). For these systems, it is necessary to equip the infrastructure with the GSM-R system. Depending on the selected ERTMS / ETCS level, the infrastructure must be equipped with the appropriate infrastructure part. For both ETCS-L1 (LS) and ETCS-L2, the infrastructure must be fully equipped with conventional infrastructure technologies. The ETCS-L3 level allows significant savings in terms of infrastructure equipment, conventional control-command systems are not necessary and are fully replaced by on-board technology, provided that the integrity of the train is ensured.

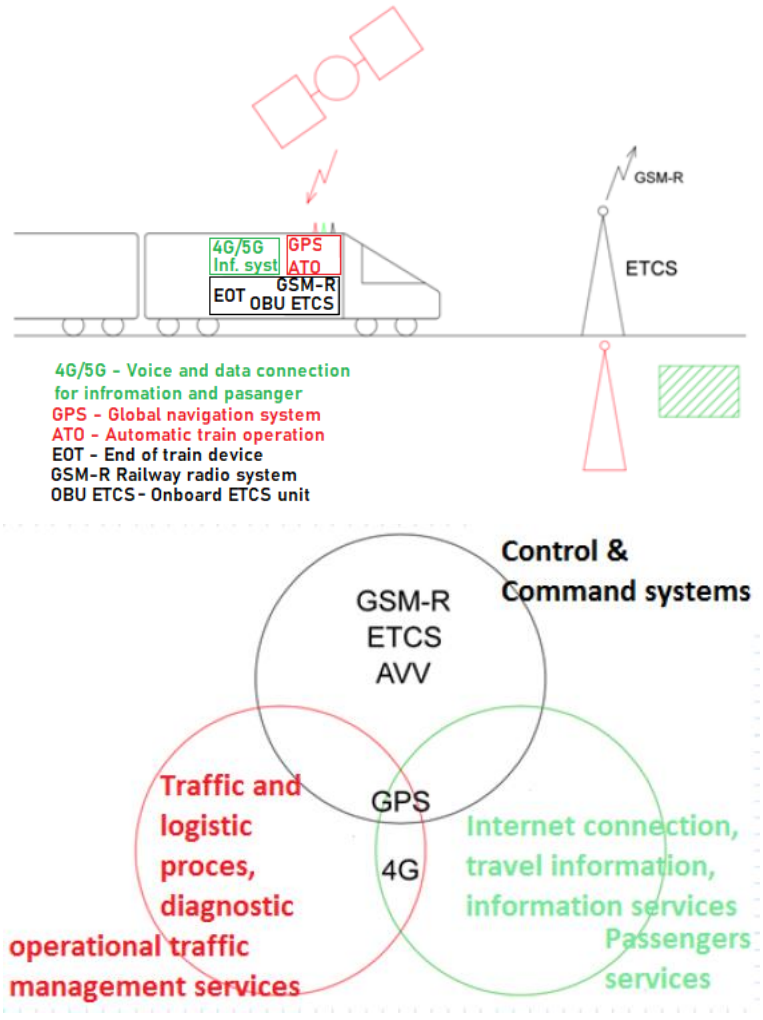

Figure.2 The ITS-R vision

To increase efficiency and optimize traffic management, increase infrastructure capacity, reduce operating costs (fuel and energy consumption, wear and tear of vehicles and infrastructure), all vehicles must be equipped with an automatic train control system. This subsystem can obtain

most of the information for its operation (track, vehicle, authorized path, etc.) via the ERTMS / ETCS signaling system.

To ensure greater attractiveness of travel using modern information and handling systems and for the superior logistics services of carriers and their customers, it is also necessary to ensure the coverage of railway infrastructure by high-speed data services (eg 4G / 5G technology; shown in green and red in Figure 2). High-speed data connectivity must be ensured in all vehicles, ie not only on the traction unit, but also on all trailers (in the case of complete sets inserted).

The list of functions defining an intelligent vehicle does not include EDT - a device for downloading and displaying the work schedule (Electronic Timetable Display). EDT is essential for the proper functioning of timetable information systems (JRs) and the online availability of up-to-date JRs, which are changing flexibly, especially when dealing with emergencies, and arises shortly before a train runs. Obtaining a valid JR is also a prerequisite for ATO's activities. The ITS - R vision must therefore also respond to the clear tendency for the annual JR to decline in favor of allocating currently valid ad hoc JRs. The ITS concept will therefore not only focus on safety, but also on the operational quality of the railway's operation, based on the allocated JR. Equipping vehicles with an ETD terminal is a prerequisite for the smooth acceptance of allocated JRs in an ad hoc mode and especially in a very short period of time.

Measures - strategic objectives

a) Equip the infrastructure with the ERTMS / ETCS line part min. L2 for all TEN-T lines
b) Verify functionality and implement ERTMS / ETCS L3 for all regional lines in the Czech Republic
c) Analyze the possibility of implementing ERTMS / ETCS L3 for national lines
d) Equip all vehicles in the ERTMS / ETCS on-board as well as with the automatic train control system and the ETD system
e) To cover the entire railway infrastructure in the Czech Republic with wireless communication systems, which will ensure data transmission for the needs of traffic management and safety, support logistics processes and improve passenger comfort
f) Interconnection of the partial information subsystems of the railway system, in order to ensure the optimization of vehicle movement, transport and logistics processes

Benefits for the Czech Republic, infrastructure manager, carrier, passenger, industry

The introduction of intelligent transport systems on the railway should bring opportunities to increase the efficiency of the entire transport system in the Czech Republic:

a) The Cech Republic, manager of whole traffic infrastructures:
   a. Increasing the capacity of transport infrastructures
   b. Increasing traffic reliability, minimizing delays
   c. Reduction of transport infrastructure wear
   d. Reducing wear and tear on transport infrastructures
   e. More efficient rail transport with the possibility of creating integral means using the railway as the backbone means of transport
   f. Optimization of investments in transport infrastructures
   g. Optimization of investments in transport infrastructures

b) Carrier, passenger:
   a. Reduction of vehicle operating costs (energy, operating costs)
   b. Reduction of traffic accidents
   c. Increasing the attractiveness of rail transport for passengers
   d. Increasing the attractiveness of rail transport for freight carriers
   e. Increasing the attractiveness of rail transport for carriers (passenger and freight)
   f. Increasing transportation profits

c) Industry:
   a. Opportunity for development and application of new products and services
   b. Export of modern technologies with the potential to gain a foothold in foreign markets

First actions

At present, all technologies are already developed. If we want to fulfill the above strategic measures, we propose the implementation of the ITS-R pilot project as the first step. We propose to implement the pilot project on a suitable regional line, where the functionality of individual sub-components will be verified. The subject of verification should be ERTMS / ETCS L3 technology, including automatic train control, information and communication systems providing data transmission for traffic management and control purposes, logistics processes and passenger services.

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Prepared by the ITS-R ITS&S working group led by doc. Martin Leso
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