ETCS Migration
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The transportation market in Europe has undergone a profound change. The key reason for this, in addition to the general increases in the transportation of goods and passengers, is largely the process of closer European integration. This fact is of crucial importance to the railway transportation system; power and signalling and safety systems have developed separately in the individual countries for several decades.

In the context of harmonisation, the ETCS (European Train Control System) is to create the opportunity for integrated intra-European transport. This means that special technical solutions and complex transmission procedures for trains necessitated at the present borders will no longer be required, thus improving and accelerating the entire transportation process.

The technical progress of the ETCS has reached a stage at which introduction of the system can commence. Various projects in Europe are in the implementation or planning phase. These include:

- Germany: Jüterbog – Halle / Leipzig
- Netherlands: HSL (high-speed line) Zuid
- Spain: Madrid – Barcelona
- Switzerland: Rothrist – Mattstetten
- United Kingdom: West Coast Mainline

However, cost-effective deployment and full utilisation of functionality can only be achieved if the long-term prospects of full-scale installation are targeted. Otherwise a large number of vehicles would have to be equipped even though they only spend a very small proportion of their turnaround on lines with corresponding equipment. Such a situation would particularly affect smaller railway operators who would be hit comparatively hard by costs for equipping individual vehicles with less than optimum utilisation.

The standardised ETCS approach, scalable according to specific requirements in the network, allows for optimum full-scale installation with complete utilisation of functionality. The ETCS technology used is suitable for all network and operating situations. This means that all different old systems are fully substitutable and just one standardised scalable procedure with a standardised fall-back level is provided. At the same time, this enables a reduction of the installed infrastructure. The fall-back level for Level 2 should be Level 1 with simplified signal aspects (restricted to proceed and stop).

For example, for German Railways (DB AG) as the largest railway transport and infrastructure company in Europe, full-scale installation means equipping around 25,000 route kilometres in the core network as well as an additional optional 14,000 route kilometres in the regional area. In an integrated European rail network, the figures would be around 140,000 km in the core network and additionally approx. 70,000 km of regional lines.
In order to develop a targeted strategy for introducing a standardised train protection system, it is important to define the overriding boundary conditions for a realistic target horizon, such as how European railways will look in 2030:

- Many European operators will operate the various segments in all national networks. They will be in intense competition with each other.
- Customer demand and benefit, and consequently transport quality, will be crucial to shaping passenger transportation.
- The demands placed on the technical equipment and technical integrity will be regulated by an appointed European supervisory body in consultation with the infrastructure companies.
- Commercially oriented instruments (e.g. pathway prices) in conjunction with minimum technical specifications govern access to the railway network.

In order to achieve this status, now called for by politicians and the general public, extensive installation of standardised and modern signalling and safety systems is essential in order to reach the highest possible safety standards combined with flexibility in terms of the various running speeds of individual trains. Through the use of modern signalling and control systems, underpinned by innovative expertise from information technology (IT), these ambitious aims are much more than a vision.

By deregulating and opening up the railway networks and by intensive promotion of technical development, European governments have already generated significant impetus. However, there is still work to be done if the described scenario for 2030 is to become reality.

Starting with relay systems, the field of railway safety systems has developed into a highly innovative branch of electronics over the last 15 years. This field is also characterised by the short innovation cycles of the IT sector. For this reason, there is a real need to pay special attention to maintaining and expanding the level of expertise among all personnel resources concerned.

Despite (or maybe because of) the fast pace of change and the huge (for the railway sector) economic dynamic, the specific safety of the railway systems must not be pushed into the background. Both manufacturers and operators of the systems must pay attention to ongoing technical integrity and interoperability. For example, when designing the components, it must be ensured that the respective infrastructure component communicates safely with each on-board unit. At present there are five major manufacturers, who between them have produced 25 potential interfaces. To avoid having to consider a separate safety case for each of these possible combinations, technical acceptance must be performed in accordance with standardised European regulations. This must be ensured by the supervisory authorities (e.g. the “notified body” of the Federal Railways Office in Germany (EBC Eisenbahn-Cert), Notified Body for Interoperability)). However, this should not hide the fact that the technical implementation of safety standards involves costs. The greater the prospects and the simpler the structures and processes involved, however, the greater the savings potential in this area.
In order to utilise these effects, a migration with the objective of a standardised European train protection system is required. The initial impetus is noticeable. For instance, the requirements of cross-border passenger and goods transportation are resulting in the fitting out or preparation of the new generations of vehicles (BR185, BR189, ICE3). Furthermore, the creation of individual new high-speed networks (Spain, Italy, Switzerland) and removal strategies for obsolete systems (West Coast Mainline) provide for the gradual introduction of modern technology. In themselves, these isolated projects are not sufficient as a driving force for extensive introduction of the ETCS. In order to initiate the process for full-scale installation as soon as possible, an impetus is required for standardised migration strategies and implementation programmes.

The creation of an extensive integrated European railway protection system is the objective for the next 30 years. This will ensure the continuous creation of European routes with European operators with regard to signalling. It is worth pointing out here that similar considerations should also apply to other as yet unharmonised areas, such as data processing systems, operating rules etc.

The development of the technology involved has reached a stage at which introduction of the system can commence. ETCS components from Siemens are used in a wide variety of European projects; entire systems are being implemented in the HSL Zuid and Jüterbog – Halle/Leipzig projects. The diagram below illustrates the areas of application and functionalities of various system components.

Figure 1: ETCS projects
The overall Siemens system is being used on the Jüterbog – Halle/Leipzig (JHL) pilot line in close cooperation with DB AG and in a consortium with Alcatel SEL. Testing will be completed by the end of 2003. Similar pilot projects are underway in other European countries and calls to tender are being issued for additional ones.

Within Germany, there is already extensive experience of migration towards the standardisation of diverse technical systems in the field of railway signalling and safety. Development of train protection systems in Germany has diverged as a result of separation. The reunification of Germany was followed in 1993 by the merging of the hitherto independent railway companies (German Federal Railway/German State Railway).

The basic ideology of railway signalling and safety, founded on the same basis, was the same in both parts of the country. However, the technical realisation of this was (and remains) different. The differing types of the INDUSI (inductive train protection system) and the signalling system are cited as examples of this.

The PZB90 harmonisation programme was launched in order to standardise the INDUSI. To achieve this, all lines were consistently fitted out (500 Hz magnets) and the functionality of the various on-board units was adapted, thus ensuring a standardised mode of operation.

In the creation of a joint German signalling system, none of the hitherto established systems (HV and HL) were selected, but instead the newly developed KS signalling system was introduced (combination signals with extension of speed signalling). This signalling system was integrated into all new and converted installations. Consequently, the signalling system in Germany is gradually being standardised along the main lines (core network). However, for engine drivers, the introduction of these systems meant having to learn new operating and functioning methods. Germany currently has three signalling systems that engine drivers must clearly identify. The same situation also applies to the as yet incomplete INDUSI harmonisation process. In comparison with European harmonisation, the training requirement seems to be relatively high. In order to minimise uncertainty in this safety-related area, it is therefore necessary to target rapid implementation of standardisation with radical reduction of transitional periods.

On the basis of this experience, it is possible to introduce ETCS. The diagram below illustrates the gradual migration through to full-scale installation on the core network at DB AG.
Figure 2: Timescale for introduction of ETCS

The graph refers to the DB AG network, but the essential principles can also be transferred to the entire European railway network.

According to latest information, availability of GSM-R in the core network at DB AG is envisaged by 2005. For this reason, work on equipping the lines of this network can be started already. This network covers approx. 27,000 route kilometres. If the project were to develop at a constant rate, this would result in around 900 route kilometres being converted each year. For controlling and monitoring around 50 km of line, an RBC is provided, resulting in an annual installation of approx. 20 RBCs by 2030. In parallel with this, the corresponding adaptations to the interlockings must be made. In order to take into account the gradual upgrading of the lineside equipment, approx. 3000 vehicles should be equipped by 2015. The relatively high number of vehicles is due to the turnarounds. To begin with, more vehicles must be equipped, so that the infrastructure, to date only installed on individual lines, can be used effectively. A similar effect exists already with regard to the lines fitted with continuous ATC, in order to achieve speeds of 160 km/h. On the basis of previous assessments, 200 vehicles per year should be converted or put into service.

Provided that a sufficient number of equipped vehicles are available, the gradual removal of signals on the first lines (line sections) can begin from 2015. This process will continue until 2030. At that time there will be no more signals in the core network of DB AG.

This scenario applies not only to DB AG, but also to all European railways. Individual countries are already in the phase of preparing specific development strategies for the signalling systems to be used in future.
The migration strategy in Switzerland is one example. It is currently being defined in a working group between Swiss Federal Railways (SBB) and the industry. Here too, this must involve the gradual transfer of the existing train control system into the ETCS environment. Migration ranges from upgrading the existing train control system to operate on lines with Eurobalises (a prerequisite for ETCS), equipping many vehicles with the ETCS L2 devices by the end of 2004 and installing the GSM-R network. Priority will be given to equipping new and modernisation lines. Provided that a sufficient number of vehicles and corresponding GSM-R infrastructure are available, the entire line network can gradually be converted to ETCS. Here, the objective is to attain optimum cost-effectiveness with high performance of the lines.

The ultimate goal in Europe is a railway network with a standardised, safe train protection system with development and extension prospects and cost-effective installation, maintenance and repair. In order to clear the obstacles described and successfully handle the enormity of the task, all those involved in Europe must make sure that cost-effective automation is created that leads to a self-supporting wave of modernisation in which only suitably equipped vehicles are used on modernised lines.

The 30-year programme outlined here for creating and introducing the technology for a standardised European railway system is a task comparable to the construction of the national railway networks over 100 years ago.