VIEWPOINT Josef Doppelbauer

Rethinking the train control loop

Advances in technology are opening up opportunities for a more decentralised approach to railway command and control systems, which could lead to convergence with other modes, ERA Director Josef Doppelbauer told the Institution of Railway Signal Engineers on June 13.

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Executive Director of the EU Agency for Railways since January 2015, Dr Josef Doppelbauer started his career at the Alcatel Research Centre in Wien, later becoming Chief Technical Officer for Alcatel Transport Automation Solutions. He joined Bombardier Transportation in December 2002, becoming Chief Technical Officer in 2008 and Vice President Research & Technology in 2014.

Railway control systems have come a long way since the earliest days of signalling, but such is the rate of technological advances that I believe we are on the threshold of a fundamental change, and the emergence of what we could call Command & Control 4.0.

Increased processing power, the greater use of sensors and crowd intelligence look set to unleash a new potential for innovation in railway control systems. In the not too distant future, most functionality will move onboard, although some form of central traffic management will have to remain for network-wide optimisation.

We will most likely see three layers of control — local to each train, 'communities' of nearby vehicles (potentially including the virtual coupling of vehicles into collective 'trains'), and a top level looking at optimising capacity and conflict avoidance. But even at this network level, traffic management does not have to be centralised; we will soon see the emergence of 'trackside in the cloud'.

Vehicle-to-vehicle communication can also include non-rail vehicles, providing the possibility for mitigating other hazards, such as the interaction of rail and road vehicles at level crossings.

Architecturally, I believe that rail control systems will gradually converge with the evolving technology for self-driving cars. This could offer rail the opportunity to re-use components developed for automotive applications, taking profit from the vastly greater volumes. At the same time, other modes could benefit from the automation and control concepts that have become more common in rail over the past 50 years.

Command & Control 4.0 will allow highly automated scheduling and precise control, enabling real-time traffic management. Interruptions can be taken into account, helping to avoid a cascade of disruption. This will enable the reduction of pathing and recovery allowances in the timetable — the more accurately the position of a train is known, the less buffer is needed (Fig 1). Rendering obsolete the need to operate under worst case assumptions should bring improvements in line capacity.

Backbone of smart mobility

Integrating the operational architecture of different modes offers a vast potential for improving transport services to the citizens of Europe by de-congesting urban centres and minimising the environmental footprint of each journey. Rail needs to position itself as the backbone of smart mobility, but it has traditionally been known for its slow uptake of innovation. If railways are not to become irrelevant in the new mobility era, we must focus on what the technology can do best — moving heavy loads quickly over medium to long distances in the main line sector, and moving high volumes of people with minimum use of space in the denser urban environments.

Apart from the need to carefully manage migration, in a shared system, with a new safety logic based on geography, independent from track layout and operational rules, there is the fundamental need to know exactly where the trains are. Precise localisation and secure communication are the critical requirements for Command & Control 4.0 to work. Cybersecurity will be a design requirement of the system, with a modular design allowing for easy upgrades.

It will be essential to address some structural issues that currently hinder interoperability. While virtually all other modes today operate under global rules, for historical reasons railways — particularly in Europe — operate under fragmented national or local rules that leave the network deeply divided.

Although all control, command and signalling systems are based on the same block principle, almost every infrastructure manager has their own operating concept, resulting in different technical specifications for mobile and fixed equipment. Despite the advent of ERTMS, full interoperability across national borders has yet to be achieved.

The ERTMS deployment philosophy must be reviewed. We need to rethink the current planning for ETCS Level 2 and accelerate towards Level 3, if we are to achieve the vision of significantly reducing the number of physical assets in the track. In view of the long timescale envisaged for the deployment of ERTMS in Europe, it could be economically very attractive and redefine Level 3 to facilitate an upgrade to 'Level 4.0'. This would enable railways to migrate directly — as far as is feasible — to some sort of decentralised system without writing off existing investment.

Command & Control 4.0 requires a new mindset, where state-of-the art technology and components can be imported from other sectors instead of 're-inventing the wheel' every time. Mainstreaming railway technology in this way, accompanied by market opening and greater mobility of assets, could attract new levels of private financing.

Take rolling stock as another example. The globalisation of railway technology and regulation could lead to product standardisation and less customisation, increasing the number of more standard vehicles compared to today. This would lead to huge efficiencies, and a more level playing field. It is an opportunity that rail cannot afford to miss. ■

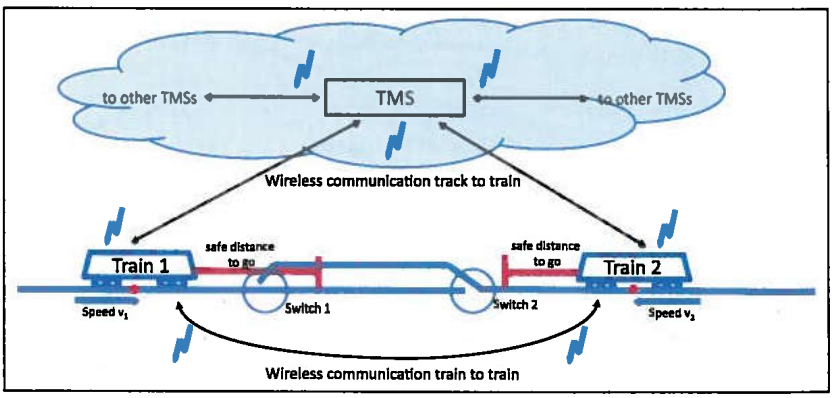

Fig 1. Schematic showing how a Command & Control 4.0 environment might be structured.