SIEMENS

Mobility Division

Background Information

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The digitalization of mobility

Our world is increasingly being digitalized – from the way we communicate with one another to how we develop, produce and consume goods and services. And the megatrend of digitalization is also transforming rail transportation. New customer needs and new technologies will substantially change the world of mobility over the next ten to twenty years. The mobility of people as well as goods will become increasingly networked, flexible and multimodal – made possible by the availability of smart sensors and increasingly sophisticated data transmission, storage and communication possibilities. Digitalization is one of the key factors for ensuring the better quality, attractiveness, capacity and reliability of rail transport. The future of the sector lies in integrated, digitalized rail networks, the growing use of networked trains, and their integration with individual transport modes. In Germany alone, the combined efficiency and growth effects resulting from intelligent mobility are expected to total up to 16 billion euros a year by 2022.

Joint innovations in Europe

To achieve these effects, interfaces and data exchanges are critically important – both within the various individual transport carriers and among them. Standardized and interoperable interfaces and integrated transport information will make possible intermodal trip and logistic chains – “from door to door.” It will be possible to seamlessly combine various transport modes – ranging from public road and rail systems to rental cars and private cars. In the end, less traffic on the road will save travel time and costs and, at the same time, reduce environmental pollution.

The digitalization of rail systems has become a joint effort of operators and industry in recent years. “Shift to Rail” is a private-public-partnership founded in 2014 by EU transportation ministers between the rail industry and the European Community to promote research and innovation for the rail sector. Funds of around one billion

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euros have been earmarked for optimizing rail transport in the European Union and increasing its competitiveness by 2020. Digitalization will be one of the most decisive factors in this process. The goal is to ensure common, secure data exchanges for participating partners based on an open architectural model.

More capacity through intelligent rail automation

The influx of people into large cities and metropolitan areas, and their growing desire for mobility, are bringing rail systems worldwide to the limits of their capacities. The modernization of infrastructures and operations control systems and the automation of processes – including secure, fully automated rail operations – will pave the way for the full digitalization of operations. And this is precisely what is happening with rail transport in the United Kingdom. Railways there have been experiencing continually growing demand for years now. In fact, the number of passengers has doubled since the 1990s, and capacity utilization on heavily traveled routes now lies at a scarcely imaginable 200 percent. To increase the capacities on British rail routes, plans call for the fastest possible implementation of the European Rail Traffic Management Systems (ERTMS) by installing the European Train Control System (ETCS). And there is also a first rail route in Germany relying on ETCS. On the new ICE line running from Erfurt to Leipzig/Halle (VDE8), trains are controlled and secured via wireless signaling to drivers in the locomotives or driver’s cabs instead of using permanent trackside signals that divide the route into blocks. The new system makes it possible to dispatch train after train on the route – not much different than networked cars operating on the highway in safe, computer-controlled intervals calculated from their respective braking distances. By using the complete spectrum of available data about the train, rail route and train trip, for example, the braked weight of the trains can be precisely calculated and the safety distances between the trains can be further shortened. With the help of this technology, the capacity of a rail route can be increased by up to 40 percent.

ETCS is on the march throughout Europe and will also be the future standard on other continents as well. Providing higher capacities with the help of digital technology is also the goal of metro systems around the globe. This especially applies to the automation of operations: In 35 cities worldwide, there are already over 50 metro lines operating fully automatically with automated train control systems. UITP, the international association for public transport, expects automated metro systems to triple over the next ten years to a total of 1,800 kilometers of lines.

Increase reliability and avoid downtimes with digital diagnostics

One major advantage offered by digitalization is the predictive avoidance of disturbances and faults in rail systems. Step-by-step, digitalization establishes a technical efficiency that ensures one-hundred percent availability of rolling stock and rail infrastructure for all operations. In the future, stranded trains or delays due to technical faults in vehicle components or the infrastructure should no longer be a problem. By collecting, channeling and intelligently evaluating data, service and maintenance processes in the rail sector will substantially be improved. This process has already begun: Remote diagnostics are used to detect faults in vehicles that are under way and notify the depot about the necessary repairs or replacements. And digitalization is also leading to automated processes in the depots using laser- and sensor-based diagnostics systems to inspect things like brakes, bogies or pantographs. Other possibilities for the future include the use of 3-D printers to quickly and locally reproduce parts subject to wear.

So-called “rolling stock intelligence” – that is, the generation and utilization of status information from rail vehicles – requires the seamless networking of information from rail operations already available today in many forms: data on components, train weights, route parameters, weather conditions, etc. While under way, every modern locomotive and every trainset continually and automatically transmits thousands and thousands of diagnostic reports and measurement data collected from many hundreds of sensors. In one year, for example, these onboard diagnostic systems deliver around one million diagnostic reports and about one billion sensor values for a single locomotive. This huge volume of data has to be processed and evaluated, of course, and this, in turn, depends on perfectly functioning data transmission capacities.

With the help of modern technologies for data storage and analytics, the flood of collected data can be analyzed and evaluated using specially developed, complex machine learning programs. The volumes of data reveal irregularities in the technical life of trains that even experienced railway engineers and depot workers would have missed. The intelligent programs enable the development of guidelines that indicate when specific service or maintenance work on a locomotive or trainset is actually needed, or when a part must be replaced. This way, interventions are undertaken only when necessary, and costly operating downtimes can be avoided.

Digitalization can also lead to the end of traditional systems of vehicle maintenance. In the past, it was required by law to regularly inspect the condition of trainsets in depots – and this led to downtimes in their commercial operation. Digital diagnostics, in contrast, could require only those rail vehicles to be sent to the depot that actually need repairs or servicing. This would ensure a higher availability of rolling stock and improve the competitiveness of rail service. At the same time, lifecycle costs could be reduced by 20 to 30 percent if only actually defective parts had to be replaced.

Qualified predictive maintenance also ensures that the rail infrastructure itself is safer and more reliable. For years now, sensors have detected faults in tracks and modern digital detection systems have perfected this technical monitoring. These systems keep an electronic eye on the tracks and register changes in the steel with the help of vibration measurements. The same is also done for points, one of the failure-prone components in rail networks. The German rail network operator DB Netz, for example, is planning to equip some 70,000 points with sensors that are connected with a control system that indicates – from current measurements when the point is switched – whether the mechanism is functioning normally or has become sluggish.

Electronic networking is also becoming a key part of major infrastructure projects. Under the leadership of Germany’s Ministry for Transportation and Digital Infrastructure, the “Building Information Modeling” (BIM) has been developed – an information and data platform for major transport infrastructure projects. The construction of the Rastatt Tunnel for the new Karlsruhe – Basel rail line (Germany / Switzerland) is serving as a pilot project. BIM networks all aspects of the project – including project concept, needs requirements, planning, authorization procedures, tendering, construction, invoicing and commissioning. The platform ensures that all project participants have access to common information. Cost savings of ten percent are expected in the construction of the Rastatt project, and there are also considerations to employ a similar platform for infrastructure maintenance processes.

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