Digitalization in the rail sector

Abstract

There has been much press attention on the digital revolution or Industry 4.0 in the economy. But what is digitalization in the rail sector about?

In this abstract BearingPoint expresses its view on this topic dedicated to the rail industry, comprising the business of railway undertakings, infrastructure managers, rolling stock suppliers, rail equipment suppliers, maintenance companies and regulatory bodies. We’ll explain which aspects and benefits of digitalization are important, which use cases are conceivable, and which hurdles should be surmounted to generate efficiencies and attain profit goals. We understand digitalization as a necessary step in the maturity development of the industry. It is a lever to raise efficiency in daily operations and long term planning - for the benefit of the customer, to lower costs, as well as to strengthen competitiveness in relation to other modes of transport. Lastly, we discuss how significant improvements in rail operations open up a wide range of opportunities that might change the business models of existing companies, but also bring new players into the market that partly operate with disruptive approaches.

But let’s begin by describing digital technology in more detail. Digital technology may be defined as the use of ITC (computing capacity + telecommunications) to gather, transfer, and process data to provide the communication backbone for all users of the rail network. Digital technologies in the rail industry include:

- sensors for rolling stock: usage monitoring (temperature, light, use of a seat, etc.), status monitoring of the rolling stock or of equipment within rolling stocks and conditions of use (doors, load per axle, gear temperature, vibrations, etc.), external conditions monitoring (weather, temperature, etc.), for localization purposes (GPS, accelerometers, etc.)
- sensors for infrastructure equipment: usage and status (switch position, number of trains having passed a point), external conditions (weather, temperature, etc.)
- video camera (for surveillance) both on-board and on the ground
- display units, voice communication units
- on-board processing capacity
- data communication within rolling stock (WIFI access points, wireless networks to connect sensors / displays), the stations or the infrastructure; data hubs for high speed data transmission
- mobile devices
- 3D printing (for spare part production)
- document management, etc.

All these elements produce huge volumes of dynamic data and enable communication between defined origins and destinations (internet of things). In addition, there are static data (e.g. train time table) or target/control data (e.g. temperature for axles) in place that can be compared with data from operations. Thus, it is possible to generate value and, for example, develop an early warning system that may detect a defect prior to the rolling stock dropping out. This is an example of predictive maintenance for rolling stock. The following graphic provides an overview of the key communication and data flows occurring between single players:
Taking the big data potentials into account, you can imagine numerous use cases in different segments of the rail value chain aiming at gathering, transferring, and processing data to provide a communication backbone for all stakeholders - from rolling stock suppliers to national and international rail authorities. Below, you will find some exemplary use cases:

- **Clients**
  - **Passengers**: internet access; mobile phone access (note: in recent carriages with metal shielded windows for temperature control, the phone signal cannot penetrate into the carriage and has to be relayed through specific onboard transmitters); services: identification of free seats in the coach, information services (both static time schedules, tariffs and real time: delays, connections with rail and other modes, etc.), point-to-point multimode journey planning (including seat booking) and ticketing, train-sharing apps, virtual mall shops in the stations; emergency calls
  - **Rail Cargo**: localization of goods, weather conditions, delivery date / time, etc.
- **On-board staff** (drivers, controllers, etc.):
  - internet access; mobile phone access; professional apps: information services (static commercial information such as time schedules and tariffs; access to real time data: delays, connections – with rail and other modes; access to CRM in relation to passenger, etc.), ticketing, alerts; notifications of out-of-order equipment/abnormal situations, possibly remote support for light repair/re-activation; emergency calls
- **Infrastructure manager**
  - **Operations**: real time status of network (circulations of trains, switches status, rail control management, etc.); alerts / accidents
  - **Maintenance**: spare parts and maintenance operations planning; obsolescence monitoring, prediction of failure, preventive maintenance & renewal policy; field service apps (access to equipment stored data, automated diagnosis, bill of material and task lists, configurations, instructions and other technical documentation, access to remote experts)
- **Railway undertaking**
  - **Commercials**: information services to passengers via on-board / station displays (online information on time schedule, delays, connections, composition of trains, platforms, etc.)
Advertisement. Entertainment, etc.); good quality / continuous connectivity (mobile, WIFI) on-board and in stations
- Operations: situational awareness (location of trains, speed, passengers on board, door status, conditions of use, load, etc.); energy consumption optimization, e.g. adjusting lighting / air conditioning to external conditions (sun) and actual occupancy; video (surveillance, for security purposes etc.); alerts (abnormal conditions of use, shocks, extreme vibrations, etc.) / accidents; real time rescheduling
- Rolling Stock Maintenance & Repair operations (MRO):
  - spare parts and maintenance operations planning; obsolescence monitoring, prediction of failure, preventive maintenance and renewal policy; field service apps (access to on-board stored data, automated diagnosis, bill of material and task lists, configurations, instructions and other technical documentation, access to remote experts
- Safety / National authorities / investigation entities:
  - access to multi-source data history for safety analysis purposes.

The rail industry as a whole has entered this digitalization path. The European Union is supporting a “Digital Single European Railway Area” with “Shift2Rail” as a big research & development program to help amongst other programs establishing digital solutions in rail businesses.

Almost all required technologies are already available (even if the equipment has to be ruggedized to cater for the difficult train operations conditions: temperature ranges and variations, vibrations, etc.). The current technology development includes low energy – high bandwidth wireless communication, and self-powered sensors for increased autonomy / longer life times.

But, typically, for new technological inventions there are open topics or hurdles that prevent fast development of the “connected train” idea. BearingPoint identifies the following open issues:

- Business case: How to prioritize use cases? Are users ready to pay for additional services? How to define fair innovation incentives for all participating partners of digitalization? How to fund new business models for development, and the building and running of new uses cases?
- Implementation of digital solutions during operations: How to implement new equipment without requiring a rolling stock overhaul?
- Liabilities: How to guarantee that the “connected train” will not harm/endanger current rail operations, and safety and security measures?
- Data management: multiplicity of sensors and real time data will generate very large flows and volume of data; extended use of data for customer service and for operations will raise data privacy and data security / integrity issues: this is a known issue, but will the rail environment add new constraints or threats? There are, in particular, legal issues (who is the owner of big data?); risks by using big data (data privacy, data ownership, liabilities, etc.) and operational issues (ability to analyze and interpret big data and find optimization rules; platforms and exchange standards; governance for data collection, exchange, access, analysis, etc.).

Our survey on the “Connected Train” sought to provide a current status view on digital solutions in the railway business and its future trends. In this sense we are also capturing opinions and evaluations about the open topics mentioned above.