SIEMENS

Mobility Division

Background Information

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Digitalization in rail transport – the Mobility Data Services Center

Utmost reliability and maximum availability are critically important for ensuring the cost-efficient operation of rail vehicles and the infrastructure they use. Railway operators and leasing firms expect the virtually fault-free operation of locomotives and trains during their calculated service life of 30 to 40 years. Since inventories are often reduced and no reserve vehicles are available, operators demand availability higher than 99 percent from the rail industry. After all, malfunctions and downtimes cost money, cause delays and frequently also lead to compensation claims from passengers, local transport purchasers and freight customers.

Predictive maintenance

High rates of availability are possible only when service and maintenance activities are systematically planned and carried out, and this is where digitalization plays a key role. Siemens is already using this technology to analyze huge volumes of data continually collected by hundreds of sensors and control devices in trains, locomotives and rail infrastructure. This data keeps track of things like the temperature of axle bearings and transformers, the condition of hydraulic oils, vibration of the bogies, dynamic operating data from the traction systems and brakes, operation of the automatic doors, and information about the heating, ventilation and air conditioning systems.

With the help of special connectivity solutions, Siemens technicians maintain regular access to vehicle data via redundant and highly secure mobile wireless links. This collected data is then analyzed in a central diagnostics system in order to calculate failure predictions and provide technicians in the Siemens depots and workshops as well as the rail operators specific recommendations regarding acute or scheduled servicing and maintenance needs.

Siemens AG
Communications
Head: Clarissa Haller

Wittelsbacherplatz 2
80333 Munich
Germany

Unique Big Data analytics in the rail industry

Long before faults actually occur, their potential sources should be identified. To provide this information, Siemens is the first company in the rail industry to operate a special data analytics center, located in Munich, Germany. In this Mobility Data Services Center, a team of data scientists, physicists, engineers, computer scientists and mathematicians thoroughly analyzes the diagnostic data being collected from rail vehicles and rail line infrastructure components. Algorithms and models are worked out using machine learning, data analytics, mathematical and physical methodologies to provide secure forecasts for the future behavior of vehicles and components. In this case, “secure” means a probability of well over 90 percent that the forecast will be accurate. Inaccurate forecasts also cost money and unnecessary downtimes.

Digitalization ensures reliable prognoses for predictive maintenance that make failures and disruptions highly improbable. Moreover, fixed maintenance intervals and superfluous stays in the workshop or depot are a thing of the past. Rail transport is made more punctual, cost-efficient and safer through the data analysis and intelligent predictive servicing concept so far practiced only by Siemens.

In concrete terms, this means that when the data specialists analyze the data, they search for patterns that predict, for example, the circumstances in which a traction drive, an electric door motor or a wheelset will fail and when wear or spontaneous error messages require attention. The goal of data analysis is to provide a precise forecast about how long a component or a drive unit will continue to function under specific conditions. And the analysis also determines with greatest accuracy that action must immediately be taken when a behavioral pattern registered by the data and based on past experience indicates that an acute failure can be expected in a short time.

Data analysis can also be used to research the relevance of fault messages generated by the vehicle’s central processor. For example, it could prevent a driver from dispatching his vehicle to the depot when the analysis indicates the vehicle would remain completely functional and reliable for many more kilometers and days. This way, unnecessary downtimes and costs can be avoided.

Prognoses and pattern analyses are continually refined

Data specialists at the Mobility Data Services Center therefore also continually analyze patterns and rules that have previously proven accurate in order to repeatedly verify and further refine them. For this purpose, not only is data delivered by the onboard units of a vehicle analyzed, but reports submitted train drivers, requests for spare parts, shop protocols and work instructions from the Siemens Support Center are also collected and used in the ongoing pattern analysis. With the help of machine learning – earlier sometimes known as artificial intelligence – the prognosis systems are continually refined and improved. This process is also supported by newly developed mathematical procedures developed and also patented by the MSD team. Using data mining, the data analysts dive even deeper into the steadily growing body of data and try to identify new patterns. The more data that is available, the easier it is to discover relevant relationships that can be used for providing prognoses and finding solutions. The result is a system that automatically predicts when a locomotive or train family can reckon with specific faults and when maintenance is unavoidable.

The volumes of data are enormous. At present, Siemens analyzes over one billion data points collected per rail vehicle every year. The mountains of data are rapidly growing and can be effectively administered only with the help of specialized relational databases and non-SQL databases. The hundreds of locomotives in the Siemens Vectron fleet, for example, generate around one terabyte of data every month. Only massive parallel processing systems, in-database processing and specialized supercomputers are able to handle and analyze such huge volumes of data with complex algorithms.

Looking at all possible parameters for errors

The data analysts also look for local relationships or contexts. If vehicles frequently generate fault messages and disturbances at a particular location in the rail network, the problem could also be caused by the track geometry, a defective point or a joint in the overhead power line, or be the result of an abnormal electromagnetic interference between the rail vehicle and the train control system.

When, for example, a rail operator wanted to increase throughput and let the trains run faster, there were frequent point malfunctions. As a result, the trains ran slower

through the network than before. By analyzing the data, experts were able to identify and eliminate the effect caused by faster operation.

Data analysis for own and third-party vehicles and infrastructure

The data analysis process currently benefits, in particular, the company's own maintenance depots for Siemens' Velaro high-speed trains in Russia and Spain as well as numerous trainsets operating in Germany and in the United Kingdom. As a result of predictive service and maintenance, nearly 99.9 percent availability of the trains can be guaranteed. The data analysis process can also be used for rail vehicles of outside companies as well as for the infrastructure. Weather-induced short circuits, disturbances in interlockings, and apparently random communication breaks between vehicles and balises can be identified through algorithms and their causes subsequently fixed.

Contact for journalists:
Ellen Schramke, tel.: +49 (0)30 386 22370
E-mail: ellen.schramke@siemens.com

Further information is available at: www.siemens.com/press/innotrans2016

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