The Smart Freight Train

26 May 2016 / 6 June 2016 - Consultants Rob van Looveren MSc and Peter van Kats MSc discuss the benefits of implementing the Smart Freight Train system, designed to inform train drivers on the technical condition of hauled wagons.

Link: http://www.europeanrailwayreview.com/27538/railway-extra/smart-freight-train/

Rail goods transportation is a safe modality. However a serious threat for freight trains are derailments which cause damage to the train and tracks and disrupt the traffic circulation. This can be limited to the derailment of one or more wheelsets, but can also end in a disaster with the explosion of tank cars (2009: Viareggio Italy, 2013: Lac Mégantic Canada). In the report on "Assessment of freight train derailment risk reduction measures" by Det Norske Veritas (2011) an advice is given to provide the train driver with an alarm when a derailment is suspected. With the Smart Freight Train system the train driver will get a "rear view mirror" to observe his train. And train reports are send to parties at trackside concerning the health of wagons and the progress of the train in relation to the time schedule. This application will also fit in the policy set by the 4th Railway Package. An innovation with a win-win situation for many parties.

Rail goods transportation in Europe

The European Committee has decided to create a Single European Railway Area. Especially international goods transportation should be done seamless throughout Europe. In the Railway Packages goals are set to improve the reliability and attractiveness of the rail transport. Goods transport should shift from road to rail.

Transportation of goods via rail is sustainable and can be done at low costs. The maintenance of the railway network and rolling stock is a continuous process. Keeping tracks and trains in good condition is vital, because derailments can easily turn into a disaster. The train driver is responsible for the safe movement of his train, but he is dependent on efficient and effective maintenance. This raises questions. How will Railway Undertakings be convinced that all wagons are in good condition? Will the ECM (Entity in Charge of Maintenance) plan a visit to the workshop in time for their wagons?

Risks in freight train operations

Collisions between trains are usually related with traffic management. One-sided accidents with trains are track or train related. Thorough investigation for the causes of accidents has provided a lot of knowledge which is valuable when looking for remedies and solutions.

Freight trains are longer and heavier than passenger trains. Freight trains use pneumatic brake systems whilst passenger trains are equipped with electro-pneumatic disc brakes. The reaction time of the brakes on freight trains demands an appropriate brake procedure. A human error of the train driver can be seen as a safety risk. Other risks for the train driver are events on wagons which he cannot notice while moving his train; i.e. unreleased handbrakes, shut off of the brakes, hot box, un-roundness of wheels, loss of brake shoes, etc. Also the derailment of a wheelset or bogie is hard to detect by the train driver. And during marshalling and (un)coupling of wagons human errors of yard personnel may lead to unexpected situations. For example valves of the brake system not closed or opened, handbrakes not set or not released.

Other risks are related with technical failures of the wagons and/or the tracks. Non-alignment of tracks, running through a not properly locked switch, a hot box or sticking brake shoes are causes for derailments. Other indirect causes are overloading, which might damage bearings, and insufficient maintenance.

The need for inspection of tracks and trains is evident. Freight trains can be monitored when passing wayside monitoring locations. There is however the uncertainty about "are technical faults detectible and did they arise" when passing the monitoring location. Instead of location dependent detection you should apply a continuous observation method to detect irregularities in time. Studies and investigation in the past did not result in an operational solution. This inspired us and our belief is that we designed a system which is technical feasible at reasonable costs.

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Electronics on railway wagons

Passenger coaches need electricity for lighting on-board. A generator is driven by the axle of the wheel set. Batteries provide power supply when the train is halted. Freight wagons however are designed for the transport of goods. The wheel sets and the pneumatic brake system on each wagon are vital elements for a safe movement of the train. To monitor these elements while moving the train you need an electronic system on-board with sensors which also needs electricity. This however gives quite a different challenge. What kind of power supply do you need? How do you switch on the system in time? Will the power supply on each wagon still hold energy after a standstill of a few weeks or months? We have gone through a variety of solutions and we had to reject a lot of them, because they would soon fail in the operational rail environment. How to develop such a system? With "proof of concept" projects we learned which choices we should make. Now we know that the design of a system with low energy electronic components demands precise engineering.

The on-board solution

The measuring methods to apply on-board a wagon will meet challenges due to the harsh rail environment, i.e. all type of weather conditions and mechanical impacts. Electronic equipment is needed for measuring physical parameters. A vital element is the power supply. Will batteries meet the requirements? To create a solution with a long life cycle demands more expertise and creativity. As electrical engineers with a long working experience we were not afraid to take the challenge.

The Smart Freight Train concept

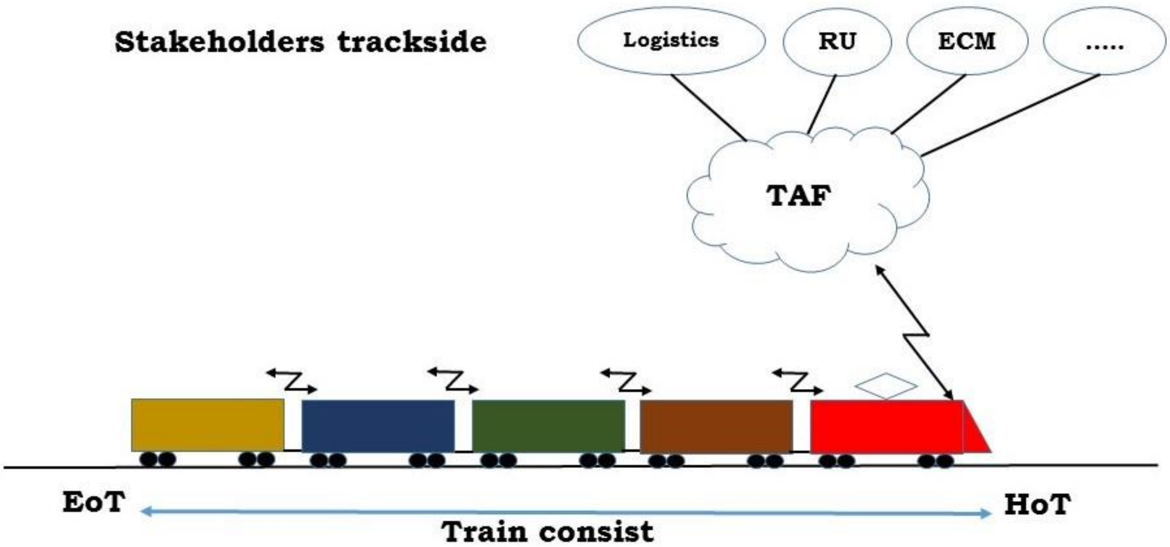
How do we implement all the required functions technically? More than 10 years ago a concept was made called the Intelligent Freight Train. The technology available at that time made the application very costly and power consumption was too high to realize an economic system. Nowadays a lot of low energy electronic components are available which make it feasible to create a self-providing energy supply system on each wagon with a long life cycle (> 10 years). The technical requirements are clear, but it is for sure that the system needs appropriate life pilot testing.

Continuous condition monitoring

The on-board condition monitoring system of the Smart Freight Train performs a continuous monitoring while the train is moving. Irregularities are reported real-time to the driver and reports are send to trackside.

Before departure the train driver shall make his train ready. Can he really check if all brakes function properly and no handbrakes are still set on? How can he verify if the train consist corresponds with the train documents? Once the on-board SFT system is activated and the brake test is performed an automatic check will be made on the status of the brake system. And the real train consist will be checked against the digital train documents.

After departure a continuous monitoring will be performed of proper function of the brakes and smooth running of wheels and bearings. Irregularities will be reported to the train driver real-time. The train driver will be able to slow down or stop his train in order to prevent a derailment. Condition reports are sent to trackside and can be used for predictive maintenance planning. The progress of the train against the time scheduled will also be reported. Within TAF (Telematic Applications for Freight) these real-time train reports can be used for further evaluation of the train movements on freight corridors. Another important issue is the monitoring of the Train Integrity which is a mandatory function for deployment of ERTMS Level 3.



The future change

In the world of the railways long existing working procedures are not easy to change. And in the European countries these working methods all have their own origin from the historical past. New technology creates the opportunity to make the step forward. With the introduction of the Smart Freight Train system the scene will change. Real-time information coming directly from the moving train will provide more accurate information to be used in the various trackside processes. We admit that all parties involved in freight train operations should be informed in an early phase about these innovations. Adopting changes takes time and therefore we take the chance to present our ideas.

SFT Associate Partners

We, a Dutch team of engineers, believe in this concept of the Smart Freight Train. Who will help us to make this become a reality?

Biography of Rob and Peter

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Rob and Peter both have a degree in electrical engineering of the Technical University of Delft and have a long working experience.

Rob started his career in automation as a systems analyst. He continued his career in telecommunications in various fields (technical planning, network planning, policy making, special projects and innovation). Now he is self-employed as a consultant for Telecom & Railway systems.

Peter started his career at the telecommunications laboratory for investigation of radio technology and setting up regulations for EMC on a European level. He continued his career in management of public telecommunication networks and deployment of new technologies like fibre cables and transmission technology. The next phase of his working career were projects for large data centres for worldwide area networks. Now he is self-employed as a consultant for Radio & Telecom systems.