Train Integrity, making ETCS L3 happen

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Making ETCS L3 happen is not only dependent on the availability of suitable solutions to the task of onboard train integrity monitoring. Economical and political aspects have to be considered as well. The provision of practical, reliable and vital train integrity monitoring systems seems to be very difficult on trains that have no electrical infrastructure. As a consequence, for the time being, the introduction of ETCS L3 might be limited to dedicated passenger lines or corridors operated with state of the art freight trains that are equipped with a train bus system allowing for train integrity monitoring.

While ETCS L1 and L2 projects are actually being realized all over Europe and the world, many infrastructure managers stick to the vision of ETCS L3 as the ultimate solution of an interoperable train control system.

With ETCS L3 the trackside signaling infrastructure can further be reduced. With trains determining and forwarding their position and integrity by themselves, conventional train detection systems like track circuits and axle counters would become obsolete. Infrastructure managers could get rid of the trackside train detection systems which today are causing a significant maintenance effort and account for up to 50 % of the disturbances and failures of the signaling system.

In such a railway system infrastructure managers who are today relying on track circuits for broken rail detection would need to introduce alternative procedures and equipment to monitor the condition of the rails.

The absence of trackside train detection systems shifts more responsibility for the safe operation of the railway from the infrastructure managers to the railway undertakings. The latter have to make sure by means of vital technical onboard equipment and safe operational procedures that their trains remain complete throughout the whole journey. Any left alone or lost vehicle would result in a non detectable obstacle on the track endangering the safe journey of other trains. Like the trackside train detection systems, onboard train integrity monitoring systems need to comply with the highest safety integrity levels. On high speed trains and lines operated with short headways these systems require high performance in terms of detection of any loss of train integrity or system failure which has to be notified to the trackside control center within seconds.

At present only few activities on the train integrity topic are visible in the profession of signal engineers. Industry is focusing on the finalization of the ETCS SRS 3.0.0 which shall close important open issues of the present deployed versions like harmonised braking curve calculation, handling of level crossings and others. These functionalities are needed on the corridors of the Trans European Network (TEN) which are actually being equipped with ETCS L1 and L2 systems all over Europe.

The vision of ETCS L3 is actually pursued within the UIC ERTMS Regional project and a pilot application on a Swedish regional line. ERTMS Regional is however not addressing the aspect of onboard train integrity monitoring systems. The pilot project relies on established trackside train detection equipment and operational procedures i.e. staff checking the train integrity which is considered to be sufficient for regional lines with low traffic only.

In October 2000 the Train Integrity Monitoring System Working Group (TIMS WG) of the former EEIG ERTMS Users Group finalized their work on the TIMS Functional Requirement Specification (FRS).

A look at the patent applications in this field shows a peak in the years 1999 to 2001 but only few applications in recent years.

The technical solutions for train integrity heavily depend on whether the trains have an overall electrical infrastructure or whether the air brake pipe is the only link between the vehicles besides the mechanical couplings.

Modern passenger trains are equipped with bus systems used for traction and vehicle control functions, traditional mainline trains are using the UIC cable which has cores that can be used to implement a train bus system. On these trains a TIMS system can be implemented with reasonable engineering effort, the main challenge is the high safety requirements of this function compared to the non vital train control functions. In some countries passenger and freight trains are equipped with automatic couplings or EP brake systems. The electrical infrastructure of these systems could also be used as the backbone of a TIMS system.

The ultimate challenge for monitoring train integrity is with freight trains that have no electrical infrastructure along the train. This is the field which most of the patent applications on the matter are focusing on. An analysis of these patents shows different solutions which can be classified into three classes.

1 Classes of solutions

Systems relying on an end of train device

- Detection of the train head and tail position by means of satellite positioning systems. The position of the train end device is transmitted by radio to the evaluation unit installed on the leading vehicle. Due to the non continuous coverage by satellite signals through shading caused by buildings, topography and tunnels a satellite based system needs to be complemented by a second, diverse system.