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From platform detection to door selection

IAIN WILKINSON, business development manager of ***Hima-Sella****, recounts the development of an interim Correct Side Door Enabling and Selective Door Operation system for the new Bombardier 'S Stock' trains being introduced onto the Circle, District, Metropolitan and Hammersmith & City lines*

On-board train control systems play an essential role in safety within modern railway infrastructure; and to a large degree this safety has to be afforded irrespective of the age of the rolling stock and of the stations they serve. Understandably, the systems need to meet a variety of operator and regulatory requirements, and one in particular became important with the advent of powered doors, which reduce the amount of time trains stop at stations and improve passenger safety.

Whether opened by or for passengers, the operating doors must be on the platform side of the train; a requirement which has given rise to the term Correct Side Door Enabling (CSDE). However, it is not simply a case of enabling all doors on one side of the train or the other, as many trains are longer than some of the platforms they serve. Accommodating this has given rise to the term Selective Door Operation (SDO).

Needed for the S

CSDE and SDO (functions) are required on 191 new Bombardier 'S Stock' trains which are being built as part of London Underground's network upgrade to the Circle, District, Metropolitan and Hammersmith & City lines; served by 104 stations which, between them, have 249 platforms (of which 51 are bi-directional, a.k.a. 'reverse working').

The CSDE and SDO functions were originally to be included within a new control/signalling system but this was deferred when London Underground's former PPP contractor, Metronet, went into administration and was transferred to London Underground ownership. It is likely that CSDE and SDO may still be provided through a future signalling system, however the functions need to be present on the new trains as they enter service via a phased roll-out which started in August 2010 and will conclude in 2016.

To this end, London Underground turned to Hima-Sella (in January 2009) to develop an Interim Correct Side Door Enabling and Selective Door Opening System (ICSS).

Based in Stockport and established in 1974, Hima-Sella has been active in the rail sector since the early 1980s; and is an appointed partner of Germany-based HIMA, an independent designer of automated safety solutions that are used in a variety of industries including rail, oil & gas and nuclear.

At a fundamental level, CSDE requires knowledge of which side of the train the platform is on and SDO requires knowledge of how many doors should be opened. Hima-Sella's solution for conveying this knowledge is through the wireless transfer of data, from platform to train, using its Tracklink III product. It comprises two key elements for the transfer of data, namely:

- A passive tag for storing data relevant to a platform
- A train-mounted reader for reading that data.

The Tracklink III Tag

Constructed from flame-retardant, toughened polymer and with an aluminium base, the tag is factory sealed (to IP 67) and suitable for use in a variety of harsh environments.

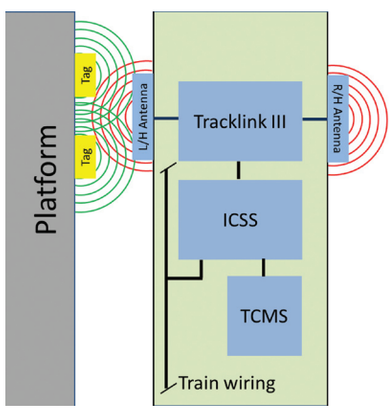
The 'passive' aspect of the tag relates to it being a beam-powered Radio Frequency ID (RFID) device and requires no power cable or batteries. ***Note**: previous systems for track-to-train data communications have typically employed large track-mounted inductive loops, wired to and powered from trackside transmitter cabinets, which have high installation and maintenance costs.*

The Tracklink III trackside beacon contains a circuit board comprising an antenna and RFID device that is energised by the RF field transmitted by a train-mounted (and powered) antenna.

In each of the stations, two or more tags are fitted at the stopping points of each platform. Each set of tags is programmed by Hima-Sella at the time of manufacture and contains data for the door opening patterns for all possible lengths of train serving the platforms (in this case 6-, 7- or 8-Car Trains) and all possible stopping positions.

System-level

Below is a representation of how the ICSS elements connect and how the Tracklink III antennas energise the tags – which then transmit the door opening pattern. The illustration shows just two tags, but typically three would be employed at a designated stopping position. For at-speed data transfer, within a tunnel for example, one tag may suffice.



On-board the train

As for the train-borne Tracklink III Reader, it is an RFID interrogation device. One is mounted to the underside of each Driving Motor Car, i.e. two per train.

Each reader connects to two antennas, one on each side of the train, and knows which of the two antennas has detected a tag. They are set to energise and read tags from a distance of about 1m and they work continuously so, if a tag is in range, it will be read (several times per second).

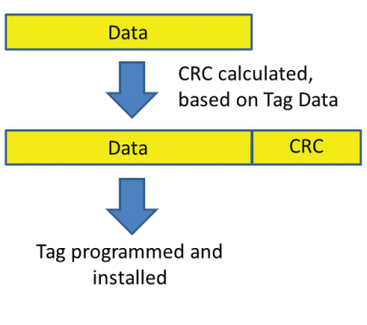
***Note:** whilst for this application the tags will be read by trains that are coming to a stop the units have been verified at speeds of up to 125mph. This means Tracklink III tags and readers can be employed in a wide variety of scenarios. For example, at-speed data transfer could be used to convey tunnel-in, tunnel-out, regenerative braking zone, traction limiting zone, pantograph-up, pantograph-down and other geographical triggers.*

Each Tracklink III Reader connects to an ICSS Control Unit, built around an F30, dual-processor HIMA HIMatrix programmable logic controller(PLC) that is certified up to Safety Integrity Level (SIL) 3 in terms of both its internal hardware and as a 'software programmable' platform (i.e. a fail-safe architecture). The ICSS also includes circuitry for converting switched train voltages (of 110V nominal) into discrete logic levels for the HIMatrix, switching train control circuits and speed monitoring.

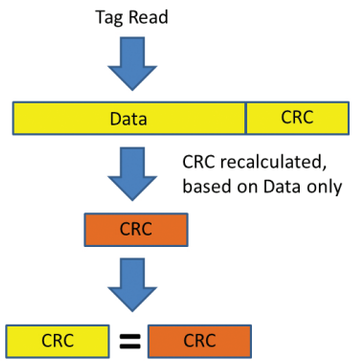
Each ICSS interfaces with the train's hard-wired relay logic for CSDE and SDO plus the train computer (or Train Control & Monitoring System – TCMS), and is aware of how long the train is so all it needs is the data from the Tracklink III tags at each station to enable the opening of the correct number of doors on the platform side of the train.

Safely received

As mentioned, Tracklink III tags are used to store data (in this case door opening patterns, but space is available for lots more information). When programmed, the data undergoes a Cyclic Redundancy Check (CRC). This is essentially a calculation done on the data that results in a CRC code; which is tagged onto the end of the data.



The tag's data and CRC code are read by the Tracklink III reader, which repeats the same calculation on (just) the data. The read and re-calculated CRC codes should of course be identical; thus validating the integrity and therefore validity of the read data.



Each door has a dedicated (local) control system that interfaces with sensors and motors – and in terms of 'logic' the door will open if:

- The driver has pressed the door-opening buttons in the cab; and
- The ICSS is enabling the door to be opened (itself dependent on the tag-based door opening pattern and the train being stationary).

The functionality and operation of the ICSS are continuously monitored. For example, the outputs of CSDE and SDO relays are fed back as inputs. Should there be any mismatch between the intended and actual state of outputs a fault is flagged; and if it is a 'hazardous mismatch' the system's outputs are locked off in safe-mode.

Conclusion

This project represents the first use of Hima-Sella's Tracklink III (tags and readers) on such a large scale. Also, the development and on-going provision of Interim Correct Side Door Enabling and Selective Door Opening System (ICSS) means the 'S Stock' trains being built for London Underground's Circle, District, Metropolitan and Hammersmith & City lines can (immediately) provide the passenger safety and reduced time-at-platform benefits that powered doors offer. ■

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