Transmission Based Train Control (Seltrac) Signalling Technical Overview

The new signalling system is Transmission Based Train Control (TBTC) enabling Automatic Train Operation (ATO) to drive the train and Automatic Train Protection (ATP) ensuring the train runs in its own safety zone. Track side signalling and tripcock protection will be taken out once TBTC is in place. TBTC is based on the moving block principle, allowing more trains to safely occupy the same amount of track. Named Seltrac the new signalling is supplied by Tube Lines and produced by Thales.

Moving Block
Moving block technology defines a safe separation between trains. The position a following train can travel to is a target point defined by the position of the rear of the preceding train. This moving target point is continuously updated. The following train is not allowed to move over the point until the Vehicle Control Centre has confirmed the point is reserved for it, in the correct position and locked. The safe separation of trains normally relies on the speed of the train, so that if the trains are running fast then the distance between the trains will be greater than if the trains were going slower.

System Description

TBTC is made up of a number of sub-systems providing control throughout the line.

- **System Management Centre (SMC):** I/O Rack, Automatic Train Supervision Rack, Workstations each with two monitors, Maintenance Workstation, MIMIC Display, printers and servers. It is placed in the Service Control Centre.
- **Vehicle Control Centre (VCC):** Each VCC has a Data Transmission Rack, Input/Output Rack and a second generation VCC Rack. It is also located in the Service Control Centre.
- **Vehicle On-Board Controller (VOBC):** responsible for train movement only within speed/distance permission of VCC. It is placed on the train.
- **Station Controller Subsystem (SCS):** communicates with the VCC and other SCSs and is responsible for safety within its area of control. Inputs to SCS include emergency stop devices, point status, route secure status, axle counters, key protection switches and peripheral equipment. It is placed in the signalling equipment rooms (SERs).
- **Inductive Loops:** loop cable is laid between the track. Each loop has a crossover every 25 metres. The VOBC detects the change in the signal from the loop at each of these crossovers to help determine the train's position within the loop. Each 25 metre section is divided into...
positions: there are four positions per crossover hence 1 position equals 6.25 metres on the track.

**Track Information**
Loop boundaries are displayed on the SMC. Loops have a unique identifier displayed on the SMC.

Sections of the guideway are split into blocks. A train enters and leaves a block by passing over axle counter heads. During normal operation more than one train could occupy the same block. Axle Counter blocks are displayed on the SMC (block limits and occupancy status).

Tracks and track sections (generally 25 metres long) have a unique identifier displayed on the SMC.

**Defining the direction and positions of trains**
TBTC defines the direction the train is travelling in as Guideway Direction zero and Guideway Direction one. Piccadilly line also has an alpha gamma point to define where Guideway Direction zero changes to Guideway Direction one on the Heathrow loop.

The VCC sends all positional information i.e. track number/position/guideway direction and track section to the SMC. The SMC displays this train position centred in the middle of the track section reported by the VCC. The SMC displays the train’s position as an icon.

**Train modes**
Trains can run in four modes:
- **Automatic (ATO):** at a station the VOBC can open the train doors, at departure the train operator closes the doors and presses the ‘ATO –START’ button and the train then travels under the control of the VOBC.
- **Protected Manual:** the train is driven by the train operator but is supervised by ATP.
- **Restricted Manual:** the train operator is responsible for the control of speed, motoring, coasting and braking of the train. The train is not controlled by ATP and must be driven at a low speed typically 17 kph.
- **Off mode:** no train movement is allowed, the emergency brake is applied and the propulsion is disabled. The trains position and status is reported to the VCC.

**Main line Operations**
The service controller has a number of views available on the SMC workstation: Line Overview view dynamically represents the entire line showing the position of the trains and the points; Alarm view; Timetable view with train labels indicate the train mode selected or defaulted to; System Status view for checking subsystem status such as VCC; Performance Tools view to monitor the performance of the system; User Authority view for logging on and for authorising the transfer of control and the VCC view for seeing the data output from the VCC terminal.

The SMC workstation issues particular codes. Code amber will hold and prevent the departure of a train while code red will stop trains at their target points.

**Emergency Stop Devices and other TBTC Station Equipment**
Emergency stop devices are emergency stop plungers, staff protection key switches, decommissioned floodgates, track circuit interrupters and out of gauge detectors.

With the exception of staff protection key switches, when required emergency stop devices can be overridden by VCC command so their activation does not close any tracks and affect train operation.

**Fault Management**
Alarms are displayed on the SMC alarm screen and are split into five areas: regulation, train, wayside, miscellaneous and history. There are two types of alarm displayed: latched alarms which can be active or inactive and unlatched alarms which are more like informative messages. Some alarms have automatic system responses by the VCC.

Degraded mode control and SCS local control are also available to the operator in the event of VCC system failure. In the event of complete SMC failure VCC control mode provides a means for basic TBTC safety and protection.

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