SUB-SURFACE RE-SIGNALLING

Further details of Thales resignalling plans were included in an October 2015 article in “Rail Engineer”. It seems that concept design work was finished by the end of 2014 and the preliminary design, comprising system requirements and interface specifications, will be completed by the end of 2015. The final design including the application of the system to the existing railway is a 2016 activity. In parallel, installation work can proceed from early 2016 with Thales using various subcontractors for the necessary trackside work. More importantly, testing of the system comprising a full wayside installation and prototype equipment on a test train at Old Dalby is already underway. Modifications may then be required and a second train with a finalised train configuration will be ready by summer 2016. This will lead to the provisional roll out stages of 2018/19 Hammersmith to Paddington, then the rest of the Circle Line, and then 2019/20 to the District and then Metropolitan lines. These dates are aspirations and better the contract requirements. It remains to be seen whether they can be achieved but hopes are high. Starting in the central area delays interface problems with other lines, and brings forward the biggest capacity gains from resignalling flat junctions.

The operation of the Thales Seltrac system will be similar to that in service on the Jubilee and Northern lines. Trains receive a communication from the control every second to ensure continuance of their Movement Authority but, if no message is received within five seconds, an emergency brake application will occur. The existing lines use a loop-based system, this being mounted on the track with a crossing point every 25 metres to give a positional reference point. However, the new system will be radio-based, already in service in South Korea and China. Train positioning data is derived from track mounted balises (TAGs) positioned in a multiple of 25 metres. Once passed, the train’s odometer counts the distance until the next TAG. In busy areas, and at the approach to junctions or stations where a train is braking, the spacing will be 25 metres, but in country areas distances may not be so critical and TAGs may be as far apart as 200 metres. The TAGs are locally powered by a battery with a 10 year life, but incorporate an alarm if power is running low. Should one fail or be misread, an update position is obtained from the next TAG. Axle counters will remain used as a backup when degraded mode is in operation, these being positioned near stations and critical junctions so as to form logical block sections.

Trains communicate the latest TAG information to the on-board Vehicle Control Computer, which is continually scanning ahead for other trains, stations and point positions and will call for routes to be set as appropriate. The Movement Authority is regularly updated to tell a train how far it can go and at what speed. A safe separation distance of around 100 metres between trains is achievable, but will depend on gradients and braking profile conditions. Normally trains will operate in automatic mode but drivers can switch to protected manual mode with permission. Such occasions may arise during unusual adhesion conditions or when engineering works mean trackside workers are present.

The introduction of radio transmission will be a learning curve. No dedicated radio channels are envisaged, instead use will be made of the unlicensed 2.4GHz public Wi-Fi band. Frequency-hopping using algorithms to search around the band and a security protocol to an international industry standard will be employed.

Free space propagation will be used throughout, even in the tunnels, and no use of radiating cable is foreseen. Aerials will be positioned approximately every 250 metres, mounted on a six-metre mast for above ground lines and on the side wall of tunnels about half way up. In twin track tunnels, alternate aerials will be on opposite sides of the tunnel so as to minimise the blocking effect of one train to another coming in the opposite direction. Loss of any one base station will not adversely impact on coverage to the trains. A full radio survey on the central section has already taken place during ‘engineering hours’ using kit mounted on two trolleys to replicate a train and portable base stations in the predicted positions. Further surveys on other sections are planned as the project progresses. Full data recordings have been made of the radio signals such that installation of the network infrastructure can now proceed. The radio system will be fully duplicated to achieve maximum redundancy borne upon a new fibre cable network designed to form overlapping transmission rings. Power supplies will also be duplicated. The new cables will have spare fibres that might be used for other operational systems or, even, by third parties.

Junction optimisation will be key to achieve the required 32 trains per hour in the central section. Normal operation will be to timetable mode but, where trains are out of sequence, then a 'first come, first served' with caveats will kick in. The system will know if any trains are 'fast' over a section (particularly true of the Metropolitan Line), so allowing a slow train to proceed ahead should not happen. Equally important is not allowing too many trains to approach a restricted terminus, such as Aldgate, if platform capacity does not exist.

The work to fit the trains with Seltrac and radio equipment will be done by returning the trains to the Bombardier works at Derby. Most equipment can be contained within the driving cab but under floor tag readers, roof aerials, odometry and power supply elements need to be interfaced into existing components. The engineering fleet will also need to be fitted, but this is being planned as an in-house LU job.

Several sections share services with other lines and train operators. There is no single solution and each one has to be considered individually. West of Rayners Lane Seltrac will be fitted for SSR train running with fixed block signals retained for Piccadilly Line trains. On the Wimbledon and Richmond branches Seltrac will be overlaid on the Network Rail signalling with lineside signals retained and movement authorities governed by the signal sections.

Between Harrow-on-the-Hill and Amersham the existing LU signalling will be replaced with standard Network Rail three-aspect signals controlled by the Seltrac system intelligence such that automatic operation can be maintained for Metropolitan Line trains. This is to be known as an 'underlay' and LU drivers will see a blue signal under normal circumstances. The train description system will know which trains are controlled automatically and which are manually driven. Chiltern Railways' drivers will continue to see either a red, yellow or green aspect and will drive accordingly. Their trains will retain tripcock apparatus to trigger any signal overrun braking. It will not be permitted for a standard red, yellow or green aspect to be displayed at the same time that a blue light is showing.

The section from Watford High Street to Watford Junction will only be required once the Croxley Link is constructed but, on the current programme, this will be completed before the Seltrac system reaches the extremities of the Metropolitan Line. Hence the new section will require initially to be fitted with conventional LU signalling. LU is still considering whether to subsequently extend the Seltrac CBTC into Watford Junction, but the signalling on the section from Watford High Street to Watford Junction shared with London Overground trains will need to be decided.

To install, test and commission the new equipment, some 70 partial closures at weekends will be required. Driver duties will remain similar to those undertaken on the other Seltrac lines. Training will be mainly by cab simulators but a section of the Hammersmith line will also be made available for driver familiarisation of the actual system.

Source: **http://www.railengineer.uk/2015/10/15/london-underground-sub-surface-re-signalling/**