SSL Resignalling in Trouble

By Piers Connor

SLIPPAGE

Those of us who take a interest in the engineering and operations of the London Underground often rely on contacts for information on the latest ideas or how projects are progressing but, in recent times, better transparency has offered us access to board reports and similar papers detailing the progress of projects, or the lack of it. One interesting source is Transport for London's (TfL) corporate web pages, which often contain monthly or quarterly reports prepared for board meetings and committees. These are sometimes a good source of information on the progress of new ideas or upgrade works.

Since the authors of these papers are fully aware of the exposure their work is getting, they usually tend to be reticent about detail but some interesting clues appear from time to time. Anyone going through these reports over the last year or so cannot have failed to notice that there are a number of signs that the £354 million Sub-Surface Lines (SSL)[1] resignalling project with Bombardier is in serious trouble. TfL's quarterly progress reports have, for the last year, been showing signs that all is not well and the latest to be issued (October 2013) confirms this clearly. It was noticed by regular UN contributor John Hawkins, who contacted our editor. The report describes the situation as follows:

"Demonstration of the new SSR signalling system at the Old Dalby test track was not achieved by the August 2013 "key date" in the Bombardier contract. Following LU review and challenge, Bombardier has acknowledged that this will not be achieved until at least June 2015. LU believes that if their current plan is continued, there will be a similar delay in contract completion taking it beyond the DfT target date of 2018. This would also lead to significant LU exposure in excess of SUP funding. A range of options are being considered to maintain delivery of the upgrade by 2018."

What is significant here is that official reports of this type are usually gauged more by what they don't say than what they do say. Since this report, short though it is, says quite a bit, you can be sure that there is a lot more that isn't being said. Contacts have intimated that the "review and challenge" phrase in the report has escalated the problem to Bombardier's head office in Montreal, Canada. There was even talk of Bombardier being "dropped" and a new supplier found. What is also significant is that the "key date" mentioned in the October report that the Old Dalby test date has slipped to June 2015 comes just three months after the July TfL Board report stated that the date was December 2014. This means the programme has slipped six months in three months. It is abundantly clear that the situation is bad but just how bad is it and why?

TIMESCALES

The original plans for the resignalling of the SSL were drafted in the years 1999-2002. During this period, it was envisaged that Westinghouse would be the supplier for both Metronet's PPP contracts covering the SSL and the Victoria line and that they would resignal the lines with their Distance to Go-Radio (DTG-R) system. When Metronet collapsed in July 2007, LU looked at the whole resignalling arena exposed by the collapse and decided that Westinghouse was too expensive. Progress on the Victoria line was too far advanced to change the contract then but, without any substantial work having been done on SSL, Westinghouse was dropped and paid off (handsomely) to go away. After a year and a half of going round to various cities looking at what systems were available and which of them might be used on LU, the work was put out to bid.

REBID SURPRISE

[1] In typical LU fashion, the description of the sub-surface lines was adopted as SSL by the contractor, originally Metronet, but was called the "sub-surface railway" (SSR) by the client side – the operators. This difference was typical of everything that went on during the years of the Public Private Partnership (PPP) fiasco.

What with the time spent sorting out the Westinghouse compensation package, the touring of cities, pre-qualifying suppliers, preparing new invitations to tender and then going out to tender again, it took LU almost four years to appoint a new contractor and this, to the surprise of many of us, turned out to be Bombardier Transportation. It was a surprise for three main reasons. First, it introduced yet another signalling technology to the Underground, bringing with it even more interface problems - hadn't they had enough on the Jubilee line with the installation of the SelTrac S40 signalling? Secondly, the new system was untried in the UK safety environment in general and in the LU signalling environment in particular and thirdly, it was being supplied by the company who were already in a fractious relationship with LU over their rolling stock supply contracts. The worst of all worlds, you might think. Its only saving graces seem to have been the price – at about £2.2 million a route km[2] roughly half the price of the original Westinghouse contract and 20% less than the Thales (formerly Alcatel) SelTrac system adopted for the Jubilee and Northern Lines – and the fact that it didn't have the track mounted wiggly wires of the SelTrac S40 system but offered similar, moving block performance[3].

Sacking

There are two schools of thought in engineering project management. One says that the person who managed the bid should continue with the project and see it through to the end. He (or she) knows the project, understands the how the programme was built up and the financial base and knows "where the bodies are buried". They provide continuity throughout the project. The opposite view is that a bid manager is usually a completely different type of person from one who knows how to motivate a diverse workforce in a big engineering design and construction project and therefore a new project manager should be installed to run the project when the contract is signed. I think the jury is still out on that one but, when a big project starts to go wrong and the troubles are elevated to board level, the natural reaction in some companies is to sack the project manager and replace him with "someone who can get the job done".

This is usually a futile exercise, since there is little chance of recovering any delay while the new PM learns the real depth of the "doodie" that the proposal team has dropped him in and gets to know his team and it will usually lose still more time.

Throwing more resources into the project won't necessarily help either. Soon people will be falling over each other. Perhaps what is needed is a careful assessment of the workflow and the steps needed to clear the path ahead to the ultimate objective.

NO IDEA

When TfL announced the choice of Bombardier in June 2011, they said, perhaps in a search for some sort of reassurance for the passenger and taxpayer, that the original Westinghouse offer "...would also have left LU with the legacy of a signalling system not compatible with others across the Tube network". This is such a ridiculous statement that I realised then that there were some people in the organisation at an embarrassingly high level (at least high enough to approve press releases) who had no idea what they had dumped when they got rid of Westinghouse, no idea what they had bought in its place and no idea that they were going to go through the same trauma that the Jubilee line had gone through, only on a much bigger railway.

At the time of the announcement, I wrote in Modern Railways[4] that "Bombardier have a huge task ahead of them. Their signal engineers will not be familiar with the complex LU engineering philosophy and their rigid operating procedures and LU don't know the "Ebilock" interlocking technology (remember the aborted Horsham installation?) nor the train control system, which has its origins in the American Westinghouse airport people-mover system, like the one at Gatwick Airport, where little, 4-wheeled shuttle cars trundle up and down between terminals. Transferring that technology onto complex junctions like Earls Court or Harrow-on-the-Hill will be just as "challenging" as the S40 has been."

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[2] It is worth noting that the Singapore metro (SMRT) has contracted Thales to replace its existing ATC system with radio-based SelTrac on its two existing lines in overlay mode at £1million per kilometre.

[3] It is worth remembering that all modern metro-type train control & signalling systems offer similar performance in terms of train throughput. Other variables, like station spacing, train length, train performance, terminal operations and volume of traffic all contribute to the actual performance on a day-to-day basis.

[4] Modern Railways, July 2011.

Since the S40 system was two years late in completion on the Jubilee line and it suffered more than its fair share of bugs, it was only to be expected that the Bombardier system would suffer a similar fate on the SSL and it seems it's already started[5].

THE NEW SYSTEM

The Bombardier train control system is their Cityflo 650 product. It isn't new. It was originally developed in the 1990s by Westinghouse[6] of Pittsburgh USA. The 650 system uses radio to provide both train detection and control over sections of line that Bombardier call "regions". As with most other modern automated systems, it is divided into Automatic Train Protection (ATP), Automatic Train Operation (ATO) and Automatic Train Supervision (ATS). The core safety system is ATP. Bombardier adds "region" to the front of their descriptions so ATP becomes RATP and ATO becomes RATO.

The ATS functionality is provided from the control centre (on the SSL, the new one at Hammersmith control centre) and is connected to a trackside radio transmission network. This network links to the RATP, the RATO, and the RATP computer systems on either side of the region. These sub-systems are responsible for the safe and optimal performance of the train control system. Information flows between these sub-systems through the trackside network and to the central control network.

What Bombardier calls "Base Data Radio" (BDR) equipment, connected to each RATP, communicates with the vehicles via a leaky coaxial antenna or conventional radio system. Train control data is exchanged between the trackside and train-borne systems through this link referred to as the "Train to Wayside Communication (TWC)" link. In addition, the system has "norming points" - fixed points along the track that are used to update the on-board train location software. These do a similar job to the APR (Absolute Position Reference) points on the Westinghouse Victoria line ATC system or the 25m points where the transmission loops of the S40 system cross over.

TRAIN REGISTRY

A Bombardier write-up of their system[7] describes how traditional CBTC systems need a complete "manual sweep" of each region to check that the line is clear at start-up or after a complete shut-down during a failure. The sweeping is usually performed by driving the trains manually through the region. As the Jubilee line has discovered, this is a very time consuming process and can take up to an hour on a large metro line before the service can be restored.

To overcome this, Cityflo 650 incorporates a computer-based "train registry system" (TRS). This is an automatic recovery programme that tracks trains separately but in parallel with the normal train control system. The TRS uses an independent and vital computer that maintains a record of all trains operating within a certain pre-defined area. This information is communicated to the Automatic Train Protection (ATP) system, which then polls and establishes communication with all the trains in the system. This, they say, removes the need for sweeping after a failure and allows normal automatic operation to be resumed within a very short time, usually a few minutes.

"Train Registry" is a completely new idea for London Underground. The fact that it is described as vital (fail-safe to you and me) is likely to cause problems for both LU and the safety authorities. There will probably be those who regard the whole idea as not proven and not safe enough for LU

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[5] It is easy to say, "I told you so" but it is disappointing that the railway industry continues to make the same mistakes that they made years ago. I was asked, in 1998 when the PPP proposals was being offered to industry for comment, what I thought of the proposed break-up of the LU infrastructure. Naturally I raised signal system incompatibility as the big issue. A year later, I told the Adtranz Metronet proposal team that all resignalling projects needed a minimum of two years added to whatever time the signalling company said they needed for the job. This was the average delay being experienced on Railtrack resignalling projects at the time. It's a shame that we don't seem to have progressed very far in 15 years.

[6] The irony of the name is not lost on me but actually the US Westinghouse company has long been separate from the UK company.

[7] Jadhav R. (2005), "Bombardier CBTC Solutions", RSE Technical Convention Singapore, 24-26 October 2005

to use until they've done extensive testing and validation. I can imagine LU engineers wrestling with how such a system copes with trains in complex junctions and whether it has to be capable of detecting interlocking status when the system is being re-booted after a shutdown. This is dark territory for LU and even darker for Network Rail who are busy struggling with ETCS (the European Train Control System) technology and the introduction of ATO on Thameslink.

TO OVERLAY OR NOT TO OVERLAY

When the Westinghouse DTG-R ATC system was installed on the Victoria line, it was a selling point that it was to be in "overlay" mode. This meant that the line could be equipped with the new system on top of the original 1960s ATO system so that DTG-R would be used by new trains while the original system still worked for old trains. A big advantage is that track circuit train detection is used for both systems. This allowed a "mixed mode" of old and new trains working at the same time over the same line detected by the same track circuits but each using their own ATC equipment. The disadvantage is that the whole line has to have DTG-R before new trains can run.

This sort of overlay was not possible for the SelTrac S40 system on the Jubilee and Northern lines. With S40, the line has to be divided into areas, each one controlled by a computer, the VCC (Vehicle Control Computer). Before an area can go over to the new system, all trains using the area (effectively all trains on the line) have to be equipped with the necessary kit - the VOBC (Vehicle On Board Computer). For the current installation on the Northern line, all the 1995 Tube Stock trains are equipped with S40 and they all work in manual over the sections still using the traditional LU equipment. As sections switch over to S40, each train entering the new area switches over to ATC and works automatically. When it returns to the border with the old system, it switches back to manual driving.

Since the architecture of the Cityflo 650 system is similar to SelTrac's S40, it would be reasonable to assume that installation would follow a similar path. However, that would mean all trains would have to be equipped with the system before they could enter a newly opened "region". OK, you might say but how will this work north of Harrow with its Chiltern trains and the lines to Richmond and Wimbledon? And what about Piccadilly trains running to Uxbridge?[8]

All these issues point towards the need for mixed mode operation and therefore DTG-R overlay strategy for implementation. Since "legacy" trains use track circuit detection and the 650 system uses radio-based detection, some sort of correspondence must be in place before mixed operation can be allowed. Bombardier says that it is possible with their system. This means that both 650 equipped trains and non-equipped trains can work through a "region" once it is commissioned. It also means that the 650 system has to be fed track circuit train detection information as well as radio based train detection information. There was also a plan to retain tripcock operation on some sections to retain the capability of interworking of non-650 equipped trains.

Getting all this to work on the ground is another story entirely. As an example, just trying to get the track and trainstop circuitry and associated relays to interface vitally with the 650 system software will be a major design task in its own right. Adding to our recipe for chaos, we must remember that the new S Stock was originally designed with Westinghouse DTG-R interfaces that now have to be adapted for the 650 system and add to that the procedural complexity of getting everything approved, I doubt that the Bombardier signalling people, scattered around the world as they are in Pittsburgh, Thailand and Sweden, had any idea what they were getting themselves into.

INTERFACES

In the end, it all boils down to interfaces. Sir Peter Parker, the charismatic, one-time chairman of British Rail is quoted as saying, "The railway falls flat on its interfaces". He was right and London Underground has been in the unfortunate position of proving that with worrying regularity, especially since the takeover of their engineering by private industry under the PPP. Even since

[8] To get the full benefit of 650, all 1973 Tube Stock will have to have it fitted so it can work over the District between Acton Town & Hanger Lane Junction and over the Uxbridge branch. Getting such a new system onto a 40-year old design will be a "tough ask". Just finding space for it will be fun and what the camshaft controlled traction kit will do the delicate electronics is surely an unknown unknown.

being released from their PPP straightjacket, they have insisted on repeating the mistakes made during the PPP era and have selected yet another unknown train control system from an unknown supplier that has to interface with four other systems before it can work.

One final thought. All the new ATC systems provide similar performance. On LU, they are looking for 33-34 trains per hour in the peak direction and, on the Victoria line, they are now getting it. This means that LU could have got new ATC standardised across the system with only one learning curve, one debug period, one supplier to deal with, one set of drawings, one set of instructions and one maintenance system. It would be a valuable exercise for someone to look at the original costs of the Westinghouse, SelTrac and Bombardier systems and compare these with the final costs of installing each technology on the LU lines concerned, including the costs of years of delay and the resulting losses of benefits, plus the costs of internal LU project and engineering time and resources. Then, compare the results with the Westinghouse price and the likely cost of its installation across the system, without all the time delays, disputes, learning curves and other losses. I am sure there would be an interesting result.