

TRANSPORT FOR LONDON

BOARD

**SUBJECT: LU DELIVERY OF VICTORIA AND SUB-SURFACE LINES
UPGRADES – PROGRESS UPDATE**

DATE: 24 MARCH 2010

1 PURPOSE AND DECISION REQUIRED

- 1.1 The line upgrade programmes on the Victoria line (VLU) and Sub-Surface Lines (SUP) (comprising the Metropolitan, Hammersmith & City, Circle and District lines) were inherited from Metronet on TfL's acquisition of the former Metronet Public Private Partnership (PPP) business in 2008. In both cases, London Underground (LU) has taken direct management control of live programmes in the implementation phase.
- 1.2 This paper provides a progress update on these two critical projects, covering the background, scope, progress, cost and access. It also provides comparisons with the upgrade programmes being delivered by Tube Lines Limited (TLL) through the PPP.
- 1.3 The Board is asked to note this paper.

2 LU'S LINE UPGRADES: BACKGROUND AND PROGRESS

- 2.1 LU's line upgrades are highly complex and ambitious programmes of integrated activities to renew life expired assets on one of the world's busiest, and its oldest, metro, while minimising impacts on current intensive operations. At the heart of the programme lies the replacement of fleet and signalling assets dating back, in some cases to the 1920s. Through renewal, the upgrades will provide increased capacity and journey time improvements to address current crowding and growth aspirations in the Mayor's London Plan. Across LU, the Line Upgrade Programme will deliver around a third more peak capacity into central London, journey time and quality benefits worth £22bn, and wider economic benefits estimated at £36bn.
- 2.2 The upgrades are therefore about re-equipping the railway to allow it to continue to function, generating the very greatest possible passenger-carrying capacity, journey times and quality from the existing infrastructure, and are the critical foundation of the Mayor's Transport Strategy. A line upgrade typically involves some combination of new signalling and/or rolling stock replacement, together with investments in depots, track, power, platform modifications, and in some cases cooling and station capacity. Under the PPP, the Infrastructure Companies (Infracos) were/are charged with delivering upgrades to achieve specified targets (denominated in terms of the average reduction in customer

journey time). The Infracos were free to choose the form of solution, technology and upgrade methodology. LU, however, was obliged to deliver the power, cooling and station capacity investment necessary to make the Infraco solution operable. In addition, the structure of the PPP contracts obliges LU to grant temporary closures of the railway to the Infracos to the extent of their agreed allowance.

- 2.3 The first wave of line upgrades in the PPP contracts covered the Jubilee and Northern lines (JNUP being delivered by TLL) and the Victoria and Sub-Surface Lines (SUP) (Metronet, now LU). The following table summarises the current status of these upgrades. Those on the Piccadilly and Bakerloo lines are due to follow later in the decade.

	Jubilee	Northern	Victoria	SUP
Capacity increase	33%	20%	21%	33%
Contract target date	Dec 09	Jan 12	Aug 13	Mar 18
Original forecast	Mar 09	Mar 11	Aug 12	Mar 18
Current forecast	Oct 10	TBD	Apr 12	Mar 18
New trains	None ^(b)	None	47	191
New signalling	Thales Seltrac	Thales Seltrac	Invensys ^(a) DTG	TBC – awaiting contract award

Notes:

(a) Formerly Westinghouse Rail Systems Ltd.

(b) The project to add a 7th car to the existing Jubilee line fleet was funded directly by LU outside the core PPP.

- 2.4 As shown in the table above, the Victoria and SUP upgrades include renewal of trains, and consequentially train maintenance facilities, power supply, low loss conductor rail, platform lengthening for SUP and other enabling works, whereas the current Jubilee and Northern upgrades being delivered by TLL do not, as these fleets were the most recent on the LU network to be replaced in the late 1990s. Renewing trains, depots, power and signalling in the same programme significantly increases the magnitude and complexity of the delivery task. The SUP is by far the largest of the upgrade programmes, delivers the most benefit, and includes a step change in train facilities with inclusion of air conditioned passenger saloons and through gangways for the first time on the Underground.
- 2.5 Metronet contracted the main works for its upgrades to Bombardier, who in turn contracted the signalling elements to Westinghouse Rail Systems Ltd (WRSL). When Metronet entered Administration, in July 2007, work on the whole Victoria line (signals and especially train replacement) had progressed, and on the SUP extensive design work had been completed for the new “S Stock” fleet. By contrast, SUP signalling was at an early stage and LU had concerns about the technological maturity of the proposed solution, its migration strategy, and the associated costs. Ultimately this led to the main signalling contract being abandoned as part of the exit from Administration. Following this, LU began the process of retendering the main Automatic Train Control (ATC) signalling

contract, as described below. Contract award is expected to be made in late 2010. The change of approach on signalling was one of a number of changes that together avoided £2.5bn of expenditure that Metronet would have otherwise incurred. This was described to the Board in a paper dated 24 June 2009.

- 2.6 The new delivery model following the integration of Metronet into LU continues to see substantial private sector involvement in the projects. However, through the integration, duplicated management layers have been removed, and the delivery approach recognises where private sector partners and contractors can add most expertise and where risks are best retained and managed by LU.
- 2.7 The management approach adopted for each of VLU and SUP embodies a 'one team' approach where all parts of LU and the key suppliers are co-located and jointly involved in addressing problems and programme board decision-making. This method of work facilitates complex planning such as intensive planning of possessions worksites to allow multiple activities e.g. signalling, trains, track and power by different parties. It has also proved invaluable in delivering flexible and swift corrective action to lessen the impact of adverse events, such as extreme weather, TLL delays and industrial action. Following TfL's acquisition of the former Metronet business, a strong sponsor role has been established in LU to ensure that the upgrade programmes deliver or exceed all the business benefits identified in the business case.
- 2.8 Both VLU and SUP are progressing to time and budget. The first four VLU trains are in service today, and later in 2010 new trains will be in regular passenger service on the Metropolitan line. Signalling implementation is on schedule, with VLU in delivery phase and tender evaluation underway for SUP
- 2.9 More detailed information on the VLU and SUP projects can be found in Appendix 1 to this paper.

3 COMPARISONS WITH TUBE LINES LIMITED (TLL)

- 3.1 The upgrade challenges faced by the delivery units of LU and TLL are radically different.
- 3.2 LU is tackling more comprehensive replacement of all train system assets including rolling stock - on the Victoria line all line assets are approaching life expiry at the same time, and on the Sub-Surface lines parts of the ageing fleet are now 50 years old. The two TLL upgrades in progress (Jubilee and Northern) are signalling/control programmes only with these systems being fitted to relatively new trains that were introduced by LU in the mid/late 1990s.
- 3.3 One area where current comparison can meaningfully be drawn is the signal upgrade elements of Jubilee/Northern and Victoria line upgrades. Even then, each signalling upgrade has differences which limit comparability of costs and access requirements (e.g. different maturity of the chosen technology; requirements for traction power upgrades to enable new timetables).

Costs

- 3.4 The Arbiter selected various upgrades to benchmark against JNUP in his cost determinations for Tube Lines. In the case of the VLU, he took the average of

high and low assumptions and adopted a rate of £4.25m per track kilometre⁽¹⁾. This is lower than the rate projected by TLL for JNUP which was £4.46m per track kilometre. In his final determination however, the Arbiter considered that the efficient and economic unit rate was £2.7m per track kilometre for JNUP and £2.0m for the Piccadilly Line Upgrade (PLU).

- 3.5 However, the costs used by the Arbiter for the VLU (which were only used as a benchmark for JNUP) included costs that LU considers should have been excluded including development costs in relation to SUP and Bombardier profit and mark-up. LU maintains that the like-for-like cost would be around £2.5m per km.
- 3.6 In any event, the VLU solution is not an economic and efficient starting point. The Bombardier contract for fleet and signalling was embedded in the Metronet PPP bid and thus inherited by LU on the exit from PPP Administration. Bombardier was a shareholder member of the Metronet consortium and the contract includes high levels of cost mark-up. In addition, scope, operational constraints and technical solutions are specific, and VLU involves more system development compared to the proven Thales system chosen for JNUP.
- 3.7 It should be noted that both VLU and JLU rates are higher than the target level for the Sub-Surface signalling contract (currently out to tender) which is expected to be more representative of international benchmarks

Access

- 3.8 Due to the multiplicity of asset upgrade requirements, the VLU had to minimise its closure requirements and its signalling implementation strategy was to maximise the use of “off-site simulation/testing”, and to adapt an “overlay” approach with the new signalling system being installed in parallel with the current system. The signalling system is then mostly tested during normal engineering hours without the need for weekend closures. This is a significantly different strategy to that used by TLL on its upgrades, for which weekend closures have been used more intensively with greater disruption.
- 3.9 The following table provides a comparison of the equivalent access requirements (in equivalent 52 hour minor closures) for VLU and JLU signalling upgrades, which shows the number of closures and resultant disruption to LU’s passengers generated by the JLU signalling upgrade to be substantially higher than for the VLU. (The VLU closures are an allocation of the total closures across the different programme elements).

¹ The average benchmark used by the Arbiter for the Victoria Line Upgrade (VLU) is £4.25m per track km. This number has been revised from £3.36m per track km in the Arbiter’s draft determination (i.e. £2.32m per track km uplifted by 45% for project management and Underground factors).

Estimated Signalling Closures (in equivalent 52hr minor closures) at 10/2/2010	VLU (to March 2012)	JLU (to July 2010)
Route Km	21.25	37.80
Number of Closures	22 ^(a)	129
Closures per Route Km	1.04	3.40
Total actual Lost Customer Hours (LCH) charged	1,957,200	6,505,600

Notes: (a) Including VLU Extended Engineering Hours equivalent.

3.10 The SUP signalling invitation to tender set an expectation of seeking to minimise closures, following international best practice from Metro de Madrid and other metros. Early analysis shows that the bidders have responded positively to this challenge.

4 CONCLUSIONS

- 4.1 The LU line upgrades programme satisfies two fundamental requirements; it renews life expired assets to enable LU to continue providing its core services, while exploiting the opportunity presented by renewal to ensure the maximum passenger carrying capacity possible is provided to cater for current and future levels of demand given the constraints of the infrastructure. The Mayor's Transport Strategy describes the programme as being the "critical foundation" without which LU will not have the capacity to provide the same service as today, let alone keep up with demand which is still forecast to increase dramatically over the next two decades.
- 4.2 The highly ambitious and complex multi-asset upgrades of the Victoria line and Sub-Surface Lines, being delivered by LU following TfL's acquisition of the former Metronet PPP business in 2008, are progressing well and are being delivered both to time and to the agreed budget. In comparison, Tube Lines' delivery of the Jubilee and Northern line upgrades is behind schedule and over budget. The Arbiter has awarded economic and efficient costs that are £500m less for upgrades in RP2 than sought by TLL.
- 4.3 Where comparisons can be drawn, primarily between signalling upgrade on the JLU and VLU, LU's delivery costs are comparable, though as noted above, LU is the first to acknowledge that the inherited Metronet contracts are not necessarily an economic and efficient benchmark. The SUP ATC is being developed on the basis of much lower unit rates, in line with international best practice.
- 4.4 Similarly, international experience shows it is possible to undertake line upgrades with fewer closures. LU is applying this to its own upgrade programmes and is urging TLL to do the same. TLL instead is seeking to increase, through the dispute process, its future access allowance.

5 RECOMMENDATION

- 5.1 The Board is asked to NOTE this paper.

6 CONTACT

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FURTHER DETAILS ON LU UPGRADES

1 VICTORIA LINE UPGRADE (VLU)

- 1.1 The VLU is delivering on time and on budget as set on the exit of Metronet from administration and transfer to TfL. Overall the upgrade delivers a 21 per cent increase in peak capacity on one of LU's most intensively used lines.

Purpose

- 1.2 When it opened in 1968, the Victoria line was the world's first automatic metro line. Forty years on, the assets, particularly the trains and signalling, are reaching the end of their economic lives at the same time. Moreover, the Victoria line has become one of the most intensively used on the network, carrying 180m journeys per annum, with the core section of the line between Kings Cross St Pancras and Victoria experiencing heavy peak crowding. Traffic growth will continue, particularly with the opening of High Speed 1 at St Pancras.
- 1.3 The upgrade solution involves replacement of both signalling and rolling stock assets to run higher capacity trains at higher frequencies. VLU will deliver 32 trains per hour (tph) capability on the trunk section from Seven Sisters to Brixton, up from 28 tph today.

Scope and progress

- 1.4 The scope of the upgrade includes:
- 47 new "09 Tube Stock" trains, now in production and being delivered to the line, together with upgrade works to Northumberland Park depot in order to maintain the new trains.
 - Replacement signalling controlled from a new line control facility. As part of this, 14 new signalling equipment rooms have been constructed along with the new control centre. Physical installation of equipment has been completed.
 - The Victoria line track renewal programme (including the installation of low loss conductor rail) was completed ahead of the line upgrade to facilitate introduction of the new fleet and to avoid disruption later.
 - The power systems are being upgraded to support the requirements of a more intensive service using a new fleet. Mid-tunnel ventilation fans are being upgraded as part of a package of cooling works to address the tunnel temperatures. The majority of these works have completed. (These works were always outside the scope of the PPP but are now being delivered as part of an integrated approach).
- 1.5 Two pre-production trains were delivered to the line in 2008 and the first train began trials in customer service as planned on 21 July 2009. The first production train ran in the inter-peak in January 2010. Peak running commenced successfully on the evening peak of 4 March 2010. One of the

pre-production trains has returned to Derby for modification and four production trains have now been delivered to London. Three trains ran together in service on Sunday 14 March 2010 with five planned to run together during April. The first of the old trains has been decommissioned and decommissioning will start in earnest on receipt of the fifth production train (at which point there is no longer be depot capacity).

- 1.6 The testing programme has identified certain production quality issues with the first few trains. This issue has been raised at the highest levels with Bombardier. Fleet reliability is growing and is consistent with the performance achieved by other fleets at this stage in the programme. Significant early problems with doors have been addressed with changes being made in the production run. Reliability growth has improved from 1,075 km mean distance between service affecting failure in October 2009 to a current level of 1,744km. Once LU is satisfied with the overall fleet performance, the fleet is due to be delivered at a rate of one new train each fortnight.
- 1.7 Physical signalling works are complete and the new signalling has been commissioned. Again, the reliability of lineside signalling is growing having improved from 77 hours mean time between service affecting failure in October 2009 to a current level of 142 hours.
- 1.8 The focus of the upgrade now is the successful introduction of the new fleet and reliability growth in trains and signalling. This effectively enables the full customer benefit to be realised, currently forecast ahead of schedule in April 2012. Thereafter the focus switches to decommissioning and removal of the redundant equipment.

Upgrade approach

- 1.9 The upgrade methodology on the VLU follows the 'overlay' approach, whereby the new signalling is introduced in parallel with the old system. The new trains are introduced on the new control system while the old trains continue to run using on the old control system. "Translator boxes" are fitted to enable the new signalling to work with the old. With the fleet migration complete, the old system can be turned off and decommissioned.
- 1.10 While this approach requires more equipment overall in the interim, and maintenance of two parallel signalling systems for a period, it is a substantially less disruptive approach than the traditional 'cut over' approach. This is because the upgrade approach allows an incremental commissioning strategy to be adopted and designed into the programme. Components of the system can be livened up and tested in shadow mode in traffic hours without service disruption with controlled increases of functionality and each stage of commissioning into service is deliberately small and reversible. Hence, initially one train was introduced late at night, then at weekends, then in the off-peak, then in the peak and then by building up numbers of trains in service. Similarly, service control was initially run in passive mode at night before taking control for the first weekend, followed by similar build-up as for trains. This approach has dramatically reduced the requirement for closures.

Costs

- 1.11 In December 2008 the TfL Project Review Group noted authorised funding of £1,072m consolidated into a single authorised sum the separate funds held within LUL and Metronet. The current Business Plan and EFC remains within that provision.

Programme

- 1.12 The VLU is delivering to programme and the following table sets out the key future milestones.

Milestone	Milestone date	Achieved Date / Status
<i>Trains</i>		
First 09 Stock in passenger service	July 2009	July 2009
All 09 Stock in passenger service	November 2011	On Target
<i>Infrastructure</i>		
Power Supply Upgrade complete	June 2009	June 2009
All track works complete	January 2010	January 2010
<i>Signalling</i>		
Commence trial of signalling control from new service control centre	November 2008	October 2008
VLU Upgrade complete	April 2012	On Target

Access

- 1.13 The following table summarises the access requirements of the VLU in equivalent 52 hour minor closures. Part of the access strategy was to utilise extended engineering hours in place of more disruptive weekend closures. Of the 105 closures, 20 per cent are estimated to be for upgrading the signalling system with the remainder for train testing and other infrastructure work, notably extensive track replacement with low loss conductor rail.

VLU Closures (equivalent 52hr minor closures)	Signalling	Other ^(a)	Total
2006/07	0	18	18
2007/08	2	16	18
2008/09	4	17	21
2009/10	3	19	22
2010/11	0	6	6
2011/12	9	0	9
Total Closures	18	76	94
Extended Engineering Hours (as Minor Closures)	4	7	11
Total Closures for the VLU	22	83	105

Notes: (a) Includes train testing and infrastructure work

2 SSL UPGRADE PROGRAMME (SUP)

- 2.1 The most significant of the upgrades, this programme will result in renewal of core assets across the oldest parts of the Underground and provide a 33 per cent increase in peak capacity across the programme. SUP is delivering on time and to budget.

Purpose

- 2.2 The Sub Surface Lines (SSL) consist of the approximately 40 per cent of LU's network by track kilometre and consists of the Circle, District, Metropolitan and Hammersmith & City lines. These lines form a complex network consisting of shared tracks, stations, signalling equipment and trains. At numerous locations the SSL also interworks with Network Rail, Piccadilly line and Jubilee line infrastructure. The numerous flat junctions cause more operating constraints than on a typical metro, which adds to the challenge of increasing capacity.
- 2.3 The SUP will renew life expired assets, while using the opportunity presented by this renewal to exploit modern technology to improve radically the service offering, culminating in 16 per cent reduction in scheduled journey times and 33 per cent increase in capacity. This will be achieved by operating higher capacity trains at higher frequencies, while minimising disruption for users during the coordinated and carefully programmed delivery phase. Trains will be automatically driven (i.e. by computer control) to achieve improved performance.
- 2.4 The signalling upgrade will enable a service of 32 trains per hour in each direction in the peak in most central areas. Without the signalling upgrade, it will not be possible to increase service levels beyond the 28 trains per hour service currently offered.

Scope and Progress

- 2.5 The SUP includes:
- A) 191 new air conditioned, through gangway (both major new features for LU) "S Stock" trains increasing capacity provision by 12 per cent and resulting in a step change in journey quality;
 - B) Comprehensive programme of train enabling works to support new train introduction including:
 - Station modifications and platform lengthening;
 - Alterations to legacy signalling;
 - Major signal immunisation programme; and
 - RVAR platform humps.
 - C) Major depot upgrades to provide maintenance for the new trains, while maintaining legacy trains for service during migration;

- D) Changes to stabling sidings including a new stabling facility for 10 trains at Lillie Bridge;
- E) New Train Crew Accommodation at Harrow and Hammersmith;
- F) Resignalling of SSL network with Automatic Train Control system, capable of Automatic Train Operation, Regulation and Continuous Train Protection, facilitating a step-change in service delivery. This will enable trains to run faster and an uplift from 28 to 32 peak trains per hour in central London with proportional increases on the branches, reducing scheduled journey times by 16% and increasing capacity by a further 21 per cent above that achieved with new trains; and
- G) Replacement of existing signal control from 12 sites with a consolidated control centre on a single site, reducing operating costs and improving the quality of overall service delivery.

2.6 Good progress has been made with signal immunisation, other enabling works and train delivery as follows:

- The extensive programme of signalling “immunisation” required in advance of S Stock introduction is on target with all of this work on the Metropolitan line completed ahead of schedule;
- The first S stock train arrived in London ahead of schedule in November 2009 after extensive testing at Old Dalby test track in the Midlands;
- This train is now being used for testing and training purposes on the Metropolitan line during engineering hours, with the first train in passenger service scheduled for later this summer; and
- Subsequent trains are now also proceeding through the production process in Derby and testing at Old Dalby.

2.7 The supply of the new signalling system is currently undergoing tender, and has been subject to open competition following pre-qualification. The Invitation to Tender seeks a product that is proven in service on other metro railways and which delivers the increased capacity required from the current physical network. The evaluation process is designed to choose the offer which delivers the required performance within the programme budget while minimising subsequent life cycle costs. Four bids, from international companies/consortia, are currently being evaluated. Details of the bids are commercially sensitive, however, initial analysis suggests that the system can be delivered to time and budget while minimising access requirements. Two bids will be selected for detailed negotiation and evaluation with contract award to the successful bidder expected by late 2010.

2.8 The contract for the new signal control facility at Hammersmith is due to be let in the next month. This facility consolidates 12 control sites into a single control centre including finally replacing nine archaic manually worked signal boxes, some with technology dating back as far as the 1920s. This project is a good example of the approach now being adopted across the capital programme; detailed value engineering and assessments of scope and construction methodology have reduced the estimated final cost by a third.

- 2.9 Extensive power supply enhancements are required for the new signalling system and especially for the new trains which are more numerous, more powerful, and have passenger air-conditioning fitted, unlike any previous LU train. These works are proceeding well and will increase in pace over the next few years.
- 2.10 The single area of the programme giving greatest concern is the upgrading of train maintenance facilities at Neasden and the other three depots on SSL. Since transfer to TfL, Metronet's plans were found to be wholly deficient. Even after value engineering and robust commercial negotiation, the cost of the full scope of works required significantly exceeded the funds allocated by Metronet for the depot upgrade.
- 2.11 Intensive work is taking place to contain the extra costs within the overall programme budget and a plan to deliver the core essential depot works is being progressed.

Upgrade approach

- 2.12 The migration methodology for the SUP differs from the Victoria line because the new trains are being introduced, manually driven, in advance of the new signalling. However, the Invitation to Tender for the ATC clearly sets an objective for a migration plan for re-signalling that minimises or eliminates the need for line closures. The premise of the upgrade is to deliver common train and signalling equipment progressively across the whole SUP network, mitigating the complex changes being undertaken and enabling maintenance and operations functions to adapt to new assets at a manageable pace of change.
- 2.13 As with the VLU, the upgrade has adopted a One Team approach with close involvement of the supply chain, operators and maintainers. Responsibilities have been allocated between the parties in a manner that best reflects the ability of each party to manage risk, and recognising that important ingredients such as domain knowledge can only reasonably come from the in-house engineers and operators.

Costs

- 2.14 The SSL Upgrade Programme authority is £4.231bn. This authority covers, in addition to the scope of the SSL Infracore's SSL Upgrade works, SSL Upgrade costs and risks for which LU is liable under the PPP contract (eg asbestos removal) as well as non-upgrade works linked closely to the upgrade delivery.
- 2.15 The bulk of the future spend is committed with the Bombardier S Stock contract and the enabling works required to support its introduction. Additional future budgeted spend is allocated to the ATC re-signalling project and supporting enabling works, with the remainder of the programme's budget allocated to programme management and engineering, and risk and contingency budgets.
- 2.16 It should be noted that while the total signalling costs represent less than a third of the total cost, they are highly leveraged, with the signalling delivering around two thirds of the overall benefit.

Programme

- 2.17 The SUP is delivering new assets into passenger service in two major phases; replacing trains by 2015 and signalling by 2018. Despite the recent challenges posed by extreme weather, TLL interface work delays, industrial action and train quality issues, all strategic milestones are on target for delivery to programme.

Milestone	Milestone date	Achieved date / Status
<i>Trains</i>		
First S stock train delivered to Old Dalby	April 2009	February 2009
First S stock train delivered to London	November 2009	October 2009
First S Stock in passenger service	September 2010	On Target
All S Stock in passenger service	July 2015	On Target
<i>Signalling</i>		
ATC Invitation to Tender issued	August 2009	July 2009
Appoint ATC Contractor	January 2011	On Target
SSL Upgrade complete	March 2018	On Target

Note: both the first train in service and ATC contract award milestones are currently working to stretch targets ahead of the milestone dates shown here.

Access

- 2.18 Efficient planning of access requirements for SUP are coordinated between the programme and other LU demands through a well established and structured process. Opportunities to exploit synergies between closures, such as programming multiple worksites in a given possession, are sought whenever possible. The major issue on access at present is the interface with Tube Lines' late running works on the Jubilee line, requiring work to be rescheduled, particularly in the Neasden area. This Tube Lines failure is causing significant difficulties for the SUP programme.
- 2.19 The Invitation to Tender for the ATC contract clearly sets an objective for a migration plan for re-signalling that minimises or eliminates the need for line closures.