Finance and Policy Committee

Date: **21 January 2016**

Item: **Four Lines Modernisation – Automatic Train Control Status Update**

This paper will be considered in public

1 Summary

1.1 This paper provides the Committee with an update on the Automatic Train Control (ATC) work of the Four Lines Modernisation (4LM) programme.

1.2 Due to the ATC System Readiness (ASR) work undertaken by Thales prior to full contract award and its experience from the Northern Line Upgrade (NLU), significant achievements have been made in the first four months of the contract, including:

(a) the Preliminary Design Review for the core system, passenger trains and test tracks, and external interfaces has been conditionally passed, with conditions to be closed by end of 2015;

(b) dynamic testing of the first ATC controlled S Stock train has started at the test track;

(c) London Underground (LU) has installed 50 per cent (17km) of the cable route management system required for the first three migration areas;

(d) the two signal equipment rooms for the first migration area are under construction and will be delivered to Thales' required date; and

(e) the low voltage switch boards for the first three sites have passed their factory acceptance tests.

2 Recommendation

2.1 **The Committee is asked to note the paper.**

3 Background

3.1 On 1 July 2015, the Board approved a revised Project Authority for the Four Lines Modernisation programme. As part of this approval it was agreed that the Finance and Policy Committee would receive regular progress updates. This report provides the Committee with an update on the ATC work of the programme. Progress across the whole programme is covered in the Quarterly Investment Programme Report. The programme is delivering the modernisation of four LU lines (District, Metropolitan, Circle, and Hammersmith & City). This modernisation will renew aging assets and allow more trains to run on these lines, to support London's growing population, which is expected to increase by 1.4

million people by 2030.

3.2 The District, Circle, Metropolitan and Hammersmith & City lines together make up nearly 40 per cent of the LU network and include the oldest part of the network built in 1863. As well as circling central London, the lines serve suburbs in the west, north west and east of the capital and carry around 1.3 million passengers a day. Following completion of this work, up to 32 trains per hour (tph) will operate on the core sections of these lines and peak passenger capacity will be increased by an average of 33 per cent.

3.3 The programme is scoped to deliver work in two significant tranches which, in combination, will achieve the necessary modernisation of the four lines, as follows:

(a) introduction of new trains and substantial associated enabling works; and

(b) replacement of existing signalling with a modern ATC system, supported by associated enabling works, to deliver faster, more frequent and more reliable services.

Accordingly, Project Authority was approved by the Board on 1 July 2015 in two separate elements.

3.4 Prior to Project Authority being granted, the programme undertook a Quantified Schedule Risk Analysis on the integrated programme based on Thales bid programme. This analysis identified a range of dates for each key milestone, with varying levels of confidence of achieving each of these. Thus the earliest possible date for each milestone has a theoretical zero per cent probability (P0) of being achieved, with other values being calculated at P50 and P90 levels. The programme is authorised against the P90 dates, but internally is measuring achievement and slippage against the P0 dates.

3.5 The programme is planning to deliver journey time benefits through a series of timetable service uplifts. The planned dates shown below are consistent with the P90 dates; however, the programme is endeavouring to better these so that benefit delivery can be advanced accordingly.

Timetable step	**Main change(s)**	**Planned Timetable Date**
1	Runtime improvements on central area sections	May 2021
2	30tph in central area and 24tph on Metropolitan trunk for 90 minute peaks	Dec 2021
3	32tph in central area and 26tph on Metropolitan trunk for 90 minute peaks	May 2022
4	32tph in central area and 26tph on Metropolitan trunk for three hour peaks	Dec 2022
5	32tph in central area and 28tph on Metropolitan trunk for three hour peaks	May 2023
6	Off peak enhancements	Dec 2023

4 ATC Programme Delivery

4.1 On 31 July 2015, the ATC contract was awarded to Thales.

4.2 The signalling system will be commissioned sequentially across 14 migration areas, as shown in Appendix 1. Migration areas MA10 and MA11 will be delivered in a single commissioning. It should be noted that in order to implement the timetable changes associated with the service uplifts referenced in Section 3.5, a number of adjacent migration areas need to be commissioned and an appropriate reliability proving period completed.

4.3 Due to the ASR work undertaken by Thales prior to full contract award and its experience from the NLU, significant achievements have been made in the first four months of the contract.

Collaboration

4.4 In order to ensure that the collaborative approach to delivery established by LU and Thales on the NLU is maintained on the 4LM, an ongoing programme of collaboration workshops has been established.

Stakeholder Engagement

4.5 Due to interoperation between the 4LM lines and other operators / infrastructure owners there are a number of key stakeholders that are being engaged with by the programme, including:

(a) Network Rail (NR) engaged though the current design activities with a dedicated project engineer based with 4LM for three days a week from October 2015; and

(b) Chiltern Trains engaged and raised no objections to the design.

System Design

4.6 System design is being progressed on a "Functional" basis, based on the functions (“delta functions”) that need to be designed and developed to meet the Works Information (WI) requirements. This has been created using a structured analysis of the NLU baseline requirements against the ATC WI requirements to identify functional gaps.

4.7 Due to the number and complexity of the ATC delta functions, these are planned to be introduced through multiple software releases prior to the revenue service software releases.

4.8 The ongoing delta function development is subject to joint Thales and LU project team design review throughout the system design development stage. The primary objective of the design reviews is to provide confidence in the maturity and progress of the system design and interface development, with design review marking the end of each System Design Review Stage. If the period between any two system design reviews is greater than six months, then a joint Thales and LU Design Checkpoint Review meeting will be held.

4.9 Since contract award, the Preliminary Design Review (PDR1) has been completed on the ASR work, as has the subsequent Preliminary Design Review (PDR2) for the core system, passenger trains and test tracks, and external interfaces. The latter review was completed with some conditions to be closed by end of 2015.

Resident Engineer

4.10 LU staff will be deployed at Thales in Toronto as resident engineers and the programme will deploy a range of staff for this depending on the phase of work e.g. System Design; Detailed Design; and Testing and Commissioning. The role is key to LU validating reported information on progress and issues from Canada, and also to support Thales in making timely decisions. The resident engineer will be in place by January 2016 and a rotating programme of travel by other key engineers has been in place since October 2015.

System Verification Review

4.11 The system verification review has been undertaken in accordance with the agreed due diligence plan, with the majority of system maturities and risks in line with the plan. Where the pre-PDR assessment changed the rating of an item to a higher risk, the item was reviewed at PDR2.

4.12 LU continues to monitor and review the progress on implementing the similar Thales Communications-based Train Control (CBTC) system in Hyderabad.

Test Track Installation

4.13 The CBTC system is now fully installed at the Rail Innovation and Development Centre (RIDC), formerly known as the Old Dalby Test Track, and has been energised in the baseline configuration to enable testing with the prototype ATC enabled S Stock (V1) and the pre-production ATC enabled S Stock (V2).

4.14 The installation is designed to exercise all train modes to ensure that the vehicle interface is fully tested prior to production and revenue service. This is one of the lessons learnt from NLU.

LU Deliverables

4.15 Under the ATC contract, LU is required to deliver a variety of assets for Thales to utilise by defined “need-by” dates. Progress on these is as follows.

Wayside Infrastructure

4.16 LU is required to provide 56 signal equipment rooms (SER), which are a mixture of new builds and room conversions, low voltage power (LVAC) to the SERs, and cable route management system (CRMS) along the whole network to carry the LVAC and other signalling cables.

4.17 Both the SERs required for the first migration area (Hammersmith and Edgware Road) are under construction, with handover to Thales for its equipment installation, planned before the end of 2015/16.

4.18 A contract for installation of the first tranche of the LVAC covering Hammersmith, Paddington, Edgware Road, Baker Street, Swiss Cottage, Moorgate and Aldgate was awarded in November 2015, with forecast delivery dates ahead of the Thales need-by dates. The low voltage switch boards for the first three sites have now passed their factory acceptance tests.

4.19 Contracts have been awarded for the trackside and station (covering Hammersmith to Latimer Road) CRMS. Installation is currently running approximately three weeks behind the Thales P0 need-by date in January 2016, due to delays with the design, but recovery plans are being implemented. Overall, LU has installed 50 per cent (17km) of the cable route management system required for the first three migration areas.

4.20 The first phases of the conversion of Hammersmith Depot into signalled sidings are being undertaken by the LU Track Delivery Unit. The first handover to Thales is required in July 2016 and may necessitate a period of shared working if Thales achieves its P0 readiness date to start there.

End State Track Layout

4.21 In addition to the ATC system, a number of track layout changes are required to achieve the planned journey times and train frequency. These are known as the End State Track Layout (ESTL) changes. The works are being delivered by the London Underground Track Programme as an integral part of their track renewal work-bank.

4.22 The first ESTL works, the removal of points at Bromley-by-Bow, have been completed and track and platform changes are underway at Putney Bridge. Preparatory works have also been completed for the major Christmas blockade at King's Cross. Works at Gloucester Road are planned to be undertaken in engineering hours between January and February 2016.

Passenger and Engineering Vehicles

4.23 The V1 prototype ATC enabled S Stock train has completed Bombardier functional testing and been transferred to the RIDC. Thales has now completed static testing and, on 25 November 2015, dynamic testing of the train under ATC commenced successfully. Full system testing at the RIDC using the V1 train is planned to start before the end of 2015. The activity is a few weeks behind the P0 programme, but is not on the critical path.

4.24 Workshops have been held with Thales and Bombardier to develop the programme for the V2 train and successful Concept Design Review of the V2 design was held in the first week of November 2015.

4.25 Thales has been instructed to move the ATC fitment of the Asset Inspection engineering train from the scope of the first migration area, to a later stage of the programme, whilst the future strategy for this vehicle is confirmed. Prior to its instructed removal this item was on the critical path for commissioning of the first migration area.

4.26 LU is reviewing the possibility of de-scoping the ATC conversion of its heritage vehicles from the ATC contract.

Hammersmith Service Control Centre

4.27 Work is underway on modifying the control centre building to accommodate the Thales equipment space requirements and fit it out with the required utilities and services ready for full fit-out access to Thales in August 2016.

4.28 Following a human factors review, consideration is being given to the replacement of the planned control centre video wall with individual overview display screens at each desk.

5 Progress against Key Milestones

5.1 At the time of writing (December 2015), the forecast commissioning date for the first migration area is seven weeks behind the P0 target date, with a similar delay in the subsequent migration areas. The critical path is driven by the ATC conversion of the Asset Inspection Train for the first migration area and, as identified in paragraph 4.25,Thales has been instructed to defer this to a later migration area, which will resolve the issue. The secondary critical path, with a three week delay, is through the development and installation of the Seltrac signalling plan and hardware control tables, for which mitigation plans are being sought.

5.2 The Project Authority was granted against the P90 dates, which are consistent with the planned timetable changes listed in paragraph 3.5. The current forecast commissioning dates for each migration area compared with the P0, P50 and P90 confidence levels is shown in Appendix 2. This demonstrates that confidence remains high that the planned timetable uplifts can be achieved on time.

6 Recruitment and Resources

6.1 Both Thales and LU have continued to increase resources to meet the staff demands of the programme, however recruiting the required staff remains challenging in a competitive rail infrastructure and signalling market. LU staff numbers on the programme are expected to reach a peak (including both for S Stock roll out and ATC work) by the end of the financial year, whereas Thales will not reach its peak headcount until the end of 2016.

7 ATC Contract Commercial Position

7.1 Thales submitted its best and final bid in May 2015. Between the bid and contract award in July 2015 a number of scope changes that could best be delivered by Thales were identified during the programme re-baseline. However, to keep the bid and works information aligned, all changes were deferred until after contract award.

7.2 To date, two compensation events have been agreed with Thales for a total value of £5.8m. These are for the transfer of scope (provision of a warehouse facility for Thales installation works and procurement and installation of the customer information system front end, which initiates disruption messages for trains and stations) from LU's delivery to Thales' following a review of cost, timescale and risk. The cost of these items above what was originally budgeted has resulted in the utilisation of £3.1m of the £77.4m of the risk for delivery of the ATC contract.

7.3 Heads of Terms have been agreed for variation to the Bombardier train production contract to include train-borne ATC fitment, which Bombardier is undertaking at cost. The variation can only be finalised once the V2, pre-production train has been tested, however initial indications are that the cost of this will be within the budgeted allowance included in the overall authority.

7.4 The ATC contract provides that the parties shall endeavour to agree the spares and repairs catalogue and the LU Quality, Environmental, Safety and Health (QUENSH) menu for the Maintenance Support Contract within five months of the contract date. Once the spares and repairs catalogue has been agreed the parties will enter into the Maintenance Support Contract appending the agreed forms of spares and repairs catalogue and QUENSH menu. LU is still awaiting from Thales a formal submission of the spares and repairs catalogue and once received will urgently:

(a) review and benchmark against the equivalent NLU maintenance support contract;

(b) engage the LU Operations team to agree a forecast operational expenditure budget; and

(c) agree with Thales next steps for document execution.

8 ATC Programme Risk and Opportunity Position

8.1 The Project Authority for ATC of £2,268m (within the overall authority of £5,412m) included 10.6 per cent of cost as a P50 risk allowance for delivery of the ATC contract, LU deliverables and unidentified scope gaps. At the end of Period 7 2015/16 the available risk allowance had increased to 12.2 per cent of cost to go.

8.2 The key strategic risks for the programme are shown in Appendix 3, along with the planned mitigations.

8.3 An innovation and opportunity register is under development, which will focus on potential savings both in the Thales contract and LU's own delivery, with the emphasis on accelerating delivery of critical items as this will realise the greatest savings.

9 IIPAG Quarterly Review of ATC

9.1 The Independent Investment Programme Advisory Group (IIPAG) has undertaken its first quarterly review of the 4LM ATC programme since the re-authorisation.

List of appendices to this report:

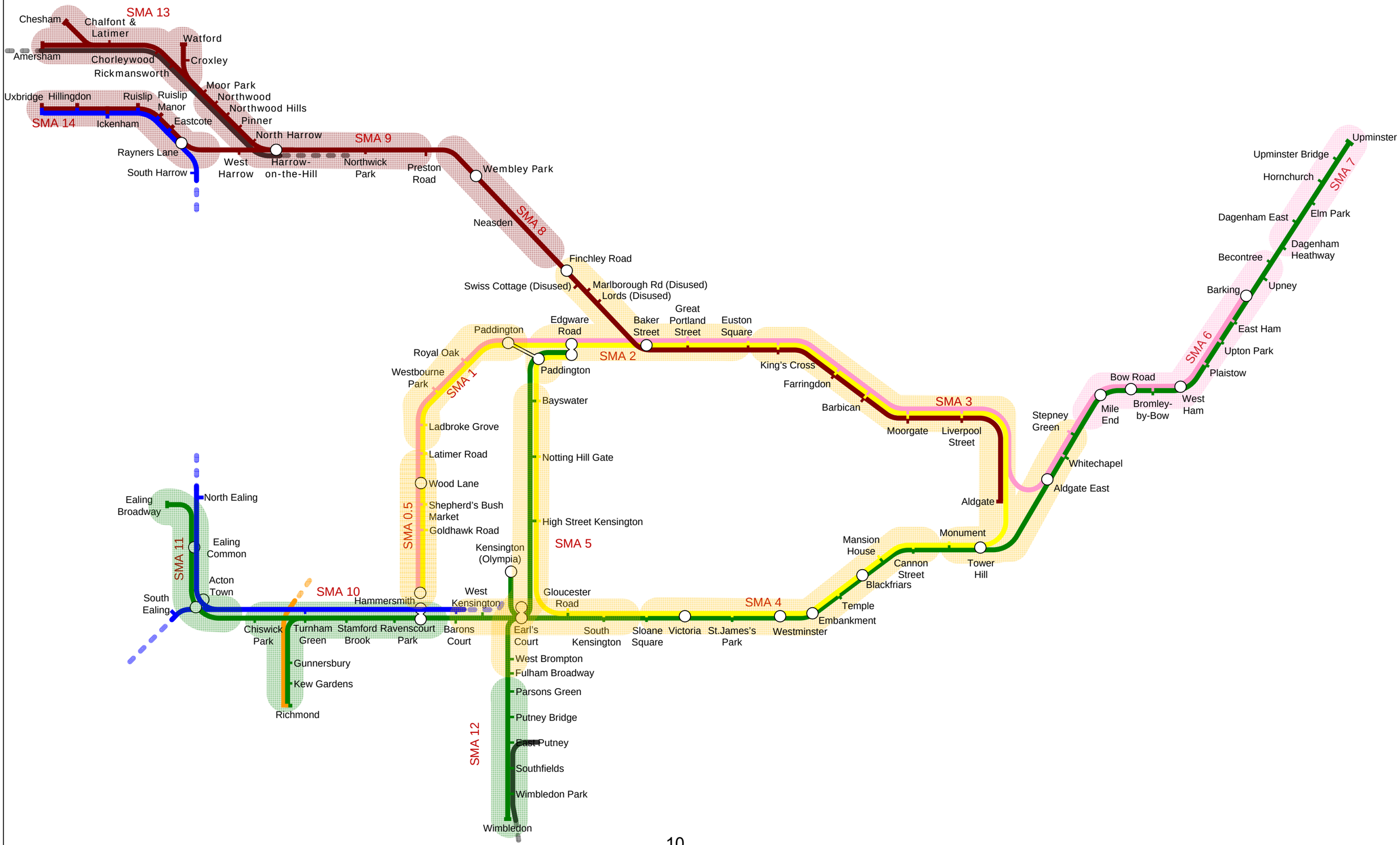
Appendix 1: Map of ATC Migration Areas
Appendix 2: Commissioning Dates
Appendix 3: Strategic Risk

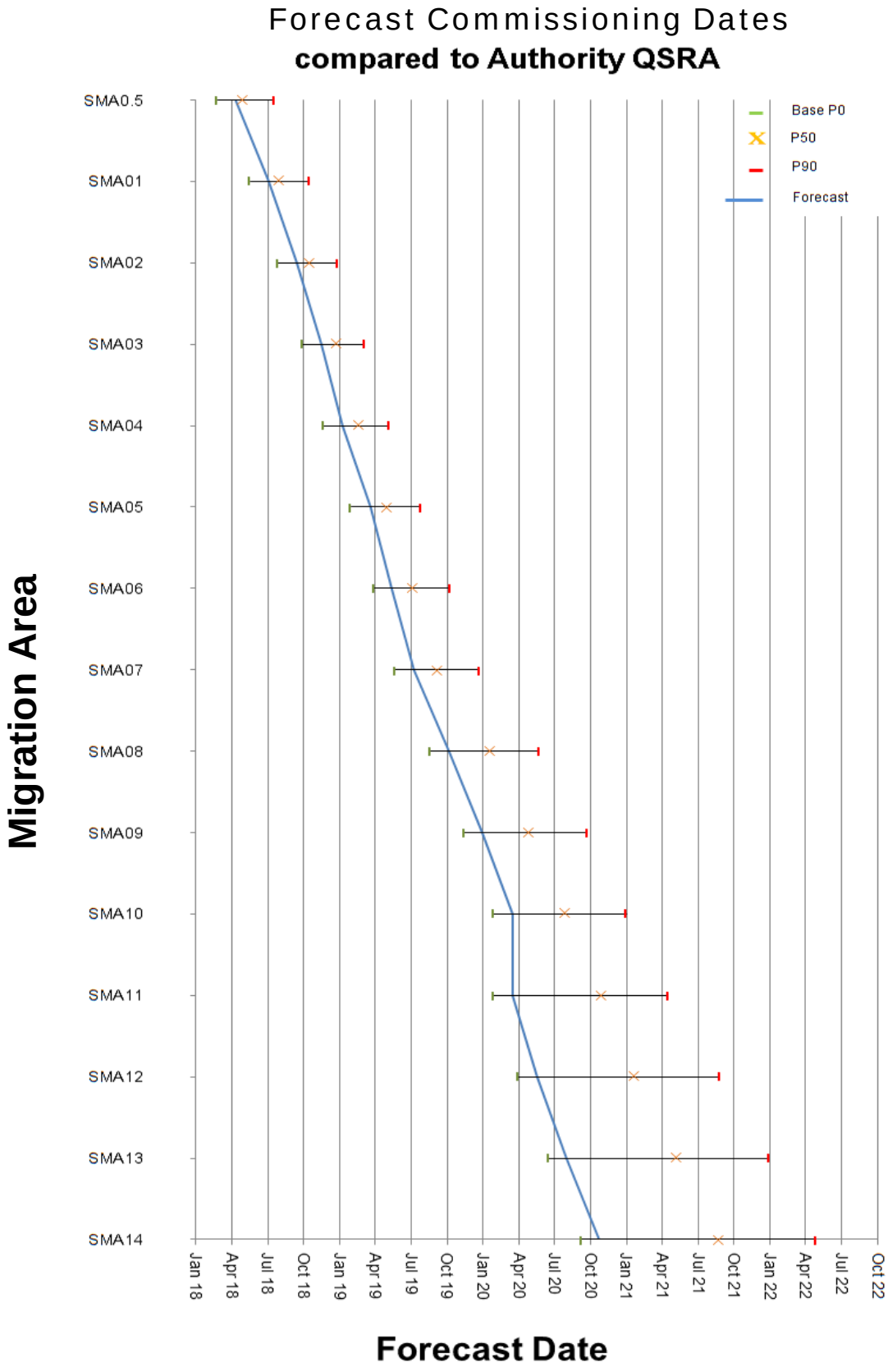
List of Background Papers:

None

Contact Officer: Stuart Harvey, Sub-Surface Programme Director, London Underground
Number: 020 7126 2909
Email: StuartHarvey@tfl.gov.uk

4LM Migration Areas





It should be noted that in order to implement the timetable changes associated with the service uplifts referenced in Section 3.5, a number of adjacent migration areas need to be commissioned and an appropriate reliability proving period completed.

Appendix 3

Risk ID	Title	Strategic Actions	Level	Change
1	Thales resourcing to meet critical software designs for 4LM and requirements for Capacity Optimisation Programme	> UK Thales resources working on all LU projects co-located at West Ferry Circus London with LU, allowing LU to prioritise their activity - 13Nov15 (Complete) > Appointment of LU resident engineer to work in Canada to oversee Thales mobilisation - 13 January 2016 (progressing)	AMBER	
2	Mobilisation of Bombardier resource through Train Fitment contract to meet Thales schedule	> Resolution of Bombardier incentivisation through Heads of Terms - 30Nov15 > Collaboration work with Bombardier and Thales. Business Partner collaboration forums held in November. - 30 November 2015 (Ongoing)	AMBER	
3	Impacts on APD & Track Programme by fitment of Engineering Vehicles to Thales schedule	> Track Hub created to manage detailed interface requirements - (Ongoing) > Integrate the EV and Track Programme (4LM track obligations and non-4LM track works)- suggested use of GIS - 31 December 2015 (Underway)	AMBER	
4	Delivery of TDU Hammersmith works in time for Thales	> Phase A, B, C works for Hammersmith integrated and opportunities identified where Thales installation works can be incorporated within TDU programme - (Complete) > TDU exploring opportunities to expedite programme - 31 December 2015 (Underway)	AMBER	
9	Impacts on service from removal of S-Stock trains for ATC fitment	> Trains team supporting AP to reduce quantity of stopped faulty units > Plan modifications and stock rotation required for current faults - 4 January 2016	AMBER	
10	Industrial action impacting on train roll-out	> Plan for rolling out S Stock and removal of D Stock now in place and reviewed weekly. If stability is maintained, risk will drop to Green - 15 December 2015	AMBER	▼
11	Depot injection rates may not be compatible with 32tph	> The current review has not established a permanent solution (Red). Further time and cost will be required for permanent and interim (Amber) solutions with feedback from Operations on technical solutions and/or timetable changes	AMBER	▲
12	Operational performance flexibility to support 32tph	> Flexibility in Thales designs at PDRs is progressing - 23 December 2015	AMBER	
13	Delivery of maintenance compliant, affordable, timely solutions for Ealing Common and Upminster depots	> Agreement with COO of scope and working methods Draft Plan is under review and due for sign off. A cost increase is anticipated. - 15 January 2016 (progressing)	AMBER	▲
15	NR engagement on undertaking works for 4LM	> Review NR engagement strategy - (Progressing) > Documents exchanged and reviews held with NR & Chiltern contacts	AMBER	▲
16	OPO winter performance	> Establish better reporting on antennae performance during faults (e.g. recent sleet) > Training scheduled for December - 31 December 2016 > Installation of OPO cone on S8 fleet - 31 January 2016 (More cones to be fitted) > Winter testing in Norway planned - 31 January 2016	AMBER	▲
18	Maintaining safety during ramp-up of site works	> Roll-out 'safe ramp up' actions established at Zero Harm Forum and continue SPC forums with suppliers to encourage reporting of incidents without blame > Develop action plan based on PSP report (especially Edgware Road and Hammersmith)	AMBER	▲
20	3rd party developments	> 4LM engaging with projects but escalation to / action by LU required	RED	new
22	Non co-location of all 4LM team	> Programme review of co-location requirements and options - 30 November 2015	RED	new
24	Funding for removal of redundant assets	> Coordination of 4LM plan with action plan held at network level	AMBER	new

KEY:

GREEN	Action(s) in place that are likely to minimise probability and/or impact
AMBER	Action(s) in place but they may not fully avoid occurence and/or impact
RED	Action(s) not identified or identified but may not avoid occurence and/or significant impact