Programmes and Investment Committee

Date: **13 October 2021**

Title: **London Underground Signalling and Controls Programme**

This paper will be considered in public

1 Summary

LU Track Signalling and Controls				
Existing Financial Authority	EFC	Existing Programme and Project Authority	Additional Authority Requested	Total Authority
£430.2m	£424.0m	£212.3m	£94.4m	£306.7m

1.1 This paper provides an update on progress since the last submission to the Committee and requests additional £94.4m Programme and Project Authority for the London Underground (LU) Signalling and Controls (S&C) Programme (the Programme). This request brings the total Programme and Project Authority to £306.7m and enables the Programme to continue delivery consistent with the Asset Strategy and the **do minimum scenario in Long-Term Capital Plan** (LTCP) to FY2027/28.

1.2 The Integrated Asset Strategy for S&C was updated in 2020/21, driving a change in the way upgrades take place with the S&C systems and added a focus on addressing and managing future obsolescence.

1.3 The Programme is split across two areas aligned to the Asset Strategy:

(a) The first area is 'Renewals', which life extends existing systems with a focus on addressing critical obsolescence within the legacy signalling systems on the Central and Bakerloo lines. This area also deals with safety related concerns arising from the asset condition register.

(b) The second area is a programme established in 2020 to enable moving to an 'incremental upgrade' approach: the Incremental Signalling Upgrade Programme (ISUP);

(i) this delivers small step changes to the lines which already have modern signalling (Central, Jubilee and Northern lines) to keep the software and hardware components in an ongoing State of Good Repair; and

(ii) the Bakerloo line control system will be incrementally upgraded to a modern computerised control system, which has already successfully been installed on the Piccadilly line.

1.4 Work to deliver this strategy varies from line to line depending on age and asset condition of the system and its components.

1.5 The paper outlines the programme on a project by project basis and is an update to the December 2020 submission which has now matured cost certainty for the renewals and incremental upgrades sub-programmes.

1.6 The outputs and schedule for this Programme are:

(a) critical interventions on the Central line extend the life of the current signalling and control system;

(b) replacement of obsolete signalling equipment on the Jubilee and Northern lines which will rectify a source of historic failures;

(c) upgrade of the Bakerloo line control system; and

(d) early stages of the upgrade of the Central line signalling assets.

2 Recommendations

2.1 The Chair, following consultation with the Committee, is asked to note the paper and:

(a) approve additional Programme and Project Authority of £94.4m, giving a total Programme and Project Authority of £306.7m (figures in outturn including risk); and

(b) note that the matters for which Authorities are sought above include commitments that extend beyond the period of the Business Plan and "Revised Budget" approved by TfL Board on 28 July 2021. Appropriate provision will, therefore, need to be made for those commitments in future Business Plans.

3 Background of the Signalling and Controls Programme

3.1 The Programme was established to provide life extension works to S&C systems in advance of full line upgrades which were planned under the Deep Tube Upgrade Programme (DTUP). Secondly, it was to ensure that concerns arising from the annual Asset Condition Report were dealt with in an appropriate manner. Safety and legislative compliance were prioritised in the scope for this submission.

3.2 The introduction of the Incremental Signalling Upgrade Programme (ISUP) in 2020 recognises that a big bang approach to replacing signalling and train assets at the same time is expensive and in the current financial environment unaffordable. However, in order to protect the continued safe and reliable operation of S&C assets there is a requirement to address life expired and obsolete equipment. LU has a significant amount of early semi-computerised S&C assets. This means that dealing with obsolescence of the current systems, which can no longer be fully replaced by a whole line upgrade, is a significant challenge.

3.3 The detail of this request is the very **minimum required to ensure that the systems can remain safe and operable**. Signalling systems are safety critical and cannot continue to operate with current performance levels if any of the elements they are made up of are in a failed state or unavailable. This is because the systems are 'fail safe' often meaning that it will prevent trains moving to bring about the safest state. Without investment, the systems will degrade to the point

where it is not feasible to continue with the expected service levels (in some cases there is potential for months of line suspension or severely reduced train frequencies) and at that time reactionary investment is expected to be higher than planned interventions.

3.4 Some of LU's current signalling and control systems date to the early 1960s, are now obsolete and are increasingly difficult to maintain. The Four Lines Modernisation (4LM) Programme is currently replacing signalling and control systems on most of the District, Metropolitan, Hammersmith and City and Circle lines with a single, standardised system.

3.5 The Victoria, Jubilee and Northern line signalling and control systems are relatively modern. However, these systems are computer based and as a direct result, system obsolescence is an increasing concern, particularly on the Jubilee and Northern lines. TfL is currently managing obsolescence in conjunction with the original equipment suppliers so that these systems can be maintained and operated throughout the lifecycle, however investment is required.

3.6 The signalling and control systems on the Piccadilly, Central, Waterloo and City and Bakerloo lines were planned to be replaced as part of DTUP. However, TfL's financial challenges in recent years have resulted in this upgrade programme being deferred. ISUP will replace the Central line signalling and control system over a longer period than traditionally associated with upgrades in order to smooth spend in line with the LTCP. Meantime, the current life extension project is underway to address the most critical obsolescence risk through a renewals project.

3.7 A shift towards incremental signalling upgrades rather than the previous strategy of 'big bang' whole line upgrades allows for the smoothing of cost over a longer period of time whilst delivering similar levels of benefit. This reflects the level of customer benefits which are realised through line upgrades; with most modern lines now running in excess of 30tph (trains per hour), there are only marginal gains to be made from re-signalling whereas far greater benefits from running more frequent trains was possible when upgrading from legacy mechanical signalling systems. As such, future upgrades of the signalling and control systems are evolutionary rather than revolutionary changes.

3.8 The last of these large benefit cases from installing modern signalling is the Piccadilly line, where there is demand for higher frequency trains services in excess of 30tph exists. New trains for the line which are currently being procured will allow an increase in frequency, with a re-signalling in the future unlocking further capacity. The Bakerloo line presents some opportunity for capacity benefits, with a much stronger case presented with the proposed line extension. In order to gain the most passenger benefit both elements will need to be completed.

3.9 The LTCP and signalling asset strategy are now complete and outline a shift towards incremental S&C upgrades. The current strategy is focused on LU and covers both legacy and modern computer-based signalling systems. It is intended to develop a TfL-network wide strategy to consider all rail-based systems such as Docklands Light Railway, the London Trams network and Elizabeth line in the future. This will ensure that commonalities in the signalling systems and supply

chain are fully considered in future investment while taking commercial structures into account.

3.10 The Programme supports the Mayor's Transport Strategy (MTS) objective of 'providing a good public transport experience' and contributes to the aim within the MTS for 80 per cent of trips in London to be made on foot, by cycle or using public transport by 2041. The Programme also supports LU's priorities for 'Safety and Reliability', 'Customer', 'People' and 'Affordability'.

4 Delivery Progress since the last submission

4.1 Since December 2020, the Programme has begun to recover from the impact of the coronavirus pandemic. Despite the slowdown of works, investment in the programme has maintained short term reliability and safety. Medium to long term reliability will be impacted in future years if further investment does not take place.

Renewals

Bakerloo Line S&C Life Extension

4.2 One of the most impactful successes of the year has been the installation and commissioning of new servers which control the Bakerloo line replacing those dating from the 1980s. The replacement of these servers is based on a critical obsolescence need and will ensure that maintenance and performance levels can be sustained until a full control system upgrade takes place. The servers have successfully been controlling the line with the old systems retained as a fallback (which to date have not been required). The next phase of the project will focus on decommissioning these old computers.

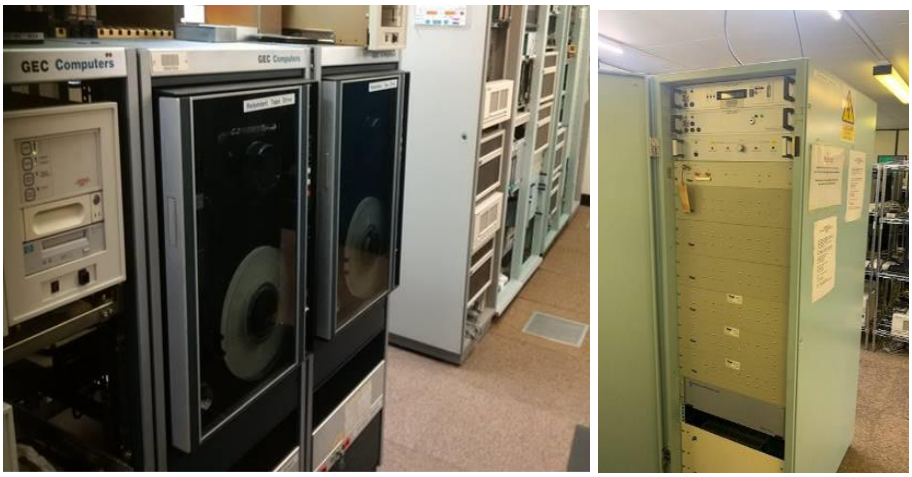

Figure 1: GPT4000 computers and new servers

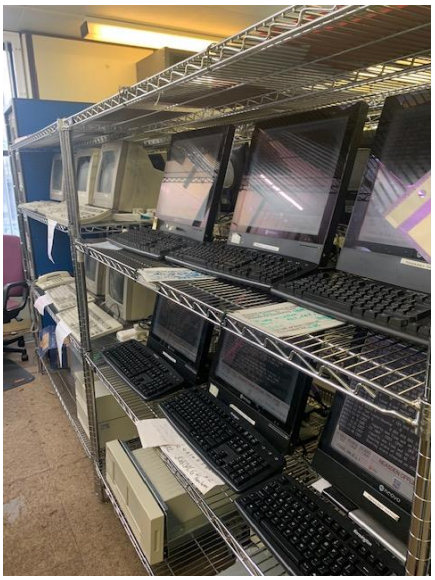

Figure 2: Old and new terminals

4.3 The trial of a new type of emergency stop light at Stonebridge Park Depot (serving the Bakerloo line) has completed installation and has been in operation since March 2021 without issue. The old lamp heads are obsolete and there is a condition concern with the pole and maintenance access ladders. The new lights use a hinged pole for ease of maintenance and LED lamps which are brighter, have a longer life and are more energy efficient than existing lamps. This also makes maintenance of the lamp safer than the previous type. It is anticipated that if the trial meets all success criteria these can be rolled out across depot and other locations to improve visibility in all conditions whilst reducing operational expenditure in the future.

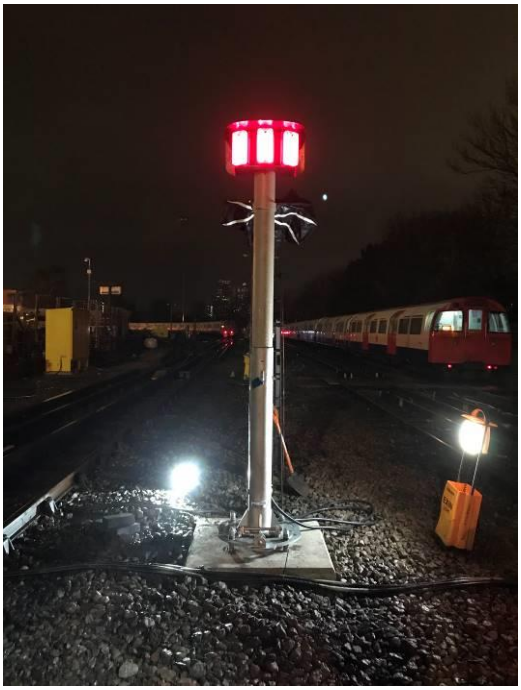

Figure 2: Old (bagged, left) and new stop light / Light illuminated at night

Central line Customer Information Systems Life Extension

4.4 To extend the life of the Central line Customer Information System (CIS), the final three (of 14) new servers, have been installed and successfully commissioned in equipment rooms across the line. These have been replaced as the old CIS servers and the platform signage they drive are obsolete and would become increasingly difficult in the near future to maintain.

Northumberland Park Depot Control System Upgrade

4.5 The 1960s equipment which enables train movements within the only depot on the Victoria line is obsolete and failure rates have been increasing. Because this equipment is now obsolete, the project will replace the signalling and control system within the depot with a modern computer based system.

4.6 Replacement of the point detection equipment with modern equivalents has been slow as a result of the coronavirus pandemic, however all conversions in the main depot area are now complete. In part, the way in which the depot tower is operated during possessions has prevented access on two occasions, something which will not be an issue once the re-signalling is completed. The remaining point detection conversions are in the depot ‘throat’ which provides the link to the mainline. These require a full line shutdown to be replaced and opportunities are being explored to complete these as soon as possible.

4.7 The project has moved forward the concept design of the new train movements room, and equipment room complex which will replace the existing depot signalling control tower. Geotechnical surveys and user engagement on the complex for this stage has completed. It is expected that the modular building and signalling user interface will be ready to move into detailed design at the end of the financial year.

Central Line S&C Life Extension

4.8 The Central line S&C systems are critically obsolete, with TfL now the only operator of this type of early computer based system in the world. In order for the system to remain operable and maintainable in the short term, replacements of many element of the system must take place.

4.9 Marking a significant milestone for the project to secure reliability and availability whilst incremental upgrades are planned, concept design has completed for all nine work packages. Contracts are to be let imminently for the detailed design and delivery for life extension works to the critical elements of the control system and signalling system.

4.10 With the current system having not undergone any significant upgrade since its commissioning in the early 1990s, these works will maintain current performance levels and allow easier maintenance of the computer systems. The replacement with modern equivalents will allow time for the development of full system incremental upgrade for the line (see below).

Asset Condition Works / Piccadilly Line Signalling Life Extension

4.11 To address a safety concern on a number of lines and to meet our commitment to the Environment Agency, equipment is being replaced which contains hazardous chemicals found in electronic equipment.

4.12 Following manufacturer shutdown during the pandemic through 2020, materials are now being produced enabling the programme of replacement of track capacitors containing the hazardous material PCBs (Polychlorinated Biphenyls) to restart across the Jubilee, Northern and Piccadilly lines. Removal of redundant equipment which either contains or is suspected to contain PCBs continues with removed types being tested. This has allowed the descoping of a number of component types which have been proven not to contain PCBs. These savings have been offset against the retention of legacy signalling on the District line western branches which need addressing before the 2023 deadline.

Incremental Upgrade

4.13 Identified as one of the most crucial areas of investment in the LU portfolio over the next 25 years as per the S&C Asset Strategy and LTCP, ISUP aims to gradually replace assets with modern, computer-based systems. This first tranche of work addresses obsolescence of computer and technology-based systems known to have inherent short asset/system life-cycles. Such systems are still preferred over mechanical equivalents as they are capable of safely supporting the more intense train service needed to keep London moving as ridership recovers.

4.14 Works on the **Jubilee and Northern line** systems to identify key components which are critical to be replaced, either through obsolescence or reliability have completed and early engagement with the supply chain has started. The approach balances replacement with the re-use of equipment as the lines have a common signalling system.

4.15 The **Bakerloo line** control system has been scoped for replacement with the same system which was successfully delivered on the Piccadilly line. A new control room has been identified and surveys have been undertaken to identify space for equipment. This is an inhouse design and installation which will lead to cost savings through common spares and resources.

4.16 The **Central line** project has completed optioneering, identifying the first equipment and a geographical bound in which the first tranche of upgrades will take place. This is complementary to the life extension projects, which allows time for design to take place for this upgrade.

5 Key deliverables for the Programme in 2022

5.1 The programme comprises of projects in two core categories: renewals and ISUP.

Renewals

5.2 The programme will continue to deliver renewals works which extend the life of the Central line signalling and control systems and Northumberland Park depot on the Victoria line. All three projects will move into the detailed design phases, with early deliverables on the Central line having direct reliability and resilience benefits. Notably the installation of fibre optic communication systems for the Central line system will remove obsolescence and provide infrastructure that can be used long into the future.

5.3 Obsolescence of the large data transfer system on the Jubilee and Northern lines will be mitigated through replacement which also brings the automation of current manual processes, reducing workload and allowing for quicker analytics of fault data.

5.4 The Central line S&C life extension projects requests £14.0m to allow internal delivery teams to install equipment following initial sites delivered by our supplier. This will take place in the latter years of the projects. Additionally, this request will ensure that ongoing project overheads including internal engineering and project management are funded.

5.5 The installation of new equipment to replace those which contain hazardous chemicals will commence so that these can be replaced to keep our people safe. The works are on target to be completed by the end of 2023, in line with our commitment to the Environment Agency.

Incremental Upgrades

5.6 As part of the ISUP, design will take place for the upgrade of the Bakerloo line control system; contracts will be let for the design and replacement of safety critical signalling equipment on Jubilee and Northern line vehicles and options will be assessed for the first phase of long term upgrades of the Central line wayside signalling equipment.

5.7 The request of £68.3m is needed in order to make multi-year commitments to secure best value with our contractors and to ensure internal resource can be committed to these projects, particularly where internal design and delivery are taking place. Without this commitment, the projects would likely be undeliverable or would increase the risk of failures which make services unavailable for our customers. Following failures, investment in a reactive manner may be more expensive or not deliver the same benefits a planned investment.

An Evolving Programme

5.8 As projects deliver their objectives they close, whilst other new priority projects are required to be initiated to deliver the vision within the asset strategy. This means there are new and closing projects. Of those closing these include the Piccadilly line Incremental Control Upgrade, point machine conversion, and life extension (obsolescence mitigation) for the Bakerloo Signalling and Control systems.

5.9 New projects planned to be initiated in the **Renewals** area over the next year, driving a new request for £12.1m have arisen from the annual asset condition report. This process identifies assets which need interventions and prioritises them. Four areas of concern have been identified which require immediate interventions.

5.10 An uplift of funding is required for the removal of further PCBs containing equipment found in signalling equipment on the District line following the deferral of parts of the 4LM programme.

5.11 Emerging concerns in signalling equipment on both the Piccadilly line and Bakerloo lines require further investment in order to life extend the systems. The Piccadilly line is suffering from age related wire degradation in interlocking machine rooms (the interface between the control system and assets on the track) which may cause failures if left. These will not impact safety but will cause delays as the systems bring trains to a stop.

5.12 On the Bakerloo line, track circuits, which detect the position of trains on the line, are obsolete. Following a successful pilot replacement scheme, sites will be modernised based on historic performance.

5.13 Jubilee line Platform Edge Doors (PEDs) have reached mid-life and require overhaul to ensure they continue to work reliably and safely. As these are part of the safety systems on the line, if they are not maintained it may lead to increased delays as a result of failures which will prevent trains from running.

Programme Summary

5.14 Table 1 summaries the Programme as a whole, illustrating the impact of continuing existing renewals projects, further progression of ISUP and the implications of various new and closing projects (all figures include risk and inflation up to 2027/28). A more detailed, ‘by project’ version of this table is provided the Appendix, which also includes some of the key deliverables planned for the next year.

5.15 Financial Authority is captured in the “Revised Budget” approved by the TfL Board 28 July 2021 and set out in LTCP beyond this. In some cases, the EFC of projects within the Programme are in excess of financial authority, often for the latter years of projects. This will be addressed through future budgets and business planning activities and will require support within any settlement with Government.

Description / Key Deliverables	Financial Authority	Estimated Final Cost	Programme and Project Authority		
			Existing	This Request	Future Requests
Renewals	119.7	136.2	121.3	14.0	0.9
Incremental upgrades	8.2	206.3	8.2	68.3	130
New projects	-	12.1	-	12.1	-
Closing projects	71.3	69.4	82.8	-	-
Programme Total to 2027/28	**199.2**	**424.0**	**212.3**	**94.4**	**130.9**

Table 1: Summary of the LU Signalling and Control Programme (£m) to 2027/28

5.16 The signalling programme delivers value for money by extending the life of the assets within the funding available whilst enabling a mid to long term solution to be developed. Options to upgrade the systems are currently unaffordable with 'do nothing' not being a feasible option. The life extensions represent the 'do minimum' scenario as outlined by the LTCP to maintain safety and reliability.

5.17 The programme will deliver modern equivalent replacement assets to reduce obsolescence and maintain reliability and safety. Procurement strategies are developed to assess the market and deliver the best possible value for money.

6 Challenges and Opportunities

Challenges

6.1 Sustained long term investment is crucial to ensure systems remain safe and reliable into the future. The challenge of short-term funding agreements with the government continue to be a threat to these works, which are often untaken as multi-year projects. Without certainty in funding, decisions may be made which lead to inefficiency in procurement, delivery and deployment of resources, leading to reduced value for money.

6.2 It is important that we ensure long term relationships with the supply chain for each of the S&C systems. Whilst we have support in the early years, it is essential that they continue to be engaged throughout the life of the assets and systems. It would be increasingly difficult to maintain, change and upgrade these systems without the support and cooperation from our suppliers.

6.3 Computer based technology is becoming obsolete in shorter and shorter timeframes. The evolution of the systems, their hardware and software will become increasingly important rather than the traditional reliance of 'big bang' upgrades of the older type of electro-mechanical Signalling and Control systems. Although the benefits delivered are smaller for these upgrades, they become essential to maintain the systems in daily operation.

Opportunities

6.4 The S&C replacement projects have been aligned to the LU drive for a 25-year long term capital plan. The signalling strategy has been updated in line with known best practice of other metros. This has led the way for incremental longer-term upgrades rather than short, large scale full line upgrades. This is expected to have longer term cost benefits, and these will be evaluated in the early stages of investment. Once incremental projects are established, an appropriate deliver strategy will be developed for each line.

6.5 Strategic relationship management with our signalling providers allow for a long term understanding of what is required to maintain performance. It is crucial that these suppliers are engaged and TfL understands the market position and are able to influence and drive meaningful relationships in a shrinking market. A number of these suppliers are involved in other asset areas and TfL should understand the benefits of engaging at a supplier rather than asset level where possible to drive efficiencies and benefits from these relationships.

7 Equalities Implications

7.1 The Programme will be delivered in accordance with the Equality Act 2010. As projects progress through feasibility and design, consideration will be given to the need for an Equality Impact Assessment.

8 Assurance

8.1 TfL Project Assurance undertook a review of the Programme in August 2021. This identified five recommendations with no critical actions, A management response has been prepared and has since been accepted by the Assurance team.

9 Financial Implications

9.1 In December 2020, the Committee approved £16.2m of additional Programme and Project Authority, taking the total authority to £212.3m until 2024/25. To support continued delivery of this multi-year, in-flight essential programme, a further £94.4m Programme and Project Authority is requested to enable long-term contracts predominantly on the Central line life extension project and Incremental Upgrade sub-programme. This is the minimum additional authority required at this stage of the programme and brings total Programme and Project Authority to £306.7m.

9.2 A summary to 2027/28 by financial year is shown in Table 2. This is based on the “Revised Budget” and LTCP. This is subject to change once these are approved.

9.3 Financial Authority is provided through the two-year Budget for 2021/22 and 2022/23 approved by the TfL Board in July 2021. In respect of Authority required today which relates to commitments outside of this period, provision will need to be agreed for these periods and there may be a subsequent prioritisation of the TfL Investment Programme.

Costs and Funding (£m Outturn)	Prior Years	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Financial Authority	93.6	35.1	68.3	65.4	49.7	47.3	46.7	24.1	**430.2**
Programme and Project Authority									
Existing	135.6	35.9	26.6	13.3	0.9	-	-	-	**212.3**
This Request	-	-	20.0	36.9	21.6	11.0	4.9	-	**94.4**
Total	**135.6**	**35.9**	**46.6**	**50.2**	**22.5**	**11.0**	**4.9**	**-**	**306.7**
Future Requests	-	-	-	10.1	20.8	34.1	41.8	24.1	**130.9**
Programme EFC	**93.4**	**38.7**	**60.3**	**63.8**	**49.7**	**47.3**	**46.7**	**24.1**	**424.0**

Table 2: LU Signalling and Control Programme (£m) to 2027/28

List of appendices to this report:
Appendix 1: Summary of the Programme (£m) to 2027/28 by project

List of Background Papers:
TfL Assurance Report

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