

Date: 17 July 2014

Item 10: Sub-Surface Upgrade Programme Automatic Train Control Contract – Lessons Learnt

This paper will be considered in public

1 Purpose

- 1.1 The purpose of this paper is to update the Committee on the Lessons Learnt Review of the Sub-Surface Upgrade Programme (SUP) Automatic Train Control (ATC) contract, carried out by KPMG (attached at Appendix 1) and the SUP management response (Appendix 2).

2 Recommendation

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

3 Introduction

- 3.1 A Lesson Learnt Review was commissioned following London Underground's (LU's) agreement with Bombardier Transportation (BT) in December 2013 to terminate and then retender the contract for replacing and upgrading the signalling of the Sub-Surface Railway (SSR) – one of the most challenging and complex pieces of work on the Underground.
- 3.2 Consistently throughout the period of the BT contract, LU worked collaboratively with BT to support delivery of its commitments. By late 2013 it had become clear that BT was not going to deliver the promised solution, either within the specified timeframe, reliably, or anywhere near the agreed price.
- 3.3 The decision to retender was the right and correct one for London. It had become apparent that the BT system needed very substantial development before it could be applied in the LU environment. The only responsible decision therefore was to seek a new supplier that could demonstrate a proven track record and ensure delivery in the unique context of the Underground and the SSR.
- 3.4 The alternative option, to press on with a supplier and contract that was certain to fail, would have jeopardised the capacity and reliability benefits of the SUP and exposed LU to considerable and potentially open-ended financial risks. It also would have delayed the project and the benefit to customers significantly beyond the delivery date.
- 3.5 The decision is in line with LU's excellent track record of successfully delivering complex signalling upgrades. The Jubilee and Victoria line upgrades were completed in time for the 2012 Games, despite the failure of the former PPP management structure. In June the final section of the Northern line was moved

over to its new signalling system, reliably, six months ahead of schedule and within budget, which will enable a 20 per cent capacity increase from December 2014.

3.6 The Lessons Learnt Review was commissioned by LU to inform the procurement process for a new supplier. In many cases the points raised by KPMG had already been identified internally by LU and implemented. These include, for example:

- (a) adopting processes for early contractor involvement;
- (b) the development of an enhanced procurement and commercial strategy; and
- (c) strengthening of mechanisms to identify and verify bidders' claims regarding technical capacity to deliver projects. The new pre-qualification questionnaire (PQQ) has been designed to set a much higher bar in terms of pass/fail criteria for consideration of technical capabilities.

4 Sub-Surface Upgrade Programme (SUP)

4.1 The objective of the SUP is to replace life-expired SSR train systems, with higher specification rolling stock, signalling and associated systems, resulting in a 40 per cent increase in capacity, of which the ATC contributes over half.

4.2 The benefits of the SUP will be delivered through the provision of faster, more reliable and more frequent SSR services, addressing many of the policy goals of the Mayor's Transport Strategy (MTS), and by extension, also meeting the requirements of the TfL Business Plan. The key MTS goals achieved via the SUP are:

- (a) support for economic development and population growth;
- (b) improvements to transport opportunities for Londoners;
- (c) enhancements to the quality of life of Londoners; and
- (d) improvements to the safety and security of Londoners.

4.3 The SUP will reduce journey time for SSR passengers, and will increase capacity to support the projected growth in London's population. This will be delivered via a combination of ATC signalling and larger S-Stock trains. Benefits of the upgrade include the following:

- (a) the ATC project will provide the SSR network with a new ATC system incorporating Automatic Train Supervision, Automatic Train Operation, Automatic Train Protection, and Automatic Train Regulation controlled from a new Service Control Centre (SCC);
- (b) the design of the new rolling stock enhances the comfort, ambience, safety and security of the travelling public via advancements such as air-conditioning and through-gangway layouts; and

- (c) quality of life issues will be addressed via enhanced accessibility for the mobility-impaired, and reductions in Londoners' exposure to pollution. This will result from the greater modal shift away from car use which will be enabled by the provision of more attractive public transport options.

5 Context for termination of the Bombardier Transportation ATC contract

- 5.1 LU awarded the original ATC contract to BT in June 2011 with a target price of £354m. As part of the award process, the Investment Programme Management Office (IPMO) commissioned Halcrow as the External Expert (EE) to review the award of the contract. Two reviews were conducted by the EE, in December 2010 and April 2011. Members of the Independent Investment Programme Advisory Group (IIPAG) were involved in the reviews, and held some additional meetings with LU in early 2011. These discussions involved many topics, including the scope of work, the terms and conditions, the delivery and commercial risks and LU's readiness. By April 2011, all the items raised in the reviews had been satisfactorily resolved and the IPMO and IIPAG C GAP Gate D Review Final Report was included as part of the award recommendation to the Committee in April 2011.
- 5.2 The contract experienced delays culminating in 2013 when it became clear that the BT ATC contract was not going to deliver.
- 5.3 The reference sites in Madrid and Shenzhen which BT relied upon during the contract negotiations had failed to deliver against the expectations.
- 5.4 The emerging extent of a development "delta" compared to what BT stated during contract discussions and evidenced using their reference sites and the reality of what is required to operate ATC on the SSR was such that it was unclear that the BT signalling system would ever deliver against the requirements necessary to reliably operate the SSR network in London.
- 5.5 Despite intensive senior management engagements with Bombardier over many months covering technical issues; installation, test and commissioning methodology, there was no prospect of BT being able to deliver, reliably, in any foreseeable timeline. In addition, it was clear that there was no prospect of BT being able to deliver within any form of acceptable cost envelope.
- 5.6 Accordingly, on 27 December 2013, the Committee approved settlement terms for BT's exit from the previous ATC contract, and authorised TfL to commence a re-procurement for a replacement contractor.

6 Lessons Learnt Review

- 6.1 KPMG were commissioned by LU to review the key lessons to be learnt from the SUP ATC contract with BT. Its report is attached as Appendix 1.
- 6.2 The report identifies 23 recommendations and five sub-recommendations, and notes many examples of LU having demonstrated good technical, commercial and project management practice in its management of this contract and other

upgrades, reflecting its experience as an operator and manager of mass transit infrastructure investments.

6.3 The review related to both pre-contract and post-contract activity and gave particular consideration to the following questions:

- (a) How the supplier came to be awarded the ATC contract?
- (b) What responses were made, when and why to the delay and non-performance under the ATC contract?
- (c) What lessons may be learned from this?

7 Management response

7.1 The KPMG report identified six core themes, all of which are being addressed by LU:

- (a) **System Capability** – This procurement has been informed by a technical review. The PQQ is recognised as setting a very "high bar" in terms of pass/fail criteria around capability. LU is using independent industry experts to verify the technical responses to key elements of the PQQ and ITT.
- (b) **Assurance, Governance, and Risk** – LU is undertaking and will continue to undertake regular assurance reviews, utilising several independent layers of assurance and oversight within LU and with external experts. In addition, the ITT includes the requirement that the risk register should be jointly owned and managed with the contractor, regardless of commercial liability for risk impact.
- (c) **People and Expertise** – LU introduced external resource and expertise to supplement LU's signalling knowledge. Further changes have been implemented by the Programme Director to achieve the optimum mix of skills and experience at all levels. In addition, the contract will ensure that the contractor provides, retains, and is prevented from changing key resources without LU consent.
- (d) **Culture** – Significant learning from the successful approach to collaborative working has been drawn from LU's well performing projects and from external programmes such as Crossrail and the Olympics. For the new procurement, a "one-team" approach is being embedded through a new delivery model adopted from previous successful LU re-signalling projects, most notably the Northern Line.
- (e) **Contract** – LU has been amending its approved NEC3 template with assistance from external lawyers and experts.
- (f) **Market** – During the latter half of 2013 a global review of the communications based train control (CBTC) market was carried out by senior LU technical and management personnel. The findings were fed into the sourcing strategy for the new procurement. These form the key

basis around which the pre-qualification questionnaire (PQQ) has been designed.

- 7.2 Overall, LU welcomes the recommendations, many of which align with LU's own findings, and which had already been introduced into the procurement process for the new ATC contract, as well as several of its other capital projects. LU did not wait for this report to be released before it started to address the issues raised by the ATC contract cancellation, and has already implemented the vast majority of the recommendations.
- 7.3 The review acknowledged the unique characteristics of the LU network. It also recognised that the global market for ATC signalling systems is imperfect. Taken together these factors mean that LU signalling projects – particularly large ones such as SUP – have a degree of complexity not faced by other cities.
- 7.4 Consequently a key theme that emerged from both the KPMG review and LU's own findings was the importance of stringently testing the claims made by bidders about their technical capability before commercial evaluation is undertaken. This has been taken forward in the PQQ for the new contract, in particular by:
- (a) using the learning from the previous BT procurement (including reviews by recognised independent external experts and by IIPAG) and also from other signalling projects across the industry (not just LU) to develop a PQQ that sets a very "high bar" in terms of pass/fail criteria;
 - (b) requiring potential bidders to provide detailed organisation structure and governance plans; focusing on the suppliers' capabilities leadership and management, interviewing key delivery personnel and contractually requiring retention of those companies, teams and individuals; and
 - (c) requiring independent proof or verification of data supplied in support of bidders' answers.
- 7.5 Only recommendation 9 in the report is considered by LU to be impractical. This relates to taking multiple suppliers through to an advanced stage of system development and testing, before deciding on which to appoint to deliver the full solution. As well as cost and programme implications, it is impracticable to construct a test process in which products from different suppliers, which may be at different stages of development, could be considered on a level footing.
- 7.6 The detailed response to each of the recommendations is provided in Appendix 2.

List of appendices to this report:

Appendix 1 – KPMG Lessons Learnt Review

Appendix 2 – Management Response to KPMG's Recommendations

List of Background Papers:

None

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cutting through complexity

London Underground - ATC Lessons Learned Review

FINAL REPORT

16th June 2014

KPMG Major Projects Advisory



This report has been prepared by KPMG LLP ('KPMG') solely for London Underground Limited ("LU") in accordance with terms of engagement agreed between KPMG and LU comprising Task 10: PS2336 Strategic Commercial Advice under Framework TfL 90440.

Following a request by LU, KPMG has agreed that this report can be published on LU's website to facilitate an understanding that LU commissioned an independent review of the Subsurface Upgrade Programme Automatic Train Control System Contract ("the Contract") to identify lessons learned so LU can incorporate those lessons within the new procurement process in order to enable successful delivery of the upgrade, and subject to the remaining paragraphs of this Notice, to which readers' attention is drawn. The Contract, which was awarded in June 2011, was terminated before completion by joint agreement with the supplier, Bombardier Transportation, in December 2013.

KPMG's work for LU and this report have been designed to meet the agreed requirements of LU only, determined by LU's needs at the relevant time. This report should not be regarded as suitable to be used or relied on by any reader other than LU wishing to acquire any rights or assert any claims against KPMG for any purpose or in any context.

KPMG does not accept or assume any responsibility to any readers other than LU in respect of its work for LU, this report, or any judgments, conclusions, opinions, findings or recommendations that KPMG may have formed or made and, to the fullest extent permitted by law, KPMG will accept no liability in respect of any such matters to readers other than LU. Should any readers other than LU choose to rely on this report, they will do so at their own risk.

KPMG conducted its review within a four week time frame as instructed and it is therefore not a full review of the subject programme. The contents of this document are based on information obtained from interviews of certain current and past LU employees, of a limited number of senior Bombardier employees and from documents made available by LU to which KPMG have had access during the course of completing the review.

KPMG does not provide any assurance on the appropriateness or accuracy of sources of information relied upon and KPMG does not accept any responsibility for the underlying data used in this report. For this report, the LU has not engaged KPMG to perform an assurance engagement conducted in accordance with any generally accepted assurance standards and consequently no assurance opinion is expressed.

The opinions and conclusions expressed in this report are those of KPMG and do not necessarily align with those of LU.

This report identifies key lessons to be learned for London Underground from the Subsurface Upgrade Programme (SUP) Automatic Train Control System (ATC) Contract which was awarded in June 2011 and terminated before completion by joint agreement with the supplier, Bombardier Transportation, in December 2013.

London Underground (LU) has a long history of procuring such systems and a deep appreciation of the technical, commercial and project management challenges that such contracts present. It is not unusual for such contracts to experience significant delay, cost escalation and substantial disruption to LU's service operation during installation and commissioning. It should therefore be noted that notwithstanding the lessons identified in this document, there are many examples of LU having demonstrated good technical, commercial and project management practice in its management of this contract, reflecting its experience as an operator and investor in mass transit transport infrastructure.

This review of the ATC Contract relates to both pre-contract and post-contract activity and responds to the requirements set out in Task 10 / Lessons Learned and in so doing has given particular consideration to the following questions:

- How the supplier came to be awarded the ATC Contract?
- What responses were made, when and why to the delay and performance under the ATC Contract?
- What lessons may be learned from this?

This review has not considered whether LU was correct to terminate the contract nor was it asked to identify and comment on the circumstances leading to the termination.

Findings and recommendations are set out in the following pages and relate to a number of opportunity areas including improved technical due diligence, contract and commercial management and programme assurance. Key strategic, overarching themes include the following:

Where LU is dependent on key strategically influential assumptions around technical and commercial commitments from a supplier:

- a) More must be done to identify, test and validate those assumptions
- b) Risks, uncertainty and mitigating actions relating to those assumptions must be subject to ongoing scrutiny at the most senior level, and be subject to sufficient identification and assessment by the project team

While we recognise that the project was subject of TfL's existing assurance 'Gates' framework, we would emphasise that where LU is investing such significant sums or is delivering on key strategic objectives:

- a) Such activities should be subject of a more effective independent assurance framework performing sufficient, high quality, regular reviews (designed-in from the start of the programme) with appropriate upward reporting, holding the investment function to account; and
- b) Key strategic decisions that may constitute a departure from original plans, and potentially affect the risk profile of an investment must be subject of openness, transparency and review at senior level by the LU Board.

From Bombardier's perspective, we found that in the early stages of their contract, Bombardier perceived the emergence of a significant gulf between what they believed they had agreed and LU's expectations for delivery. Bombardier advised that neither through the ITT, Contract or other means had they in hindsight acquired sufficient appreciation of the scale and complexity of the scope of their work and LU's expectations for levels of compliance documentation, interaction, management and scrutiny compared to the many other international signalling projects they have successfully delivered elsewhere. This is despite LU having already taken significant steps in setting up their SUP project to be more progressive and collaborative in their interactions with the contractor.

We identified six core themes:

1. System Capability

Despite pre-contract confidence, post-award the system was ultimately found to be unable to satisfy LU's technical requirements in the required timescales. More should have been done by LU during the tender process to understand the true system capability, safety integrity levels, and ultimately the amount of adaptation that would be required to better inform the tender decision. More should have been done to identify, quantify, mitigate and manage the technical risk during delivery of the contract.

2. Assurance, Governance and Risk

The quality of the programme assurance and commercial assurance framework to which the ATC Contract was subject did not reflect the scale of risk to which LU was exposed. Such major capital investment programmes demand independent programme assurance reporting independently and directly to the most senior level. Assurance interventions should have occurred earlier in the programme, at a more detailed level with a focus on the key risks.

3. People and Expertise

Signalling and ATC contracts are highly specialised, complex and with a particular risk profile. They have a unique combination of complex software functionality, specialist railways signalling technology and a high degree of integration with the operational railway environment. It is therefore strongly recommended that the LU project organisation is more fully represented by people with direct, specialist experience of such contracts and the technical and commercial risks that arise. It is particularly pertinent that this should be reflected in the expertise of those in project/programme management roles both in the LU client team and in the supplier organisation, in identified contractual 'key roles'. LU perceived that there was a gap between their expectations and the actual inputs from Bombardier in this regard. It is also strongly recommended that a greater level of assessment of the management capability of both LU and the relevant supplier is undertaken. This would enable action to be taken for example if delivery capability needed strengthening, through inputs from a specialist delivery partner arrangement.

4. Culture

LU took significant steps, jointly with the supplier, to be progressive and collaborative and sought to significantly reduce the burden of technical assurance requirements in order to streamline delivery of the contract. This was never fully realised, principally due to the gap between LU's specific requirements and the base capability of the off-the-shelf product / technology and hence the degree of adaptation and technology documentation that needed to be developed. However, at certain periods of the contract a culture of optimism and 'good news' prevailed such that underlying technical issues were not fully confronted. Effective collaboration and partnering does not mean being over optimistic – it is about mutual challenge and confronting issues, as much as providing mutual trust and support.

5. Contract

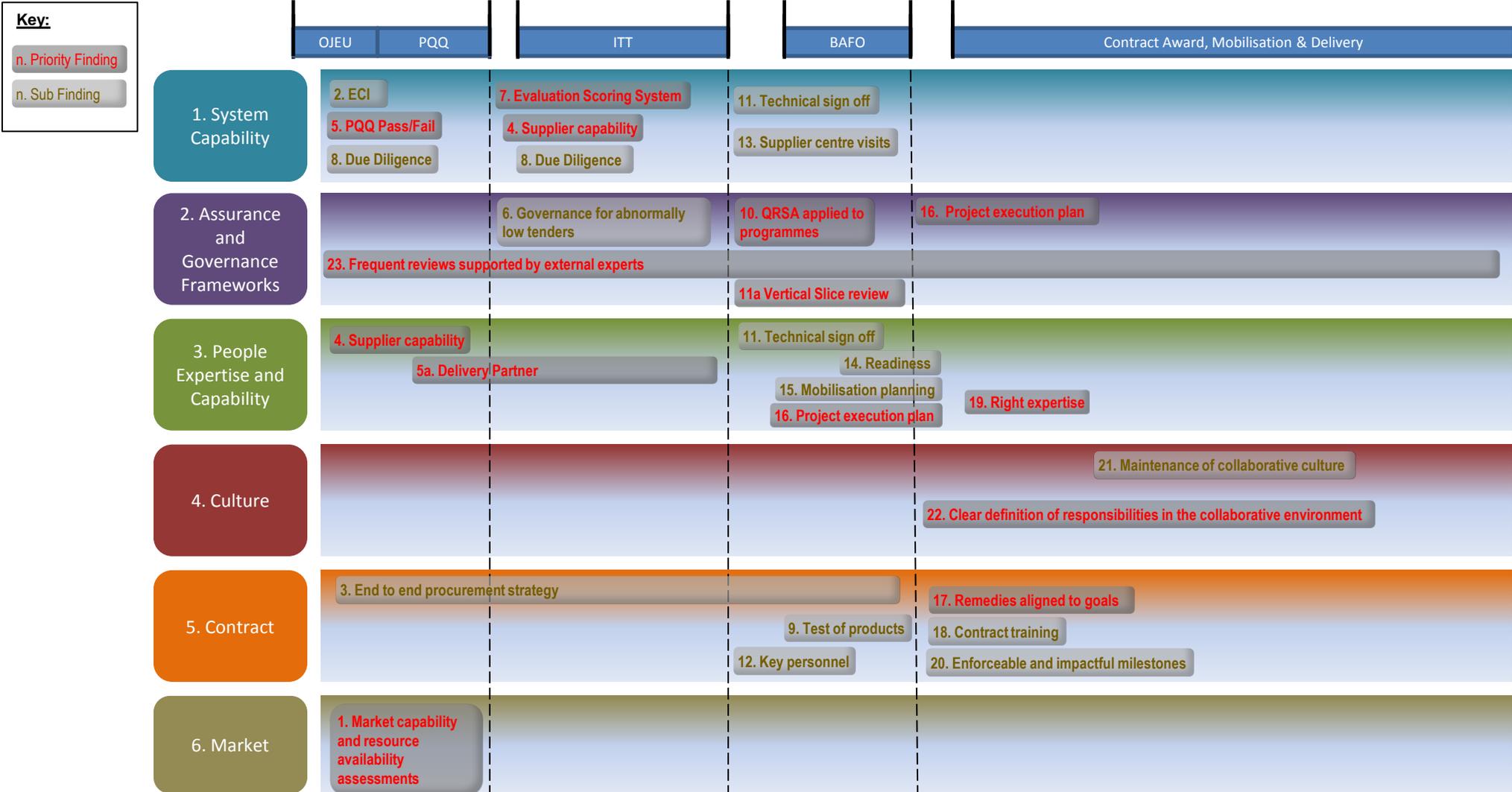
The contract and/or the way that the contract was managed did not adequately serve the needs of LU. The NEC3 form of contract as adopted is highly dependent upon the existence of an approved baseline programme / schedule which was never properly achieved for the ATC Contract. (Versions of the schedule were approved at certain points but not in a sustained, consistent way to permit ongoing management of the contract.)

6. Market

It has been noted that the procurement strategy could have been better informed through a deeper market analysis at the earliest stages. It is understood that LU were likely predominantly focussed on what they wanted and needed as a procurement solution and not what the market could actually provide and deliver.

- **Market Capacity and Capability Analysis** – undertake resource capacity and capability analysis of the market as part of the procurement and commercial strategy development phase to capture and reflect the limitations and specialist characteristics of the ATC supply chain. *(Rec1 - Pre-Contract:Market)*
- **Supplier Organisational Capability** - undertake deep due diligence of the supply chain organisations in relation to their effectiveness of leadership and management in a complex delivery context, internal operational management capability and integration of their relevant global businesses, as well as the maturity and provenance of their products. *(Rec4 – Pre-Contract:PQQ)*
- **Tender Process** - use PQQ stage as an opportunity to strictly identify a limited number of capable organisations to be taken forward to ITT, based upon stringently applied pass/fail criteria. The PQQ process should be cognisant of and recognise that resource will need to be applied appropriately to ensure adequate interrogation of all bid submissions. *(Rec5 – Pre-Contract:PQQ)*
- **Tender Assessment Criteria** - ITT evaluation assessment scores and weighting of scores should reflect the overall drivers and goals for the programme to achieve the optimum balance between all functional areas in making the selection. The effectiveness of the scoring system should be tested through a number of scenarios and sensitivity analyses including extremes of scoring to prove robustness of the regime. Initial focus should be on assessment of technical content until it has reached a satisfactory level only after which point, after satisfying the technical criteria should commercial evaluation be undertaken. *(Rec7 – Pre-Contract:ITT)*
- **Risk Management** – the key strategic risks and key assumptions relating to the specific supplier / product selection must be representatively identified (i.e. in terms of the risks presented by that particular technology), quantified and actively managed in terms of both cost risk and time schedule risk. *(Rec10 – Pre-Contract:BAFO)*
- **Contractual Programme (Time Schedule)** – a robust agreed programme is a key component of a contractual relationship and is essential prior to the award of contract and the mobilisation of the LU team. The Project Execution Plan (PEP) should reflect sufficient detail as to how it will be achieved, and be scrutinised and approved by the LU ATC Programme Board to provide confidence in the supplier's ability to deliver the project. *(Rec16 – Post-Contract:Mobilisation)*
- **Contract Remedies** – the contract should address achieving the high level drivers behind the goals for the programme using a balance of incentives and penalties to drive the desired behaviour from suppliers. Guidance and training needs to be provided to clarify the key clauses, levers and tools within the contract to avoid misinterpretation. *(Rec17/18 – Post-Contract:Delivery)*
- **LU Team Specialist Skills** - LU needs to equip itself with a balance of technical experience within the team, particularly in senior project management positions. This specifically means incorporating seasoned veterans with direct experience of complex signalling ATC projects. *(Rec19 – Post-Contract:Delivery)*
- **Programme Assurance** - Given the complex nature of the programme, **assurance** reviews should be carried out on a more frequent and regular basis (irrespective of key stage dates), typically every six months, examining key areas in greater detail and granularity. We would also advocate that the services of specialised external experts are used to support the PMO including to fulfil the technical aspect of their duties. This support should remain in place during the procurement and subsequent delivery of the contract. *(Rec23 – Post-Contract: Contract Termination)*
- **Collaboration** - the terms, roles and responsibilities of collaboration and an integrated team approach need to be clearly defined and align with the incentive mechanisms within the contract to avoid misinterpretation and confusion around contractual position. A joint mobilisation plan should be developed which includes setting out respective roles, responsibilities and behaviours. *(Rec15/22 – Post-Contract:Mobilisation and Delivery)*
- **Supplier Leadership and Management Capability** – with consideration of the envisaged scale and complexity of delivery, undertake a deeper level of assessment of the supplier's proposed project-specific leadership and management team during the tender stage, for example by conducting interviews of key personnel, and ensure that these individuals are locked into the project. Alternatively consider at PQQ stage specifying that the suppliers engage a specialist Delivery Partner whose capacity and capability would similarly need to be subject to satisfactory due diligence. *(Rec4 / 5a – Pre-Contract:PQQ)*

Recommendations mapped to theme and phase



Key:

- n. Priority Finding
- n. Sub Finding

The Sub Surface Upgrade Programme (SUP) is a key strategic investment for LU comprising of 4 main work streams (a) Automatic Train Control (ATC) system and associated infrastructure upgrades; (b) Provision of 191 new trains manufactured by Bombardier in Derby; (c) Depot upgrades; and (d) Other infrastructure upgrades (stations, power, CCTV). LU awarded Bombardier a £354 million contract in 2011 to supply its Cityflo 650 moving block automatic train control system within a major signalling upgrade of the Sub-Surface Line ('SSL') network.

The upgrade was expected to increase capacity significantly, especially on the Circle and Hammersmith & City lines where the upgrade also includes the introduction of longer trains. Bombardier has completed preparatory work for the project. It has been paid £85 million for this work.

After extensive consideration by LU, it became clear that the project will not deliver the improvements as contracted. As a consequence, LU has recently ended the Automated Train Control ('ATC') contract with Bombardier. It is important to achieve the delivery date in 2018 which was incorporated in the original contract with Bombardier and LU is in the process of procuring a replacement contract using an accelerated route.

TfL has issued an enquiry for assistance from an Adviser to conduct a review to identify lessons learned relevant for incorporation within the new procurement process in order to enable successful delivery of the upgrade. We were instructed to complete the review within four weeks and to identify key themes and lessons and produce a focussed list of pragmatic recommendations. In order to implement the issues highlighted it will in some cases be necessary for LU to work up more detailed action plans, and of course to agree related timelines and responsibilities for those actions. We would recommend that a follow-up review to assess progress with actions is undertaken within 3 months.

The advent of computer technology has enabled the major signalling suppliers to progress from conventional (relay and solid state) signalling and control systems to more intelligent automatic train control systems responsible for running an entire railway operation. This has culminated in a move from fixed-block operation towards moving-block type communications based train control. The advantage of these ATC systems is that the combination of automatic train operation and automatic train supervision enables more efficient and reliable operation of services. Added to that, a moving-block type of operation allows closer spacing of trains (greater than 30 tph) thereby increasing throughput and capacity, and enhancing recovery from perturbation.

Historically, these ATC systems have evolved over time and are bespoke to each signalling supplier. As such each system architecture is different, and with more or less track-side infrastructure versus centralised infrastructure; there are no standard interfaces; each has its own inherent operating rules; and each requires some degree of adaptation for every implementation. The recent delivery of ATC systems by various suppliers onto the LU has not been good, notwithstanding the cancellation of the SUP contract. Delivery has been late, there has been cost escalation, and there have been numerous operational problems and in-service failures. Examples of this include the Dockland Light Railway (1990's) , Jubilee Line Upgrade (2011) and Victoria Line Upgrade (2011).

From our experience, we would observe that the key reasons for this may be summarised as follows:

1. The LU railway is unique and with signalling principles and legacy systems that have evolved over time; therefore new suppliers lack a good understanding of this environment;
2. Suppliers may not fully appreciate or underestimate the amount of adaptation required of the core system;
3. Suppliers may not possess the degree of capability to manage the software development project required for the adaptation;
4. The LU approvals regime is particularly onerous;
5. Suppliers are often not good at managing multiple and concurrent projects requiring change to their core systems;
6. Suppliers are not traditionally good at integration of the products into a working system;
7. Critical resources (e.g. signalling resources) are in short supply;

The SUP, in particular, has its own challenges:

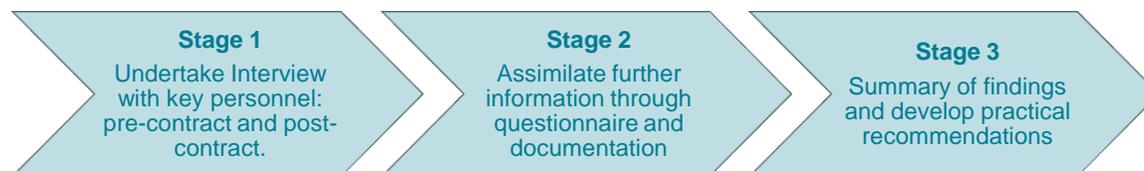
1. It is the most complex part of LU, involving 4 lines, and complex junctions. It is estimated to be the most complex metro project in the world so far;
2. The 32 tph capacity requirement through the complex junctions is right on the limit of delivery;
3. There are numerous interfaces with other railways (interoperability) and systems;
4. The timescales are demanding;
5. The system needs to be delivered onto an existing railway operation and with minimum/no disruption;

You explained that the review should be primarily forward looking in order to enable you to build the points emerging into the procurement process, the contractual arrangements and the project management of the contract. Historic considerations are required only as far as they are an essential part of incorporating lessons learned within the way forward.

The scope of work (Services) included within your enquiry document covered four main areas for review:

1. The procurement process, from the effectiveness and completeness of the scope articulation, prequalification of bidders, compilation of tender lists, tender enquiry elements, evaluation and recommendation of tenders and the successful tenderer, conversion of the successful tender into a binding contract on award, including the due diligence applied to bidders' submissions and proposals and the design of the procurement strategy and project management structure controlling its implementation;
2. Contractual arrangements, including the form of contract adopted, scope and risk management including change, milestones and payments;
3. Post award contract management including the monitoring of performance and the resolution and escalation of issues; and
4. Recommendations.

We have considered your requirements and our overall approach to this engagement has been split into three stages:



We have specifically targeted our interviewees around the key LU personnel who were involved pre-contract and post-contract. By separating the two phases and adopting a chronological approach to our interviews, it has enabled us to build a picture of the key findings as they occurred and how they manifested into the ultimate termination of the contract.

Following our interviews we disseminated a questionnaire to remaining staff involved in the project. This questionnaire includes a number of open and closed questions, designed to consolidate existing findings and identify new ones. In addition we have carried out a review of the key documentation provided and identified further documentation that has enabled us to evidence and support our findings.

The findings contained in this report are based upon the findings from our interviews, questionnaire and a review of the information and certain documents made available by LU. Our recommendations have been designed to be practical, achievable and reflect the real world nature of LU's procurement systems.

We have allocated a red / amber rating against each recommendation made throughout this report, denoting our perceived level of importance and priority. Additionally we have summarised what we believe to be the key recommendations, providing further granularity and actions to be taken.

Following completion of our fieldwork at LU we were provided with an opportunity to engage with a limited number of senior Bombardier personnel and have reflected within our report the information and views provided in those interviews.

It has been noted that the procurement strategy could have been better informed through a deeper market analysis at the earliest stages. It is understood that LU were likely predominantly focussed on what they wanted and needed as a procurement solution and not what the market could actually provide and deliver. This could have been considered in more depth. LU is an integral part of the very specific market that serves it and considering the capability in that space is crucial in setting the pace for successful delivery.

The ATC programme is significantly larger and more complex due to the nature of the LU than most 'comparable' programmes and projects. Combined with this, there were known constraints in the UK signalling market in relation to resource and its availability. There was also a track record across the industry, of poor performance from suppliers in the signalling and train automation sector.

At the time of the SSR ATC procurement, LU was experiencing significant issues on the Victoria and Jubilee line signalling contracts with two key suppliers which may have inadvertently influenced decision making. Also at the time, the UK and global economy was in the midst of a deep recession.

Therefore, greater due diligence and assurance was needed in relation to the supply chain's ability to deliver and resource the programme in the required timescales. Also, one should consider both the context of market capacity and verification of the supply chain's ability to manage the deep complexity in an integrated way, across their global organisational structures.

We would observe that earlier involvement of the supply chain in defining requirements and verifying feasibility, for example in demonstrating that the 32 trains per hour specification could be achieved, would have been beneficial. A case study was undertaken at PQQ phase but modelling of suppliers' systems did not take place until the ITT phase.

Lessons Learned Recommendations

1. Undertake a sufficient resource capacity and capability analysis of the market as part of the procurement and commercial strategy development phase.
2. Consider adopting and implementing early contractor involvement to benefit from the expertise of the supply chain in defining requirements and verifying feasibility.

It is important to understand the context in which the ATC signalling system was procured which is likely to have resulted in a number of influencing factors. In addition to the aforementioned significant challenges on TfL's two other CBTC schemes, the SUP ATC signalling programme was the first major procurement following the collapse of Metronet at a time when TfL was in the midst of a challenging financial period. We would observe that at the time of the procurement, in weighing up the relative merits of the respective products / technologies being proposed, and in the absence of any single fully compliant solution, LU would have had to make trade-off's between the relative potential product / technology risks, the perceived reduced-disruption benefits and commercial advantages of the Bombardier solution, with the known disruption risks and relatively commercially less attractive solutions of the non-Bombardier options, and in so doing, given that all suppliers would have needed some degree of development it appears that in effect that LU were not looking for an outright best solution, as such, but instead were looking for the least worst. In our interviews, some LU staff referred to a 'mindset' within the Project Team that was quite determined to push forward with the procurement given the pressure to achieve the 2018 target date. We would observe that such pressures and circumstances in a procurement can lead to an insufficient level of rigour around commercial processes (although we did not find any specific evidence that this was the case in this instance) and places greater emphasis on the need for a fully defined end-to-end procurement process and contracting strategy being put in-place before the procurement process commences. We have observed on occasions a weakness in communication between the project, commercial and legal teams.

An option could be to stick with "proven" LU suppliers in the future on the basis that it would mean implementing proven products and processes and therefore be lower risk; this would also permit better identification of capabilities and shortcoming of suppliers and their solutions, and identification of an appropriate risk mitigation strategy and contract mechanism with identification of appropriate consequences. This would need to be handled carefully as it restricts the level of competition and therefore LU would need to ensure it was receiving a bid that was value for money.

Lessons Learned Recommendations

3. A full end to end procurement and contracting strategy should be developed and approved prior to issuing the OJEU, PQQ and ITT.

At the initial stages during the Official Journal of European Union (OJEU) process it was anticipated that the minimum number of firms that would be invited to tender would be three and the maximum would be four. Following receipt of the PQQ responses, an evaluation and scoring exercise was undertaken by LU with Bombardier and Invensys ranking fourth and fifth respectively at this stage.

The evaluation document indicates that all six bidding organisations were passed through the PQQ phase, with a considerable gap between the top three bids and the bottom three bids. It has been noted that at an unidentifiable point in time between this evaluation and the Invitation to Tender (ITT) phase, a decision was made to invite all organisations that responded to the PQQ to tender. The result, as illustrated at the Tender Board Short Listing Presentation on the 8th July 2010 was the submission of 7 bids from 5 different organisations, after one organisation left the process following PQQ. Having looked through the documentation and through our numerous interviews we have been unable to substantiate the reason behind this decision.

The result of this increase in the number of organisations being evaluated in more detail was a wider distribution (and dilution of effort) of the resource undertaking the exercise, which will have impacted the depth of subsequent due diligence undertaken. Furthermore, if the PQQ had been used to identify 3 bidders as outlined in the OJEU notice, neither of the final two organisations that later competed in the Best and Final Offer (BAFO) stage would have actually made it through the PQQ phase. However, it should be noted that Bombardier's solution was still considered technically compliant at PQQ stage.

Commercial guidance issued ordained that the selection criteria (used to establish a tender list) and award criteria (used to select the best tender) could not be applied at both stages of the procurement process. It also made clear that at PQQ stage all criteria were to be 'backward facing' looking at the suppliers' track record whereas at tender stage criteria should be 'forward facing' looking at how the tenderer would deliver the requirements. It has been evident that there was confusion around both the source and nature of this advice. We understand that the impact of this advice was that important and open questions that were identified during the PQQ phase were not looked at again during ITT; the situation was also confused by all the suppliers being deemed to have therefore "passed " the PQQ and that the lack of follow up of key questions therefore did not lead to such matters receiving further focus in either evaluation or in potential risk mitigation steps required. In terms of best practice, the PQQ should seek to test capability of the organisation; and the ITT should be about meeting the detailed requirements and delivering in the timescales.

Lessons Learned Recommendations

4. Undertake deep due diligence of the supply chain organisations in relation to their effectiveness of internal operational management and integration of their relevant global businesses. Particular attention should be paid to assessing the capability of the supplier leadership and management team. An option could be to interview key individuals on the supplier leadership and management team.
5. Use PQQ stage as an opportunity to strictly identify a limited number of organisations to be taken forward to ITT, based upon stringently applied pass/fail criteria around capability. The PQQ process should be cognisant of and recognise that resource will need to be applied appropriately to ensure adequate interrogation of all bid submissions. Initial focus should be on assessment of technical content until it has reached a satisfactory level at which point commercial evaluation should be undertaken. It is entirely appropriate for LU to probe individual suppliers around particular areas of concern or risk in order to satisfy itself about the capability of those suppliers.
- 5a Consider specifying within the PQQ the requirement for a delivery capability such as through a Delivery Partner organisation whose capacity and capability would similarly need to be subject to satisfactory due diligence.

During tender evaluation, 'commercial' and 'whole life costs' criteria made up 11.5% and 30% respectively of the total scoring points and additionally it has been advised that due to the way they were scored, they carried more weight in the evaluation process. The methodology of scoring whole life cost submission information meant that it was guaranteed that the lowest price would achieve 100 per cent of the points available, thus 30% of the maximum score. This was inconsistent with the scoring methodology in other areas where no bidder may have been awarded 100 per cent of the points available and therefore reduced discrimination in these other areas and gave commercial information a disproportionate representation.

The outcome of the tender evaluation was therefore influenced significantly more by commercial and cost elements of bid submissions as opposed to technical and operational detail. This pre-existing commercial bias became exponentially greater when there was significant disparity in price between bids including receipt of Bombardier's which was outside the target benchmark range.

An LU study was undertaken in July 2013 which conducted sensitivity analysis of the scoring. The conclusion of this analysis was that the scoring mechanism for the range of responses received from bidders was sensitive to all the scoring areas but that Bombardier's bid was so much lower that despite adjustment to other scoring areas, it still achieved the highest score in both the full evaluation and all three 'detailed' sensitivity analysis checks.

We understand that as a result, there was insufficient discrimination between the technical scoring for different bidders and the best technical bids were not necessarily taken forward. Linked to this, risks associated with the technical side of the submissions may not have been scaled effectively. Nevertheless there was no strong objection nor a belief that Bombardier would be unable to deliver.

Our experience of failure on previous contracts has shown that the dominant proportion of the score should be given to a proven technical capability. An option could be to break down the evaluation by system elements with those elements attracting marks which are proportionate to the risks and consequences of elemental failure.

At the heart of the selection was the search for product maturity in order to fulfil LU's vision for minimal system development and the inherent efficiency associated with that. As a result of the information that emerged from the delivery phase (refer to post-contract section), it has been noted that deeper and more comprehensive due diligence and understanding of the technical solutions, through additional means such as self-certification (as a demonstration of 'global' corporate commitment), would serve to verify the accuracy of statements made by bidding organisations and provide better visibility of the development risks that exist and in so doing avoid potential confusion about capabilities of a given product. Additionally key known risk areas such as the safety engineering processes and safety integrity levels could have been probed further, for example through a short "vertical slice" review through the assurance process, to verify certification and safety integrity level (SIL) claims.

Lessons Learned Recommendations

6. Develop governance and process for the management of bids outside the target benchmark range.
7. ITT evaluation assessment scores and weighting of scores should reflect the business case including the overall drivers and goals for the programme to achieve the optimum balance between all functional areas in making the selection.
8. Due diligence and demonstration of the provenance of data provided at ITT should be undertaken and made central in the selection process. Consideration should be given to inserting an additional stage in procurement between PQQ and ITT in order to test the provenance of critical data.

The purpose of the BAFO stage was to assess the two remaining bidders focussing on endorsing the BAFO evaluation, selecting the technical and commercial options to be adopted, confirming that the winning bid represented an acceptable risk position, reviewing LU's preparedness and the plan to contract award and ultimately recommending the most economically advantageous bid to the Executive Committee.

The resulting comparison between the two bidders set out a compelling commercial and technical case for selecting Bombardier. Key commercial differentiators included: a price substantially lower than the next bidder, a maintenance support contract significantly lower than the next bidder, a programme that would deliver 3 months early (versus 18 months late) and a 'Service Affecting Failure' cap 100% of contract price (versus 30%). Bombardier offered a market leading benchmark 'cost per kilometre' rate. Key technical differentiators included: delivery of 32 trains per hour (TPH) capability (versus 31TPH), zero closures and limited software development.

It has been noted during the interview and document review process that in some cases the capability of the supplier to deliver these benefits had not been adequately demonstrated or interrogated at the BAFO (and prior) stages. Post contract it became clear to LU that these commercial and technical differentiators would not be realised. In particular:

- LU perceived less integrated operation and management across the Bombardier global organisation than had been expected.
- LU believe that at the time of bidding some of the statements made by Bombardier's bid team were not fully aligned with their global design centres.
- Key technical aspects of Bombardier's proposed product were not verified through evidence and were not interrogated in depth by LU at the pre-contract stage. The main impact of this was the requirement for a significant amount of development work which had not been anticipated and difficulty in proving and meeting the required Safety Integrity Level (SIL) levels. This could have been assessed further, rather than taking the suppliers bid/proposal statements at face value. For example a short "vertical slice" review of key safety functions through the assurance process would have been revealing.
- Quantitative Risk Schedule Analysis was not undertaken.
- Key personnel listed in the bid did not end up joining the programme in London from Pittsburgh as LU expected.
- LU relied on information, particularly in relation to reference sites, that proved to not be reflective of the unique LU environment and in some cases were found to be not sufficiently representative. For example LU had incorrectly understood that works could be achieved with zero closures, based on a misunderstanding of the Bombardier project undertaken in Madrid which had actually endured closures under a separate and previous piece of work. This was also subsequently found to be of limited value as a comparator given it's significantly lower complexity than the LU Sub-surface network. (We note that whilst value was placed on LU's understanding that the reference site required no closures and that this and other factors were inputs into the technology selection process, the contract did ultimately recognise that the trackside works would principally be undertaken in engineering hours and would mainly not utilise closures.)
- Ultimately a lack of proof that Bombardier's solution could in fact deliver what LU needed in LU's complex environment to the time scale and to the budget agreed.

LU took significant steps through the 'New LU' initiative to look and challenge inwardly, to reduce the technical assurance regime, promote collaboration and ease the process of seeking derogations from standards. However, the New-LU initiative could not be fully exploited in this case because of the significant degree of adaptation and development required..

Bombardier have indicated that they believe certain key detailed aspects of discussions held at BAFO stage were not ultimately fully reflected in the contract control documents ('Works Information') for delivery.

It is also apparent that certain aspects of working arrangements, such as expectations of how the respective organisations will interact and face up to each other, could have been better set out in the BAFO stage to ensure understanding between both parties was clearer.

The form of contract as adopted was subject of a number of modifications that potentially compromised the spirit of the NEC3 approach and may have contributed to the difficulties experienced in ultimately delivering this contract.

We gained the impression from the interviews that post award, within LU, the traditional LU management wanted to control and manage the project as they had all other projects and not leave the project in the hands of the team that had managed the bid and awarded the contract. If LU had felt that the original LU bid team were failing to perform, then making changes can be understood.

Lessons Learned Recommendations

9. Use of separate contracts with multiple parties should precede the final delivery contract with the purpose of providing confidence as well as testing provenance of data submitted. This would culminate with both bidders' systems being taken through to test at Old Dalby and the results of this test would be central in the contract award.
10. **The key strategic risks, project risks and key assumptions relating to the selected supplier's specific product/technology, commercial offer and delivery programme must be representatively identified (i.e. in terms of the risks presented by that particular technology, rather than technology in general), quantified and actively managed in terms of both cost risk and time schedule risk. Quantitative Risk Schedule Analysis should be applied to programme submissions. Business critical strategic risks and assumptions must be tracked at the most senior level.**
11. All technical statements made in tender submissions should be signed off by the supplier's Chief Engineer that will be responsible for delivering the work as further demonstration of formal 'global' corporate commitment by a supplier.
- 11a London Underground to undertake a brief "vertical slice" review of some key technical and safety functions through the assurance lifecycle to verify certification and SIL claims.
12. Legally enforceable mechanisms should be incorporated at contract award in relation to assuring that key personnel submitted as part of the tender are guaranteed to deploy to the delivery of the programme and that appropriate legal remedy can be pursued if critical statements and assertions on which LU are relying in their selection and decision to contract, prove to be untrue.
13. In addition to reference site visits, visits to global design centres should be made to seek assurance that they have bought into the bid and all its technical content and to understand the scale of product adaptation required.
- 13a. **In concluding agreements in the BAFO phase it is important that key details and assumptions by both parties are fully captured and reflected in agreed documentation:**
 - a) Key discussions during BAFO / contract finalisation should be documented through agreed formal written minutes of meetings
 - b) Expand the risk reduction exercise to encompass how the approvals and joint working processes will operate.
 - c) Where soft (contractually unenforceable) undertakings are committed to e.g. 'Change LU not the product', the practical consequences for implementation should be agreed in writing between the parties and supported by a defined set of metrics. Governance should be established to review the reporting against the metrics and be empowered to act where those metrics deviate beyond established and agreed parameters.
 - d) During ITT/BAFO LU needs to be clear about its own organisation and how it proposes to engage with / face up to the Contractors organisation.

Lessons Learned Recommendations

13b. Establishing the Form of Contract

- a) Minimise the number of changes to the 'vanilla' standard form of contract in order to preserve the spirit of the contract form and reduce the risk of misunderstanding between client and contractor of bespoke contract clauses. Modifications to a vanilla form of contract should be made the exception and be supported by a compelling business case and be approved by an Enterprise board level decision. (It is recognised that for some LU contracts there is a necessary sophistication reflecting the complex nature of certain works and developments.)
- b) Avoid conflicts between the 'Works Information' and the 'Contractors Information' of the NEC form. While it is recognised that the purpose and differences between the Works Information (output specification) and Contractors Information (design/approach) may be clear under the NEC form, and that Works Information takes precedence, conflicts between these documents will cause confusion.
- c) Review the 'Works Information' against two criteria, Process and Specification. Clarity should be achieved as to the process to be followed, including
 - i. how comments and their incorporation into the designs will be managed;
 - ii. the criteria by which completion (of a process design, a control, a physical installation etc.) will be tested; and
 - iii. the performance parameters that have to be achieved.
- d) These should be at a granular level for all the major work elements.
- e) The tools in the contract for encouraging performance e.g. pain/gain mechanisms should be designed to encourage the performance equally of both parties to the contract, collaboratively. Such tools should not be used to limit the exposure of one of the parties to the consequences of agreed contract objectives not being met.

Potential Influencing Factors at the time of Award

We would observe that there would have been a number of factors relating to ongoing ATC projects at the time of the SUP ATC tender process that may have influenced thinking and selection at the time of the award:

1. LU were already upgrading the Jubilee Line and Victoria line with the Thales and Invensys ATC systems respectively, and both projects had experienced very considerable periods of planned line closure at weekends and mid-week evenings to permit the installation and commissioning of those systems. The scale and frequency of closures had been seen as highly disruptive and inconvenient for customers.
2. The technology being offered by Bombardier was understood by LU to require far fewer line closures and therefore had the potential to be far less disruptive and inconvenient to customers.
3. The Jubilee and Victoria Line ATC projects were also experiencing a number of challenges in delivery including both product technical compliance and progress delays.
4. It appears that in weighing up the relative merits of the proposed systems, and in the absence of any completely compliant solution, LU will have had to carefully consider and make trade-off's between potential technical risks, reduced-disruption benefits and commercial advantages of the Bombardier solution, with the known disruption risks and relatively commercially less attractive solutions of the non-Bombardier options.
5. At the time of award the UK and global economy was in the midst of a severe recession, so price and value for money would have been at the forefront of the decision making process.
6. Based upon the information provided by tenderers through the tender and BAFO process, such circumstances would have have significantly added to Bombardier being seen as an attractive option.

Key Assumptions Critical to the Success of the Award Decision

We would observe therefore that in selecting the Bombardier solution, LU had imported a particular profile of risk and opportunity that responded to the contextual situation, i.e. the potential opportunities for reduced closures and reduced product adaptation to achieve a compliant system but which was reliant upon both the base integrity of the Bombardier product and the contractual recourse in the event of supplier non-performance. Confidence around the Bombardier product integrity and contractual recourse were assumptions key to the success of LU's decision and these two areas should therefore have been identified as principal risks in the ongoing scrutiny and assurance of the programme and have been subject to greater examination and testing prior to final selection.

At contract award there was a genuine belief and confidence amongst the LU programme delivery team that Bombardier would deliver the project to time and cost. The commitment by Bombardier during the BAFO to deliver the test track demonstration at Gate G0 on time appears pivotal as it boosted confidence of delivery amongst senior members of LU. The programme board were also convinced that Bombardier would actually deliver on the assumption that they could be held more accountable if they failed to deliver Key Date 2 and that all costs could be recovered. However, the remedies for not achieving desired progress and the exact mechanisms for termination and their consequences and hence their impact as drivers of Bombardier's performance were not fully understood until later in 2013. At the time of termination in late 2013, we understand rights and remedies in respect of failure to deliver Key Date 2 requirements under the contract had still not crystallised.

In spite of the detailed and thorough tender evaluation process, more attention should have been placed on the risks associated with such a low bid, and determining that the scale of the task was fully understood and appreciated by those bidding. The project team believed the successful award of a particularly low priced contract was the culmination of cost efficiency through the culture change element. We believe there was an element of optimism which may have clouded judgement over the deliverability of the programme at this price.

The level of detail in LU's own mobilisation plans would indicate they were adequately prepared for mobilisation and they implemented their 100 day mobilisation plan to ramp up resources and organise themselves. The rate of mobilisation and ramp up of resources has been noted through most of our interviews and has been evidenced in a number of documents which cite the Project Launch Process was slower than LU had intended. Bombardier had issued a Project Launch Plan which contained a high level schedule. Bombardier's plans to mobilise were not adequately tested during the procurement process and this document should have been more heavily scrutinised. We would observe that in our experience 'starting right' is a recognised key factor for ultimate success of major projects and contracts.

Beyond the mobilisation phase Bombardier's execution plan did not reflect all the activity expected by LU including as to how the project delivery would be managed. Had this been sufficiently scrutinised during the procurement it would have indicated a lack of familiarity with LU requirements in delivering a project of the scale envisaged and would have highlighted how Bombardier's proposed internal interfaces and organisation would function (between London, Pittsburgh, Helsinki and Madrid) and interface with London Underground. This reinforces Recommendation 1 which relates to the market being geared up to delivering a project of this nature.

Lessons Learned Recommendations

14. LU and supplier readiness is critical during mobilisation and the early phases where risks need to be managed and performance carefully monitored, to ensure projects and contracts 'start right'.
15. A detailed joint mobilisation plan should be produced and in partnership with the supply chain tested during the procurement process.
- 15a LU needs to ensure that supplier mobilisation is responsive, and that a competent and experienced leadership team is delivered on day 1 and remains in place throughout the contract.
16. The bidder should produce and agree a robust Project Execution Plan (including programme / time schedule) prior to the award of contract and the mobilisation of the LU team. The PEP should be sufficiently scrutinised and approved by the LU ATC Programme Board to provide confidence in the supplier's ability to deliver the project and the plan should reflect sufficient detail to demonstrate how it will be achieved.
(Note: While these recommendations apply to mobilisation, they will need to be developed and planned pre-mobilisation.)

Key Date 1 was not achieved in accordance with the programme and delays through Gates A and B led to a number of the requirements being de-scoped in order to proceed. Early Warning Notices were raised but did not result in the intended increase in progress. The pivotal failure of Gate G0 (Key Date 2) slipping from August 2013 to 2014/2015 was a key driver behind the eventual termination of the contract.

During this period, it was perceived by some within LU that the contract did not give LU sufficient influence and so was unable to hold Bombardier to account, although this is not entirely true. As previously mentioned, there were also mis-held assumptions by some within LU about the ability to recover all costs from the contractor in the event of delivery failure.

The contract set-up did not reflect the need to handle key performance milestones constructively. There was at project level too great an emphasis placed upon financial penalties as a motivation for changing performance and limited provision for constructive, supportive remedies such as possibly adopting collaborative approaches that would enable/support the delivery of the project objective. The payment and penalty regimes within the contract are set up to respond to spend and not progress, in which case recovering costs becomes redundant if the contractor does not deliver a complete signalling system. A greater balance of incentives as opposed to penalties may have induced a different set of behaviours. As a result, financial penalties were the primary tool for extracting performance under the contract but were never fully enforced and ultimately failed to stimulate the desired behaviour. We would observe that in the context of what is meant to be a collaborative project environment, there can sometimes be reluctance to use the contract properly for fear of being seen as contractual; there is a fine line between appearing contractual (adversarial) and collaborative and this can sometimes result in inconsistent application of the contract.

The contract did not fully support step-in rights as these were not clearly defined or understood in relation to the contractual position. It was also noted that it is particularly difficult to step-in to software development as the products are unique to the supplier.

Given the early termination of the contract we are unable to comment on whether the pain-gain mechanism was appropriate or not. It is difficult to judge whether different share percentages would have driven different behaviours as the penalties do not kick in until later in the contract.

Given the complexity, scale and nature of the project, for the first year of the contract, LU did not have the right balance of senior experience within the team, particularly in the control system and software development areas. The composition of the project team was largely from a construction related background, unfamiliar with essential core technical issues. It has been noted through a number of interviews that there was a lack of seasoned signalling, ATC and/or software project delivery professionals in key leadership roles with real world experience on similar projects, who could have enabled the earlier identification of problems, recognition of key emerging risks and the subsequent responses.

Additionally LU considered the Bombardier leadership team to be less directly engaged and influential in addressing the issues than it would have liked, and LU did manage to secure some changes to bring in known and experienced personnel; but this was arguably too late to recover the delivery programme.

As part of the vision statement, notions such as a 'New LU' and 'Change LU not the product' underpinned the overall approach. These were big statements with good intentions during the pre-contract phase but during the post-contract phase New LU never fully materialised.

In the early days of mobilisation both parties bought into the one team approach and there was evidence of significant goodwill. It is understood that as a number of Bombardier's programme milestones and commitments began to slip, it triggered a change in behaviour from both parties. As a result, LU staff became less supportive and began retreating and protecting their positions rather than helping to overcome challenges and find solutions. A prime example is the proposed light touch approach to assurance that soon became very heavy handed and reverted back to a more traditional (pre New-LU) way of engagement. This shift in behaviour was in response to submissions from Bombardier that LU regarded as non-compliant and resulted in a more confrontational culture as soon as things started to go wrong.

Both parties signed up to a collaborative working charter which outlined commitment to the vision and shared objectives. There is a collaboration clause within the Works Information and an ATC Collaborative Working document provides details of how collaboration should work. These documents were viewed as largely ineffective by those involved because they lack any real substance and do not provide detail or clarity around roles and responsibilities. There is a fine line between acting collaboratively and demonstrating contract discipline which needs to be clarified to assist both parties resolve challenging situations.

A form of joint board was in operation, the ATC Steering Board, with senior representation from both client and supplier organisations to resolve blocking issues. Despite this there were a number of significant unresolved issues, not least of which the programme, that continued to frustrate effective performance of the contract.

Lessons Learned Recommendations

17. Contract remedies should address achieving the high level drivers behind the goals for the programme using a balance of incentives and penalties to drive the desired behaviour from suppliers. Consideration of appropriate contract structure should be given including:
 - Treating the development and delivery phases of the project differently, with different forms of contract
 - Provision for handling administration of the contract in the absence of an agreed programme. (The programme should be managed in a consistent and cross functional manner that recognises the contract to be one of a number of available approaches and tools to be potentially employed in the resolution of project challenges. The contract is a tool that may be effectively employed in this way through cross functional agreement but should feature as part of a wider, overall multi element management strategy.)
 - Mechanisms for client provision of collaborative support without compromising supplier contract obligations
18. Guidance and training needs to be provided to clarify the key clauses, levers and tools within the contract to avoid misinterpretation.

Lessons Learned Recommendations

19. LU needs to equip itself with the right people to deliver the job. This specifically means a balance of experience within the team, incorporating seasoned veterans who have big signalling experience on complex projects (possibly including experienced staff from the Victoria or Jubilee Line signalling projects).
20. In setting milestones they should either demonstrate that critical stages are complete and / or be practical tests of work done at times and stages where step in rights have the scope to recover lagging performance.
21. Maintaining a one-team cooperative culture is increasingly important when faced with challenging situations that affect the programme. Every effort must be taken not to revert to an 'old LU' culture in these situations.
22. Collaboration is far more than co-location. The terms, roles and responsibilities of collaboration and an integrated team approach need to be clearly defined and align with the incentive mechanisms within the contract to avoid misinterpretation and confusion around contractual position.
 - a) Design and agree a process for identifying and escalating to a project working group / Joint Project Board which should be empowered to make binding and enforceable decisions which cut across all disciplines and departments for both Contractor and Employer at an early stage in the development of elements and the resolution of misalignments. This should not be exclusively founded in the project organisation of the Employer. The emphasis here is about not allowing the delivery team alone to manage all project execution challenges. When these challenges threaten the operation of the enterprise as a whole an executive level team that can balance the needs of the whole enterprise is best placed to make key decisions.
 - b) Where contract forms such as NEC are used which rely for their effectiveness on comparisons with an agreed baseline there should be timely agreement of baselines to promote and enable effective project monitoring and a no blame culture of declaring and discussing impediments to delivery of the baselines.
 - c) Establish an overarching project authority that is empowered to achieve the deliverable from the project and balance the pressures of money, performance, program, regulation and quality.
 - d) In the design of Governance for both Contractor and Employer a facility should be established to identify points at which cooperative 'spirit' within the joint project teams deviate at the potential expense of the project. A joint formally established above project level group should be empowered to act when such deviations are identified.
 - e) Culture, possibly through the Contract, needs to encourage these "mis-alignment" issues to get escalated and resolved quickly so as to avoid organisations entrenching in their views and programme delays.

Through our interviews with LU employees the general consensus is that more action should have been taken earlier (approximately 12 months into the contract) when LU were expressing significant concern about progress delays and yet the programme continued to slip. However it is not possible to say in hindsight whether this would have affected the outcome.

Once the full extent of the issues was known (particularly around the SIL levels and failure to reach Gate 0 on time) there was little doubt, in LU's opinion, that Bombardier would be unable to deliver a fully functional signalling system by 2018.

A 'good news culture' was prevalent during the first year of delivery phase and although the project team's perseverance to deliver the project was admirable, it perhaps delayed LU's consideration and exploration of more immediate focused remedial measures. This underlines the importance of an independent programme assurance function within LU with the right technical skills, capability, capacity, scope and approach to cast its eyes over the project and provide an unbiased perspective of commercial and project management issues at regular intervals with a focus on the key risks. Even as late as July 2012 there was a high-profile declaration of whole-team commitment to achieving the scope and timeframe despite the significant increasing recognition of serious concerns with the capability of the system.

Within the current setup, the internal LU programme assurance function is provided by the PMO team which sits within the Capital Projects Directorate. The staff responsible for undertaking assurance activities are quite separate from those involved in management and delivery of projects. The PMO reports to the TfL Managing Director Finance as well as the LU Capital Programmes Director. There are three lines of assurance: the project team; the PMO and IIPAG. The assurance timetable is based around key stages in accordance with Pathway (TfL's standard processes). It is worth noting that the assurance process is not tailored to the complexity of the project or to account for large gaps between key stage gates.

At present IIPAG carries out infrequent reviews which are carried out at a high level and remain superficial due to the limited time constraints in which they are completed (two days). Whilst providing a strategic picture, this is insufficient time to get to the core issues. Furthermore the PMO does not possess the necessary technical expertise to produce a meaningful assurance of the project.

Lessons Learned Recommendations

23. Given the complex nature of the programme, assurance reviews should be carried out on a more frequent and regular basis (irrespective of key stage dates), typically every six months, examining key areas in greater detail and granularity.

We would advocate that the services of specialised external experts are used to support the PMO to fulfil the specialist technical aspects of their assurance duties. This support should remain in place during the procurement and subsequent delivery of the contract.



cutting through complexity

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Detailed Response to KPMG Recommendations

June 2014

1.1 The SUP management response to the specific recommendations are as follows:

1.2 **KPMG Recommendation 1:** Undertake a sufficient resource capacity and capability analysis of the market as part of the procurement and commercial strategy development phase.

Management response: Noted and agreed. The global signalling market is a highly specialised one, dominated by five large companies (Thales, Siemens who acquired Invensys, Bombardier, Alstom and Ansaldo) of which only two (Thales and Invensys) currently have systems approved for use on LU infrastructure. The specialist resource and capability to resignal SUP (the oldest and most complex metro in the world) are in short supply therefore as part of business contingency planning during the latter half of 2013 a global review of the communications based train control (CBTC) market was carried out by senior LU technical and management personnel. The findings, both from the experiences in the BT contract and the developments in the industry since the previous procurement, were fed into the sourcing strategy for the new procurement. It also informs the contract and commercial strategy and forms the key basis around which the pre-qualification questionnaire (PQQ) has been designed.

It should also be noted that the very same resource restrictions in this specialist market led to the need to introduce Bombardier Transportation (BT) in 2010/11 as the other two suppliers on the Jubilee Line Upgrade and Victoria Line Upgrade were not performing creditably at the time and did not have the resource capability to take on SUP at the time.

1.3 **KPMG Recommendation 2:** Consider adopting and implementing early contractor involvement to benefit from the expertise of the supply chain in defining requirements and verifying feasibility.

Management response: Noted and agreed. Learning has been applied from the CBTC supply chain through direct LU experience across its re-signalling portfolio as well as projects such as Bank which is pioneering the “Innovative Contractor Engagement” approach, and with external companies such as Crossrail, has been sought and fed directly into the design of the scope, operating model and approach to interfaces

KPMG Recommendation 3: A full end to end procurement and contracting strategy should be developed and approved prior to issuing the OJEU, PQQ and ITT.

Management response: This requirement is recognised and has been fed into the procurement.

1.4 **KPMG Recommendation 4:** Noted and agreed. Undertake deep due diligence of the supply chain organisations in relation to their effectiveness of internal operational management and integration of their relevant global businesses. Particular attention should be paid to the assessing the capability of the supplier

leadership and management team. An option could be to interview key individuals on the supplier leadership and management team.

Management response: Noted and agreed. This procurement has been informed using a number of sources including the detailed learning from the supply chain analysis carried out by LU procurement experts for previous signalling projects across the industry, not just within LU, and the lessons learned from the previous ATC contract. This has been updated and informed by a technical review which concluded that when set against LU's business objectives to achieve 2018, minimal product adaptation is critical to deliver that result together with a different approach to the locations and management of the design and delivery phases.

Detailed organisation structure and governance plans are required, focus on the suppliers capabilities leadership, management and interviews of all key delivery personnel are provided for together with contractual retention of those companies, teams and individuals. This was reflected at the outset in the OJEU and is mirrored in the requirements set out in the PQQ and Invitation to Tender (ITT) documents. LU's findings when carrying out the due diligence have also been validated when viewed against the companies expressing an interest in bidding.

- 1.5 **KPMG Recommendation 5:** Use PQQ stage as an opportunity to strictly identify a limited number of organisations to be taken forward to ITT, based upon stringently applied pass/fail criteria around capability. The PQQ process should be cognisant of and recognise that resource will need to be applied appropriately to ensure adequate interrogation of all bid submissions. Initial focus should be on assessment of technical content until it has reached a satisfactory level at which point commercial evaluation should be undertaken. It is entirely appropriate for LU to probe individual suppliers around particular areas of concern or risk in order to satisfy itself about the capability of those suppliers.

Management response: Noted and agreed. The learning from the previous BT procurement has been reviewed internally by LU, by recognised independent external experts and by IIPAG. This has been fed into the development of the current PQQ which is recognised as setting a very "high bar" in terms of pass/fail criteria. The legal position over the approach to backward and forward facing questions has been clarified and does not impede important open questions necessary in the ITT phase.

- 1.6 **KPMG Recommendation 5a:** Consider specifying within the PQQ the requirement for a delivery capability such as through a Delivery Partner organisation.

Management response: Noted and agreed. The PQQ made it clear that the suppliers were expected to demonstrate delivery capability and were encouraged to engage a specialist Delivery Partner and this is further emphasised in the ITT.

- 1.7 **KPMG Recommendation 6:** Develop governance and process for the management of bids outside the target benchmark range.

Management response: Noted and agreed. The approach and impact of the previous commercial model has been reviewed in detail and through learning, market testing, external peer review and advice received from Turner &

Townsend has been updated for the new procurement. The model adopts an initial weighting that requires demonstration of technical and operational capabilities and capacities at a very high level which must be proven for a bidder to move through to the commercial and cost evaluation.

- 1.8 **KPMG Recommendation 7:** ITT evaluation assessment scores and weighting of scores should reflect the business case including the overall drivers and goals for the programme to achieve the optimum balance between all functional areas in making the selection.

Management response: Noted and agreed. The ITT evaluation has been developed specifically to reflect the changes in the operating model, the scope developments and the learning from the previous procurement and the 2013 study. Input to this has been taken from external peer reviews, from projects such as Crossrail and the Olympic Delivery Authority (ODA) and from support via LU's professional advisors Turner & Townsend.

- 1.9 **KPMG Recommendation 8:** Due diligence and demonstration of the provenance of data provided at ITT should be undertaken and made central in the selection process. Consideration should be given to inserting an additional stage in procurement between PQQ and ITT in order to test the provenance of critical data.

Management response: Noted and agreed. The PQQ had a significant focus in the technical section on provision of important data to support the bidders' answers that was independently proven or verified. LU is using independent industry experts to verify the technical responses to key elements of the PQQ and ITT.

- 1.10 **KPMG Recommendation 9:** Use of separate contracts with multiple parties should precede the final delivery contract with the purpose of providing confidence as well as testing provenance of data submitted. This would culminate with both bidders' systems being taken through to test at Old Dalby and the results of this test would be central in the contract award.

Management response: Not agreed. It is considered impracticable to do this because the products of the various suppliers are at such different stages of development. A significant stage in any signalling project is commonly called GO – "Offsite testing demonstration of Generic System design achieved with supporting Safety and Reliability Cases accepted." LU arranges for this testing to be undertaken at a test track at Old Dalby in Leicestershire. There are also some very practical issues about taking forward two suppliers through to GO. The infrastructure required to support each system would be very different and given the difference in timescales envisaged, it is difficult to construct a process whereby they would be on a level footing.

- 1.11 **KPMG Recommendation 10:** The key strategic risks, project risks and key assumptions relating to the selected supplier's specific product/technology, commercial offer and delivery programme must be representatively identified (i.e. in terms of the risks presented by that particular technology, rather than technology in general), quantified and actively managed in terms of both cost risk and time schedule risk. Quantitative Risk Schedule Analysis should be applied to programme submissions. Business critical strategic risks and assumptions must be tracked at the most senior level.

Management response: Noted and agreed. LU recognises the importance of identifying, analysing and actively managing the specific risks and assumptions that underpin the ATC delivery. The ITT includes the requirement that the risk register should be jointly owned and managed with the contractor, regardless of commercial liability for risk impact. A full quantified schedule risk analysis (QSRA) is already designed to form part of the ITT evaluation and is weighted accordingly. LU has already invested in industry standard Project Controls tools and techniques to support it and the supplier in this area.

- 1.12 **KPMG Recommendation 11:** All technical statements made in tender submissions should be signed off by the supplier's Chief Engineer that will be responsible for delivering the work as further demonstration of formal 'global' corporate commitment by a supplier.

Management response: Noted and agreed. This has already been included as a requirement in the PQQ and ITT documents.

- 1.13 **KPMG Recommendation 11a:** LU to undertake a brief "vertical slice" review of some key technical and safety functions through the assurance lifecycle to verify SIL claims.

Management response: Noted and agreed. This is always undertaken as part of LU's oversight and sign-off of safety-critical systems and when undertaken by LU on the BT contract identified the challenges faced in developing and delivering their systems.

- 1.14 **KPMG Recommendation 12:** Legally enforceable mechanisms should be incorporated at contract award in relation to assuring that key personnel submitted as part of the tender are guaranteed to deploy to the delivery of the programme and that appropriate legal remedy can be pursued if critical statements and assertions on which LU are relying in their selection and decision to contract, prove to be untrue.

Management response: Noted and agreed. Various studies carried out recently (including the detailed New Tube For London Signalling Procurement Study) suggested that there are challenges in this area. LU propose to include named key personnel alongside performance requirements in the NEC contract that ensure the contractor provides, retains and is prevented from changing key resources without LU consent.

- 1.15 **KPMG Recommendation 13:** In addition to reference site visits, visits to global design centres should be made to seek assurance that they have bought into the bid and all its technical content and to understand the scale of product adaptation required.

Management response: Noted and agreed. The shortlisted bidder's design centre has been visited and reviewed.

- 1.16 **KPMG Recommendation 13a:** In concluding agreements in the BAFO phase it is important that key details and assumptions by both parties are fully captured and reflected in agreed documentation:

a) Key discussions during BAFO / contract finalisation should be documented through agreed formal written minutes of meetings.

b) Expand the risk reduction exercise to encompass how the approvals and joint working processes will operate.

c) Where soft (contractually unenforceable) undertakings are committed to e.g. 'Change LU not the product', the practical consequences for implementation should be agreed in writing between the parties and supported by a defined set of metrics. Governance should be established to review the reporting against the metrics and be empowered to act where those metrics deviate beyond established and agreed parameters.

d) During ITT/BAFO LU needs to be clear about its own organisation and how it proposes to engage with / face up to the Contractors organisation.

Management response: Noted and agreed.

1.17 **KPMG Recommendation 13b:** Establishing the Form of Contract

a) Minimise the number of changes to the 'vanilla' standard form of contract in order to preserve the spirit of the contract form and reduce the risk of misunderstanding between client and contractor of bespoke contract clauses. Modifications to a vanilla form of contract should be made the exception and be supported by a compelling business case and be approved by an Enterprise board level decision. (It is recognised that for some LU contracts there is a necessary sophistication reflecting the complex nature of certain works and developments.)

b) Avoid conflicts between the 'Works Information' and the 'Contractors Information' of the NEC form. While it is recognised that the purpose and differences between the Works Information (output specification) and Contractors Information (design/approach) may be clear under the NEC form, and that Works Information takes precedence, conflicts between these documents will cause confusion.

c) Review the 'Works Information' against two criteria, Process and Specification. Clarity should be achieved as to the process to be followed, including

i. how comments and their incorporation into the designs will be managed;

ii. the criteria by which completion (of a process design, a control, a physical installation etc.) will be tested; and

iii. the performance parameters that have to be achieved.

d) These should be at a granular level for all the major work elements.

e) The tools in the contract for encouraging performance e.g. pain/gain mechanisms should be designed to encourage the performance equally of both parties to the contract, collaboratively. Such tools should not be used to limit the exposure of one of the parties to the consequences of agreed contract objectives not being met.

Management response: The NEC form of contract proposed has been amended to reflect changes deemed necessary to support a contract of this complexity. LU's template amendments have been endorsed independently and changes to them are strictly controlled through an NEC User Group which operates pan TfL.

Drafting recognises the observations made in b), c), and d). As regards e), where option C is used, it should be understood that under NEC the total of the Prices ('target price') is capable of being adjusted by implemented compensation events and 'pain/gain' is shared between the parties. This target form of contract should encourage collaboration and joint mitigation of risks but also needs to define responsibilities of the respective parties.

- 1.18 **KPMG Recommendation 14:** LU and supplier readiness is critical during mobilisation and the early phases where risks need to be managed and performance carefully monitored to ensure projects and contracts 'start right'.

Management response: Noted and agreed.. LU is in the planning phase now for the contract go-live.

- 1.19 **KPMG Recommendation 15:** A detailed joint mobilisation plan should be produced and in partnership with the supply chain tested during the procurement process.

Management response: Noted and agreed. A joint mobilisation plan is being prepared and is being tested.

- 1.20 **KPMG Recommendation 15a:** LU needs to ensure that supplier mobilisation is responsive, and that a competent and experienced leadership team is delivered on day 1 and remains in place throughout the contract.

Management response: Noted and agreed. See responses to recommendations to 12 and 15.

- 1.21 **KPMG Recommendation 16:** The bidder should produce and agree a robust Project Execution Plan (including programme / time schedule) prior to the award of contract and the mobilisation of the LU team. The PEP should be scrutinised and approved by the LU ATC Programme Board to provide confidence in the supplier's ability to deliver the project and the plan should reflect sufficient detail to demonstrate how it will be achieved.

Management response: Noted. It is agreed that the PEP is a fundamental piece of a well managed project. LU, IIPAG and their respective external advisors all concur that the CBTC supply chain are individually and collectively not capable of the sophisticated project management required for the delivery of their complicated systems.

LU has encouraged the ATC suppliers through clear articulation in the PQQ (even if it is backward looking) that we expect them to engage the services of a professional project management company familiar with CBTC and railway infrastructure projects.

- 1.22 **KPMG Recommendation 17:** Contract remedies should address achieving the high level drivers behind the goals for the programme using a balance of incentives and penalties to drive the desired behaviour from suppliers. Consideration of appropriate contract structure should be given including:

- Treating the development and delivery phases of the project differently, with different forms of contract;

- Provision for handling administration of the contract in the absence of an agreed programme; and
- Mechanisms for client provision of collaborative support without compromising supplier contract obligations.

Management response: Noted and agreed. LU has been developing the contracting model based around their approved NEC3 template, albeit that this has been amended to reflect current requirements. This is built around the updated Commercial and Procurement Strategy. External lawyers have been engaged to assist with preparing the contract. Specific inputs, in particular around the termination provisions is being developed in collaboration with John Barber, IIPAG's contract and commercial external expert.

- 1.23 **KPMG Recommendation 18:** Guidance and training needs to be provided to clarify the key clauses, levers and tools within the contract to avoid misinterpretation.

Management response: Noted and agreed. Specific contract awareness workshops are planned both pre and post contract for LU and the proposed contractor to ensure a common understanding by all parties.

- 1.24 **KPMG Recommendation 19:** LU needs to equip itself with the right people to deliver the job. This specifically means a balance of experience within the team, incorporating seasoned veterans who have big signalling experience on complex projects (possibly including experienced staff from the Victoria or Jubilee Line signalling projects).

Management response: Noted and agreed. This was recognised from the outset with the introduction of external resource and expertise to supplement LU's signalling knowledge and was continued through 2012 and 13 by the CPD Director and the delivery team. Further changes have been implemented by the Programme Director to achieve the optimum mix of skills and experience at all levels. Where appropriate this will include resources with recent experience from the Victoria, Jubilee and Northern Line signalling projects.

- 1.25 **KPMG Recommendation 20:** In setting milestones they should either demonstrate that critical stages are complete and / or be practical tests of work done at times and stages where step in rights have the scope to recover lagging performance.

Management response: Noted and agreed. LU as a business is not capable of developing or delivering the system, so it will not be possible to benefit from step in rights during the product adaptation/design phase. These rights are however recognised in the later stages and have been suitably drafted in agreement with IIPAG and others to ensure that appropriate and realistic provisions apply.

- 1.26 **KPMG Recommendation 21:** Maintaining a one-team cooperative culture is increasingly important when faced with challenging situations that affect the programme. Every effort must be taken not to revert to an 'old LU' culture in these situations.

Management response: Noted and agreed. It is always a challenge to maintain collaboration in the face of a failing contract and LU believes it adopted the right balance as BT's performance declined and for the new procurement, the "one-team" approach is being further embedded through a new delivery model adopted from previous successful LU re-signalling projects most notably the Northern Line. A pre-amble describing this approach and specific contracting obligations on LU as well as the contractor are designed to underpin its importance to both parties. It will be tested for understanding by all parties in the pre and post contract phases.

1.27 **KPMG Recommendation 22:** Collaboration is far more than co-location. The terms, roles and responsibilities of collaboration and an integrated team approach need to be clearly defined and align with the incentive mechanisms within the contract to avoid misinterpretation and confusion around contractual position.

- a) Design and agree a process for identifying and escalating to a project working group / Joint Project Board which should be empowered to make binding and enforceable decisions which cut across all disciplines and departments for both Contractor and Employer at an early stage in the development of elements and the resolution of misalignments. This should not be exclusively founded in the project organisation of the Employer. The emphasis here is about not allowing the delivery team alone to manage all project execution challenges. When these challenges threaten the operation of the enterprise as a whole an executive level team that can balance the needs of the whole enterprise is best placed to make key decisions.
- b) Where contract forms such as NEC are used which rely for their effectiveness on comparisons with an agreed baseline there should be timely agreement of baselines to promote and enable effective project monitoring and a no blame culture of declaring and discussing impediments to delivery of the baselines.
- c) Establish an overarching project authority that is empowered to achieve the deliverable from the project and balance the pressures of money, performance, program, regulation and quality.
- d) In the design of Governance for both Contractor and Employer a facility should be established to identify points at which cooperative 'spirit' within the joint project teams deviate at the potential expense of the project. A joint formally established above project level group should be empowered to act when such deviations are identified.
- e) Culture, possibly through the Contract, needs to encourage these "mis-alignment" issues to get escalated and resolved quickly so as to avoid organisations entrenching in their views and programme delays.

Management response: Noted and agreed. Significant learning from the successful approach to collaborative working has been drawn from LU's well performing projects including the Jubilee, Victoria and Northern Line Upgrades since being brought in-house, track, and the station schemes and from external programmes such as Crossrail and the Olympics. This will continue to inform the delivery model and the ITT. Space for 200 of the contractor's staff has already

been reserved at the new ATC project offices in Holborn to contribute to the success of this approach.

- 1.28 **KPMG Recommendation 23:** Programme Assurance - Given the complex nature of the programme, reviews should be carried out on a more frequent and regular basis (irrespective of key stage dates), typically every six months, examining key areas in greater detail and granularity. We would advocate that the services of specialised external experts are employed to support the PMO and fulfil the technical aspect of their duties. This support should remain in place during the procurement and subsequent delivery of the contract.

Management response: Noted. It is agreed that regular assurance reviews should and indeed have been, undertaken, and will be enhanced with an emphasis on better quality and more informed assurance, with a focus on the key risks. It needs to be recognised that in this technical area, it is difficult to find the relevant expertise and that conflicts of interest require careful management because of the handful of people with the right skills, knowledge and experience.

There are several independent layers of assurance and oversight in LU, including the project management team who work with and supervise the contractor and sub-contractors, the project engineering team who approve the suppliers' designs and method statements, the independent Engineering Director's team who provide the safety verification required by The Railways and Other Guided Transport Systems (Safety) Regulations 2006 (ROGS), the Programme Management Office and programme control teams who carry out reporting and controls, the external experts who carry out independent engineering reviews, plus the plethora of independent reviews and assurance the contractor will carry out to check and sign-off his designs. The addition of further layers of assurance to this is counter-productive and so the focus will be on enhancing the quality and capability of the assurance and oversight functions.