Transport for London

London Underground Limited

Deep Tube Upgrade Programme: UIP2344

Document Number: **DTUP-2344.1.1-LUL-RPT-00066**

DTUP Operations and Maintenance Concept (OMC)

		Signature	Date
Prepared by	Refer to individual Volumes and Parts.		
Reviewed by	Refer to individual Volumes and Parts.		
Approved by	[redacted] Head of Operational Upgrades & Asset Development	[redacted]	30th June 2017
Authorised by	[redacted] Operations Director BCV	[redacted]	14/7/17

Revision	Date	Summary of Update						
		Volume 1 Part 1	**Volume 1 Part 2**	**Volume2 Part 1**	**Volume 2 Part 2**	**Volume 2 Part 3**	**Volume 2 Part 4**	**Volume 2 Part 5**
Issue 1	26/02/16	First issue	First issue	First Issue	First Issue	For information only	Work in progress not included	
Issue 2	15/04/16	Various content updates Issue 2	Various content updates Issue 2	Minor updates Issue 2	Minor updates Issue 2	First Issue	First issue	
Issue 3	20/07/16	Various content updates Issue 3	Various content updates Issue 3	Minor updates Issue 3	Minor updates Issue 3	Minor typographical corrections Issue 1	No changes	
Issue 4	02/05/17	Various content updates Issue 4	Various content updates Issue 4	Various content updates Issue 4	Various content updates Issue 4	Various content updates Issue 4	Various content updates Issue 4	First Issue

Issue 4 constitutes a minor update of the OMC. The changes are summarised on the following page.

Deep Tube Upgrade Programme

Operations & Maintenance Concept – Changes to Issue 4

Source Version	Issue description
V3	RAM references corrected to System Definition
V3	Some references to single 4-line control centre. Subtle re-wording to allow for interim Picc-only control facility, probably at Griffin Rooms
V3	V1, P1 Fig 4 Completeness matrix updated.
V3	V1, P1 Development plan updated
V3	V1, P1 section 11 - Consultation - table updated
V3	V1, P1 appendix A and B - Open issues – updated.
V3	V1, P2 section 3.1 table 3 updated [redacted]
V3	V1, P2 section 4: Roles validated
NEW	Continuous improvement appendix added. Since it describes current and future issues it is not in the same style as other parts of the Concept and hence it is an Appendix to V1P2
NEW	LU Standards clause added to V1P1
V3	V1, P2 section 4.2 – Interface section updated.
V3	V1, P2 section 6 - Migration updated
V3	All Volumes/ Parts: 'predict and prevent' term validated.
V3	All Volumes/ Parts: Terminology updated to reflect SI26 and the PRS. I.e. NTfL to DTUP
V3	[redacted]
V3	Clause 3.2.7.3 of Vol 2, Part 1 updated to provide clarity around the Rayners - Uxbridge, SOP. The clause is amended to specifically support GOA2 only from a cab.
V3	V1 P1: • DTUP title added • Updates to sections 4 / 5 / 7 / 8 / 9 and 12 (all) • New sections: 4.1 and 8.1 added
V3	V1 P2: • DTUP Title added • Edits to sections: Summary / 1 / 3.1 / 4.2 / 4.3 / 6 • New section 5.6 added • Appendix C – 'DTUP Continuous Improvement' added

V3	V2 P1 updated: • NTfL is replaced by DTUP • RCO aligned with changes from DTSM and TOSM to Trains Manager • Section on Operational Control Centres added
V3	V2 P2 updated: • NTfL is replaced by DTUP • On-going upkeep and formatting / Minor changes to align the OMC with the URS
V3	V2 P3 Minor updates: • RAM references corrected to System Definition • Depot location strategy • Fleet Organisation • Fleet Operations Management • Depot Operations Management • Migration Maintenance Arrangements • End State Maintenance Arrangements
V3	V2 P4 – Minor edits • RAM references corrected to System Definition
NEW	Operational Control System Maintenance Interface Volume added – V2 P5

Transport for London

London Underground Limited

DTUP OMC Volume 1 Part 1

Executive Summary and Introduction to the OMC

		Signature	Date
Prepared by	[redacted] Consultant, Operational Upgrades and Asset Development	[redacted]	May 2017
Reviewed by	[redacted] Upgrade Delivery Manager	[redacted]	May '17

Revision	Date	Summary of changes
Issue 1	26/02/16	First issue
Issue 2	15/04/16	GOA acronym corrected. Executive summary update. [redacted] Change control process section added. Completeness matrix and development plan updated.
Issue 3	20/07/16	Typographical changes further to alignment review. Completeness matrix and development plan updated. 'Open issues' section for future resolution created.
Issue 4	02/05/17	DTUP title added Updates to sections 4 / 5 / 7 / 8 / 9 and 12 (all) New sections: 4.1 and 8.1 added

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OMC Revision Issue 4

TfL Document Classification: Classified

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Executive Summary

The Deep Tube Upgrade Programme (DTUP) is a key element of the TfL Business Plan, aiming to continue the LU programme to upgrade ageing assets and to respond to current and forecast increases in passenger demand. Whilst doing this the programme is also maximising the opportunity to take a step forward in reliability; this is in order to deliver a truly world class service for our customers.

This OMC sets out, conceptually, how the upgraded DTUP lines will be operated and maintained to achieve the goals and objectives that established the business need for the programme.

The scope of the technical upgrades to the DTUP lines concerns the integration of new fleet and signalling systems into the existing infrastructure along with a new common control centre. Therefore, this OMC is primarily concerned with alterations to operational processes and maintenance practices that are directly affected by these technical changes.

The OMC also informs the wider business of changes to operations and maintenance allowing business systems and processes to be developed to enable the transformation.

The OMC is structured into two Volumes and seven Parts.

Volume 1 contains overarching information: an introduction to the OMC document and the plan for its on-going development. Part 2, the Vision and Transformation Statement explains the future vision for DTUP and provides an overview of the various operational and maintenance components.

The Vision Statement also describes the purpose of operational change on DTUP, focussing on delivery of two of TfL's Strategic Objectives for DTUP:

- **Increase Capacity** – providing transport capability commensurate with forecast passenger numbers;
- **Improve Railway Safety and Reliability** – increasing passenger perception of safety whilst reducing system 'downtime'.

In driving towards the goal of increased capacity, the chief change is the number of trains operating per hour (Tph) during peak periods. This measure must be achieved consistently, throughout the peaks, whilst maintaining the recovery margins, rather than being achieved as a 'one-off'. Achieving these frequency objectives will require increased levels of operational automation. [redacted] or [redacted]

Improved maintenance practices support the drive towards the DTUP goal of increased reliability of the service. Discrete KPIs will be set in detail for maintenance in advance of the implementation of new processes, but at this conceptual level, it is the overall reliability that guides the development of new practices.

While delivering these objectives the programme must remain cognisant of the fact that improvements must be performed economically and efficiently to ensure the lowest overall whole-life cost.

Volume 2 contains concept level descriptions of operations under each of the new automation levels and maintenance for the fleet and the signalling and control systems.

[redacted]

The Fleet and Depot Maintenance Concept and the Signalling and Train Control Maintenance Concept establish a vision for a transformative maintenance and data accessibility regime for DTUP utilising a condition base maintenance approach. Heavily dependent on system selection, the concepts at this time proposes the principles and philosophy of this approach to maintenance.

The OMC is a dynamic, live document. It will be reviewed and updated as the business need is translated from a concept to a realised system. Ultimately, once the technical solution is known, the OMC will support the development of Rule Book and Maintenance Regime updates.

A completeness matrix in Volume 1 Part 1 Section 8 illustrates the current status of the OMC in terms of its overall content. It is supported by a development plan in Volume 1 Part 1 Section 9, which sets out a path to robustly populating the OMC through a holistic approach and in line with key programme milestones and the realisation of levels of detail necessary to build a robust concept, particularly in relation to the maintenance regime.

1 Introduction

In 2027, the first of the DTUP Rolling Stock will be delivered to London Underground, marking the beginning of an 11 year, £16bn Programme, to deliver comprehensive modernisation to the Piccadilly, Waterloo & City, Bakerloo and Central Lines.

These lines date from the early 20th century and currently utilise rolling stock and signalling systems introduced between the early 1970s and the mid-1990s. The DTUP programme will deliver circa 250 new trains, a state of the art signalling system and a common control centre to [redacted]

Such technical and procedural enhancements will achieve essential business and customer benefits in capacity, capability, reliability and environmental comfort.

2 Purpose of the DTUP Operations and Maintenance Concept (OMC)

The OMC for DTUP describes strategically how the future upgraded underground lines will be operated and maintained in order to deliver the proposed business benefits of the DTUP programme.

It is developed at the concept stage of the programme lifecycle and is used to derive new and validate existing User Requirements. The System Definition Requirements, from which the technical solution will be designed, must satisfy the User Requirements and therefore provide the required operational and maintenance solution. The OMC will be used to verify requirements and validate proposed technical solutions throughout the programme lifecycle.

The OMC also informs the wider business of changes to operations and maintenance allowing business systems and processes to be developed to enable the transformation.

The OMC is a dynamic, live document. It will be reviewed and updated as the business need is translated from a concept to a realised system. Ultimately, once the technical solution is known, the OMC will support the development of Rule Book and Maintenance Regime updates.

This document supersedes, the Deep Tube Railway Operations and Maintenance Concept 2020 [NTFL-UIP1973-1.1-RPT-00011]. It ensures that there is an effective understanding between those designing the upgraded assets and systems of the DTUP railway and the Operations and Maintenance community that will use them to deliver the post-upgrade service.

3 Scope of the DTUP OMC

The scope of the technical upgrades to the DTUP lines concerns the integration of new fleet, signalling and control systems into the existing infrastructure along with a new common control centre. Therefore, this OMC is primarily concerned with alterations to operational processes, maintenance procedures and the supporting organisational structure directly affected by these technical changes.

However, the overall operation and maintenance of the 4 lines is integrally related to the wider LU system as well as third party interfacing lines. While these operational and maintenance interfaces are outside the scope of this programme it is necessary to identify any impacts from, or on these interfaces, that may affect the achievement of the DTUP business benefits. Examples of these interfaces would be passenger flow management at stations or civil infrastructure maintenance.

Such interfaces will be logged in the DTUP programme interface register.

4 The DTUP OMC in Context

This Operations and Maintenance Concept is one of a suite of documents that define the DTUP system and programme. As shown in Figure 1, (taken from NTfL-UIP2344.002.002-LUL-PLN-00001) the Operations & Maintenance Concept, along with the Customer Concept, Engineering Vehicles Concept and the Sponsors Programme Requirements form the Sponsors remit for DTUP. The Operations and Maintenance Concept is owned and updated by the DTUP Operational Upgrades and Asset Development Team.

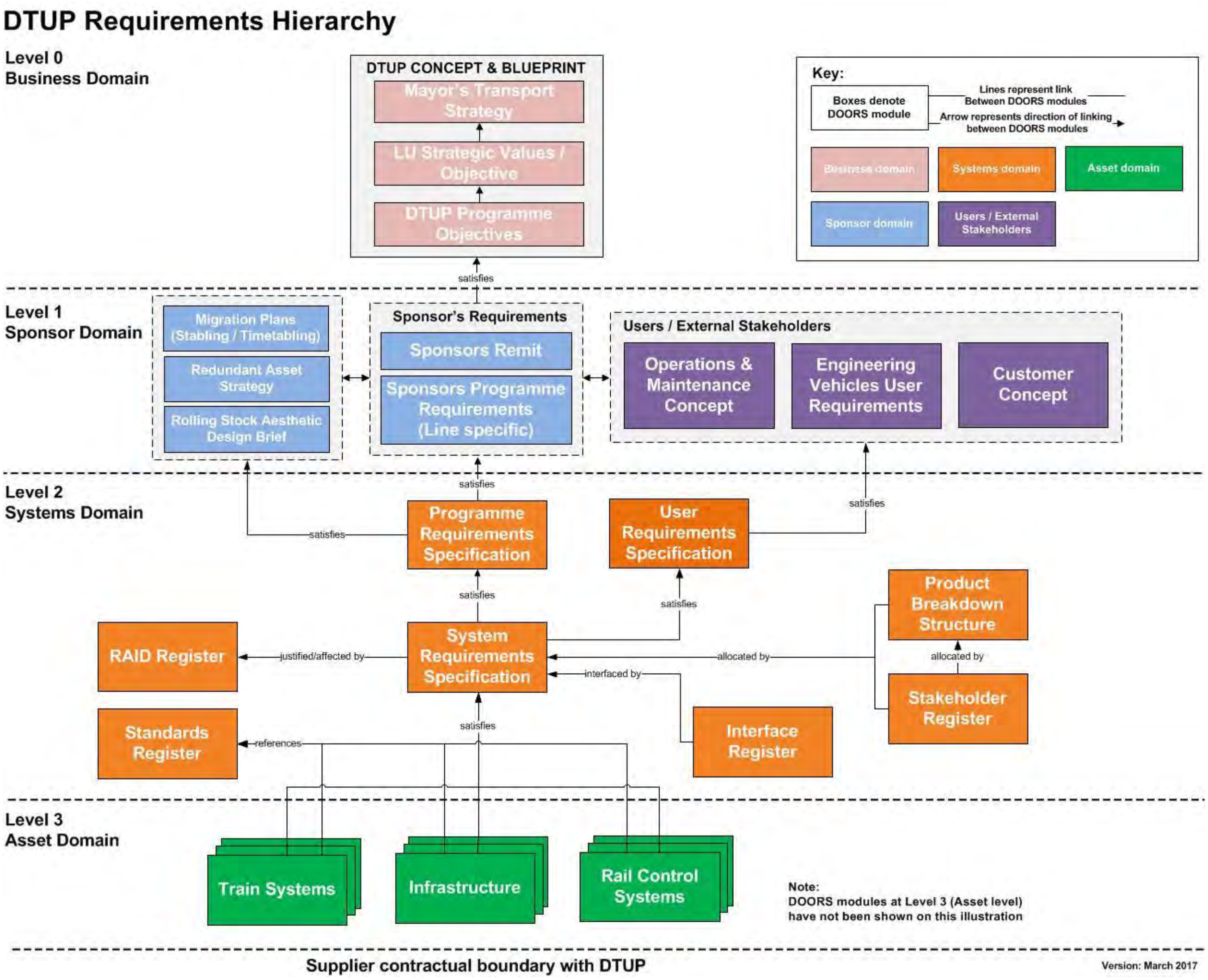


Figure 1: Illustration of the DTUP OMC within the programme requirements hierarchy

Although developed after the User Requirements Specification (URS) this version of the Operations and Maintenance Concept provides context for the URS and drives its overall completeness.

4.1 Application of Standards

Being a concept for operations and maintenance, this document does not reference the Operations and Maintenance standards to be applied. However, all London Underground Standards continue to apply as normal until formal derogation, or new standards, are required. Such changes shall be made in accordance with the formal safety change processes required by the LU Corporate Safety Management System.

5 DTUP OMC Structure

The Operations and Maintenance Concept itself is structured into a number of 'Volumes' and 'Parts' (referred to as OMC Volume or OMC Part when referenced individually) as shown below.

[redacted]

Figure 2: Operations and Maintenance Concept document structure

This structure provides clarity of content, accessibility to specific subject areas and provides a strong basis for further development.

Volume 1 contains overarching information: an introduction to the OMC document and plan for its on-going development, as well and the future vision and overview of the various operational and maintenance components.

[redacted]

As well as enabling the definition of User Requirements, the concept will drive the development of detailed operational and maintenance procedures as well as Line Emergency Plans. Over the course of the programme, additional volumes of the OMC will build on the emerging technical solution to add greater levels of detail, ultimately defining changes to the Rule Book and Maintenance Regime.

6 Configuration Management of the DTUP OMC

The OMC is a configuration-managed document that will evolve with the progress of the DTUP programme. Elements of the existing Volumes require greater development and future volumes are dependent on a greater level of system development. As such, the OMC will be updated and re-released on a planned basis; aligned to programme milestones to incorporate new developments as the project evolves. All releases will be issued under Sponsor Instruction.

7 Governance of Volumes and Parts

The overall OMC will be approved & authorised as a single entity when it is changed and/ or updated. However, various parts of the OMC have differing authors and reviewer requirements. As such, they will have individual "Prepared by" and "Reviewed by" cover pages. The detail for this governance is as follows in Table 1:

OMC Part	Part Title	Prepared by	Reviewers, Approvers and Authorisers
Overall OMC sign off	Operations & Maintenance Concept	Operational Development Managers	Reviewed by: Upgrade Delivery Manager Approved by: Head of Operational Upgrades & Asset Development Authorised by: Operations Director BCV
Volume 1, Part 1	Executive Summary and Introduction to the OMC	Operational Development Manager	Reviewed by: Upgrade Delivery Manager
Volume 1, Part 2	Operational Vision and Transformation Statement	Operational Development Manager	Reviewed by: Upgrade Delivery Manager
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
Volume 2, Part 3	DTUP Fleet & Depot Maintenance Concept	Operational Development Manager	Reviewed/Approved by: Head of Fleet JNP Head of BCV Fleet
Volume 2, Part 4	DTUP Signalling and Train Control Maintenance Concept	Operational Development Manager	Reviewed by: Incident Response & Command Manager Head of Signals Maintenance SSR BVC Area Infrastructure Manager Head of Signal - JNP

Volume 2, Part 5	Operational Control System Maintenance Interface	Operational Development Manager	Reviewed by: Upgrade Delivery Manager Head of Operational Upgrades & Asset Development

Table 1: Review and approvals required for various OMC Parts

It should be noted that the OMC is a single document. Therefore, **full sign off of every OMC Part is required for all version updates**. This includes any OMC Parts that have not undergone any change in content.

8 Current Baseline Status

This OMC is a live document, subject to development and change. This will occur both as the operational concept itself matures and as the technical solution becomes realised. Changes will be driven from within the programme and potentially also from external stakeholders.

This Baseline (Issue 4) represents the current maturity of the OMC, in line with the current programme lifecycle stage and available information in relation to programme requirements and the maturity of the technical system solution.

To fully understand the status of this OMC Issue, a completeness matrix (Figure 3: OMC completeness matrix below) has been developed and included here. This matrix defines the elements that need to be incorporated to the overall OMC, whether or not they are relevant to particular OMC Parts and the percentage complete relevant to the current programme maturity level (lifecycle stage and availability of information.)

[redacted]

This matrix will continue to be updated as the OMC is updated, and completeness may vary as the lifecycle progresses and new information becomes available.

For ease of reference, a summary table of all currently 'open issues' (decisions or choices not yet taken, not yet able to be taken or not yet able to be confirmed) from all Volumes of this OMC are given in Appendix A of this Part. These open issues constitute the on-going OMC development work.

8.1 OMC to User Requirements trace

During the winter of 2016/ 17 work has taken place to finalise the User Requirements Specification (URS) to the point that any future changes shall be formally change controlled. Each individual URS in DOORs, where relevant, now contains a list of the OMC Issue 3 clauses that concern that requirement. This version of the OMC therefore maintains the Issue 3 formatting to preserve these links. Where new clauses are added they use a different numbering system. Where a clause has been deleted, (whatever the reason) the previous number remains in place with the section noted '***No longer used'.***

	Executive Summary & Introduction to the OMC		Vision and Transformation Statement		GoA2 Operational Concept		[redacted]		Fleet and Depot Maintenance Concept		S&TC Maintenance Concept		Operational Control System Maintenance Interface	
	Applicable	% Complete	Applicable	% Complete	Applicable	% Complete	[redacted]	[redacted]	Applicable	% Complete	Applicable	% Complete	Applicable	% Complete
Document														
Structure														
Overall OMC structure	Y	100%	N/A		N/A		[redacted]		N/A		N/A		N/A	
Structure of individual OMC Part	Y	100%	Y	100%	Y	100%	[redacted]	[redacted]	Y	100%	Y	100%	Y	100%
Integration of operations concepts	Y	100%	Y	100%	Y	100%	[redacted]	[redacted]	N/A		N/A		N/A	
Integration of maintenance concepts	Y	100%	Y	100%	N/A		[redacted]		Y	100%	Y	100%	Y	100%
Consistency of format and style	Y	100%	Y	90%	Y	90%	[redacted]	[redacted]	Y	90%	Y	90%	Y	90%
Governance														
OMC governance process	Y	100%	N/A		N/A		[redacted]		N/A		N/A		N/A	
OMC governance responsibilities	Y	100%	N/A		N/A		[redacted]		N/A		N/A		N/A	
Change request approval process	Y	90%	N/A		N/A		[redacted]		N/A		N/A		N/A	
Alignment														
Programme alignment														
Alignment of FBS to OMC	Y	90%	Y	90%	Y	100%	[redacted]	[redacted]	Y	100%	Y	100%	Y	100%
Alignment of operational architectures to OMC	N/A		N/A		Y	75%	[redacted]	[redacted]	Y	100%	Y	100%	Y	100%
Alignment of other architectures to OMC	N/A		Y	90%	Y	75%	[redacted]	[redacted]	Y	100%	Y	100%	Y	100%
Alignment of URS to OMC (Gap analysis)	N/A		Y	100%	Y	100%	[redacted]	[redacted]	Y	100%	Y	100%	Y	50%
Alignment of other req sets to OMC (Gap analysis)	N/A		Y	50%	Y	tbc	[redacted]	[redacted]	N/A		N/A		N/A	
POTIC analysis interface	Y	100%	Y	100%	N/A		[redacted]		N/A		N/A		N/A	
Content														
Whole System														
High level principles of Operation	N/A		Y	100%	N/A		[redacted]		N/A		N/A		N/A	
High level principles of Maintenance	N/A		Y	100%	N/A		[redacted]		N/A		N/A		N/A	
Whole NTfL system	N/A		Y	80%	Y	100%	[redacted]	[redacted]	Y	100%	Y	100%	Y	100%
Alignment between concepts within OMC	N/A		Y	95%	Y	100%	[redacted]	[redacted]	Y	100%	Y	100%	Y	100%
Interfaces with wider TfL System (station operations, 3rd party lines, infrastructure maintenance etc)	N/A		Y	20%	Y	30%	[redacted]	[redacted]	Y	10%	Y	10%	Y	10%
Interface with Customer Concept	N/A		Y	35%	Y	35%	[redacted]	[redacted]	N/A		N/A		N/A	
Interface with EV Concept	N/A		Y	40%	Y	100%	[redacted]	[redacted]	N/A		N/A		N/A	
Interface with 3rd parties	N/A		Y	10%	Y	10%	[redacted]		N/A		N/A		N/A	
Modes of operation														
Normal Mode	N/A		Y	80%	Y	100%	[redacted]	[redacted]	Y	0%	N/A		N/A	
Abnormal Mode	N/A		Y	80%	Y	100%	[redacted]	[redacted]	Y	0%	N/A		N/A	
Degraded Mode	N/A		Y	80%	Y	100%	[redacted]	[redacted]	Y	0%	N/A		N/A	
Emergency Mode	N/A		Y	80%	Y	100%	[redacted]	[redacted]	Y	0%	N/A		N/A	
Operational and Maintenance needs through Technical Migration														
Current Operations (applicable Rule Book references)	N/A		Y	90%	Y	100%	[redacted]	[redacted]	N/A		N/A		N/A	
Current Maintenance (applicable Maintenance Regime references)	N/A		Y	75%	N/A		[redacted]		Y	100%	Y	50%	Y	0%
End state Operations	N/A		Y	100%	Y	100%	[redacted]	[redacted]	N/A		N/A		N/A	
End state Maintenance	N/A		Y	75%	N/A		[redacted]		Y	100%	Y	50%	Y	50%
Migration of operations	N/A		Y	10%	Y	25%	[redacted]	[redacted]	N/A		N/A		N/A	
Migration of maintenance	N/A		Y	10%	N/A		[redacted]		Y	40%	Y	20%	Y	20%
Operational Lifecycle														
Planning operations & maintenance	N/A		Y	50%	Y	50%	[redacted]	[redacted]	Y	70%	Y	40%	Y	40%
Delivering operations & maintenance	N/A		Y	90%	Y	80%	[redacted]	[redacted]	Y	40%	Y	40%	Y	40%
Service performance analysis	N/A		Y	30%	Y	30%	[redacted]	[redacted]	Y	30%	Y	30%	Y	30%
Implementing improvements	N/A		Y	0%	Y	0%	[redacted]	[redacted]	Y	0%	Y	0%	Y	0%
Line Specific														
Bakerloo line (all modes, all states)	N/A		N/A		Y	75%	[redacted]		Y	50%	Y	50%	Y	50%
Central line (all modes, all states)	N/A		N/A		Y	75%	[redacted]	[redacted]	Y	50%	Y	50%	Y	50%
Piccadilly line (all modes, all states)	N/A		N/A		Y	90%	[redacted]	[redacted]	Y	50%	Y	50%	Y	50%
Waterloo & City (all modes, all states)	N/A		N/A		N/A		[redacted]	[redacted]	Y	50%	Y	50%	Y	50%

Notes
Completeness is measured relative to the level of detail appropriate for the current stage of the programme lifecycle
OMC content is subject to maturity of information available at the time of writing.
Completeness is measured relative to the maturity of currently available information.
The content of the OMC is subject to change as the programme develops and technology solutions are realised.
Completeness will therefore be re-assessed as information becomes available and following approved change requests.

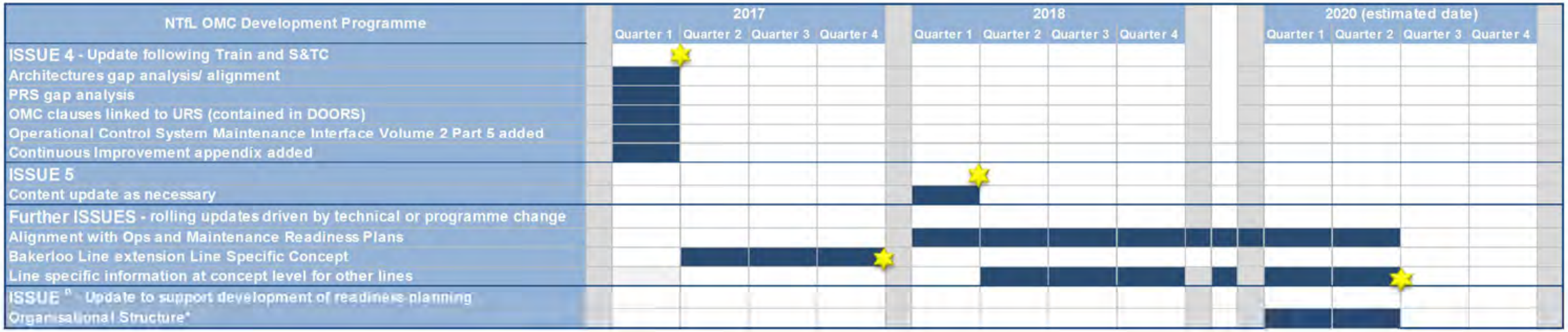
Figure 3: OMC completeness matrix

9 Development Plan

The completeness matrix (Section 8) defines a number of areas of the OMC which require further development. Figure 4: DTUP OMC Development Plan on the following page sets out a programme for continuing to develop the OMC to reach full maturity as a concept. Additionally it shows how the OMC becomes a driver for the development of line specific plans in preparation for operational readiness.

Issue dates for the OMC are based on programme milestones that are considered likely to need an update to the OMC, i.e. requirements changes for the S&TC ITT necessitating updates to the OMC. This way the Operational Upgrades team can continue to develop the OMC but minimise changes impacting the program through multiple re-issues.

This plan is an accurate representation of the proposed development of the OMC at the time of this baseline Issue, but will be updated as the OMC is updated for subsequent issues.



Notes:
Issues are driven by the need to update as specified. Ongoing development within the Operational Upgrades Team will align to these drivers to minimise revisions.
Dates for issue are approximate and subject to Programme changes.
* Dates for drivers need to be confirmed.

Figure 4: DTUP OMC Development Plan

10 POTIC Considerations

POTIC is included in the Programme Blueprint and summarises the operational states through the migration stages.

11 Consultation

In alignment with the Governance structure for the OMC, consultation was undertaken in 2016 as shown in Figure 5 below.

[redacted]

12 Appendix A – Currently 'open Issues' (taken from all volumes of the OMC)

The following table highlights the main OMC 'open issues'. Work is on-going to close these out. The update of the OMC planned for the end of Q1 2018 provides the next opportunity to formally close issues out and add new ones in progressive levels of detail.

Section	Open issue	Notes:
V1P1	**Executive Summary and Introduction to the OMC**	
OC Leadership Consultation Minutes in Issue 2	Need a proper strategy for crewing on the DTUP lines, given it's not been fully considered for the District line post 4LM and subsequent DTUP West London changes (SW)	Dependent on Operations Readiness Plan development and implementation
OC Leadership Consultation Minutes in Issue 2	Given the "every second counts" nature of the railway, we needed to influence customer behaviour through design, to ensure we can maximise the benefits of the project (SG)	Closed – this is part of on-going design and also Readiness Plans
V1P2	**Operations Vision and Transformation Statement**	
Section 3.3	Operating principle 9: Manage performance Performance management details are a work in progress, reference the development plan Volume 1 Part 1 Section 10.	Updated in February 2017. OMC update in 2018 will provide next substantial update
Section 4.1.1	Unlike operational roles, maintenance roles are dependent on a mature architecture and geography of the system solution, and therefore cannot be defined at this time. No significant alterations as currently proposed. Some roles are identified in relation to the control centre.	This is dependent on architecture development processes and is not expected to be complete until the 2020 OMC update
Section 4.2	Development of interfaces with DTUP in all operational states is on-going.	On-going commensurate with design
Section 6	Where the underground lines are being upgraded whilst providing continuous passenger service, the OMC will describe how the operations and maintenance of these lines will be performed during the migration from one technical system to another. The detail of this element of the OMC will be developed in alignment with the development plan in Volume 1 Part 1 of this OMC.	[redacted]
V2P1	**GOA2 Operational Concept**	
Section 3.2.5.8	Once the train is in place, the Train Operator shuts down the train and exits. [Note: If ATP is present in the depot, the Train Operator may leave the train in Automatic – this will be refined during the detailed design phase.]	Dependent on final Depot strategy in this area

Section	Open issue	Notes:
Section 3.2.7.3	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
Section 4.1.1.6	[redacted]	[redacted]

Section	Open issue	Notes:
V2P3	**Fleet and Depot Maintenance Concept**	
Concept further development and update	This version of the concept has been developed prior to critical input of the detailed Train Maintenance Plans that will be received and analysed from the Rolling Stock supply chain forming part of the submission pack received back in the Invitation to Negotiate (ITN) process. As a result a large number of assumptions have been made of Fleet Maintenance strategy and Depot facilities based on recent experience. These assumptions are planned to be revised in late 2016 following the analysis of specific information directly related to the DTUP train. It should therefore be noted that a major revision of this concept is planned at this point.	Work is on-going for update in a later document. The information remains confidential at time of Concept update.
6.2	For seasonal Maintenance, the Sandite Trains are required to continue at Hainault and Ruislip Depots and may also be required at the other upgraded depots. A Future strategy for provision of Rail Adhesion Trains to replace the legacy trains (Central & Piccadilly Line Provision) will need to be agreed to ensure that this provision it continues following completion of the upgrade.	Dedicated workstream in progress (yet to conclude) managed by Peter Turrell (S&SD)
9.8.5	The full strategy for stores management will be outlined in a subsequent version of this concept.	Still In progress for future update.
14.9	OPO, CCTV & CSDE are integrated systems impacting both Rolling Stock Maintenance and Stations Maintenance however they have been allocated for provision by the Rolling Stock supplier. There are significant lessons to learn in terms of defining future maintenance strategy and more development work and stake holder engagement is planned thought 2016 to accurately define maintenance principles to confirm in line with the requirements of this concept.	Still In progress for future update.

Section	Open issue	Notes:
V2P4	**Signalling and Train Control System Maintenance Concept**	
4.2.2	It is recognised that the suggested architecture for DTUP's Operational Control Centre deviates from this arrangement by placing the line Control Room in a separate location from the signalling control equipment. This is currently being termed as a 'campus' arrangement. Whilst there are benefits associated with the adoption of this arrangement, careful consideration will need to be given to the location of the control system equipment. If the Control Room is placed a significant distance from the control system then the maintenance organisation will need to provide coverage at both the Control Room and the Control system locations if TTS targets are to be met. In addition, it is likely that call depot facilities will need to be provided adjacent to the equipment room(s) which allows for the requisite incident response coverage. Clearly, the introduction of additional staff & 'call depot' facilities will erode some of the benefits that would be expected from a Control Room / Control system combined in one place (or separate within a reasonable distance).	The system architecture will be detailed at a later stage when the supplier has been appointed. This will further detail the issue as decisions are taken to close it out – e.g. when the Control Centre Design Package is let.
General	New organisation charts to be updated further to design development particularly regarding the Fleet structure, S&TC and the Control Room	This will be produced at the end of the Competitive Development Phase.

13 Appendix B: Operational Concept leadership consultation meeting notes – Open Issues

	Note / Action (Originator)	Response / Comment	[redacted]	When	Status
4	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
5	[redacted]	Pass to Sponsor for consideration	[redacted]	End March '16	[redacted]
6	[redacted]	Sponsor to note / consider concern	[redacted]	End March '16	[redacted]
9	Endorse the approach of having a single Control Centre (all)	Note	[redacted]	N/A	Complete and in concept

[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

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Transport for London

London Underground Limited

DTUP OMC Volume 1 Part 2

DTUP Operations Vision and Transformation Statement

		Signature	Date
Prepared by	[redacted] [redacted]	[redacted]	16 May 2017
Reviewed by	[redacted]	[redacted]	16 May '17

Revision	Date	Summary of changes
Issue 1	26/02/16	First issue
Issue 2	15/02/16	High level principles of maintenance updated to align with RAMS based approach. Levels of Maintenance and Predict & Prevent sections added. Geographic change section updated to incorporate LPC and maintenance elements. Transformation overview of Fleet and Depot Maintenance and S&TC Maintenance added. Maintenance elements incorporated throughout, including acronyms, descriptions, checklist and development plan. GOA acronym corrected.
Issue 3	20/07/16	Minor typographical changes/ Changes to the Control Centre Staffing model; [redacted]
Issue 4	02/05/17	DTUP Title added Edits to sections: Summary / 1 / 3.1 / 4.2 / 4.3 / 6 New section 5.6 added Appendix C – 'DTUP Continuous Improvement' added

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Livelink Nickname: **349782481**

OMC Revision: Issue 4

TfL Document Classification: Classified

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Summary

This Operations Vision and Transformation Statement provides an overview of the vision for operations and maintenance following upgrade of the DTUP lines.

The DTUP Programme is a key element of the TfL Business Plan aiming to continue the LU programme to upgrade ageing assets and to respond to current and forecast increases in passenger demand. Whilst doing this the programme is also maximising the opportunity to take a step forward in reliability; this is in order to deliver a truly world class service for our customers.

The Vision statement focusses on delivery of two of TfL's Strategic Objectives for DTUP:

- **Increase Capacity** – providing transport capability commensurate with forecast passenger numbers;
- **Improve Railway Safety and Reliability** – increasing passenger perception of safety whilst reducing system 'downtime';

In driving towards the goal of increased capacity, the chief change is the number of trains operating per hour (Tph) during peak periods. This measure must be achieved consistently, throughout the peaks, whilst maintaining the recovery margins, rather than being achieved as a 'one-off'. Peak values are between 27 and 33 Tph dependant on the line.

[redacted]

Improved maintenance practices support the drive towards the DTUP goal of increased reliability of the service. Discrete KPIs will be set in detail for maintenance in advance of the implementation of new processes, but at this conceptual level, it is the overall reliability that guides the development of new practices.

A set of operating and maintenance principles are established within this Vision describing a high level view of the way in which DTUP intends to operate and maintain the four lines post upgrade. They are relevant to the operation of the depots and stabling facilities as well as giving consideration to the protection of people who are working on or near the running lines, the depots or other operating hazards such as electrification equipment. It also considers contractors, passengers and other members of the public.

The principles provide guidance to future development of the OMC and subsequent processes and practices, as well as providing confidence to programme stakeholders that the concept is being developed to deliver operations and maintenance in accordance with their expectations.

This Statement looks at the impact of change on DTUP and the wider LU network. The people change aspects are common across the lines and are therefore described in some detail here. The main focus of this is the change in command and control structure that will transition to a Railway Manager and a Railway Controller (RC). The latter will have a direct interaction with the control system, thus combining the traditional roles of Service/Line Controller and Signaller.

Subsequently an overview of the Transformation is presented, summarising the detail of the individual concepts that form the OMC Volume 2. The exception to this is the overview of GOA1 with new train. This transformation is largely correlated to current operations and maintenance changes are captured in the Fleet & Depot Maintenance concept (OMC Volume 2 Part 3). Therefore, no discrete Part of the OMC is required.

Finally, Appendix C describes how Continuous Improvement processes are enacted within London Underground today and considers the impacts and considerations required for it during the development of DTUP. This also introduces how information availability can be harnessed by those requiring access to it within the wider LU organisation as described in Volume 2 part 5; Operational Control System Maintenance Interface.

1 Introduction

[redacted]

2 Programme Background

The DTUP Programme is a key element of the TfL Business Plan aiming to continue the LU programme to upgrade ageing assets and to respond to current and forecast increases in passenger demand. Whilst doing this the programme is also maximising the opportunity to take a step forward in reliability; this is in order to deliver a truly world class service for our customers.

Aligned to the Mayor's Transport Strategy and TfL's Strategic Objectives the four goals of DTUP are to:

- **Increase Capacity** – providing transport capability commensurate with forecast passenger numbers;
- **Improve Railway Safety and Reliability** – increasing passenger perception of safety whilst reducing system 'downtime';
- **Improve Customer Experience** – enhancing the travelling environment;
- **Reduce Whole Life Costs** – improving value for money through investment.

These goals are supported by a set of core Programme Objectives which are as follows:

[redacted]	[redacted]
Increase Capacity	To deliver increased line capacity to meet rising demand for services, address crowding and congestion on the network and reduce customer journey times.
Improve Railway Reliability	To achieve a step-change in railway reliability performance to rival leading world metros through a more complete understanding of inherent asset reliability and the interaction of assets with staff and customers in service.
[redacted]	[redacted]

[redacted]	[redacted]
Reduce Whole-Life Costs	To achieve the uplift in line capacity economically and efficiently through the specification of all aspects of the complete railway system to ensure the lowest overall whole-life cost.
Provide Air Cooling	To enhance the customer environment through the introduction of saloon air cooling on deep tube trains.
Managing Rising Platform Temperatures	To design solutions that consider fully the energy impacts of increasing capacity and performance in the constrained deep tube environment that when implemented will minimise energy consumption, enable energy recovery and maintain acceptable station temperatures.
Asset/System Renewals	To replace life-expired train systems and rolling stock assets with modern equivalents which deliver higher train performance, increased capacity and a reduction in journey times.

Table 1: DTUP Programme Objectives

3 The Vision

3.1 Operational Objectives

In driving towards the goal of increased capacity, several changes to the four lines will be implemented. Chief among these is the number of trains operating per hour (Tph) during peak periods. This measure must be achieved consistently, throughout the peaks, whilst maintaining the recovery margins, rather than being achieved as a 'one-off'. The objective for each of the lines is as follows:

DTUP Line	Piccadilly	Bakerloo	Central	W&C
Peak frequency objective	**33 Tph**	**27 Tph**	**33 Tph**	**27 Tph**
Note: figures for the Piccadilly, Bakerloo and Central lines are for the central part of each line at peak hours. Outer sections require lower train frequency. W&C line frequency is for the whole line. Full details are set out in the 'DTUP Programme Concept and Blueprint' document [Reference 9]				

Table 2: Peak frequency objectives for the DTUP lines at final state of upgrade

[redacted]

[redacted]

3.2 Maintenance Objectives

Improved maintenance practices support the drive towards the DTUP goal of increased reliability of the service. Discrete KPIs will be set in detail for maintenance in advance of the implementation of new processes. At this conceptual level, it is the overall reliability that guides the development of new practices. These overall targets are detailed as follows:

System	Overall reliability target for system
Rolling Stock	120,000 km mdbf
Signalling and Train Control	Defined for each ATC functional group, reference Volume 2 Part 4 Section 4.4

Table 4: Overall system reliability targets

3.3 High level principles of operation and maintenance

The following operating and maintenance principles provide a high level view of the way in which DTUP intend to operate and maintain the four lines post upgrade. They are relevant to the operation of the depots and stabling facilities as well as giving consideration to the protection of people who are working on or near the running lines, the depots or other operating hazards such as electrification equipment. It also considers contractors, passengers and other members of the public.

The principles, although grouped differently, are aligned to the Functional Breakdown Structure [Reference 10]. They will provide guidance to the on-going development of the OMC and operating and maintenance practices that will be enacted post-upgrade.

It should be noted that the development of these principles is impartial to the level of automation of the operational railway.

[redacted].

Operating Principle 2: Safely operate trains

All trains will be operated in a safe manner whether controlled manually or automatically. This principle applies to all trains on the DTUP lines, in all operating modes such as when rescuing a stranded train or managing the service during a signalling system failure. Safe operation also includes all activities associated with train preparation and transition into passenger service.

Operating Principle 3: Manage boarding and alighting of train services

Boarding and alighting of train services will be managed in such a way that all passengers and staff are able to use the transport system without risk to their health and safety. This applies to the stopping of trains in the correct location, supervision of passengers boarding and alighting, provision of communication and the safe departure of trains following boarding and alighting.

Operating Principle 4: Manage special running conditions

In the event of abnormal or degraded operations, planned and unplanned changes to the service plan or individual train missions will be enacted ensuring continued safe operation at all times.

Operating Principle 5: Detect and manage emergency situations

Railway systems (both technical and procedural) shall be designed to ensure that any incidents or emergency situations can be managed both safely and efficiently. Standard incident management protocols will apply, mirroring the Gold, Silver and Bronze command and control structure used by the emergency services, as implemented on the LU network today.

[redacted]

Operating principle 6: Protect people from hazards

Staff, passengers and members of the public will be kept safe from known hazards, this includes safe procedures for switching off traction current, application of protection zones for planned work on or near running lines and keeping non-railway employees safe from moving trains when entering railway controlled infrastructure or property.

Operating principle 7: Communicate with customers

Customer communication is essential to the effective movement of passengers to their destination and management of emergency situations. It occurs both visually and audibly, both in real-time and when triggered by pre-defined criteria, additionally two-way communications occur between passengers and staff.

Wherever possible the provision of customer information is automated. Live announcements using a public address system take precedence over automated announcements.

Operating principle 8: Manage and control traction power

Centralised traction power control will enable quick co-ordination between railway operations and power control. Efficient use of power ensures that the system is never in a condition where demand for power exceeds supply. This ensures the risk of loss of traction current and consequently stranded trains is minimised. Co-ordinated controls are especially important during emergencies in terms of providing safe movement for people both by bringing trains to stop in stations for evacuation purposes or by enabling the safe movement of people (passengers, staff or emergency services) on foot.

Operating principle 9: Manage performance

The systems to provide operational intelligence concerning how the service is performing, in order to enable immediate as well medium to long term service decisions. *[Performance management details are a work in progress, reference Appendix C.*

Maintenance Principle 1: Reliability

The maintenance regimes for the system, asset and components will be developed to provide high reliability rates for the overall system, thereby enabling the delivery of the required service performance. The system will feature inbuilt redundancy for safety, signalling and service affecting components, eliminating single points of failure wherever practicable.

Maintenance Principle 2: Availability

The maintenance regimes for systems, assets and components will be based on a ‘predict and prevent’ model, to assure high levels of system availability, which will enable the delivery of the required service performance. Maintenance will be scheduled to maximise service availability, whilst high levels of redundancy will afford teams the time to respond to, and rectify failures, without affecting the on-going operation of the railway.

Maintenance Principle 3: Maintainability

The capability and capacity to deliver the required availability and reliability will be assisted by both a system and procedures that are designed for ease of maintenance. It is essential that faults can be identified easily and that faulty equipment can be changed quickly and efficiently. This will be complemented by a maintenance model that seeks to extend the time between planned maintenance activities as far as possible, without increasing the risk of failure to the signalling system. Enabling features will include a strong human factors focus and supporting training regimes.

Maintenance Principle 4: Safety

The system itself and its maintenance procedures will be designed to ensure that hazards associated with maintenance activities are either eliminated entirely or are reduced as low as reasonably practicable (ALARP).

[redacted]

[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
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- [redacted]
- [redacted]

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[redacted]

4.1.4.1 Monitoring Sources, Data Capture & Storage

The strategy functions on the principle whereby the sources of asset data (from Condition Monitoring and manual inspection) are integrated and analysed together with other relevant contextual sources. Other data sources include work history, cost, and external factors like weather/temperature (i.e. the data warehouse is represented by the large black rectangle in the diagram).

4.1.4.2 Data Analysis

[redacted]

From this data (and with the suitable analysis tools) the following can be undertaken to enable:

a) Visualise and report on the data
b) Create alarms/alerts and risk based recommendations for the business to respond. This response may be work (i.e. planned or rapid response) on the asset as well as operational changes to mitigate the risk from the asset whilst it exists. Feedback of information on the work done etc. is fundamental to the learning process. We want to reduce the occurrence of alarms/alerts and increase the risk-based recommendations i.e. we become more predictive.
c) Use historic data to develop knowledge and understanding of assets and the effectiveness of our maintenance regimes.

4.1.4.3 Improved Asset Performance

The analysed data is then used to enable the implementation of the following improvements at asset performance to enable a predictive approach to be implemented including:

- Effective use of asset data to improve the maintenance and management of our assets
- Change and enhancement of maintenance regimes
- Applying a systems approach to the assets which make up our network
- Implementing the business change to make the benefits sustainable.

[redacted]

4.1.6 Technical

Technological change will be required to enable the new operational structure and process models. This will impact both the fleet, signalling and control systems. Design of this technology will be governed by the System Definition Requirements which must satisfy the User Requirements Specification derived from the three sponsor level concepts (this OMC, the Customer Concept, and the EV Concept.)

4.2 Operational impact on the wider LU system

Interface analysis is in progress and a series of workshops have been held in coordination with the DTUP Interface Manager for on-going development and as part of wider Operational Readiness planning.

[redacted]

[redacted]

5.1 GOA1 with new train

The new train will be introduced onto the Piccadilly and Bakerloo lines and will be manually driven, using the existing Trainstop / Tripcock signalling protection, until the Signalling system is fully Upgraded as part of the Programme.

As a result of the introduction of new Rolling Stock, customers will benefit from:

- Improved passenger comfort
- Real Time customer information
- Air Cooling
- Greater Accessibility
- Improved ambience
- Increased capacity

Key enablers for the Programme are:

- Operational staff will be trained and competent to make use of the new assets as they become available
- Depots will have all facilities required for the maintenance of the new train available prior to the arrival of the first train.
- All additional stabling capacity to be provided by the Programme will be available prior to the first train arriving on the network, to ensure that the legacy rolling stock can be retained for service longer than would otherwise be the case; in order to maintain service levels should the new trains be unavailable.
- Maintenance staff will be trained to perform all maintenance functions on the new train and will be supported by a skilled internal engineering team with extensive technical knowledge of the train.
- The trains will feedback key information about their status & health to a centralised point from where technically capable staff can ensure reliable operation.

[redacted]

[redacted]

5.4 Fleet & Depot Maintenance

Alongside the introduction of new rolling stock the duty cycle of the railway will be significantly expanded with both service frequency and hours of operation increased. Therefore, there will be a smaller window of opportunity for maintenance. Availability of a reliable fleet will be paramount.

The new maintenance regime will make full use of modern condition monitoring and inspection technologies to deliver maintenance according to condition. As much as possible a production line methodology will be realised via a flexibly designed depot layout.

This ethos will derive a maintenance approach that delivers the key business objectives of the future maintenance function:

- Reduced whole life cost
- High asset and service reliability
- Efficient use of resources
- Consistent, predictable and high levels of asset availability.

First line maintenance will be performed 'in-house'. Staff performing this work will be trained in the maintenance of the fleet, signalling the depot and use / maintenance of depot equipment (as appropriate) prior to assets being brought into use. Therefore, this will enable a smooth transition from old stock to new, with the aim of delivering high quality maintenance from the start.

A detailed description of the Fleet and Depot Maintenance concept can be found in Volume 2 Part 3 of this OMC.

5.5 Signalling and Train Control Maintenance

In conjunction with the introduction of new trains, a new signalling system will be commissioned to enable the capability to operate the lines under Automatic Train Operation / Automatic Train Control in alignment with their planned Grade of Automation.

Effective asset management of the RCS will be a critical element in ensuring that the lines continue to function at their optimum performance levels. This includes a reduction in service affecting failures, minimised maintenance interventions and reduced time to repair.

The new system will have inbuilt design to reduce service affecting failures: minimised trackside equipment which is located as far from trackside as possible, inbuilt redundancy eliminating single points of failure risk, and inbuilt emerging technologies enabling the remote reporting and diagnosing of faults.

The maintenance regime employed, similarly to the Fleet Maintenance regime will reduce the number of planned, periodic maintenance interventions. Condition monitoring will be used extensively to enable preventative maintenance without service interruption. Additionally any planned maintenance will be based on usage and or likelihood of imminent failure.

The maintenance regime employed will deliver the same key business objectives as mentioned in Section 5.4.

Similarly, all staff will be trained in the new maintenance procedures and the performance of maintenance itself. With the emergence of simulation and virtual reality technology there is the opportunity to develop a ‘system wide’ S&TC training facility which retains the core equipment of a traditional training facility but provides a virtual railway system which the equipment interacts with.

A detailed description of the Signalling & Train Control Maintenance Concept can be found in Volume 2 Part 4 of this OMC.

5.6 Operational Control System Maintenance and Data.

The maintenance of the Operational Control System and its operation and maintenance data interfaces to the wider LU are further described in a new Volume 2 Part 5 of the OMC.

6 Migration

[redacted]

7 Abbreviations

The following abbreviations are used in this document:

Table 7: Abbreviations	
Abbreviations	Definition
4LM	SSR Upgrade Programme
ACA	Asset Condition Assessment
ACCAT	Adhesion Controller Condition Assessment Tool
ADC/ADO	Automatic Door Closing/Opening
AGS	Asset Group Strategy
ALARP	As Low As Reasonably Practicable
ATC	Automatic Train Control
ATMS	Automatic Track Monitoring System
ATO	Automatic Train Operation
ATP	Automatic Train Protection
ATR	Automatic Train Regulation
BCV	Bakerloo, Central & Victoria (Lines)
BTUK	Bombardier Transportation United Kingdom
C&I	Control & Information
Cat 1	Category 1
CBTC	Communication Based Train Control
CCTV	Closed Circuit Television
CIS	Customer Information System
COTS	Commercial Off The Shelf
CRMS	Cable Route Management System
CSDE	Correct Side Door Enable
DISI	Defective In Service Instructions
DP&E	Depot, Plant & Equipment
DRM	Duty Reliability Manager
DSIM	Duty Signalling Incident Manager (BCV, SSR)
DTUP	Deep Tube Upgrade Programme
EMS	Energy Management System (also known as Building Management System)
EOT	Electrical Overhead Travelling crane
EP	Electro Pneumatic
FFCCTV	Forward Facing CCTV
FSA	Fleet Support Agreement
[redacted]	[redacted]
HMF	Heavy Maintenance Facility
HMI	Human Machine Interface
HVAC	Heating, Ventilation and Air-Conditioning
IT	Information Technology
ITN	Invitation To Negotiate

JNP	Jubilee, Northern & Piccadilly (Lines)
Kms	Kilometers
L0-7	Level 1 to 7 maintenance interventions – see also 0
LIM	Lead Incident Manager (BCV, SSR)
LPC	Local Performance Centre
LRU	Line Replaceable Unit
LU	London Underground
LUCC	London Underground Control Centre
LUL	London Underground Limited
M	Metre
MDBF	Mean Distance Between Failure (Also MDBSAF – see definition of SAF)
MIG	Maintenance Introduction Group
Mph	Miles per hour
[redacted]	[redacted]
MSA	Manufacture and Supply Agreement (MSA)
MTBF	Mean Time Between Failure
NDF	No Defect Found
OCC	Operational Control Centre
OCS	Operational Control System
OMC	Operations & Maintenance Concept
Operations (ASSETS)	Maintenance Management Team within the Operations Directorate
OPO	One Person Operation
OPO (T)	One Person Operation Tube
PA	Public Address
PCRO	Power Control Room Operative
PEA	Passenger Emergency Alarm
PED	Platform Edge Door
PKS	Staff Protection Keyswitch
PNR	Personal Needs Relief
POTIC	Process, Organisation, Technology, Information and Culture
PPP	Public Private Partnership
PTI	Platform Train Interface
RAM	Reliability, Availability, Maintainability
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
RCU	Railway Control User
REW	Railway Engineering Workshop
REW	Railway Engineering Workshop
[redacted]	[redacted]
S&TC	Signalling & Train Control

S&TCS	Signalling and Train Control System
SAF	Service Affecting Failure
SCADA	Supervision Control and Data Acquisition
SCD	Short Circuiting Device
SER	Signalling Equipment Room
SIM	Signalling Incident Manager (JNP)
SMM	Signalling Maintenance Manager
SOP	Saloon Operating Position/ Shunters' Operating Panel
SSR	Sub-Surface Rail
STECO	Steering Committee (Fleet OPERATIONS (ASSETS) led)
T/Op	Train Operator
TCMS	Train Control and Monitoring System
TfL	Transport for London
TMR	Train Maintenance Regime.
TNA	Training Needs Analysis
TpH	Trains per Hour
TSR	Temporary Speed Restriction
TTF	Time To Fix
TTS	Time To Site
UAM	User Acceptance Manager
URS	User Requirements Specification
[redacted]	[redacted]
VEID	Visual Electronic Information Device
VLU	Victoria Line Upgrade
VMI	Vehicle Maintenance Instructions (Process Instructions)
VMP	Vehicle Maintenance Processes
W&C	Waterloo & City (Line)
WSP	Wheel Slide Protection
WTT	Working Timetable
ZIM	Zonal Incident Manager (JNP)
ZMM	Zonal Maintenance Manager (JNP)

8 Definitions

The following terms are used in this document:

Table 8: Definitions	
Term	Definition
Normal Operations	"State of normal running of the railway incorporating minor disturbances and delays to the service in traffic hours and operations in non-traffic hours"
Abnormal Operations	"State of continuing railway operations with specific, planned changes to its configuration or equipment (such as special events, engineering works in traffic hours or within station public areas).
Degraded operations	"State of continuing railway operations with significant equipment failures" (such as track, train related failures and communication failures)
Emergency Operations	"State of the railway in response to a major safety or security related event. Introducing contingency plans at a moment's notice".

9 References

The following documents are referenced in this document:

Table 9: References		
Ref.	**Document ID**	**Title**
International Standards		
1.		
2.		
3.		
4.		
London Underground		
5.		
6.		
7.		
8.		
Deep Tube Upgrade Programme		
9.	DTUP-2344.2.2-LUL-RPT-00035	DTUP Programme Concept Blueprint
10.	DTUP-2344.2.2-LUL-DWG-00020	DTUP Functional Breakdown Structure
11.	DTUP-2344.1.1-LUL-RPT-00032	The "DTUP Operational Model and User Requirements Executive Summary"
12.		

The reference numbers in the above table can be used as a Cross-Reference in the main body of the text to link references to the correct entry in this table.

[redacted]

11 Appendix B – Description of Assets

Introduction

The following tables contain high-level descriptions of the essential characteristics of each of the railway asset area. Each characteristic has been classified according to the 'MoSCoW' system, as follows:

Must The characteristic is essential to the operation of the upgraded railway
Should The characteristic adds value and is necessary in order for the upgraded railway to be operable in the optimum manner
Could The characteristic is desirable to enhance the operability of the railway
Will not The characteristic is not delivered by the upgrade.

A MoSCoW rating has been given for the three key stages of the DTUP upgrade, and where applicable, shown for current, pre-upgrade operations, as follows:

Current Legacy trains - manually driven by Train Operators in driving cabs, protected by legacy trackside signalling, under the control of legacy train control systems.
GOA1 New DTUP Tube Stock trains manually driven by Train Operators in driving cabs, protected by legacy trackside signalling, under the control of legacy train control systems.
[redacted] [redacted]
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12 Appendix C - DTUP Continuous Improvement

1. DTUP Railway Performance and Continuous Improvement Objectives

How the railway is planned and then operated ultimately determines the performance achieved. Unless this performance can be meaningfully measured, evaluation is impossible and hence cannot be improved upon. Operational experience, combined with data, is therefore used to identify how to improve performance. This cycle: Plan, Do, Study and make robustly controlled Adjustment - is repeated, leading to continuous improvement.

The purpose of this section is to describe how the design of DTUP will permit and enable continuous performance[1] improvement.

The ability to measure 'operational performance[1]' (and more importantly the precursors that determine it) is a fundamental principle embedded in the DTUP OMC:

> ***Operating principle 9: Manage performance***
>
> *The systems to provide operational intelligence concerning how the service is performing, in order to enable immediate as well medium to long term service decisions.*

Achievement of the four goals of DTUP and their core supporting objectives (described in Volume 1 Part 2 of the OMC) can only be demonstrated and sustained by performance data monitoring. The availability and analysis of data therefore supports the achievement of these objectives because it measures the factors that contribute to them. In turn, performance against these overall LU network objectives can only be usefully managed through the monitoring of lower level more detailed system, asset and component performance data – in effect the various factors that combine to influence each separate objective.

Figure 1 shows this using the example of the signalling system contribution to network level objectives.

Using data, performance at network level can be drilled 'down into' for the purposes of getting to root causes and the identification of good and bad performance. The use of data in this way is undertaken by Line Management on a strategic basis.

Equally, in real time, Control Rooms and Maintenance Teams can pro-actively monitor performance at component or individual asset level. The aim is to ensure that individual assets continue to function as required and consequently that line performance remains within agreed tolerances. Bigger failures are prevented through the pro-active identification of issues requiring intervention to prevent a more disruptive incident.

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[1] This section concerns 'operational performance' data only; the measures that assure LU's punctuality, reliability and customer service metrics. Other operating Principles and performance metrics cover matters of health and safety and there is no reason why this data will not be captured by Controllers and Control Room Systems for wider use.

Similar performance monitoring and measurement (plus data collection) is undertaken for all other lines, and for all the other systems that create the railway such as Infrastructure and Rolling Stock together with their assets and components.

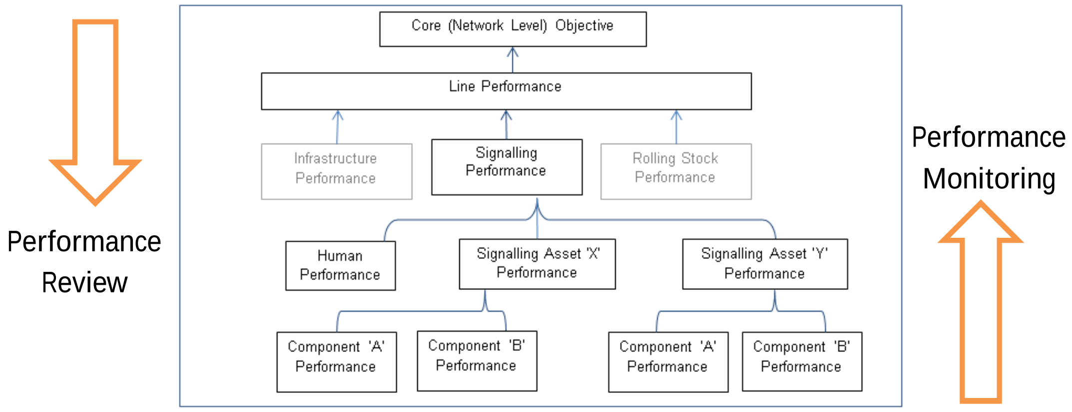

Figure 1: Component to Network performance relationship showing the use of performance data proactively and also 'after the event'

1.1 Internal Customers for DTUP Performance Data

The key internal customer groups needing DTUP Performance data are:

At System level:

- The Insight Team: The data required by LU's Insight Team for the purposes of performance reporting and benchmarking to a range of stakeholders – ensuring 'as designed' performance is, as a minimum, sustained
- Line Operations Management: Using Performance data in the OCC in real time to mitigate perturbation and also more strategically by Senior Line Operations Management to develop improvement plans.

At Sub-System level:

- Line Track and Signalling Management: Using Performance data in the OCC in real time to mitigate perturbation and also more strategically by Senior Line Maintenance Management to monitor assets and also develop improvement plans
- Fleet Management: Using Performance data in the LPC and Depot Production/ Technical Offices in real time to ensure availability and reliability. Data is also used more strategically to develop improvement plans and manage fleet reliability improvement campaigns
- Miscellaneous use by Station and Civils teams: e.g. for PED operations, tunnel and station cooling performance.

1.2 LU Current Performance Data Collection: KPIs

LU has a wide range of Key Performance Indicators. These are devised to best reflect the success criteria for the areas they represent:

- Operations areas cover: Train Operations, Station Operations and General Operations & Customer Service
- Asset Areas cover: Fleet, Track & Signals and then Stations, Civils and premises

KPI data is primarily logged and reported through the Heartbeat tool.

1.3 Heartbeat

Heartbeat is the LU intranet tool that receives data from a range of sources covering the business areas described above. It is the central point for LU Performance reporting.

The responsibility for maintaining performance data on Heartbeat lies with the TfL Insight team, whilst TfL Information Management maintains the tool and intranet site itself.

Heartbeat houses the Line and sub-level area 'Scorecards' across LU. The screen shot below shows the main welcome screen, and from here, each Line can then be further drilled into. Performance scorecards are produced for all areas of the organisation. They are broken down into specific areas of interest for job role and produced on a periodic basis (Daily Performance Dashboards are also available on Heartbeat).

Figure 2: Scorecard landing page with Bakerloo Line Detail selected showing area detail is further accessible.

2. LU Continuous Improvement Life-cycle

In simple terms, LU's 5-stage Continuous Improvement lifecycle is shown in figure 3, below.

Call out boxes explain the practicalities of how each step is undertaken. It is important to note that the diagram is not representative of a single, formal LU corporate process.

Instead, it shows a variety of ways in which the continuous improvement process will typically operate. It reflects the range of internal LU stakeholders and meetings that can identify an opportunity for performance improvement and then take steps to manage it through to implementation. Subsequent analysis ensures the desired results have been, and continue to be, achieved.

The over-riding principle of the process is that it is scaled to suit the size of the opportunity identified and managed at that level of influence with overall line or network level coordination ensuring that 'common' issues are managed and corrected consistently across the network. This system also ensures flexibility is retained for local innovation to local problems. The performance cycle used by LU seeks to enable staff to see how they can contribute to excellent performance and hence identify how to further improve it, permitting further propagation system-wide where relevant.

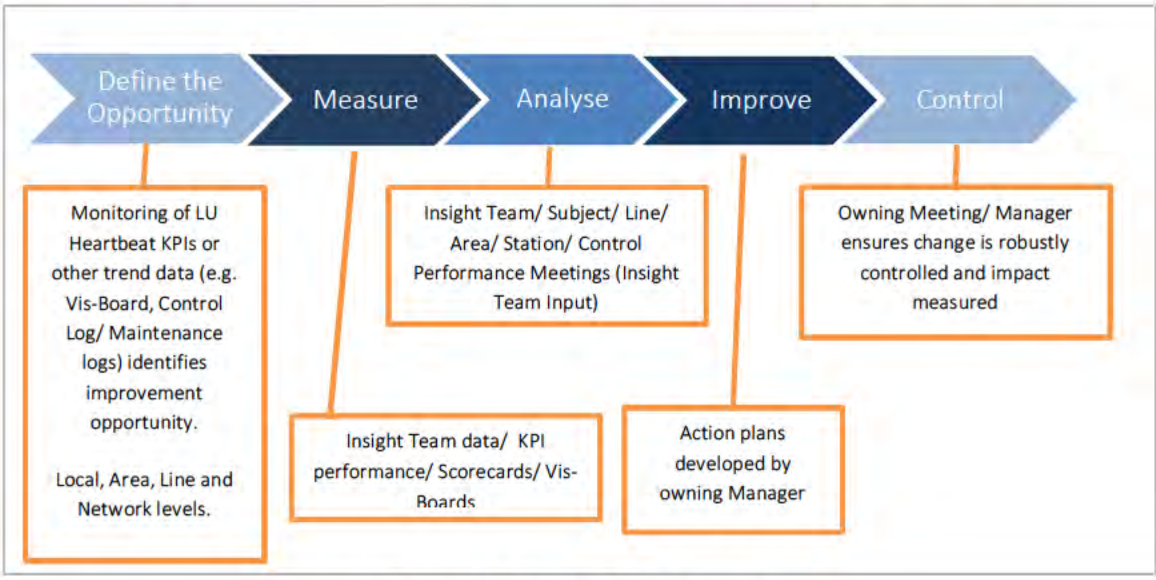

Figure 3: Simplified LU Process

2.1 Monitoring - How Data is Used

Each Line General Manager and their immediate team examine performance on a daily, weekly and monthly basis using the relevant Scorecards. Line Specific Reliability Insight Champions support them in this task. At Line specific level this review mainly concerns 'operational' data and does not seek to examine the performance of infrastructure assets or Rolling Stock where these have been the cause of operational delay. The management of infrastructure and fleet is undertaken by specific departmental reviews.

The Operations Directors and teams then review the performance of lines that form an operational group. At this level, analysis concerns review of the system as a whole and therefore examines operational, infrastructure and fleet performance in equal detail.

The Chief Operating Officer and Leadership monitor overall LU performance at Network Level.

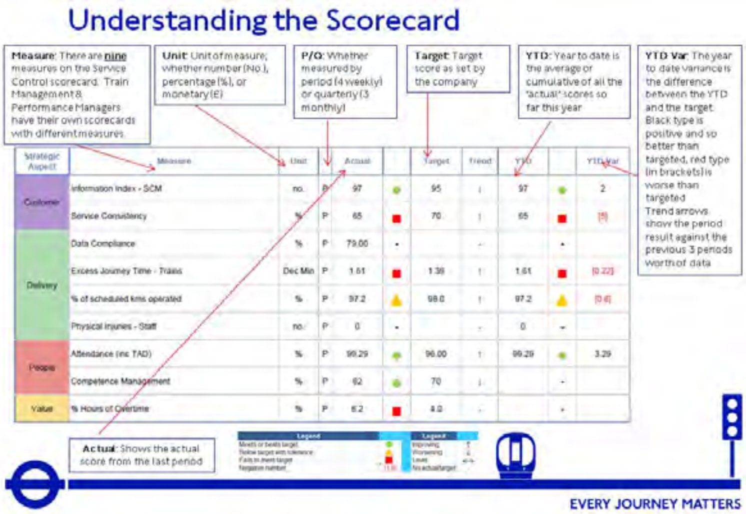

Figure 3: Service Control Scorecard explained

At local level, Scorecards are augmented with more real-time information via Vis-Boards.

2.2 Sub-System Level Monitoring

At sub-system level, information is used to populate Vis Boards – which give visibility of the current operational targets and the results actually being achieved. The Vis boards are generally used by weekly performance review meetings (a few daily, some fortnightly), which review recent performance and agree containment and tactical level actions.

Vis boards therefore allow a more dynamic look at trends so that things can be addressed in order to get the scorecard as good as it can be at period end. An example Vis Board is shown in Figure 4.

The scorecards are periodic, so review performance on a four weekly basis, and examine performance from a more strategic point of view.

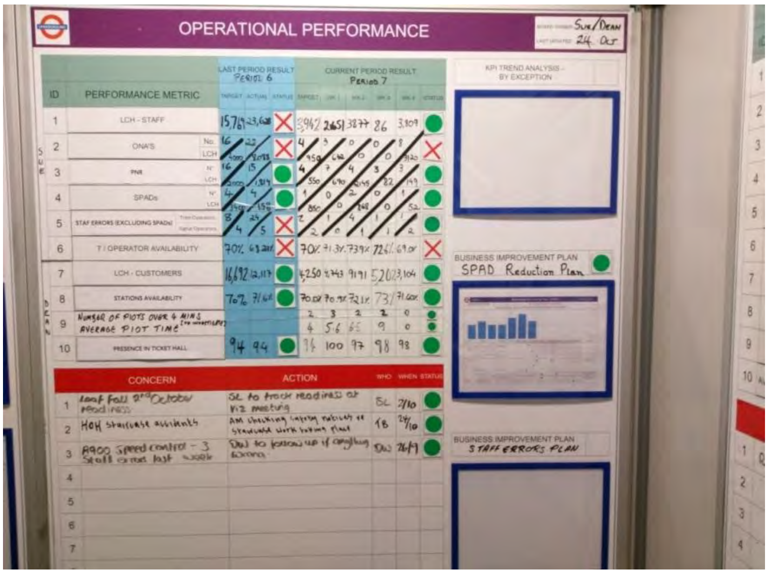

Figure 4: Typical Vis-Board

2.3 Data Sources and Automation Levels

At present, levels of ‘data collection automation’ vary according to the technologies employed by the different business areas concerned.

The current processes supporting each level of review are largely manual in terms of data collation, report compilation (including Heartbeat scorecards) and review. Meeting data packs take time to assemble and data cannot easily be viewed and manipulated by non-specialists. Only specific people can view and drill into collected data.

It is in this area that the technology for DTUP and advances in data collection automation and presentation can add value because root cause will be easier to identify.

Equally, many of the current LU assets were procured before asset condition monitoring technology was prevalent and before remote data connectivity. Again the investment that the DTUP Programme is making in this new technology offers the potential to review performance in real-time (e.g. precursor monitoring at the OCC Maintenance desk).

In addition to KPI monitoring via Scorecards and Vis-Boards, comprehensive data is compiled by LU’s Insight Team into subject specific reports.

Therefore, as a minimum, DTUP must be able to deliver the information necessary to support performance reporting in the following areas as per the current arrangements:

<u>Insight Team Products and Services (September 2016)</u>

- Delays measured in terms of ‘Lost Customer’ hours - totalling the additional travel time caused by hold-ups lasting more than two minutes (Peak hours result in more lost customer hours because more customers are affected)

- Journey and Excess Journey Time (EJT): This metric is part of a government measure designed to reduce the time it takes for customers to travel on the LU system. The EJT target measures the time it takes (in minutes) to complete an average journey on the network over and above the expected time, weighted by customer time values. DTUP can influence the platform waiting and on-train segments of the EJT measure.
  - Platform 'excess waiting time': providing a weighted average of the length of time customers wait for a train versus how long they should wait according to the timetable
- Peak and off peak performance
- Passenger-related delays per car km.
- Percentage of actual kilometres operated versus those scheduled to be operated (e.g. to take account for planned changes to the timetable e.g. engineering work.
- Service consistency
- Headways - Measures proxy excess platform wait times - the key indicator of train service reliability - targeted measure used in NOC daily review, Scorecards, & Tracker.
- Rolling Stock performance by average distance between failure
  - Train Reliability
  - Train Availability

- Equipment related incidents causing a five-minute delay per million car kilometres – caused by: Platform Screen Doors/ Power/ Track/ Signals/ Rolling Stock or 'Other' incident.
- [redacted]

- o Service update information frequencies
- o Staff sickness and lost time due to injury or assault
- o Customer incidents and accidents
- o Signalling faults
- o Track incidents:
  - o Derailments
  - o Broken Rails and other track defects
  - o Points defects
- Energy Efficiency

2.4 Performance Analysis (to find the root cause and what can be changed)

At Service Delivery Organisation (SDO) level, good as well as bad performance is reviewed and the opportunity is taken to identify the reasons for good performance (as this can be applied on other lines) in addition to developing action plans to mitigate poor performance.

At Line and SDO review levels, improvement activity is either commissioned locally or raised to a more appropriate or 'issue specific' senior review group comprised of subject matter experts. This decision will depend on the delegated authority or scale of impact – i.e. is the issue local to a specific line or could it occur to more than one line?

2.5 Improvement Action (trial changes)

Once data analysis has highlighted the reasons for good and bad performance trends at root, causal factor and underlying factor levels, action plans can developed to identify how to either improve performance or promulgate best practice.

Where possible resource is focussed on taking only a few actions that will bring most benefit and which can be robustly implemented. It is better to implement 5 actions sustainably than 20 which quickly falter.

2.6 Control / propagate improvement to make sure it continues to be effective

The final stage is the process of ensuring that action plans are robustly implemented and then regularly checked to ensure that they continue to work as designed; that they are having the desired performance results. This begins to implement new, standardised 'ways of working' and starts to embed a new operational and maintenance organisational culture.

It is often at the stage of corrective action plan implementation that the job is considered complete and management focus moves elsewhere. This often leads to a return to former ways of working and the initiative fades. Therefore, data must be constantly scrutinised to check that the change has been successful and that the control measures continue to work as intended.

3. Future Process to enable DTUP Continuous Improvement

3.1 DTUP Objective: Data to Support Identification of Performance Causes

The sections above have outlined LU's general continuous improvement process and show how data is used to inform decisions. This will continue on DTUP Lines and the opportunity to collect more data and make it useful to a variety of staff is a by-product of this.

DTUP will permit a change in approach (and ultimately culture) through the procurement of the tools necessary to implement 'Condition Based' Maintenance policies covering DTUP assets. This will permit pro-active decision making in real-time - based on the data collected - versus simply reacting to and reporting on, historical trends.

The concept is that asset performance data is used in a number of ways in addition to 'period end' (backwards looking) review and the opportunity is taken to record data where the introduction of new assets facilitates it.

It will support:

- OCC Operations and Maintenance staff in tactical minute to minute decision making
- Line Management daily and weekly performance reviews
- LU corporate performance reporting both internally and externally
- The management of precursors to failure of individual assets (permitting intervention before failure)
- Trend detection and analysis; hence contributing to continuous improvement
- Investigation of incidents which led to significant Lost Customer Hours
- Ease of data access and filtering - user friendly for a number of internal customers – e.g. Control Rooms, Senior Line Operations Management, Line Maintenance Management and LU Corporate Performance Teams. In essence, this is LU intranet accessible data with the ability to restrict user access to Administrator specified levels of detail.

Additionally, and in support of a proactive response, human continuous improvement is possible through the provision of the data and equipment necessary to analyse incidents in specific time stamped detail. This will permit the development of 'locally identified' KPIs to monitor, permitting Control Room staff to practice improved responses to incident precursors or incidents themselves.

3.2 System Approach

High levels of overall system performance are attained through the monitoring and management of the individual sub systems; moreover the assets and components that comprise them.

To properly measure the on-going achievement of DTUP objectives, they must therefore be further broken down in order that the 'achievement influencing' elements are identified and then sustainably managed. Each asset or input is measured to ensure that it is contributing (as a minimum standard) as expected to the overall system operation. This will, in final state, permit the monitoring of the system and the metrics that govern its performance in forensic detail.

Equally, and importantly for DTUP, the indicators of performance required are both leading and lagging. Lagging indicators for example may be expressed as service affecting failures (SAF) events – they can only be measured following the event. Such events may also be defined as being of low frequency but of high consequence to LU and its customers.

The tracking and management of leading indicators however, is designed to proactively prevent failure and is a key strategic goal for DTUP; contributing to the predict and prevent policy. It is only through the measurement and analysis of low level 'precursor' events (high frequency but low consequence) that permit SAF events to be forestalled before they can occur - taking action early can break the causal chain. This is a key thrust of the LU 'Predict and Prevent' strategy.

LU's approach for DTUP is to maximise the opportunities to improve reliability through taking a system approach.

It should also be recognised that DTUP has to be delivered as a series of stages before reaching a final 'steady state' which will take place over a number of years. The upgrade will occur as a series of phases in a live railway environment.

An example of how a DTUP system could operate in terms of maximising data use in real time and then retrospectively is shown diagrammatically in Figure 5.

3.3 Future Performance Management

The key point about future process is that Performance Management will:

- Be less 'top down' and will be built by allowing staff access to user-friendly data. This will enable staff to do their jobs more effectively
- Be User friendly - Data and systems will give staff the information they need to understand how they can affect performance and hence how to improve it.
- Allow, within reasonable constraints and without affecting operational safety, testing of potential performance improvements within the operational environment – such trials to be an output of carefully controlled continuous performance improvement initiatives/ plans.
- Once proven, propagate improvement measures thus creating best practice that can be applied across all 4 lines.

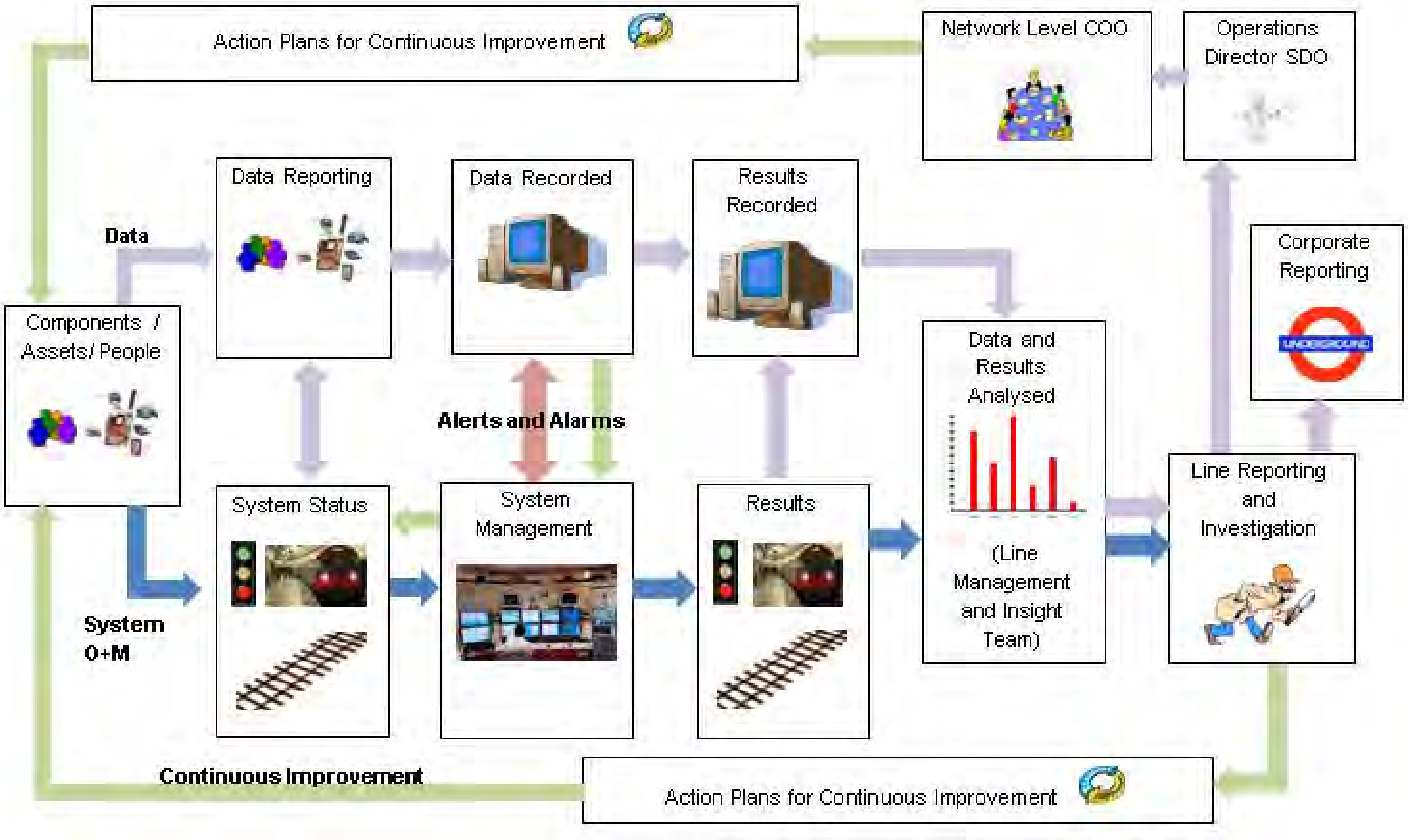

Figure 5: DTUP Collection and use of data for Continuous Improvement

3.4 DTUP 'Space-proofing' for Performance Data

It is envisaged that the RCO will have access to the following the general information:

- A performance-monitoring tool capable of collecting and analysing data relating to train service Key Performance Indicators. The outputs of this analysis will be viewed on a dashboard.
- RCUs will be able to view the status of the train service on a specific DTUP line on a Service Performance Dashboard. This dashboard will be displayable at workstations and/ or on the Overview Display Screen. The information displayed on the dashboard will be configurable.
- The performance-monitoring tool will be capable of comparing and displaying actual service performance against planned or historic performance.
- Performance-monitoring tools capable of dynamically collecting and analysing service performance data relating to the real-time delivery of the train service.
- The up to date status of selected Key Performance Indicators on a Service Performance Dashboard.
- A configurable Service Performance Dashboard. The configurable parameters will include: What service performance data is displayed and how the data is displayed (graphical and/ or numerical representation of selected performance measures); and Comparison functionality.
- Interfaces permitting storage and retrieval of historic service performance data. *Note: Service performance will be stored for comparison purposes with previous periods or service days.*
- The performance-monitoring tool will be capable of providing real-time and historic indicators of service performance relating to each of the DTUP lines.
- The performance-monitoring tool will provide a range of pre-defined historic reports or creation of bespoke reports
- Interface to the LU corporate performance monitoring systems for the export of data to these systems.

4. Conclusion

The guiding principle for enabling continuous improvement once DTUP is in operation is the provision of equipment (and the data from it) that enables staff to see current performance in detail and at overall level. This helps to identify how they can contribute to excellent performance and hence identify how to further improve it; permitting further propagation system wide. This investment will be focussed particularly on Operational Control systems.

DTUP Data capture systems will interface with existing LU performance review processes in order to assist with the identification of DTUP elements that may permit better performance and continuous improvement.

Transport for London
London Underground Limited

DTUP OMC Volume 2 Part 1

DTUP GOA2 Operational Concept

		Signature	Date
Prepared by	[redacted] Operational Development Manager	[redacted]	25/5/17
Reviewed by	[redacted] Upgrade Delivery Manager	[redacted]	25/5/17

Revision	Date	Summary of changes
Issue 1	26/02/16	First issue
Issue 2	11/04/16	Explanation of document style added to Introduction along with some minor refinements to phraseology throughout document.
Issue 3	20/07/16	[redacted]
Issue 4	02/05/17	NTfL is replaced by DTUP RCO aligned with changes from DTSM and TOSM to Trains Manager Section on Operation Control Centres added

TABLE OF CONTENTS

1 INTRODUCTION

1.1 Executive Summary

[redacted]

[redacted]

[redacted].

The DTUP railway in GOA2 is characterised by:

- An increase in peak train services from 24 to at least 33 trains per hour (TpH) in the central section of the Piccadilly line
- ATO on the Piccadilly and Bakerloo lines
- Migration from legacy ATO to DTUP ATO on the Central line, maintaining peak train services to at least 33TpH
- An increase in peak train services to from 22 to 27TpH on the Bakerloo line
- [redacted]
- A new signalling and control system
- A new Operational Control Centre that will eventually incorporate all four lines
- Off-train PEA awareness
- [redacted]
- Early prediction of and rapid recovery from disruption
- Improved flexibility allowing service to be maximised when the railway is degraded
- More robust assets providing greater reliability and availability
- Use of off-train data transmission to enable continuous monitoring of asset performance information and targeted, pro-active maintenance planning
- The provision of more timely, targeted and beneficial customer information
- A railway capable of operating 24hour passenger services
- Engineering hours and traffic hours consistent with the current network practices
- Non-normal directional movement under signalling protection to expedite train recovery.

The content of the document is an amalgamation of existing practice, established strategies and creative vision. In this context, the document depicts a potential state of the DTUP post upgrade and provides the basis for consultation, on-going conceptual design and development of user requirements. It should be read in conjunction with the User Requirements Specification, which contains explicitly, the user's needs for [redacted] operation.

1.2 Scope & Structure

This document is written from the end user perspective and provides a description of future DTUP operational practice operating in [redacted]

The scope of this document is:

- The Operational Organisation Structure and staffing model at GOA2
- The operational processes and techniques that are adopted to manage the service in normal, abnormal, degraded and emergency conditions
- The procedures for managing interoperability of DTUP trains with other lines and train services.

The structure of this document is:

Section 1 *Introduction* - contains an Executive Summary that highlights the salient points of DTUP GOA2 operation.

Section 2 *DTUP Operational Organisation Structure* - illustrates the Operational Organisation's structure.

Section 3 *DTUP Railway Processes* - describes the operational processes and procedures used to deliver the service.

Section 4 *Interoperation* - describes the operation of interoperable areas of the DTUP railway.

Section 5 *Appendix 1* - contains supporting information and context for content within Sections 2 - 4.

1.3 Style

This document is intended to provide a vision of Train Operations post upgrade to GOA2, but with variances that suit the operation of the upgraded railway in order to:

- enable the service for capacity uplift (as highlighted above in section 1.6);
- maximise the benefits from new technology;
- [redacted]

It is therefore written in the present tense from the perspective of someone describing the upgraded railway. This was the most effective way found to describe how LU will operate systems that have yet to be designed. Where something has been referred to in the past tense – it is describing the railway before the upgrade and will reflect today's operation of the railway.

Operational Procedures that are no different from those carried out on today's railway can be found in the Operational Rule Books. These can be located electronically in *The Management System* library http://onespace.tfl.gov.uk/lu_/OSSRB/default.aspx. Where relevant the specific Rule Book and section have been referenced.

2 DTUP RAILWAY – OPERATIONAL ORGANISATION STRUCTURE

2.1 [redacted]

[redacted] in [redacted]

Figure 1 – GOA2 Operational Organisation

2.1.1.2 [redacted]

2.1.2 [redacted]

[redacted]

[redacted] [redacted]

2.1.3.1 [redacted]

- [redacted]

2.2 Train crew accommodation

2.2.1 Piccadilly Line

2.2.1.1 There are four train crew accommodation and relief locations for Piccadilly line Train Operators: Northfields, Acton Town, Arnos Grove and Cockfosters.

2.2.2 Rayners Lane to Uxbridge

2.2.2.1 [redacted]

[redacted]

2.2.3 Central line

2.2.3.1 There are five train-crew management facilities on the Central line, at West Ruislip, White City, Leytonstone, Loughton and Hainault.

2.2.4 Bakerloo line

2.2.4.1 There are two train-crew management facilities on the Bakerloo Line at Elephant & Castle and Queens Park.

2.3 Operational Control Centre (OCC)

2.3.1 New OCC

A new OCC co-locating the control of all four lines will be built as part of the DTUP. At the time of writing, it is assumed that:

2.3.1.1 The Bakerloo line will be the first to transfer from its existing Baker Street service control facility to the new OCC, to support migration to GOA2.

2.3.1.2 The Piccadilly line will then migrate to the OCC once the Bakerloo line Upgrade is complete.

2.3.1.3 The Central and Waterloo & City lines will then join as they are upgraded

2.3.2 [redacted]

[redacted]

2.3.3 Back up control

2.3.3.1 A requirement exists to have the ability to control the railway in the event of either OCC detailed above becoming unavailable

2.3.3.2 This capability will be required when new signalling is commissioned on a line (when inherently, previous back up arrangements cease to be available).

3 DTUP RAILWAY PROCESSES

3.1.1 Introduction

3.1.1.1 This section describes the processes used by the operational organisation to deliver, maintain and, where necessary, recover the train service in normal, abnormal, degraded and emergency conditions, whilst ensuring the safety of customers and staff at all times.

3.1.1.2 The processes described have been developed in response to the functional design undertaken in the feasibility stage of the project, and aim to identify how the various railway functions will be delivered by the operational organisation, utilising new and upgraded assets.

3.1.1.3 The structure of this section (3.2 to 3.8), therefore, mirrors the DTUP Functional Breakdown Structure, to ensure consistency and clarity of understanding. [Note: the User Requirements Specification is also structured in this way]

3.2 Train Movements

3.2.1 Scheduling Train Movements

3.2.1.1 The railway's control system schedules train movements for each day. As inputs, it takes account of the following:

- The active Working Timetable (WTT)
- Forthcoming maintenance tasks scheduled by maintenance planning tools (e.g. Maximo and Ellipse), providing requests for particular train sets to be at specified maintenance facilities within a stated time-frame
- The availability and location of rolling stock, determined by maintenance activity and depot management
- A list of ad-hoc train movement requests made by the responsible RCU.

3.2.1.2 The schedule states the times and locations of individually identified trains over the planned-for period using the basis of the Working Timetable to:

- Set routes for trains
- Schedule the trains' routes and trips into and out of service from Depots and stabling locations
- Generate movement authorities for trains
- Highlight potential conflicts between planned movements and train-crew scheduling
- Schedule empty stock-balancing train trips.

3.2.2 Controlling Train Movement – Automatic Operation

3.2.2.1 The train's movement and systems operate automatically other than where it is specifically described within this concept.

3.2.2.2 Each train is given authority to move (movement authority) by the signalling system, which commands each train to motor, coast and brake, thus enabling Automatic Train Operation (ATO).

3.2.2.3 All necessary settings and controls to the DTUP infrastructure, for example, setting routes necessary for the scheduled train movements are applied automatically.

3.2.2.4 The train travels automatically between stations. The railway control system continuously monitors each train's location and ensures it is adhering to line speed, which includes all local speed restrictions. The train's target speed (the speed at which the signalling system determines the train needs to operate in order to maintain the targeted service) along with confirmation of availability of ATO and Automatic Train Protection (ATP), is indicated to the Train Operator on the train's control panel.

3.2.2.5 Continuous automatic corrections are applied to the running of trains to even out gaps between trains, avoid trains being held stationary in tunnels, and deliver the timetabled service. Relevant information pertaining to the condition of the service is presented to RCUs in the Operational Control Central (OCC), ensuring they have the relevant situational awareness, should a manual intervention be required to prevent or recover from an interruption to the normal running of the service.

3.2.2.6 These corrections may take the form of instructing trains to coast/motor to increase/reduce inter-station run-times, and extending dwell-times, within pre-defined parameters, to even out headways between trains.

3.2.2.7 These corrections are applied automatically and in most circumstances invisible to Train Operators when the train is moving between platform stops. Train Operators are presented with the dwell time for each station stop, which supports timely departure. If the train is held, extending the dwell, the Train Operator is made aware. Passengers are kept abreast of changes to services that may impact their journey.

3.2.2.8 ATO automatically brings trains to a halt within the tolerance of each designated platform stopping point.

3.2.2.9 The Train Operator's responsibility for each station stop is covered in section 3.3 'Customer Movement'. When it is safe to depart the platform, the Train Operator initiates the train's departure, which is then controlled automatically by the system.

3.2.2.10 The Train Operator is able to override and inhibit automatic train movements, e.g. to prevent the train from leaving a platform in response to an observed unsafe condition.

3.2.2.11 The Train Operator is able to directly apply the train's emergency brake, and in these circumstances, the railway's control system cannot restart that train's movement. The Train Operator must initiate restarting the train when they are satisfied it is safe to do so.

3.2.2.12 Trains can be routed in a non-normal direction to aid the recovery of trains, or in the event of a serious failure which prevents the train from moving forward in the normal direction (See section 3.2.12).

3.2.3 Controlling Train Movements – Manual Operation

3.2.3.1 When it is necessary for a Train Operator to directly control the movement of the train, the Operator puts the train into Manual Mode and uses the Traction Brake

Controller to command the train to motor, coast and brake.

3.2.3.2 Trains can only be permitted to move in Manual Mode when authorised by the responsible RCU.

3.2.3.3 When a train is operating in Manual Mode, it is identified as such to RCUs in the OCC.

3.2.3.4 If automatic train protection (ATP) is available, i.e. signalling and train control is functioning correctly, indication of the presence of a movement authority and target speed at which the train is to be operated are provided. The Train Operator observes this information and keeps the train at or below the indicated target speed and within the limit of the movement authority.

3.2.3.5 If the train exceeds the target speed, a warning is provided and if the over-speeding continues, or exceeds a predefined limit, the ATP will bring the train to a halt. Similarly, if the Train Operator attempts to move the train beyond its movement authority, the ATP will bring the train to a halt. In both cases, the infringement is detected which raises an alarm to the responsible RCU.

3.2.3.6 If ATP is not available, the Train Operator drives the train by line of sight, observing the roadway ahead of the train, and bringing it to a halt before any obstructions.

3.2.3.7 Indications are provided on the train's exterior to inform observers that the train is not under signalling control and may therefore move when and where it is not expected to.

3.2.3.8 The Train Operator is able to view platform and stabling berth stopping positions from the train's driving position (described in section, 3.2.4).

3.2.3.9 In certain circumstances it is necessary to move a train beyond its movement authority when the ATP is still operational, for example, in order to couple two trains together (see section 3.2.13), or to move a train into a maintenance facility.

3.2.3.10 In these circumstances, the Train Operator must first ensure that their train is at a halt and then seek authorisation from the responsible RCU before proceeding. Once authorised, the Train Operator moves the train as described in section 3.2.3.6.

3.2.4 Platform stopping positions

3.2.4.1 There are two methods that assist the Train Operator to stop the train within the tolerance of the platform stop when the railway is degraded and trains are driven manually. These are:

- infrastructure mounted chevron signs that are viewed against fixed markers on the train at the operating position when the Train Operator is seated, provide the Train Operator with a visual target to aid stopping within the platform's tolerance;
- an additional stopping accuracy detection system, which may utilise the in-cab monitors to provide the Train Operator with a visual indication that assists them to stop the train at the correct position. [redacted]

[redacted]

3.2.5 Transfer the train to a stabling location or siding (inc emptying the train)

3.2.5.1 Prior to a train entering the depot or sidings to stable, passengers are detrained by the Train Operator or station staff. Information visible from the platform, informs staff that the train terminating requires detraining.

3.2.5.2 On train customer information informs passengers that the train is terminating.

3.2.5.3 The train is checked to ensure it is clear of customers and any lost property. De-training staff then use controls within the saloon to close all doors on each car as they walk through the train, to ensure no customers re-board the train.

3.2.5.4 Note: when a train is due to reverse in service via a siding without laying over (i.e. remaining there for an extended period of time), staff are not required to attend and detrain customers. Audio/visual messaging informs customers that the train is terminating at this station and they must alight from the train. However, since the train will not be stabled in the siding and will shortly return to the station (albeit on a different platform), there is no risk of customers being stranded in Sidings if they do not alight. [Note: in the event that the return move is delayed, saloon CCTV on the train can be used by the Train Operator to check whether any customers have remained on the train].

3.2.5.5 Once the train is clear of passengers and all passenger doors are closed the Train Operator returns to the cab. The train is operated in Automatic mode and moves away from the platform onto the depot reception road.

3.2.5.6 Not used.

3.2.5.7 The train stops at the signalling boundary where the Train Operator changes the driving mode from Automatic to Manual Mode. Once authority to proceed is given to the Train Operator, the train is driven manually into its designated berthing location.

3.2.5.8 Once the train is in place, the Train Operator shuts down the train and exits.

3.2.5.9 More information on depot operations can be found in Vol 2 Part 3 DTUP Fleet & Depot Maintenance Concept

3.2.6 Staff access depot or sidings

3.2.6.1 Access to the depot is strictly limited to trained and licensed staff wearing the correct personal protective equipment. The Train Operator uses the official walking route to access the train. Where crossing the track is necessary, safety measures are in place to protect people. Access to the drivers cab is via modified access platforms. [Note: In order to access sidings in tunnelled sections, traction current must be removed.]

3.2.6.2 Not used.

3.2.7 Staff Access to the train

3.2.7.1 The train is equipped with a driver's cab and cab-side doors.

3.2.7.2 For GOA2 operation, the Train Operator's duties are carried out from a partitioned cab, which is accessed from track or platform via a cab side door, and from the passenger saloon via a door in the cab back wall (the J-Door).

3.2.7.3 *Not used.*

3.2.7.4 Access to the train's cab and operating position at crew change locations is from the platform, through the cab-side door.

3.2.7.5 At stabling locations and in depots access to the train's cab is through the cab side door via staff access platforms.

3.2.7.6 At a number of locations on DTUP lines, the train is greater in length than the platform and the cab will be in the tunnel. Under normal circumstances the Train Operator is not expected to have to leave the cab but if access to the platform is required at these locations, it is through the J-Door and leading passenger saloon doors.

3.2.8 Train preparation for service

3.2.8.1 [redacted]

3.2.8.2 *Note: The Train's Operating Environment allows for simplified preparation. It is easily accessible, with minimal time required to set up ready for Operation; incorporating Human Factors best practices and lessons learnt from recent LU Rolling Stock upgrades. The features and controls are intuitive and allow for quick adjustment; they include a fully adjustable chair and footrest. Other features are included to meet the expectations of the Train Operator such as: cupholders, sunblinds, storage space for belongings, temperature and air flow controls, controls for task lighting, enhanced sightlines, intuitive and ergonomic controls and instruments, minimal ambient noise.*

3.2.8.3 A facility at the operating position will be provided for the Train Operator to notify the RCS that the train is now under operator control.

3.2.9 Transfer of train from stabling site to station stop

3.2.9.1 When ATO is present at stabling locations, including depots, movement of the train is consistent with the mainline and initiated when movement authority permits, by the Train Operator. On leaving the stabling site, the train automatically travels to the first designated platform where the train stops and the saloon doors automatically open [See 3.3.2.4].

3.2.9.2 When ATO is not present at stabling locations, movement of the train is under the manual control of the Train Operator. Once ATO becomes available, the Train Operator changes the train to automatic mode, and instigates the re-starting of the train movement.

3.2.10 Non–stopping platforms

3.2.10.1 Due to certain operational requirements, it occasionally becomes necessary to prevent trains from stopping at a platform (or platforms). This can be due to an incident or safety risk, a planned closure of a station or platform for maintenance activities, or an asset failure [Note: See section 3.5.2 – Programme Platform/Station Skip]

3.2.10.2 If a train approaches a platform it is not due to stop at, and the route through or ahead of the platform is not clear, the train comes to a halt before any part of it enters the platform road. This is to prevent a train halting in a platform either partially or fully without the customer doors opening, which is undesirable, as it causes confusion to customers, who may attempt to board or alight from the train, or to operate Passenger Emergency Alarms (PEAs).

3.2.10.3 Once the route through and ahead of the platform becomes clear, the train is instructed to automatically move through the platform.

3.2.10.4 The train traverses non-stopping platforms at the appropriate speed. This is to mitigate risks caused by a fast moving train passing close to customers at the edge of the platform.

3.2.10.5 The Train Operator receives an automated notification informing them that the station or a platform is closed.

3.2.10.6 An automated announcement notifies the customers on the train of the station or platform closure and that the train will not be stopping at the platform.

3.2.10.7 The train's external information displays change to reflect that the train is not stopping, to inform passengers on the platform when at the previous open platform, of the next available station stop.

3.2.10.8 If the train is not stopping at a terminus platform, the previous open platform becomes the terminus point, which is reflected by the train's Customer Information.

3.2.11 Movement of engineers' vehicles and alien trains

3.2.11.1 Engineers' vehicles are fitted with the DTUP ATP system, enabling them to run under signalling protection on DTUP lines. They are manually operated and depending on type, may need to operate at a reduced speed compared to passenger trains.

3.2.11.2 Stabling berths to accommodate over-length engineers' vehicles are provided in the Piccadilly and Central line depots. [Note: certain reversing sidings on the Piccadilly and Central lines are also able to accommodate trains of this length].

3.2.11.3 Some vehicles that cannot be equipped with DTUP ATP, for example some road-rail vehicles and legacy stock, are occasionally required to run on DTUP lines. These vehicles are only able to run inside an engineering possession.

3.2.12 Non-normal direction movement of trains

3.2.12.1 It occasionally becomes necessary for a train to be moved for a limited distance in the 'wrong' or non-normal direction. This can occur at any location on the railway and is usually in response to a serious failure or incident that prevents trains from continuing in the planned direction of travel, and therefore risks customers being stranded on trains in tunnels for an extended period of time.

3.2.12.2 In these circumstances the responsible RCU makes arrangements to prevent any other trains moving into the area in which the non-normal direction movement is to take place.

3.2.12.3 In addition, the train undertaking the movement is prevented from moving beyond the agreed limit of the movement.

3.2.12.4 The responsible RCU defines the location at which the non-normal direction movement will be completed (the Limit of Movement). The train immediately to the rear of this location is brought to a halt, and the Train Operator is instructed to immobilise their train until further instructed. When the train is immobilised, an external indicator is illuminated continuously at both ends and the train's headlights are extinguished. .

3.2.12.5 This train then provides a physical barrier that prevents any other train from entering the area, and prevents the train undertaking the non-normal direction movement from proceeding further than the agreed limit of that movement.

3.2.12.6 The location of the Limit of Movement is communicated to the Train Operator. Note: All Train cabs are fitted with operational radios, which provide secure one-to-one communication between the responsible RCU and the Train Operator. In addition, Train Operators carry hand held radios that offer the same functionality as the Train's operational radio, and which are linked to the train's operational radio.

3.2.12.7 Note: A Train Radio failure requires a second person on each train, as required by Railway Operating procedures. If a second person cannot be provided, the alternative is to suspend the service.

3.2.12.8 The Train Operator then operates the Wrong Direction Move lighting, displaying red tail lights at the rear and both head and tail lights at the non-normal direction leading end.

3.2.12.9 The Train Operator then moves the train as far as the agreed limit of the movement. While the train is moving, the Train Operator sounds a continuous series of short whistle blasts to alert anyone on or about the railway that it is moving in the non-normal direction.

3.2.12.10 Once the non-normal direction movement has been completed, the Train Operator is instructed to resume normal direction operations.

3.2.12.11 The protection can then be withdrawn, and the train to the rear can be instructed to switch back to automatic movement.

3.2.12.12 Not used.

3.2.13 Rescuing Stranded Trains – General Principles

3.2.13.1 The use of continuous automated asset condition monitoring and remote fault-finding and fault-rectification has rendered it extremely unlikely that trains become stranded between stations with customers on board.

3.2.13.2 However, it is recognised that such a situation could still arise and therefore, the following section sets out the various procedures to be undertaken to rescue stranded trains.

3.2.13.3 A strategic plan for recovering the stalled train is developed by the responsible RCU. This may be the Service Controller in charge of the area in which the train has become stalled, or it may be the Service Manager who takes charge.

3.2.13.4 In most instances, one or more DRMs will attend and assist the Train Operators with the actual recovery on site, in response to, and under the strategic guidance of, the RCU in charge of the recovery. Station staff may also assist with the procedure.

3.2.13.5 Other RCUs in the OCC adjust the service and/or individual train trips to provide the optimum service to customers on the rest of the line. This may include suspending the service on part of the line and applying procedures from the Line Emergency Plan which may involve implementing an emergency Timetable – for more information see OMC Reference Data and section 3.5.13.

3.2.13.6 Evacuation of customers is detailed in section 3.3.7 – 3.3.8.

3.2.14 Rescuing Stranded Trains – Coupling trains together

3.2.14.1 DTUP trains are fitted with coupling devices at each end of the train, which allows coupling and train recovery on all areas of the railway.

3.2.14.2 A stranded train can be recovered using an assisting train to either push or pull the stranded train to a suitable location. Trains must be coupled together to achieve this.

3.2.14.3 Having ensured that no other trains are in the area, the responsible RCU arranges protection (Section 3.5.3) to prevent any other trains from entering the area.

3.2.14.4 Prior to recovering the stranded train, whenever possible and therefore in most circumstances, passengers are detrained from the assisting train onto an empty platform.

3.2.14.5 To recover a train the assisting train proceeds under signalling protection towards the stranded train, up to full line speed, until it no longer receives movement authority. Once the limit of movement is reached, the Train Operator receives authority from the RCU, puts the assisting train into Manual Mode and proceeds towards the stranded train. A yellow light at each end of the train's exterior flashes, denoting the train is being driven in Manual Mode and without signalling protection.

3.2.14.6 The Train Operator on the stranded Train secures and immobilises it by applying the train's brakes to ensure is does not roll when the assisting train couples to it.

3.2.14.7 The assisting Train Operator checks the exterior of the stranded train for the indication that it is secured, and checks the alignment of both trains' couplers.

3.2.14.8 Images from Forward Facing CCTV targeted directly at the front of the train, can be selected from the in-cab monitors, providing the Train Operator on the assisting train an alternative perspective of the couplers.

3.2.14.9 If passengers remain on the stranded train, an RCU can trigger pre-determined customer information from the OCC, to the train, keeping passengers abreast of the procedure. The Train Operator on the stranded train is available to reassure passengers, and make regular Public Address announcements in order to keep passengers informed of progress. Remote Public Address is also available from the OCC. Similarly, on the assisting train, if passengers remain on board, pre-determined customer information can avoid the Train Operator's use of the PA, unless they are required to do so specifically.

3.2.14.10 The assisting Train Operator moves the train towards the stranded train and couples the trains together.

3.2.14.11 Confirmation of coupling is notified to the Train Operator at the operating position of the assisting train and to the responsible RCU at the OCC.

3.2.14.12 Communication between the Train Operator at each operating position is via the Train Radio or the Cab-to-Cab handset, the latter allowing for private conversation to take place between the Operators, if passengers remain on either train. Hands-free Cab-to-Cab communications can be selected, which allows the Operators to converse, without having to physically hold the handset.

3.2.14.13 Once the trains are coupled, the Operator on the rescuing train is able to control the brakes on both trains (providing this is not prevented by the underlying defect). The Operator on the defective train is also able to apply an emergency brake to bring the coupled trains to a halt, if necessary.

3.2.14.14 Movement of coupled trains is limited to manual.

3.2.15 Rescuing a stranded train - pushing out with an assisting train

3.2.15.1 If the stranded train is to be pushed by the assisting train, the Train Operator from the stranded train moves to its leading end.

3.2.15.2 Once at the leading end, the Train Operator establishes the method for applying the brakes of the coupled trains in an emergency, and sets up a secure communication channel with the Train Operator on-board the assisting train.

3.2.15.3 When both Train Operators are satisfied that the procedure can commence, the assisting train is put into Manual Mode. The stranded train is put into a mode that permits the train to be moved.

3.2.15.4 The Train Operator on the stranded train contacts the responsible RCU, confirms the location of the planned limit of movement for the coupled trains and requests authorisation to proceed. When authorised, the Train Operator on the stranded train observes the road ahead and instructs the assisting Train Operator to proceed.

3.2.15.5 The assisting train is driven in Manual Mode and the assisting Train Operator controls the movement of the coupled trains, in response to instructions to motor, coast and brake from the Train Operator at the leading end of the stranded train.

3.2.15.6 If the stranded train contains passengers, the Train Operator on the assisting train shunts the stalled train into the next available platform, stopping in a position that allows the passengers to be detrained.

3.2.15.7 The train is taken out of service and recovered to an appropriate location.

3.2.16 Rescuing a stranded train - pulling out with an assisting train

3.2.16.1 If the stranded Train is to be pulled by the assisting train the Train Operator secures and immobilises it and moves to the leading end.

3.2.16.2 The Train Operator in the adjacent cab of the stranded train establishes the method for applying the brakes of the coupled trains in an emergency, and sets up a secure communication channel with the Train Operator on-board the assisting train.

3.2.16.3 When both Train Operators are satisfied that the procedure can commence, the assisting train is put into Manual Mode, the stranded train is put into a mode that permits the train to be moved.

3.2.16.4 The Train Operator on the assisting train contacts the responsible RCU, confirms the location of the planned limit of movement for the coupled trains and requests authorisation to proceed.

3.2.16.5 The train is driven in Manual Mode and the assisting Train Operator controls the movement of the coupled trains. If the stranded train contains passengers, the stalled train is pulled into a position that allows the passengers to be detrained.

3.2.16.6 The train is taken out of service and recovered to an appropriate location.

3.2.17 Rescuing stranded legacy Tube Stock

3.2.17.1 The DTUP Stock train is capable of recovering legacy Tube Stock train by use of a portable interface coupler. [Note: Throughout the migration phase, the portable couplers may need to be placed at strategic locations along the Line.]

3.2.18 Recovery of a gapped train

3.2.18.1 A train is said to be “gapped” when it stops in such position that it is sitting over a gap in the traction current conductor rails, and none of its current pick-up shoes are in contact with the live rails.

3.2.18.2 The layout of traction current conductor rails and the configuration of current pick-up shoes on the train have been designed to minimise the risk of trains becoming gapped.

3.2.18.3 A train can become gapped, however, in the event of it losing some of its pick-up shoes due to, for example, striking obstacles on, or near the track.

3.2.18.4 Batteries on the train may enable up to a minimum of 50 meters of slow speed self-powered movement when crushed laden or 200m when empty on level gradient.

3.2.18.5 When moving under self-power the train normally remains in Automatic Mode, maintaining signalling protection (self-powered movement is also available when the train is driven manually). All self-powered train movements require authorisation from the responsible RCU, and are enabled by the Train Operator.

3.2.18.6 The train provides the Train Operator with an indication at the operating position when it is unable to pick up traction current, and potentially needs, therefore, to be moved under its own power.

3.2.18.7 The Train Operator and the responsible RCU are aware of the train's self-powered capacity.

3.2.19 Recovery from a failure in the supply of traction current

3.2.19.1 If it becomes necessary to switch off traction current when trains are operating in customer service, every attempt is made to work all trains in the affected section into platforms and bring them to a halt, or to allow them to work clear of the affected section before current is switched off

3.2.19.2 Occasionally, however, this is not possible due to an emergency or a failure of the power supply.

3.2.19.3 The on/off status of traction current power supply in every current section is interlocked with the signalling and train control, but can be overridden to enable the movement of trains in the affected section. In the event of traction current being switched off, or lost, the RCS brings to a halt any train approaching the dead section, which can safely be stopped before any part of it enters the dead section.

3.2.19.4 The RCO are aware of the status of traction current in each section; when it is switched off, or lost, the responsible RCU receives a notification. When the train loses traction current the Train Operator receives an on-board notification.

3.2.19.5 Trains already moving in the section when traction current is lost are automatically instructed to coast until they reach the platform stopping point at the next station, provided they have sufficient inertia and a movement authority.

3.2.19.6 If a train is moving between a station and the end of the dead section, and providing it has a movement authority and sufficient inertia, it coasts into the next live section. Providing the train is in Automatic, once it is has picked up traction power again, Movement Authority is confirmed to the Train Operator and the train re-starts.

3.2.19.7 Not used.

3.2.19.8 If a train comes to a halt in the dead section without reaching a station, the train's batteries have sufficient capacity to maintain those services on-board which are essential to customer safety and comfort for a minimum of two hours. The status of the power sources is presented to the Train Operator and to the responsible RCU, enabling strategic decision making on how best to use remaining power. This is essential to enable operational staff to determine the train's capacity to move under its own power, without compromising the ability to maintain essential systems.

3.2.19.9 These services include:

- Saloon emergency lighting
- Train Radio
- Remote public address system
- Passenger emergency alarms
- Train secure indication
- External lighting and display systems,
- Recording and on demand transmission of CCTV images
- Saloon ventilation
- Sufficient control functionality to enable train to resume automatic operation on restoration of traction power
- Sufficient control functionality to enable self-powered movement
- Fire detection
- Saloon interior digital customer information displays

3.2.19.10 If a train has come to a halt in the dead section, but still has a movement authority the responsible RCU or Railway Manager may take the decision based on a dynamic risk assessment, to use the power from the train's batteries to move it closer to the station under the advice of Service Control.

3.2.19.11 The Train Operator initiates self-powered movement from the operating position.

3.2.19.12 This action impacts on the amount of time the essential services on the train can be maintained. The decision is therefore based on a dynamic risk assessment, determined by the capacity status of the train's batteries, the proximity of the train to the nearest station, and the predicted time to recovery of traction power.

3.2.19.13 In the event that loss of traction current is likely to persist for a significant period of time, and trains are stranded in tunnels without movement authority or sufficient battery power, the responsible RCU may take the decision to evacuate customers on foot to the nearest platform or evacuation point.

3.2.20 Recovery from a failure of the signalling system

3.2.20.1 In the event of a failure of the wayside or centrally located signalling system, the RCS raises an alarm to the responsible RCU indicating the affected section of the railway.

3.2.20.2 All trains in the affected section detect the loss of signalling control and brake to a halt; where possible further trains are prevented from operating into the affected area.

3.2.20.3 Communication between customers on the train and the Train Operator, and CCTV feeds from the train to the in-cab monitors are unaffected by signalling systems failures. Therefore, it remains possible for Train Operators to communicate with customers on affected trains to provide them with reassurance and instructions, and to monitor conditions and customer behaviour on-board trains.

3.2.20.4 A record of the last logged position of each train is retained for Service Control staff. If the system cannot recover, without human intervention, a procedure is put in place to recover the trains. [Note: This could be one of a number of recovery procedures available to the RCU but without signalling protection the movement of trains will be in Manual Mode.]

3.2.20.5 When the failure has been rectified, signalling communication is re-established with all trains in the affected area, and gathers information about their actual locations. This is automatically cross-referenced with the record of the trains last known location.

3.2.20.6 In the event of being unable to establish signalling control of individual trains, the response is the same as for recovery of a non-communicating train.

3.2.20.7 Once ATC has established the location of, and control over all trains in the affected area, the RCU authorises automatic working to re-commence.

3.2.20.8 If the failure has affected a significant number of trains, the sequence in which they re-start is automatically staggered to prevent overloading and tripping out the traction current system.

3.2.21 Recovery of a non-communicating train

3.2.21.1 In the event of a failure of train-borne signalling equipment on an individual train an alarm is raised to the Train Operator and the responsible RCU.

3.2.21.2 As a precaution, the train brakes to a halt; the signalling system imposes a buffer zone around the last known position of the train to protect from collisions and if possible, any further trains from entering the affected section

3.2.21.3 If the failure of the train-borne signalling cannot be rectified, as there is no protection, the train is recovered in a Manual Mode and driven by line-of-sight at low speed, until it has re-established communication with the signalling system, or if this is not possible, to the nearest suitable stabling location.

3.3 Customer Movement

3.3.1 Introduction

3.3.1.1 This section deals chiefly with the movement of customers on and off trains, and with evacuation of customers from trains.

3.3.1.2 Upgrades to Station operations are outside of the scope of the DTUP project, therefore the movement of customers around Stations, and Station Operations other than the provision of customer information on platforms, are not dealt with in this document.

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

3.3.3 Close door and train runs out

3.3.3.1 The monitoring of the PTI is consistent with attended operations on ATO lines across the LU network and is managed by the Train Operator during platform departure and arrival.

3.3.3.2 Platform based cameras transmit pictures to OPO CCTV monitors at the operating position, enabling the Train Operator to view the full length of the PTI. The Train Operator is able to select between images from OPO CCTV and in-car CCTV cameras, enabling visibility of individual saloon doorways, if PTI incidents occur. However, they would be primarily using the OPO CCTV to monitor the PTI.

3.3.3.3 Note: Images from the OPO, headwall and platform CCTV camera are available to RCUs in the OCC, enabling them to monitor potential crowding or safety issues, and to assist with the timely dispatch of trains, if necessary.

3.3.3.4 The Train Operator is provided with an indication of the dwell time, and a countdown to the point at which departure can be initiated. When the dwell time expires, the Train Operator will be provided with an audible alert and visual indication.

3.3.3.5 Not used.

3.3.3.6 Once movement authority is received the Train Operator checks to confirm the PTI is clear from hazards and therefore safe.

3.3.3.7 The Train Operator closes the passenger doors.

3.3.3.8 The Train Operator initiates the train's departure from the platform.

3.3.3.9 If the dwell time is extended beyond what is predetermined within the service pattern, the Train Operator and the responsible RCU in the OCC are notified.

3.3.3.10 When departing the station, OPO CCTV images are provided at the operating position enabling the Train Operator to monitor the PTI, up to the point the train is entirely clear of the platform.

[redacted]

3.3.5 Saloon doors failing to open/close

3.3.5.1 Not Used.

3.3.5.2 If the train doors fail to open or prove closed, and in the event of failure of the Correct Side Door Enabling (CSDE), doors can be opened using an emergency door open override. The train cannot be moved and the emergency brakes are applied in this case.

3.3.5.3 Individual train doors can be taken out of service by the Train Operator, if they become defective. Automatically generated customer information advises passengers at the doorway that the doorway is out of service and directs them to move to a different one.

3.3.5.4 If the Train cannot close and lock all doors, the Train Operator will not receive a *doors closed visual* indication and the train will not generate movement. To clear an obstacle preventing door closure, the Train Operator can choose to either re-open or close all doors, or selectively re-open and close the individual doors failing to close and lock. Outside Door Indication Lights (ODIL) are fitted on both sides of each car, which when illuminated inform operational staff from the platform that a saloon door is not closed.

3.3.5.5 In the event that a fault resulting in doors failing to close and lock cannot be rectified, the door interlock system can be cut out, to enable train movement.

3.3.6 Customer Evacuation – General principles

3.3.6.1 This section details the way in which customers can be evacuated from trains at various locations on the railway, in the event of a serious incident or emergency.

3.3.6.2 In the event of a serious incident or failure leading to trains becoming stranded in tunnels, the RCU in charge of the incident (usually the RM) assesses conditions on-board trains, including saloon temperatures and loading, which are reported by trains to the RCS. This information provides context to the decision to evacuate customers from trains. The Train Operator will feed information back to OCC, informing them of status of passengers on board the train. This informs the response to the incident.

3.3.6.3 Not Used.

3.3.7 Customer Evacuation

3.3.7.1 If a train is stranded at a platform, and powered door control is unavailable, staff on the platform use manual controls on the exterior of the train to release at least one set of saloon doors allowing customers to alight.

3.3.7.2 If powered door control is unavailable, the Train Operator accesses door controls in the vicinity of each doorway allowing them to manually open the saloon doors.

3.3.7.3 If a train is stranded in a tunnel, and traction current is still available, the quickest and safest way for staff to reach the stranded train is by travelling on another train. Otherwise, staff must walk along the track to the stranded train(s), having taken suitable safety precautions.

3.3.7.4 Customers can be evacuated by transferring them directly to an assisting train, via the end-doors, or they can be evacuated to the track and escorted to an assisting train, platform or evacuation point.

3.3.7.5 The train's end doors (M-Doors) remain unlocked. [Note: The open/closed status of the rear M-Door is reported to the Train Operator at the active cab. Opening the rear M-Door initiates an alarm in the drivers cab and prevents the train from moving automatically.]

3.3.7.6 Trains are equipped with detrainment devices at both ends to enable staff and customers to get safely from the train to the track (and vice versa), or directly to the cab of an assisting train.

3.3.7.7 Detrainment devices are not accessible to customers, but can be deployed and re-stowed by a single, trained member of staff.

3.3.7.8 When the detrainment device is deployed, lighting on the train illuminates the device, and the area of track at its base.

3.3.7.9 Trains carry a short-circuiting device at each end, to be used by attending staff to prevent accidental recharging of traction current, once it has been switched off to allow staff and customers to walk along the track.

3.4 Managing the Service

3.4.1 Managing the Service and Staff – General principles

3.4.1.1 This section details routine operations which require the intervention an RCU or Train Operator.

3.4.1.2 In cases where an RCU needs to make changes to the automated running of the railway, for whatever reason, they are provided with decision support information. For example, this information takes the form of validation checking of proposed changes allowing the RCU to understand the potential impact of their proposals before either continuing with the change, or adopting an alternative course of action.

3.4.1.3 A channel for secure one to one voice communications between all operational staff is available across the DTUP network.

3.4.1.4 A channel for one-to-many voice communications encompassing all operational staff is available across the DTUP network.

3.4.2 Edit a train's route/path

3.4.2.1 The RCU also has option to cancel and amend the route and destination of individual trains in response to observed, reported or predicted changes to operational conditions. This includes routing a train to a different branch due to customer demand, taking a train out of service before the planned end of its mission and routing it to a stabling location. This is required, for example, if that train has become defective and cannot complete its mission.

3.4.2.2 Arrangements for the detrainment of customers when a train is taken out of service are as described in section 3.2.5.

3.4.2.3 If it is necessary to change the route / destination of a train, the RCU changes the train's path to an alternative path within the active Timetable, having first checked with the Train Crew Manager, and communicated with the Train Operator by radio. The appropriate announcements are made to customers, and destination displays and if applicable the running number on the train are changed without the need for action by the operator.

3.4.2.4 Note: The Train Operator can manually set or change the Train's Destination Indicator and Running Number from an interface provided at the operating position, if the RCS in unable to.

3.4.3 Stepping Back

3.4.3.1 Stepping Back is a planned timetabled event where Train Operators are booked to "step back" to a later train at a reversing platform. This technique is used to provide a higher level of service than otherwise possible if each Train Operator took the same train out which they brought in, due to the time it takes to change ends. Trains are not renumbered in stepping back.

3.4.3.2 The Train Operator shuts down the train, leaves the cab, and activates an indication they are clear. The Train Operator waiting at the other end of the train is provided with an indication informing them what mode the train is in, that the rear cab is clear and that he/she may now open up the cab at their end of the train.

3.4.3.3 Not used.

3.4.3.4 The RCS will not will not clear the route for the train to proceed on its return trip until the rear cab is confirmed clear and the leading end of the train is fully active.

3.4.3.5 Note: Stepping back on the current railway occurs at Arnos Grove on the Piccadilly line and Elephant and Castle on the Bakerloo line. Despite a low TpH at Arnos Grove (11Tph), Stepping back increases the speed in which the service can be recovered, reducing turnaround times to 2 minutes. Stepping back on the Central line only takes place during closures and can be carried out at White City or Liverpool Street.

3.4.3.6 Due to the proposed uplift in TpH, it is possible that post upgrade, stepping back may take place at all available reversing locations.

3.4.4 Reforming the Service

3.4.4.1 Reformations are used to recover disrupted service patterns and late running. If a train is sufficiently delayed that it is now running in the timetabled path of a subsequent train, its running number is changed, at a suitable location (usually at a Crew relief point), to that associated with the path in which it is actually running. The Train's running numbers are changed automatically, as they receive the new path allocated to it.

3.4.4.2 The subsequent train is also re-numbered to avoid having two trains with the same running number. The process is repeated, as appropriate, until the service is again running to timetable.

3.4.4.3 The RCU can renumber trains but it is the responsibility of the DTSM to ensure that Train Operators are on the trains which they are rostered to operate.

3.4.5 Code Amber

3.4.5.1 Code Amber is an operational procedure that is used to hold trains in platforms when an incident or failure occurs.

3.4.5.2 The responsible RCU can apply this function with great flexibility using signalling controls.

3.4.5.3 The RCU chooses to apply Code Amber, as applicable, to:

- all trains on the line
- all trains on either road
- all trains within a specific area
- multiple trains
- individual trains

3.4.5.4 The RCS then permits any trains not already standing at a platform to proceed into one, and prevents all trains in the affected area from departing platforms until the Code Amber is lifted.

3.4.5.5 If a train is prevented from moving into a platform, it is held as near to the platform as signalling permits.

3.4.5.6 Operators of trains in the affected area are automatically alerted if Code Amber has been applied.

3.4.5.7 Real-time disruption messaging is automatically transmitted to affected trains and Station information systems.

3.4.5.8 If it becomes necessary for the responsible RCU to permit specified trains to move out of platforms without lifting Code Amber, the RCU overrides the command for individual trains and authorises them to move as far as a specified location.

3.4.5.9 When Code Amber is lifted, if a number of trains in the same traction current section have been held, the sequence in which they re-start is automated to prevent overloading and tripping out of the traction current system.

3.4.5.10 Not Used.

3.4.5.11 The RCU can choose remove Code Amber to the same level of granularity as it is applied.

3.5 Managing Special Running Conditions

3.5.1 Managing Special Running Conditions - General principles

3.5.1.1 This section details railway processes used to manage non-normal events which do not require an emergency response.

3.5.2 Programme Station/Platform skip

3.5.2.1 When it becomes necessary to prevent trains from stopping at a platform or platforms (for example, if a station is closed), an RCU selects the appropriate platform, station or group of platforms, and uses the RCS platform skip function to close it/them either indefinitely, or for a user-specifiable period of time.

3.5.2.2 The RCU can override the non-stop instruction for a selected train, or trains. This may be used, for example, when an empty train is used to take staff to a worksite on a closed platform.

3.5.2.3 It is also possible to prevent an individual train from stopping at all platforms between two designated points on the line. This is generally used for empty stock movements, e.g. transferring a faulty train to a maintenance facility.

3.5.2.4 An automated notification is sent to the Train Operator if a station or a platform is closed.

3.5.3 Providing protection for persons on the track

3.5.3.1 The word “protection”, when used in an operational context, refers specifically to protection from moving trains. Therefore, providing protection in an area entails ensuring that no trains are able to move into or within that area. Such an area is known as a Protection Zone.

3.5.3.2 Protection Zones are usually enforced by the signalling system.

3.5.3.3 However, a Train Operator can enforce a Protection Zone by immobilising a train behind the area in which the protection is required.

3.5.3.4 In this circumstance, the Train Operator secures their train, ensuring it cannot be moved. The secured train then prevents any other trains moving into the zone from the rear. This train cannot be moved until the Train Operator permits this to happen by un-securing it.

3.5.3.5 This does not protect staff on the track from a train undertaking a non-normal direction movement (see section 3.1.12). However, since an RCU or Train Operator must obtain authorisation from the responsible RCU before accessing the track or permitting others to access the track, and a non-normal direction movement must also be set up and authorised by the responsible RCU, this provides an operational control to manage that risk.

3.5.3.6 The responsible RCU can also remove movement authority. Trains operating in ATO within and approaching the Protection Zone are prohibited from moving by the signalling. [Note: this does not prevent trains from being moved in Manual Mode (unprotected), however, authorisation for such movement is required from the responsible RCU, which provides an operational control to manage that risk]

3.5.3.7 Depending on location, the responsible RCU can also set and hold points such that any approaching train is routed away from the Protection Zone.

3.5.3.8 When a Protection Zone has been set up, all other RCUs are able to see, the physical limits of the protected area, and the identity of the responsible RCU.

3.5.3.9 The RCU communicates the extent of the Protection Zone to the Train Operator via the operational radio.

3.5.3.10 A Hand-signaller can be put in place to prevent a train from being manually driven into the Protection Zone.

3.5.3.11 Only the responsible RCU can lift the protection and permit trains to run again once confirmation is received from staff on site that it is safe to do so.

3.5.4 Providing protection for persons on the track (Staff Protection Key Switch)

3.5.4.1 At certain locations, a Protection Zone can be established by use of a Staff Protection Key Switch (PKS). This is a physical switch which can only be operated when a unique key is inserted in it, and which interfaces with the signalling system. A PKS can be operated by any member of staff requiring access to a clearly specified and delineated section of track, provided they have first contacted the responsible RCU and requested permission to operate the switch. The RCU must first ensure that no trains are in, or approaching the area. When the PKS is operated, the signalling prevents any train from entering the area associated with the switch.

3.5.5 Responding to a track defect

3.5.5.1 [redacted]

3.5.5.2 [redacted]

3.5.5.3 If a track defect is confirmed a temporary speed limit may be imposed on all trains running through the area until the defect is rectified by the Maintenance organisation.

3.5.6 Response to a Train Overrunning its Movement Authority

3.5.6.1 The most likely cause for a train overrunning its movement authority is poor wheel/railhead adhesion, causing the train to slide past the point at which the signalling system intended it to stop. In this circumstance, the Train Operator is aware the train is out of the platform stopping tolerance and an alarm is raised to the responsible RCU.

3.5.6.2 At platforms if the train overruns and is within one car length the Train Operator can set the train back to the correct stopping position.

3.5.6.3 If the train overruns by more than one car length and as long as the route ahead of the train is clear, the RCU is able to cancel the Station stop, instigate automated announcements to customers both on the train and at the Station, and authorise the RCS to move the train on to the next Station, or as far as the signalling permits. [Note: this option is only available if it can be positively confirmed that the overrun has been caused by factors unconnected to the signalling system, e.g. poor wheel/railhead adhesion, and that the signalling system is healthy and available. If this is not the case, the train must be driven in Manual Mode].

3.5.6.4 If the train has stopped short of the correct position, the Train Operator puts the train into Manual Mode, and provided it is otherwise safe to do so, correctly berths the train.

3.5.6.5 The train can be moved back into place with a non-normal direction move.

3.5.6.6 In certain circumstances, for example if a train overruns the stopping point at a terminal or reversing location, the Train Operator may be required to move in Manual Mode back to the stopping point.

3.5.7 Response to miscellaneous train generated alarms

3.5.7.1 The train transmits data to the OCC and Depot regarding the "health" of the train. The train constantly transmits data, this will allow an RCU in the OCC the ability to respond to disruption of potential sources of delay in a timely manner.

3.5.7.2 More information is detailed in Vol 2 Part 3: DTUP Fleet & Depot Maintenance Concept.

3.5.7.3 [redacted]

3.5.7.4 Where possible, the train will take the necessary steps to resolve the problem without human intervention.

3.5.7.5 A Human-Machine Interface (HMI) is present at the train's operating position which is reflected in the OCC for the responsible RCU and maintenance representative to support the Train Operator and respond to a train fault. Where possible the train will indicate any fault to the Train Operator and staff in the OCC.

3.5.7.6 Not Used.

3.5.7.7 When an on board system failure occurs the Train Operator is notified by an audible and/or visible alarm on the HMI.

3.5.7.8 Not Used.

3.5.7.9 The train's maintenance strategy makes use of remote asset condition monitoring, self-monitoring and self-diagnosis. Real-time data aids the rectification of on train faults, assisting fleet maintenance and enhancing reliability.

[redacted].

3.5.7.11 Note: More information and the current DISI can be found in The Management System library.

3.5.8 Operate an inspection Train – without track access

3.5.8.1 On occasion it is necessary to inspect an area of track or tunnel. In most circumstances this will be carried out by a Train Operator driving through the affected area at reduced speed and reporting anything they might see.

3.5.8.2 The Train Operator puts the train into Manual Mode which allows the train to be driven at a reduced speed should they choose to do so, or to easily stop the train at a particular point of interest (e.g. to inspect a set of points).

3.5.9 Operate an inspection Train – with track access

3.5.9.1 When required the train will be used to transport staff to locations along the railway in order to carry out track inspections.

3.5.9.2 In this instance, the train identified to carry out the inspection will pick up the required staff from a platform near to the location where the inspection is to be carried out. The staff enter the cab through either the cab-side door (if available) or the leading set of passenger doors and then via the J-Door.

3.5.9.3 The Train Operator drives the train in Manual Mode at an appropriate speed until the inspection site is reached.

3.5.9.4 Not used.

3.5.9.5 At the inspection location the train is put into Train Secure mode and immobilised.

3.5.9.6 In tunnel sections, inspection staff access the track via the train's end-door, whereas, in open sections, if there is sufficient space, they use the cab side door.

3.5.9.7 Once the inspection staff are back in the train, or in a place of safety, the Train Operator confirms to Service Control that all staff and equipment are clear of the track. If ATO is available, the train is put into Automatic mode, and the Train Operator instigates automatic driving, allowing normal operation to re-commence.

3.5.10 Responding to low adhesion

3.5.10.1 LU's predictive Condition Monitoring system (ACCAT) will be in continuous all year round operation to manage performance and implement a range of mitigations in areas subject to variations in adhesion.

3.5.10.2 To assist trains meeting the braking performance required, they are fitted with Wheel Slide Protection (WSP) and an automatic sanding facility which will deposit sand automatically on the rail head when the train detects wheel slide. Sand levels are reported remotely to the condition monitoring system.

3.5.10.3 In addition dedicated trains will dispense Sandite (thick paste adhesion improver active for a number of hours) during the leaf fall season (October – December) when adhesion levels in certain areas are subject to significant degradation. The operation of these trains is co-ordinated by maintenance staff.

3.5.10.4 The acceleration and braking profiles of trains used by the ATO system can be adjusted, for specified areas of the line, depending on the environmental conditions affecting the track, as predicted by the ACCAT, and/or in response to reported activations of WSP. It is possible to set different braking profiles on different sections of track. The adjustments are made by members of the maintenance organisation in consultation with the Service Control staff.

3.5.11 De-icing trains

3.5.11.1 Each train has sleet brushes to remove snow/ice deposits that have accumulated on the traction-current conductor rails. In GOA2 these are manually controlled by the train operator, on instruction, or as required.

3.5.11.2 A proportion of the fleet has a de-icing capability that works by laying de-icing fluid directly on to the conductor rail head as a preventative measure while the train is running at line speed in ATO. The laying of the de-icing fluid is switched on by the OCC or by the Train Operator. The dispensing of de-icing fluid in tunnel sections is automatically inhibited. The decision to activate de-icing from the OCC is assisted by the use of weather reports and information from dedicated line side weather stations.

3.5.11.3 The de-icing levels are reported to the condition monitoring system. Levels are replenished by the train maintenance staff in dedicated quick refill facilities located in each depot to assist quick refill in periods of high risk

3.5.11.4 Note: During winter months, scheduled de-icing train missions are included as ‘run as required’ paths in the Working Timetable. The decision to run these missions is taken at network level according to criteria laid out in the Network Winter Weather Plan. When required, the responsible RCU enacts the appropriate option via the RCS.

3.5.11.5 Not Used.

3.5.11.6 Not Used.

3.5.12 Turning traction current on and off

3.5.12.1 RCUs in the OCC have the ability to directly switch off, and enable switching on, traction current in any section across the whole of the line. When an RCU switches off traction current, a lock is automatically applied, which inhibits the section from being switched back on by Power Control Room (PCR) staff without the authorisation of the responsible RCU [Note: this lock can be overridden by PCR staff, if necessary, provided the correct operational checks and controls have been applied].

3.5.12.2 Platform equipment enables staff at Stations to directly switch off traction current in their area in an emergency.

3.5.12.3 A safety critical data feed from the traction current system allows all RCUs to know, with absolute confidence, the on/off status of every traction current section.

3.5.12.4 If a traction current section has been switched off to allow staff to access the track, for example to attend a Person Under Train Incident (PUTI), the responsible RCU can, depending on the location of the PUTI, remotely open traction current section switches in order to sub-divide the traction current section, allowing it to be partially re-charged in order to move stranded trains and provide some service to customers while the incident is being dealt with.

3.5.12.5 Traction current is always switched back on by an operative in the London Underground Power Control Room. However, the switch on must first be authorised by the responsible RCU in the DTUP Control Centre. Note: the responsible RCU must first reset the automatically applied inhibit.

3.5.13 Partially suspending the service

3.5.13.1 A partial service suspension occurs when a failure means it is necessary to prevent trains from being routed to a destination, or onto a branch, while maintaining as good a service as possible on the rest of the line.

3.5.13.2 Where this occurs the customer information is automatically updated and broadcast on trains and at Stations.

3.5.13.3 The responsible RCUs apply procedures from the Line Emergency Plan which may involve implementing an emergency Timetable on sections of the line not affected by the suspension – for more information on the existing Line Emergency Plan see OMC Reference Data.

3.5.13.4 All decisions regarding train movements must take into account train crew duty schedules in order to avoid potential conflicts between planned movements and crew scheduling requirements.

3.5.13.5 Within the suspended section, the responsible RCU has the option to halt all trains, or to allow trains to continue to move, if possible, until they have cleared the suspended area or worked into platforms.

3.5.14 Setting a temporary speed restriction (TSR)

3.5.14.1 If a track, or other defect, necessitates that trains run more slowly than normal through a section of track, the responsible RCU is able to set a speed restriction in any area of track.

3.5.14.2 The permitted speed that can be set and the geographical area in which the restriction applies, is defined by the RCU, and is not restricted by the system.

3.5.14.3 TSRs are normally set as a first response to a reported track defect or rough-riding, or in response to a request from the maintenance organisation. TSRs are only lifted once it is proven that it is safe to do so.

3.6 Manage the Service in an Emergency

3.6.1 General Principles

3.6.1.1 Standard incident management protocols continue to apply, mirroring the Gold, Silver and Bronze command and control structure used by the emergency services, remaining consistent with Rule Book 2. Incidents are categorised from 1- 3 depending on their severity. The command structure is dependent on the level of incident.

3.6.1.2 In an emergency, members of the RCO and Train Operators are able to override automated operations, provided they have the sufficient level of authorisation within the system and subject to operational procedures and controls that include a dynamic risk assessment. This may be conducted by Senior Operating Officials who are not part of the RCO.

3.6.2 Code Red

3.6.2.1 In an emergency, it may become necessary to immediately bring trains to a halt, regardless of their location. This is known as 'Code Red'.

3.6.2.2 It is usual practice to apply Code Red across the whole of a line as a first response, however, RCUs are able to select sub-divisions of the line in which to apply Code Red, if time allows.

3.6.2.3 The RCU chooses to apply Code Red, as applicable, to:

- the whole line
- specified sections of the line
- specified groups of trains
- individual trains.

3.6.2.4 When a Code Red is applied all affected trains are immediately braked to a halt, and held where they have stopped.

3.6.2.5 Trains at platforms are not allowed to depart, and if a train has already closed its doors, the Code Red application causes them to re-open.

3.6.2.6 Train Operators within the zone of a Code Red, and other RCUs in the OCC are automatically alerted that the procedure has been applied.

3.6.2.7 A message is automatically broadcast to customers on trains and at Stations.

3.6.2.8 If it becomes necessary to move individual trains to places of safety while the Code Red is in force, the responsible RCU is able to select those trains and permit them to move to a specified point.

3.6.2.9 When the nature and affected location of the emergency has been identified, the responsible RCU can, if applicable, lift Code Red from unaffected sections of the line while it remains in force elsewhere.

3.6.2.10 The RCU can choose to remove Code Red to the same level of granularity as it is applied.

3.6.2.11 When a Code Red is lifted, the automatic working of trains resumes without the need for further operator action.

3.6.2.12 The start-up sequence of trains in each traction current section is staggered to prevent the electrical system being overloaded by the current demand from multiple trains at the same time.

3.6.3 Fire/Smoke detection inside a train

3.6.3.1 When the train detects fire/smoke, an indication of which detectors have been activated is provided to the Train Operator and to the responsible RCU. The Train Operator contacts the RCO to confirm receipt of the alarm. The train continues to the next available platform stop.

3.6.3.2 The Train Operator maintains the ability to inform and reassure passengers using the PA or trigger pre-recorded messages. The Train Operator, if possible, responds to passengers who may have activated a PEA.

3.6.3.3 The responsible RCU contacts the Station in advance to notify them and to prepare for a possible train fire.

3.6.3.4 The responsible RCU also contacts the LUCC to notify them and request the attendance of the emergency services at the station in advance.

3.6.3.5 When the train detects smoke in the passenger saloon, it shuts down the heating and cooling but maintains air ventilation on a car by car basis.

3.6.3.6 A Code Amber is automatically applied to the incident train, and to any train standing at or approaching the station to the rear.

3.6.3.7 The ventilation systems on the incident train and in the tunnel are automatically adjusted to maintain a supply of clean air, as far as possible, without fanning any fire present.

3.6.3.8 If a train has already left the Station to the rear, it is stopped in the tunnel in readiness for a non-normal direction movement away from the incident train, if that becomes necessary.

3.6.3.9 When the incident train reaches the next Station and the saloon doors are opened, an evacuation message is automatically broadcast to customers.

3.6.3.10 If a fire is found, the service may be partially suspended while the emergency services deal with it.

3.6.3.11 Once the incident has been dealt with, the responsible RCU lifts the Code Amber, and automatic control of the affected trains resumes.

3.6.4 Fire/smoke detection exterior to a train

3.6.4.1 [redacted]

3.6.4.2 The responsible RCU receives an alarm and an indication of which detectors have been activated.

3.6.4.3 Depending on whether corroborating reports have been received from the Train Operators, customers or station staff, the responsible RCU may take the decision to detrain customers from the train standing at the Station to the rear, and run it empty through the affected area while the Train Operator observes the route for indications of fire.

3.6.4.4 If a fire is found, the service may be partially suspended while the emergency services deal with it.

3.7 Communication with Customers

3.7.1 General Principles

3.7.1.1 This section includes the provision of service and travel information to customers, both in real-time and when triggered by pre-defined criteria; and with two-way communications between customers on trains and staff.

3.7.1.2 Wherever possible the provision of customer information is automated. This is to ensure that messages are standardised and consistent with all other information and that messages are delivered to customers by both audio and visual means [Note: information is relayed by both audio and visual means, unless otherwise stated].

3.7.1.3 The Customer Information System interfaces with existing Station Management Systems (SMS) and provides them with data feeds to ensure that information given to customers on Stations is as timely and accurate as that given on trains.

3.7.1.4 Live announcements made by the Train Operator, RCU or a member of station staff using a public address system (PA), either at a Station or on a train, take precedence over automated announcements. This ensures that if an emergency announcement is being made, it is not cut off by less urgent routine messages.

3.7.2 Communication with customers on the train

3.7.2.1 Customer information provided by the systems on the train is primarily automated and managed centrally by RCUs, thereby improving the timeliness and consistency of information across trains that are in service.

3.7.2.2 Audio and visual customer information is provided to passengers on the train where possible via Visual Electronic Information Displays (VEIDs) and saloon loudspeakers.

3.7.2.3 VEIDs enable pictorial information, enhancing the messages provided to passengers in the event of a delay, disruption and when applicable in an emergency and so helping to manage operational responses.

3.7.2.4 The Customer Information System requires little or no input from the Train Operator, but functionality is retained that allows them to:

- trigger “one-shot” messages - these are generic and can be applied ad-hoc dependant on the situation;
- make Public Address (PA) announcements;
- keep informed of customer and real time disruption information active on their train.

3.7.2.5 If the automated system fails the Train Operator can trigger pre-recorded disruption messages, as a back-up.

3.7.2.6 Not used.

3.7.2.7 All disruption information is provided in real time and distributed to trains by a responsible RCU located within the OCC. Information can include: disruption to journey interchanges, destinations, stations; facilities; information pertaining to emergency and degraded operational scenarios and major events.

3.7.2.8 Customer information can be sent to individual trains, groups of trains and all trains.

3.7.2.9 Automated real time information is provided that replicates the 30 and 90 second messages which Train Operators have traditionally provided via the PA in the event of a short term delay.

3.7.2.10 “One shot” messages can be sent to individual trains by an RCU, replicating the functionality available to the Train Operator.

3.7.2.11 The Train Operator is able to select an “Out of Service” function which triggers specific customer information content and inhibits door controls to prevent the Train Operator accidently opening them.

3.7.2.12 Out of Service mode can be trigged through the RCS when a Train is being, or has been, removed from passenger service or is being used as a non-passenger carrying test train.

3.7.3 Making announcements to the train

3.7.3.1 The Train Operator has a PA facility at the operating position, enabling communication to passengers on board the train. A PA made by the Train Operator takes precedence over all other automatic information provided to passengers.

3.7.3.2 Remote PA is available to enable communication from the OCC to individual, multiple and all trains, overriding all other information provided to passengers.

3.7.4 Passenger Emergency Alarm (PEA) – General functionality

3.7.4.1 PEAs do not require an Operator to attend and re-set them locally. PEAs are cleared from the train’s operating position.

3.7.4.2 Not used.

3.7.4.3 Not used.

3.7.5 A PEA is activated and the Train is stationary

3.7.5.1 If the train doors are already open, they remain open.

3.7.5.2 If the train doors are closed but the train has not departed, the train doors will remain closed until the Train Operator re-opens them.

3.7.5.3 On departure, if the train is within station limits, and no PEDs are present, activation of a PEA will apply the Emergency Brake (see section 3.6.7)

3.7.5.4 The train cannot depart the platform until all active PEAs are cleared by the Train Operator.

3.7.5.5 Activation of a PEA prompts an audible alarm notifying the Train Operator, whilst visual information enables its location within the train to be ascertained. The alarm is silenced when the PEA is acknowledged.

3.7.5.6 The Train Operator is presented with CCTV images of the area around the activated PEA on in-cab monitors, which assists them to determine what response is required. If necessary, to improve situational awareness, they scroll through the in-car CCTV images, via the in-cab monitors, providing an alternative perspective.

3.7.5.7 CCTV images of the area around the activated PEA are available to the Train Operator until it has been cleared. CCTV images are stored on the train and can be downloaded to support incident investigation. Each CCTV image is identifiable by Car Number, camera location, date and time.

3.7.5.8 If multiple PEAs are activated CCTV images for the next PEA are presented as each PEA is cleared, this prevents different CCTV images being presented to the Train Operator each time an alternative PEA is activated.

3.7.5.9 Note: PEAs do not require the Train Operator to leave their cab in order to clear. The Operator is able to clear PEAs from the cab if they are confident the PEA does not require investigation in the saloon.

3.7.5.10 The Train Operator acknowledges the PEA from the operating position and communicates with the passenger via the talkback facility.

3.7.5.11 The active PEA initiates an alert in the OCC. Any conversation between the Train Operator and the customer who has operated the PEA is recorded, and can be accessed to assist with incident investigation.

3.7.5.12 If the Train Operator is required to leave the cab and investigate further, they secure the train and exit via the J-Door into the passenger saloon, otherwise if possible; they can exit the cab via the cab-side door and walk along the platform.

3.7.5.13 PEA status indication lights on each car enable platform staff to determine the location of active PEAs. The lights extinguish when all of the PEAs in a car are cleared.

3.7.5.14 PEAs are cleared one at a time from the operating position. Once all PEAs are cleared, the Train Operator is given authorisation to initiate normal platform departure.

3.7.6 The train is outside of station limits and in motion

3.7.6.1 Activation of the PEA prompts an audible alarm in the cab notifying the Train Operator and visual information enables its location within the train to be ascertained. The train continues to the next station.

3.7.6.2 Not used.

3.7.6.3 The Train Operator acknowledges the PEA and communicates with the passenger(s) via the talkback facility.

3.7.6.4 The PEA can be cleared by the Train Operator, if they ascertain by talking to the customer that no assistance is required, or that the train does not need to be held at the next station.

3.7.6.5 The passenger doors open at the next available Station stop, and remain open until all PEAs have been cleared.

3.7.7 Not used

4 Interoperability

4.1 Piccadilly line interoperability

4.1.1 Rayners Lane to Uxbridge

4.1.1.1 DTUP trains operating on the Piccadilly Line between Rayners Lane and Uxbridge run on track operated by the Metropolitan Line, and are controlled from the Sub-Surface Railway (SSR) Control Centre at Hammersmith.

4.1.1.2 Not used.

4.1.1.3 Primary responsibility for signalling control, traction current and management of incidents, transfers to the Metropolitan Line Service Controllers once the train has left South Harrow, Westbound. The exact location is indicated by a trackside marker.

4.1.1.4 Once past this point, any call made by the Train Operator to Service Control using the train radio is automatically routed to the SSR Control Centre at Hammersmith.

4.1.1.5 On returning Eastbound, the reverse situation applies and control passes back to the DTUP Control Centre when the train is on the approach to South Harrow, with the exact location, again, indicated by a trackside marker.

4.1.1.6 Not used.

4.1.2 Barons Court to Acton Town

4.1.2.1 The Piccadilly and District Lines run parallel to each other between Barons Court and Acton Town.

4.1.2.2 Responsibility for signalling control, traction current and management of incidents on the Piccadilly Line in this area remains with the DTUP Control Centre.

4.1.2.3 Responsibility for signalling control, traction current and management of incidents on the District Line operating as far as Turnham Green, remains with the SSR Control Centre.

4.1.2.4 Once District Line trains leave Turnham Green, Westbound, Primary responsibility for signalling control, traction current and management of incidents affecting them, transfers to the DTUP Control Centre. The exact location is indicated by a trackside marker.

4.1.2.5 On returning Eastbound, control for District Line trains passes back to the SSR Control Centre when trains are on the approach to Turnham Green.

4.1.2.6 In the event of a service disruption affecting either the District or Piccadilly lines, or in the event of an emergency, Piccadilly line trains can be signalled to stop at the following platforms:

- Stamford Brook, Platform 2
- Ravenscourt Park, Platform 2
- Ravenscourt Park, Platform 3

4.1.2.7 Although Piccadilly lines trains would normally travel through these platforms without stopping, this facility enables customers to be transferred between the two lines, as appropriate, allowing them to continue their journeys if either of the lines is seriously disrupted. The normal facilities for managing the PTI, such as correct side door enabling (CSDE) and OPO CCTV, are therefore provided for DTUP Piccadilly line trains at these platforms.

4.1.2.8 In addition, if a Code Amber is applied in this area, Piccadilly line trains approaching the platforms listed in 4.1.2.6 will be held at those platforms.

4.1.2.9 Note: At the time of writing, it is proposed that District Line trains returning to Ealing Common Depot are taken out of service at Turnham Green, but due to the time constraint imposed by the need to maintain headways for District Line trains routed in service to the Richmond/Wimbledon branch, the out of service trains will be checked to ensure all customers have alighted at the old Chiswick Park Westbound platform.

4.1.3 Acton Town to Ealing Broadway

[redacted]

4.1.3.2 District Line trains work to Ealing Broadway and reverse there in order to transfer to Ealing Common Depot. Conversely, a certain proportion of District Line trains leaving Ealing Common Depot work to Ealing Broadway and reverse Eastbound to Acton Town and then towards Turnham Green, where they enter service.

4.1.3.3 Primary responsibility for signalling control, traction current and management of incidents for all trains in this area is with the DTUP Control Centre.

4.1.4 Transfers to and from other lines

4.1.4.1 In addition to the areas of interoperability described above, it is possible for trains to transfer between the Piccadilly and other lines at three locations. These transfers normally only involve Engineers' vehicles. The locations are described below.

4.1.4.2 Trains can transfer from the Northbound road of the Northern Line to the Eastbound road of the Piccadilly line at King's Cross.

4.1.4.3 Trains can transfer to the Victoria Line from the Eastbound road of the Piccadilly line and from the Victoria Line to the Westbound road of the Piccadilly line at Finsbury Park.

4.1.4.4 Trains can transfer from the Eastbound road of the District Line to the Eastbound road of the Piccadilly line (and vice versa), and can also transfer from the westbound road of the Piccadilly line to the westbound road of the District line at Hammersmith.

4.2 Bakerloo line interoperability

4.2.1.1 DTUP trains operating on the Bakerloo line between Queen's Park and Harrow & Wealdstone run on track operated and controlled by Network Rail, therefore, the Bakerloo line service adheres to the adheres to Network Rail Rules and Procedures contained in the "Working Over Books".

Note: It is expected, that because DTUP trains will be running under the control of existing Network Rail signalling, some functionality available to the Operator throughout the London Underground operated area, will be limited. Further detail will be elicited throughout the design phase, once we have a greater understanding of how DTUP assets are likely to perform.

4.2.1.2 Similarly to the Piccadilly line between Rayner Lane and Uxbridge, because of the mixed operation of LU Tube Stock and Network Rail surface stock and the different floor height and door spacing, it is not possible to install PEDs. [redacted]

4.2.1.3 Bakerloo line serving stations remain owned and managed by Transport for London (TfL).

4.2.1.4 Incidents affecting the service beyond Queen's Park are dealt with in the first instance by Network Rail incident response, which is not covered within this document but can be found in the Network Rail Rule Book http://www.rssb.co.uk/standards-and-the-rail-industry/the-rule-book/new-digital-rule-book-manuals

4.2.1.5 In the situation where an incident does occur, the Bakerloo line RCO is notified. Due to the time it can take for a Network Rail incident manager to attend and resolve the incident, it can be more effective for the incident to be managed by the DTUP RCO and supported by LU staff.

4.2.1.6 The DTUP OCC maintains visibility and awareness of the entire Bakerloo line service and as it does on the rest of the line, manages the train's health status and condition of LUL assets.

5 Appendix 1: Supporting information

5.1 Roles Supporting Train Operations

5.1.1.1 The Performance Manager Trains (PMT) on each line is responsible for the day-to-day delivery of the train service. They are supported by **Train Operations Managers (TOM), who each manage a train crew depot, and the Service Control Manager (SCM), who manages the service control staff in the OCC.** Their roles are essentially that of personnel management, and as such, they are not considered to be RCUs. The SCM directly manages, and is supported by Service Managers (SMs), and the TOMs directly manage and are supported by the Train Managers (TMs).

5.1.1.2 The **Trains Manager** replaces the Duty Train Staff Manager (DTSM) and Train Operations Standards Manager (TOSM) roles. The Trains Manager is responsible for the management and performance of Train Operations within an assigned depot, whilst supporting the service delivery of the line and network.

The role of the Trains Manager is a key leadership position within the traincrew depot, accountable for first line management of a team of Train Operators to maximise customer benefit whilst on shift. The role is responsible for:

- Collaborative working across the depot, line and network; driving performance and delivering an efficient service
- Supporting a 24/7 business through rostered shifts and allocated time to carry out specific duties comprising of early, middle, late and night shifts
- The on-going development of Train Operators, including competence management and the management of attendance, discipline and conduct
- Supporting improvement to depot and line performance through the identification of key trends and the effective use of management information to identify and manage improvement initiatives to achieve Operational Excellence
- Training of Trainee Train Operators through effective Instructor Operator deployment as well as setting, monitoring, signing-off and feedback of individual performance against the standards required by LU Operations and the depot Managing Health and Safety matters affecting the traincrew depot.

5.1.1.3 **Train Operators** are the Line's resource, and are located at one of the various Train Crew depots. The main T/Op accountabilities are:

- safe operation of the train
- responding to and assisting with the recovery from faults, failures and emergencies
- Customer service and communication.

Train Operators do not have user rights to the RCS and are not, therefore, considered to be RCUs.

5.1.1.4 **Instructor Operators (I/O)** are Train Operators with responsibility for carrying out the line based training for all Train Operators and all other staff who are a deemed necessary to hold a Train Operators license. I/Ops perform, when not on training duty, the duties of a Train Operator

5.1.1.5 The **Service Manager (SM)** is the senior RCU on shift, usually based in the DTUP Operational Control Centre (OCC). The Service Manager's role incorporates the following:

- Single point of contact on each line for senior management and external stakeholders.
- Deploying RCO staff and ensuring that they operate in a cohesive, effective and efficient manner
- Ensuring that the service is delivered to the highest level at all times
- Supervision, guidance and direction of RCO staff
- Strategic planning and management of response to, and recovery from, failures, incidents and emergencies
- Ultimate decision maker regarding operational issues for the line resolving service delivery conflicts
- The SM directly manages, and is supported by Service Controllers and Duty Reliability Managers.

5.1.1.6 **Service Controllers (SC)** are responsible for:

- Line Control – i.e. monitoring the state of the service, identifying actual or potential decline in acceptable service levels, determining strategies for preserving or recovering service levels
- Routing of trains – manually controlling train movements that are not directed by the automated system
- Managing traction current
- Managing access to the track and implementing protection arrangements
- Communicating with customers – e.g. responding to passenger emergency alarms, instigating non-routine customer information messaging
- Communicating with staff on the line – e.g. responding to requests to switch off traction current in an emergency, providing real-time information updates
- Communicating with non-line based agencies – e.g. LUCC, emergency services, ERU
- Managing infrastructure and signalling equipment issues that have the potential to impact on the safe delivery of the service Strategic incident management

5.1.1.7 **Duty Reliability Managers (DRM)** are line based, reporting to the SM, and have accountability for:

- Proactive management and support to Train and Station staff during incidents and events
- Responding to incidents on site, on behalf of the Service Manager
- Active and on-site monitoring of the effects of all incidents and disruptions to the normal operation of the train and station service
- Acting to ensure that safety is maintained for customers and staff on the railway
- Investigating and reporting on incidents, failures and delays, including conducting fact-finding interviews and taking witness statements
- Providing incident reports, detailing root causes, to enable business performance improvement and to meet legislative and corporate reporting requirements.
- Providing emergency cover for SCs in the OCC.

There are usually two DRMs are present at all times, and are based at strategic locations around each DTUP line. The base locations for DRMs are equipped with standard IT equipment to enable them to prepare incident and investigation reports. When not attending incidents, or present at their base location, DRMs are expected to travel around the area of the railway for which they are responsible. This is to facilitate maintaining specialised railway knowledge, to build familiarity and collaborative working practices with station staff, and to provide customer service. The SM instructs the DRM(s) to attend incidents and events, as necessary. Additionally, DRMs are competent to use the S&TCS, and may be deployed to the OCC to assist the SCs in the event of an emergency or major incident. In this role, they are qualified to work on any DTUP line.

5.2 Train crew management

5.2.1 Train Crew Duty Allocations

5.2.1.1 Train Crew duty allocations are generated through SAP and are given to 'rostered' Train Operators a minimum of 28 days in advance of the duty. Pool Operators are notified of allocations on the Thursday of the preceding week prior to the duty. During normal service operation, the Train Manager takes actions to ensure all train paths in the timetable have a Train Operator assigned to them at all times throughout the traffic day. This may involve ad hoc allocations of spare operators to cover, for example:

- a Train Operator requesting a physical needs relief break (PNR)
- a train reformed to a path without a crew changeover on the current trip
- a Train Operator not in position to pick up their assigned train (due to service disruption, lateness, unauthorised absence, accident on duty etc)

5.2.2 Train Operators booking on for Duty

5.2.2.1 Train Operators book on for duty with the Train Manager at one of each line's train crew management facilities. Operators book on at staggered times throughout the day, from the start of traffic to the close of traffic. Some Operators remain on duty throughout the night to facilitate late stabling, running 24 hours tube services, sleet working overnight and the earliest possible running of trains at the start of the traffic day.

5.2.2.2 The Train Manager is responsible for ensuring that Train Operators are available for all timetabled movements. The Train Manager is responsible for informing the Service Manager if attendance or similar issues will affect the ability to deliver a service. The Train Manager also liaises with the Service Controller to manage any short-term coverage issue, such as temporarily removing a train from service until a spare operator becomes available (laying over).

5.2.2.3 Train Operator shift patterns are allocated via a roster. Each week of the roster has a set of predetermined duties and rest days. Provision is made to cover annual leave, sickness, welfare and disciplinary issues.

5.2.2.4 Each train operator duty is broken down into the running number of the trains to be operated, during the working day, together with book on/off time, times and locations at which the operator is to commence operating each train, and the times of meal reliefs.

5.2.2.5 At the start of their duty the Train Operator books on with the Train Manager, confirming their fitness for duty. If the Train Operator is required to bring a train into service from a siding or depot they receive information about the train's location. This includes the road number and leading car numbers.

5.2.2.6 Time is built into the start of each duty to enable Train Operators to carry out administrative tasks, receive management instructions, updates about the service, read notices and other publications.

5.2.3 London Underground Train Operator Coverage Planning (TOCP)

5.2.3.1 TOCP is an LU system used by the Train Manager and accessed via LU's SharePoint site. The TOCP system interfaces with SAP and enables each Train Operator's location and trip details to be viewed online. It also shows the location of spare operators, each crew member's latest finishing times and their required meal reliefs. Service Control access the TOCP in a read only state which assists them to proactively rectify the service in a way that is simpler for the Train Manager to crew because they have sight of remaining duty times for each Train Operator.

5.3 Timetables

5.3.1.1 London Underground makes changes to permanent Working Timetables (WTTs) for a number of reasons, for example but not limited to:

- Changes to customer demand
- Changes to asset capabilities
- Changes needed in consequence of other interfacing operators' changes

5.3.1.2 Changes to WTTs, are effected through the Train Service Change Process. This document outlines the two year timescale for specification, development, approval, compilation and introduction of timetables and their associated staff duty schedules. Temporary timetables for part-line closures are issued as a Timetable Notice (TTN) via a separate process.

5.3.1.3 The timetables are produced in "book" form and also as a data file, using the "Common User Format" (CUF) for use on computerised control systems. The CUF file is then converted to the appropriate format for the various control systems present across LU. This task is usually undertaken by the local Asset Performance Control & Information (AP C&I) teams, however in the case of the Central line LU Scheduling Services, who compile the timetables and duty schedules, also complete this conversion process. CUF files are converted to the format supported by the RCS.

5.3.1.4 The Piccadilly and Bakerloo line WTTs change on set Sundays in May and December only, in line with National Rail timetables. In the case of the Bakerloo line, this is to co-ordinate with the inter-operation of London Overground services, in the case of the Piccadilly line; this is to co-ordinate with the inter-operation with the Sub-Surface lines, which in turn inter-operate with National Rail services in various locations. Any changes outside of these dates are constrained by ensuring use of identical timetable paths in interoperable areas. Working Timetable changes on the Central and Waterloo and City lines can take place at any time, but are normally done on Sundays, partly to minimise any consequences of any problems arising from the change.

6 References

The following documents are referenced in this document:

Table 1 – References		
Ref.	**Document ID**	**Title**
International Standards		
1.	UGTMS	UGTMS - Urban Guided Transport Management System
2.	IEC 62290-1	Railway applications – Urban guided transport management and command/control systems
3.	RSSB – (GE/RT8000)	RSSB – Rule Book
4.		
London Underground		
5.	N/A	London Underground Rule Books
6.		
7.		
8.		
Deep Tube Upgrade Programme		
9.	DTUP-2344.1.1-LUL-RPT-00032	DTUP Operational Model and User Requirements Executive Summary
10.	DTUP-2344.1.1-LUL-RPT-00066	OMC Vol 1 Part 2 Operational Vision and Transformation Statement
11.	DTUP-2344.1.1-LUL-RPT-00066	[redacted]
12.	DTUP-2344.1.1-LUL-RPT-00066	OMC Vol 2 Part 3 DTUP Fleet & Depot Maintenance Concept
13.	LiveLink ref: DTUP-2344.4.5-LUL-DOC-00002	RCS Restatement Description
14.	DTUP-2344.1.1-LUL-RPT-00055	DTUP Customer Concept
15.	DTUP-2344.1.1-LUL-RPT-00032	The "DTUP Operational Model and User Requirements Executive Summary"
16.	DTUP-2344.2.2-LUL-DWG-00020	DTUP Functional Breakdown Structure
17.	TBC	OMC Reference Data

7 Consultation

The following people were consulted in the preparation of this document:

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		Head of Operational Upgrades and Asset Development	27/01/16
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5 CONSULTATION

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