Traffic Management System Definition

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VK-290318-0001 Date: 29 March 2018

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TLB-030418-0014 Date: 03 April 2018

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ANDM-030418-0015 Date: 03 April 2018
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Version History

<table>
<thead>
<tr>
<th>Issue</th>
<th>Date</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Draft 0.1</td>
<td>28th Jan 18</td>
<td>Initial draft created by Arvind Bali</td>
</tr>
<tr>
<td>Draft 0.2</td>
<td>30th Jan 18</td>
<td>Circulated for internal peer review</td>
</tr>
<tr>
<td>Draft 0.3</td>
<td>31st Jan 18</td>
<td>Updated to reflect comments made in workshop from Louie Lawana, Sam Lawson, Michael Lane, Vish Kalsapura and Yihan Wu.</td>
</tr>
<tr>
<td>Draft 0.4</td>
<td>5th Feb 18</td>
<td>Updated to align with SoS System definition and issued for Final Review.</td>
</tr>
<tr>
<td>Draft 0.5</td>
<td>15th Mar 18</td>
<td>Updated to incorporate comments from requirements team and issued to technical author.</td>
</tr>
<tr>
<td>Draft 0.6</td>
<td>23rd Mar 18</td>
<td>Updated to reflect comments from Technical Author and Jonathan Evans. Ready to be issued</td>
</tr>
<tr>
<td>Draft 0.7</td>
<td>27th Mar 18</td>
<td>Updated to add section on Integration fundamental handbook. Ready for sign off</td>
</tr>
<tr>
<td>V1.0</td>
<td>29th Mar 18</td>
<td>Document issued after updating comments from Tracey Best and Anders Moeller</td>
</tr>
</tbody>
</table>

Exclusions

These are items currently missing from this version of the document that should be included in a later publication.

1. Alignment with updated Concept of Operations for TM
2. Alignment with TMS Interface Requirement Specification

Assumptions
These are items upon which the validity of this document relies and which will be delivered by others. Non-delivery of these items will necessitate a change to this document.

3. The TMS will interface to operational telecommunications systems for the purposes of routing calls / text messages to and from the TMS workstations and instigating railway emergency calls.

4. The TMS will not contain, nor interface directly to, any Defect Reporting and Corrective Action System (DRACAS), Fault Management System (FMS), or Failure Reporting and Corrective Action System (FRACAS). However, these systems will need to be updated to include additional fault codes and data fields for the TMS.

5. A de-conflicted/agreed master timetable for each operating day is available to the TMS from the appropriate national systems.

6. Functional SIL allocation will be undertaken as part of the development.

7. Data Comms: Adequate communications capacity will be available in the ROC to meet the needs of the installed TMS.

8. All controls and indications for CCTV crossings due to be controlled from the TMS are provided within their respective interlockings /TDMs.

9. All operational and maintenance staff interfacing to the TMS will work to a common set of national standards.

10. Power requirements for Traffic Management subsystems are undertaken as part of detailed design.

Dependencies

These are items upon which the validity of this document depends. Any changes to the dependencies document may require further changes to this document.

1. TM Generic Principles and Functionality, [RD 9]

2. System of Systems (SoS) System Definition, [RD5]
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1 INTRODUCTION

1.1 Background

Digital Railway is a rail industry-wide programme designed to benefit Great Britain’s economy through more effective train operation, and improved customer experience and industry adaptability, enabled by accelerating the application of digital technologies to the railway. The benefits of the Digital Railway are expressed as:

- More trains
- Better connections
- Improved reliability

These are to be delivered by the Digital Railway Programme to GB Rail through the application of modern train control technology. The vision, purpose and objectives have been summarised as [RD1]:

- Increased capacity
- Safer, more secure & environmental railway

1.2 Improved train performance (reliability and availability)

- Improved whole life cost and sustainable commercial model
- Wider socio-economic benefits (e.g. skills, productivity, housing, exports)

This is an industry-wide programme involving Network Rail (as Infrastructure Manager), Train and Freight Operating Companies (as Railway Undertakings), the Rail Safety & Standards Board (RSSB), Yellow plant, and the supply chain. It will also engage with the Regulator and the Department for Transport (DfT), as necessary, to secure the required improvements to safety and customer provision, funding and approvals.

1.3 The Digital Railway Programme (DRP)

The Digital Railway Programme has several principal outcomes. These are:

1. Creation of a generic customer requirements suite for deploying Digital Railway (DR) Systems (using European Train Control System (ETCS) Level 2, a Traffic Management System (TMS) and other sub-systems and enablers).
2. Preparation of business cases and strategic business plans for specific routes using specific applications of DR Systems.
3. Assisting the routes in deploying specific DR Systems as a result of the Business Case analysis work undertaken at 2, above.
4. Production of a series of guidance notes, rules, processes and templates to help a specific delivery project to deploy DR Systems.

In the context of the DR Programme, the term ‘System’ refers to the various digital technologies to be deployed (i.e. European Train Control System (ETCS) Level 2, Traffic Management System (TMS) and other sub-systems and enablers).

System of Systems (SoS) refers to the integration and deployment of the various ‘Systems’ to reap the full benefits of the Digital Railway Programme. Both terms include more than just the products themselves, but also the people, processes and data required to operate them.

Within the DR Programme, the System Requirements and Integration team is charged with producing the output required under items 1 and 4 above.

As part of the System of Systems, the DR Programme is describing four key systems:

- ETCS Onboard
- ETCS Trackside (including interlocking functionality)
- C-DAS (Connected Driver Advisory System)

**Traffic Management System – scope of this document**

Whilst the concept is to deploy all of the four systems, each system may be contracted separately and the sequence of deployment may reflect the needs of the business for a particular application.
1.4 Context & Purpose of this Document

An EU Regulation on the adoption of a Common Safety Method (CSM) on Risk Evaluation and Assessment (CSM RA) came into full effect through Regulation 402/2013 [RD2] and was amended by Regulation 2015/1136 [RD3] in August 2015. The CSM RA applies when any technical, operational or organisational change is being proposed to an operational railway. The Digital Railway Programme considered as a whole will bring complex technical changes to the rail infrastructure resulting in a significant impact on the operation and organisation of GB rail. A formal assessment of the significance of the change has been undertaken [RD4] and concluded that the change is significant with high uncertainty and high consequence.

A key component of the hazard identification and risk assessment process defined in the CSM RA is the preparation of a System Definition, i.e. this document. The purpose of the System Definition document under the CSM RA is to complement the hazard record by bounding the scope of the hazard identification and risk assessment process and provide sufficient context to facilitate an assessment of the correct application of the process by an independent body (the Assessment Body, or AsBo).

Due to the industry-wide nature of DR, it is also an essential requirement that the DR programme clearly define what is meant by 'System of Systems' and 'System' and their interfaces to ensure successful requirements apportionment. This will result in minimising integration risk.

This System Definition document will fulfil that need of defining the Traffic Management System and its interfaces and thus minimise integration risks. It forms part of a suite of System Definitions that support the deployment of the DR System of Systems, including the System of Systems Definition document [RD5].

The System Definition defines the key details of the Traffic Management System, its purpose, functions and interfaces, and the existing safety measures that apply to it, so that it provides a generic application design in support of subsequent development and deployment (i.e. application-specific design and implementation).

It also allows the generic application specification and design for the Traffic Management System to be assessed in accordance with the CSM-RA in order to provide a basis for a safety case and the associated business change, operational rules and processes to be developed to support it.

This document has been written to promote a high-level understanding of the Traffic Management System, and is also intended to support the early stages of impact and hazard analysis of the proposed solution. It will clearly articulate the system in terms of form, fit and function to ensure that it is understood by all stakeholders and is able to be integrated with the SoS.

1.5 Scope

This document applies to the Traffic Management System only. The principal output from the System Requirements and Integration team is the Customer Requirement Specifications for the SoS, the systems within the SoS boundary, and the Interface specifications.

This definition only considers the deployment of the core System within the SoS and does not consider how a particular section of the railway might operate if only this system is deployed. Any variation from a full deployment of the SoS will need to be addressed by the particular Route (i.e. Infrastructure Manager and Railway Undertakings) concerned.

This document does not apply to a specific deployment of the core System; it deals with the generic system design and its associated interfaces (both physical and non-physical (e.g. operators)).

This document does not describe the Systems of Systems within which it sits as this has its own System Definition [RD5]. Whilst this document may be utilised to describe the scope of a contract or project, it is intended to be read and applied within the context of the SoS System Definition.
1.6 Background to the Generic System of Systems (SoS)

The SR&I team will deliver a set of GB rail specifications for system development and integration purposes using a common baseline architecture referred to as the System of Systems (SoS). The Traffic Management System is one of the core systems within this architecture.

The SoS provides a modern integrated railway signalling command and control system based on:

- ETCS Level 2 No Signals
- Traffic Management System
- Connected-Driver Advisory System (C-DAS)
- Modern interlocking technologies

The SoS will be supported by:

- A fixed data network, e.g. the Fixed Telecoms Network (FTN) or the FTN – next generation (FTNx)
- A voice and data communications network
- Data services, systems and protocols, Key Management and EULYNX
- Operational readiness to support the people and process change required

The SoS configuration ensures that the systems within it, e.g. Connected Driver Advisory System (C-DAS), the European Train Control System (ETCS) and Traffic Management System (TMS) can be developed by the supply chain with the majority of the interfaces built in to minimise future integration and migration costs for deployment programmes.

1.7 Document Maintenance

This System Definition Document is owned by the Lead Architect Traffic Management. It will be subject to review at least prior to each stage gate to ensure its ongoing adequacy for progressing to the next stage gate. Other updates may be instigated, as necessary, when directed by the Head of Systems Engineering.

This document has presumed a particular technical solution as outlined in the SOS System Definition [RD5]. However, if during delivery of this plan, a different technical solution comes to light that would also achieve the Digital Railway primary objectives (see section 2), then these will be considered. An update to this document may then be necessary.

This System Definition will be updated during this programme to reflect the evolving stages of development and a final update will include the safety requirements identified from the Hazard Identification (HAZID) to form an accurate and final representation of the System.

The application of individual DR Systems to a specific section of railway is outside the scope of this System Definition document. Specific applications will be addressed through deployment-specific System Definition documents.

1.8 References

1.8.1 Dependant References

An update to one of these references requires an update to this document:

RD1. Digital Railway Programme – Vision, Purpose, Objectives (DRAFT), issued by email 19th December 2016 by Digital Railway Comms
RD4. Digital Railway – M9 Significance of Change Assessment, 147833-NWR-ASS-ESS-000001, Ver.0.1, 6th November 2017
RD5. DRP System of Systems Definition Document, 153819-REP-DRP-ESE-000002,
1.9 Terms, Abbreviations & Acronyms

Please refer to the DRP Glossary of Terms and Abbreviations [RD6].
2 SYSTEM PURPOSE AND OBJECTIVES

The Traffic Management System is one of the four core systems within the DR System of Systems. The generic design has been developed as part of that integrated system however the output is equally applicable to:

- Deployment of an integrated and repeatable train command, control and safety system on GB rail to meet the objectives mentioned in 1.3, including:
  - Traffic Management System;
  - European Train Control System (both Onboard and Trackside);
  - Connected-Driver Advisory System; and
  - Interlocking; or
- An individual deployment of the Traffic Management System by the industry that support future integration with the other core systems mentioned above.

Traffic Management Systems support high levels of automation during normal working and around Conflict resolution – They are used in various roles across the route to:
  a) validate and de-conflict the day’s plan prior to start of service;
  b) resolve Conflicts & Considerations as they occur; and
  c) plan/re-plan the train service during times of perturbation.

To ensure that any future deployment is successful, business change activities (e.g. people and process change) will also be required to support optimal operation of the system and to maximise benefits gained.

Manipulation of the train service within Traffic Management, either via automation or manual manipulation by a user, results in the route setting sub-systems carrying out the intended actions.

This System Definition (and architecture) is route and solution agnostic; however, it is based around current and emerging technology solutions. The system architecture shown in Figure 1 represents the Digital Railway Integrated Traffic Management architecture (in the box) and associated systems.

![Figure 1 – Traffic Management System Architecture](image)

The Information Exchange Layer (LINX) is not part of the DR SoS but is a vital interface which connects the TMS with the Business Systems and is responsible for providing operational and business input to the planning layer of Traffic Management System. Some of the SoS systems like C-DAS are reliant on LINX to get information. The Planning & Operations layer and Signalling Control layer form the core part of the TMS
and they connect to the Trackside through the Field Equipment layer. ETCS Trackside and ETCS capable interlocking are again part of the SoS and are shown in the architecture for completeness.

The users at the Signalling Control Layer are presented with a single integrated interface to the system allowing both automatic and manual control of the railway. The interface with the ETCS Trackside is used to communicate with different types of field equipment in order to provide abstraction and the ability to transfer areas of control between workstations, and even ROCs, subject to configuration.

Management of rail traffic will be largely automated, with the computer system performing repetitive day-to-day tasks and controlling trains in accordance with a set of rules. Regulating decisions will be made based on predicted train movements, and the system can be operated by a small team of skilled personnel. The technology will optimise the use of the existing infrastructure and enable better capacity utilisation without impacting performance.

The objectives of Traffic Management are to:

- de-conflict a planned timetable ahead of implementation;
- provide a greater level of automation;
- reduce workload;
- enable recovery of the timetable more quickly during perturbation;
- make management of capacity within the network more efficient;
- make regulating decisions upon predicted train movements;
- enable the sharing of real-time information between stakeholders to allow more informed decision-making;
- assist schedule manipulation by providing a forecast prior to any measures being applied in order that a user, or indeed the Traffic Management System itself, can understand the impact of each proposed solution, therefore allowing the optimum solution to be implemented;
- assist the Business Change process within Network Rail with respect to the introduction of near to real-time train planning;
- use other automated functions such as Conflict Detection and real-time timetabling and re-planning;
- resolve disruption, quickly and pro-actively, through improved decision support, reducing the potential for operational safety issues, e.g. delegation of control;
- plan service delivery as a continuous process; and improve the quality of information disseminated to the industry, customers and passengers, and to other parts of Network Rail for post-event analysis.
3 **OVERALL SYSTEM OF SYSTEMS**

This section provides the context of the Traffic Management System in relation to the SoS work produced by the Digital Railway Programme.

This work identified the baseline architecture, referred to as the System of Systems, as follows:

![Digital Railway Programme – Functional Architecture](image)

**Figure 2 – The SOS Architecture**

Further details of the interfaces shown in Figure 2 (including protocol, bearer and multiplicity) and the information flowing over them are covered in the document Digital Railway Programme Interface Description Document [Ref RD7].

The TMS and its interfaces in the context of the SoS are shown in bold Red lines (see Fig. 3, below).
Figure 3 – TMS interfaces

Details of the information and data flows required by, or from, the TMS will be developed as part of the generic design and are recorded in the Interface Requirements Specification [Error! Reference source not found.].
4 TRAFFIC MANAGEMENT SYSTEM FUNCTIONS AND ELEMENTS

This section provides an outline of the System operations and enablers required to support future deployment of a Traffic Management System on GB Rail.

The following are considered essential System elements to support future deployments:

- Traffic Management System
- Operational Readiness
- Enabling Projects (e.g. GSM-R upgrade, National Key Management System (KMS), etc.)
- LINX development

In addition to these elements, which are described in detail in the following sections, there will be a need for the industry to develop the following to realise the full potential of deploying Digital Railway Systems:

- Configuration Data: At each location where a DR System is deployed, there will be site-specific configuration data (e.g. geographic, functional, etc.) that will define how that specific DR System interacts with the railway it controls and the site-specific functions it applies.
- Maintenance Procedures: The new functionality provided by the Digital Railway System will require revised maintenance procedures for areas of the railway where the DR Systems are deployed and any transitional arrangements that may be required where new and old technology exists.
- Operator Manuals: Manuals will contain comprehensive material that supports new and existing skill sets and will define the tasks that operational and maintenance staff will carry out on the various parts of the System.
- Maintenance Tools: The DR System may assist maintainers in predicting and identifying faults. Maintenance tools will enable maintainers to predict, identify and rectify faults in the DR System.
- Training Material: Training material will enable operational and maintenance staff to learn and practise the tasks that they will be required to carry out in their role before they have to do this on a live system.

4.1 DR System Operation

The TM Concept of Operations will provide greater detail on the desired System operation. However, this section is included to provide a brief summary of how a TMS typically operates to aid understanding of other sections of this document.

The DR System will support operation in normal, degraded and emergency modes, although the latter two will depend on the cause and scale of the degraded mode of operation.

A TMS will allow larger areas of our network to be controlled from fewer locations, and help increase capacity and improve reliability. The new system and processes will automate many repetitive tasks and bring a number of operational benefits, such as real-time planning/prediction and resolution of conflicts. Areas of control will be easily reconfigured when operational needs dictate. A single operational information system will provide real-time information to passenger and freight customers, particularly during times of disruption.

The key functions supported by TMS are given below:

- **Provide planning information**: Network Rail coordinates capacity requests and provides a working timetable. This function receives the timetable from national planning.
- **Operate the network to the current plan**: Requests that routes be set in the correct order and at the correct time to allow trains to move across the network safely in order to fulfill the current plan.
- **Provide information to the signaller**: Continuously provides the signaller with the latest operational network information and the current plan. This allows the
signaller either to supervise effectively or perform the ‘Operate the Network to the Current Plan’ function.

- **Monitor train movements against the current plan**: Using available information, monitor train movements across the rail network against the current plan to ensure movements remain within the agreed tolerances.

- **Optimise current plan**: When the current plan is no longer achievable within the agreed tolerances, the system performs a re-plan based on the latest available information. This activity optimises the proposed plan to achieve the desired outcome (e.g., maximum capacity, recover to the original timetable, etc.). Once optimised, the proposed plan is then agreed by relevant parties and published to all concerned systems as the new ‘current plan’.

- **Support Incident Management**: This can be triggered at any time when the external Incident Management System determines that CCS activities need to take place. Upon receipt of a task from the Incident Management System, this function steps through a sequence of activities. This optionally provides confirmation that each step has been performed in the correct order, before notifying the Incident Management System of completion. Following completion of the actions, the ‘optimise plan scenario’ should run to update the plan to take any new perturbations into account. TM will support this interface via LINX.

- **Support Connected Driver Advisory Systems (C-DAS)**: This interface will enable the provision of information updates to trains in near real time and also offers the potential for the control system to use data received from trains to inform regulation decisions. In this way, the guidance provided has the potential to optimise the performance of the wider network. TM will support this interface via LINX.

- **Interface with mainline entrance/exit**: Once the need for co-ordination with depots, sidings or other third-party infrastructure has been identified, the signaller ensures that arrangements are made and agreed to before updating the current plan with any resulting changes.

- **Support stock and crew interface**: TOCs and FOCs can provide the latest stock and crew resource constraints (e.g., a driver constraint on what routes they may be able to drive due to route knowledge limitations). Following receipt of a change to these constraints the ‘Optimise Current Plan’ function is triggered to ensure that these constraints are taken into account in the current plan. This interface will be supported by TM via LINX.

- **Managing Possession**: Takes control of an area or zone to enable access and working for a specified time. Persons in Charge are responsible for possessions zones. Prevents unauthorised train movement into a possession.

- **Short notice possessions**: Unplanned event requires an immediate response involving short notice works.

- **TM Protection**: The Traffic Management System will support the granting and taking back of possessions remotely. TMS protection will interact with the operator, and other elements of the DR Systems, as appropriate, and take control of an area or zone.

- **Support Customer Information System (CIS)**: Provision of timely and accurate information during periods of disruption will provide operators with an increased opportunity to focus on the management of, and recovery from, disruptive events, decreasing the time spent gathering and analysing information, allowing concentration of effort on service recovery and related tasks. Similarly, this use of a single system and its connection to downstream systems will lead to increased customer confidence in the accuracy and timeliness of the information received. TM will support this interface via LINX.

### 4.1.1 Normal operation

Under normal operation, the TMS will provide frontline operators with the tools to create and manage the current plan for the train service better. The technology will provide real-time forecasting of train movements, taking into account the following:
• current service performance;
• specific train and rolling stock performance;
• infrastructure or rolling stock restrictions; and
• disruptive events.

Any conflicts, such as two trains being forecast to arrive at the same point on the infrastructure at the same time will be highlighted to the operator.

The technology will support operators in resolving conflicts by proposing resolution options and displaying the resultant impact of those decisions prior to any change being committed to the plan.

Conflicts can be highlighted and resolved or flagged as 'Accepted', if intentional. Any planning alterations will be incorporated into the current plan along with any imposed restrictions on rolling stock, crew and/or infrastructure.

The Traffic Management System will then use the agreed or updated plan to request routes automatically, and in a timely manner, for all trains in its area of control. These requests will be sent to the interlocking, which will set routes for those requests that can be actioned, rejecting those that would create conflicting train movements.

Traffic Management will support the imposition of speed restrictions and the granting and taking back of possessions. In both cases, the TMS will interact with the operator and other elements of the DR Systems, as appropriate. Speed restrictions are informed by an external business system; the TMS will disseminate that information to the ETCS Trackside (L2 No Signals) system.

4.1.2 Degraded mode operation

The Traffic Management System will acquire changes from operational systems as they occur, and will support management of events that perturb train service running as they happen. Thus, the initial plan for the day's service will be dynamically updated with changes to ensure continued train service delivery, wherever possible, in spite of service-affecting events.

The TMS will support safe management of trains in the event of failures and incidents disrupting the railway. This includes:

- Managing Very Short term Timetable (VSTP) process
- Implementing a service recovery framework
- Taking mitigating action
- Applying infrastructure restriction
- Applying infrastructure speed restriction
- Applying train speed restriction
- Managing Incident timescale average

4.1.3 Emergency mode operation

The TMS will support emergency mode operation. This section will be populated in subsequent revisions of this document.

4.2 The Deployed System

The Traffic Management System informs schedule manipulations by providing a forecast prior to any measures being applied in order that a user, or indeed the Traffic Management System itself, can understand the impact of each proposed solution, therefore, allowing the optimum solution to be implemented.

The TMS provides the operations and signalling control layer of a Digital Railway where manual and automated control of the railway can be exercised and sources of operational information are integrated, displayed and used to manage train service delivery. It supports possession and speed restriction related activities. And it supports 'exporting' train movement data to other systems using the LINX interface, including
Customer Information Systems (CISs), Stock and Crew Systems, Incident Management Systems and CDAS. TM interfaces with national operations systems such as TRUST, CIS and TOPS via LINX and with the RBC and Interlockings.

The TMS includes the core function of Plan/Re-Plan. Planning of service running is a continuous process and the system allows prediction of conflicts and enables real-time timetabling and re-planning, as required. Proactive resolution of operational issues results in a better service for passengers, train and freight operating companies, particularly during times of disruption. The TMS allows the control of traffic at a strategic route level as well as at the tactical level in day-to-day operations, as and when they arise. In full automatic mode, amendments to train services are achieved by the TMS through manipulation of the train plan, using the Plan and Re-plan system. The TMS will provide real-time train running information, which can then be shared with other systems, e.g. CIS and C-DAS, and it allow easy manipulation of the daily plan at times of disruption.

Deployment of a TMS provides opportunities to improve track worker safety by introducing new processes of a higher reliability for managing possessions of the line, removing human error failure modes of historic processes. Functionality for Remote Possession Management will be provided, coupled with the necessary process change. It will be possible to deploy a protection/possession system from a remote location.

The TMS provides Reconfigurable Areas of Control which enable management of signaller workload and improved responses to incidents. This includes the capability for the signalling control, voice communications and level crossing CCTV imagery associated with a particular section of the railway to be transferred as a co-ordinated entity between different workstations.

4.2.1 Business Continuity

Continuity is the ability of the business to absorb perturbations and continue to run the service. The level of service can change according to the degree of perturbation. Business continuity requirements will be included, where applicable, within the System CRS.

The TMS configuration should minimise the impact of failure of a single component and enable quick and efficient recovery from failure.

4.2.2 Operational Readiness

This will ensure that the systems to be deployed are ready to enter into service, i.e. they can be installed, operated and maintained by competent personnel.

Operational Readiness requirements will be produced for inclusion in the Traffic Management CRS.

4.2.3 Training (incl. Simulator)

The purpose of the DR programme is to enable successful deployment of new technology and operations on the rail network and, consequently, significant training and capability activity will be required to underpin Digital Railway deployment.

The following are expected to be produced, where applicable, for the system:

- A training simulator specification
- Training requirements
- A list of training scenarios

4.2.4 Deployment Guide

The Digital Railway Programme will produce a deployment guide, where felt necessary, that will facilitate the implementation of the system by the deployment programmes.
4.2.5 Integration Fundamentals Handbook

To help enable successful integration of the Traffic Management System, DRP will be producing an Integration Fundamentals Handbook for programmes to use as best practice guidance when deploying and integrating DR technologies.

4.3 Enabling Projects

These are projects that are deemed to be outside of the DR System but which are critical dependencies to / from the System. In some cases, the DR SR&I team will be specifying interface requirements for these projects to ensure that they will integrate with the Traffic Management System.

The critical enablers for the TMS are:

- LINX
- Data
- Telecommunications
- Stock & Crew System
- Business Continuity
- TSR System

Please refer to the DRP SoS System Definition [RD5] for a brief description of the key enabling systems as details of them are not repeated here.
5 SYSTEM BOUNDARY
The elements contained within the system boundary are shown in Figure 1, above. As this is a System Definition for a generic System, with no specific application in mind, there are no geographic boundaries that can be discussed in this section. These will be considered in the System Definition documents for specific DR deployment schemes as and when they occur.
6 PHYSICAL INTERFACES

When deployed in the railway environment, the Traffic Management System will also interface to other physical systems as listed below.

6.1 ETCS Trackside (incl. IXL)

This incorporates interfaces with both the Interlocking function (requesting routes, determining the state of the railway) and with the ETCS Trackside (Level 2 No Signals) (providing various status updates and command requests).

6.2 Other TM Systems

This represents an interface with another TMS which may be operated by another Infrastructure Manager.

6.3 LINX

This incorporates the functional interfaces with C-DAS and external business systems (including the Temporary Speed Restriction tool) for the receipt and exchange of traffic data. External systems connected via LINX include (but is not limited to):

- Customer Information Systems
- Stock & Crew Systems
- Incident Management Systems

6.4 CCTV network

This is to receive CCTV images and to control the CCTV camera (Tilt/Pan/Zoom) and wiper blades.

6.5 Operational Telecoms

The TM will have an interface to the Operational communications systems so that a subset of the Human Machine Interface (HMI) functions can be provided within the DR System to the operator for convenience.

6.6 SCADA

The TMS receives the energisation status of the traction sections and, if specified, could issue commands to control these sections (e.g. for maintenance or incident management).

6.7 Voice Comms

Voice comms are established through an external Computer-Telephony Interface (CTI) which provides geographical mapping of incoming calls to the correct TMS workstation (according to the area of control) and provides the TMS operator with the identity of the phone used.

6.8 Trackside Objects

This interface is for receiving train status information from trackside devices such as Wheel Load Impact Detection, Hot Axle Box Detection, and Pantograph Checking.

6.9 Data

One of the core capabilities, and an integral part of delivering the SoS and its systems, will be managing and exploiting data as a business critical asset. Achieving this means transforming the way that data and information is perceived and used by the industry and requiring changes across: People, Process & Technology.
6.10 TM Protection

This will provide functionality for Remote Possession Management, coupled with the necessary process change. This is an integrated part the TMS and has been listed here only for completeness.

6.11 Rail Operating Centre (ROC)

6.11.1 Building Interior

The principal systems that comprise the TMS infrastructure hardware will be housed within a ROC building. The building provides space in a secure, temperature-stable environment where equipment can be easily accessed by operational and maintenance staff.

6.11.2 Power Supply

Within each ROC, the systems that comprise the DR system are expected to interface to the existing diverse and secure power supplies which are provided within most ROCs. Appropriate survey activities will need to be undertaken to determine available spare capacity and changes made to support deployment, as necessary.
7 FUNCTIONAL INTERFACES

Digital Railway technology interfaces to the high level functional systems as described in the DR SoS System Definition [RD5].

These interfaces will be implemented with appropriate cognisance of the required service level, presentation, capacity, quality of service, availability, integrity, security, etc. appropriate to each one. Some interfaces may also entail some provision for confidentiality where commercially sensitive data is being exchanged between systems.

7.1 Staff

Discussion of staff within this document is limited to only those staff that will directly interact with the DR System. Thus, users of supporting operational information systems such as TPS, TRUST, TOPS, etc. are excluded.

7.1.1 Operational & Maintenance Staff

Operational Staff are defined as any individuals who are authorised, competent and responsible for the movement of trains, e.g. signaller, and who interfaces with the DR System as part of their duties. This includes staff that contribute to the safe movement of trains through their role, e.g. TOC platform staff undertaking train dispatch duties.

Maintenance Staff are defined as individuals who are responsible for undertaking engineering activities on railway infrastructure and vehicles. This includes those that work trackside and, thus, those that may require protection arrangements to be made by the DR System to ensure that they can conduct their work with appropriate safety measures in place.

For the purposes of the Traffic Management System, the two groups defined above sit within the system boundary and, as such, appropriate operational readiness activities will be needed to enable the successful deployment and operation of the Traffic Management System. The operational readiness activities should also generate appropriate supporting procedures to allow the staff to operate the System in a safe and efficient manner.

Interfaces to the system will be procedural or technical. Details for specific groups of staff are described in the following sections.

7.1.2 Operations Staff

The following roles are anticipated to require direct routine interaction with a TMS implementation. People in these roles would need to be appropriately trained in how to engage with the system, with continuing competence management regimes, where appropriate. The roles listed below are indicative of the activities each will be required to perform, and may differ from the role title of the personnel who perform the activity in a practical application:

- Signallers
- IM and RU Controllers
- IM Data preparers
- Performance Analysts and Capacity planning roles
- Engineers performing maintenance, configuration updates, obsolescence management, etc.
- Level Crossing Operators

7.1.3 Incident Investigators

Formal investigations into serious railway safety incidents are carried out by the Rail Accident Investigation Branch (RAIB). Examples of such incidents include: train overspeed, exceedance of Movement Authority, derailment, collision and passenger /
workforce fatality. Evidence for such an investigation will include voice or data logs from the DR System, which will be stored in a tamper-proof memory.

Others involved (but not limited to) in Incident Investigations include British Transport Police, the Centre for Protection of National Infrastructure, and the Health and Safety Executive, all of whom require access to infrastructure and control system data records in the event of an incident. Although they sit outside the boundary of the System, they are crucial interface provisions and will have to be made to share data openly and efficiently across the industry for incident investigation.

7.1.4 Remote Users, TOCs & FOCs

The TMS may also be required to supply information-only displays to other remote users at various locations. Where this is the case, then this will be achieved through LINX which, in turn, could be accessed from users’ own existing computing environment.

7.2 Command, Control and Signalling Systems

7.2.1 Adjacent Systems

The TMS will need to interface to adjacent systems, whether other instances of the system itself, existing legacy control systems, or depot control systems.

7.2.2 Operational Telecoms

The TMS will have an interface to the Operational communications systems so that a subset of the Human Machine Interface (HMI) functions can be provided within the DR System to the operator for convenience.

7.2.3 Signalling and Train Control Systems

The DR System will be required to interface to existing legacy command and control systems at the boundary of the DR deployment area, enabling handover of operational services.

7.2.4 Level Crossings

DR deployment schemes requiring interfacing to Level Crossings will need to address issues such as Human Factors, updating of existing Level Crossing control systems, and assimilation of control and indication functions.

7.2.5 Interfacing Protocols

Details of the interfacing protocols will be defined in [RD8]. The information to be shared is defined in the Digital Railway Programme – Interface Description Document [RD7].

7.3 Equipment Monitoring Systems

7.3.1 Traction Supply Control (SCADA)

The TMS will interface to the traction supply control system(s) to import traction supply status information, which will be used in making train route suitability decisions and also displayed to the operator. Traction section ‘live’ and ‘dead’ states, along with traction supply status information, are to be acquired and used / displayed.

7.3.2 Infrastructure Monitoring Systems

Various types of remote condition monitoring systems are provided to monitor key parts of the railway infrastructure. Some of these systems carry alarm and alert states that are critical to the operation of the railway. However, it is important to note that the information required is an understanding of the operational implication of the failure, not necessarily the failure message itself.
An example of such a system would be the monitoring of signalling power supplies by a system called the Signalling Power Alarm System (SPAS), which reports states to the maintainer. The TMS will interface with such systems to acquire the operationally relevant alarms.

Other systems, such as airport or rock fall trip wires, may be connected directly to the underlying signalling system as activation of such systems indicates an immediate need to protect train movements. The activation of these systems, and any associated activities to protect train movements, are then reported to the TMS by the Interlocking system. This approach replicates existing alarm reporting functionality via interlocking.

### 7.3.3 Vehicle Monitoring Systems

The TMS will interface to rail vehicle monitoring systems such as Hot Axle Box Detectors (HABDs), and Wheel Impact Load Detectors (WILDs) where the area of infrastructure under control requires this.

Note that projects that deploy DR Systems and which will, therefore, re-control the railway will be required to undertake an assessment of the freight traffic in the area; it will be necessary to deploy additional HABD sensors in mitigation of the removal of lineside observation, where local and regularly staffed signal boxes are being closed.

### 7.4 Management Systems

#### 7.4.1 Decision Support Tools

A series of optional Decision Support Tools (DSTs) will provide an interface to the TMS to support Operators with the day-to-day running of the railway in both normal operating and degraded operating modes. These tools will use the LINX interface to communicate with the TMS.

- **Stock and Crew**
  
  The stock and crew (S&C) module refers to the system(s) and processes utilised to manage events that affect the running of train services in regard to specific stock and crew route and utilisation issues. The stock and crew module will either replace or interface with existing TOC and FOC stock and crew systems.

  The stock and crew module combines activities currently undertaken separately by TOC and FOC controllers and brings this part of the decision-making within the DST, adding to the data quality and providing the information necessary for managing stock and crew allocations during perturbation. This has the potential to provide accurate and consistent information of the location of rolling stock and train crew and their subsequent availability, which does not exist at present, and it also allows operators greater focus on the management of an incident or event.

  With the use of a single, integrated system and decision support supplied to controllers, management of perturbation is expected to be quicker and more appropriate, providing a reduction in reactionary delay. Similarly, the use of a stock and crew module and its connection to downstream systems will enhance information distribution to stakeholders, including the need to comply with Passenger Information During Disruption (PIDD) requirements.

- **Incident Management**

  The Incident Management module refers to the system(s) and processes utilised to manage and resolve disruptive events that affect the running of train services.

  An integrated Incident Management system combines effective use of the technology along with the activities currently undertaken separately by controllers and brings these together to save time in the end-to-end process of managing an event, as well as providing a logical and consistent process for operators to follow in dealing with the event. This provides a nationwide consistency that does not exist at present and also allows operators greater focus on the management of an incident or event.
An integrated system will also provide a more accurate method of capturing auditable data for subsequent post-event reviews to enable future occurrences of similar events to be managed and planned more consistently and effectively. The system will provide the capability to share consistent and up-to-date information with interested parties, enabling better coordination in the resolution of the incident.

A single, integrated system providing decision support tools to controllers will facilitate a faster and more appropriate site response. This will, in turn, result in a reduction in reactionary delay. The technology provides accurate data to enable infrastructure access to be managed more accurately and effectively than current systems allow.

Similarly, this use of a single system and its connection to downstream systems will enhance information distribution to stakeholders, including the need to comply with PIDD requirements.

- **Customer Information System**

Customer information (CIS) has two distinct elements:

  i. Information supplied by Network Rail to its customers
  ii. Information displayed by TOCs / FOCS to their customers

The customer information module will provide historical, real-time, planned and forecasted information in a ‘read only’ format to all internal and external customers. This will be presented via a selection of interfaces in both graphical and tabular formats maintaining information integrity in line with the ‘one version of the truth’ vision.

The customer information module will also provide information to existing downstream TOC and FOC systems to support Passenger Information During Disruption (PIDD) and Prioritised plan information distribution. An integrated customer information module combines activities currently undertaken separately by controllers from Network Rail, TOCs and FOCs and brings these together to provide a logical and consistent process by which operators can disseminate consistent information. This will provide nationwide consistency and much improved accuracy of customer information.

7.4.2 **C-DAS**

Driver Advisory Systems (DASs) are designed, within a traffic management context, to provide drivers with information derived from the status of the current plan relating to progress updates of the train concerned, principally, required driving speed.

A Connected DAS (C-DAS) is a driver advisory system with a communications link to the TMS in each controlled area in which the train operates. This enables the provision of schedule, routing and speed restriction updates to trains in near real time and also receipt of information from trains to the TMS to improve regulation decisions. Realisation of benefits requires data to be exchanged between the on-board train units and the DST modules in response to changes to current status.

7.4.3 **Planning, Information & Management Systems**

TMS deployment requires ‘transient’ information to deliver its functions and national systems, such as TPS, are the source of this information. Traffic Management Systems will communicate with various National systems to acquire timetable, rolling stock data, train consist, possession, maintenance management system, and other types of information. These systems include, but are not limited to: TPS, TOPS, R2, TRUST and ELLIPSE.

The TMS will interface to these third-party systems via LINX and its provision of ‘message brokering services’.
8 SYSTEM ENVIRONMENT

8.1 Procedures and Rules

The majority of DR deployments will take place in existing mature operating environments and will provide new functions, facilities and shared information sources, and Operational procedures will be modified to reflect the new processes, roles and responsibilities.

Deployment of a Traffic Management System will cause changes to the Rule Book and other longstanding practices.

Particular areas of operation affected are:

- Reconfigurable areas of control
- Possessions management and remote access
- Management of incidents
- Management of train and infrastructure failures
- Management of restricted routes
- Operational Rules

8.2 Staff Competence and Assessment

In line with existing accident investigation recommendations, training facilities will be provided for train staff in the new roles in normal, degraded and emergency modes of operation, with a realistic portrayal of the area of control and the traffic (both trains and communications) within it.

It is expected that maintenance staff will need to be trained and retrained to be able to maintain and fault-find any new equipment appropriately and safely, and their competence will require ongoing assessment.

8.3 Security

Appropriate physical and cyber security requirements and arrangements will need to be implemented for the Traffic Management System. These will be made in the context of the wider NR, Network Rail Telecoms and railway industry security and cyber security policies, procedures and provisions.

Cyber security for Network Rail and Digital Railway is overseen by the DIT (Security – Transport (Rail) division) as the Regulator and implemented by the Security Assurance Framework process.

8.4 Maintenance

Deployment of a TMS will introduce new maintenance requirements.

The DR system will be provided with suitable maintenance support, both tools and local and remote facilities, to assist maintainers in monitoring, understanding, and repairing the system.

8.5 Electromagnetic Compatibility (EMC)

It is reasonable to assume that the EMC environment for the system should be compliant with the latest standard and this assumption will be validated as part of the TMS deployment validation activities.

8.6 Human Factors

For the Traffic Management System there is likely to be a significant change to the HMI for operators and maintainers. Therefore, ergonomics assessment work will be required to ensure that HF requirements are captured in the DR specifications.
8.7 TOCs & FOCs

The TOC and FOC staff co-located with Network Rail staff to operate parts of the DR System will have TMS display screens as well as their own employer’s proprietary systems and equipment.
9 EXISTING SAFETY MEASURES

The CSM RA process will be applied to the system. Therefore, all safety measures and associated requirements will be listed in the hazards record and associated safety requirements specifications.

Within a current (conventional) railway command and control system, the Interlocking contains the safety-critical functionality that ensures route integrity and provides Movement Authority.

The Traffic Management System (in isolation) respects the existing long-standing principle that the control system is safety-related and that the safety-critical functions are contained within the underlying signalling or train control systems (e.g. the interlocking or ETCS).

In operational terms, the existing safety measures include the applied maintenance regime, TOC & FOC operating practices, Railway Rule Book, and compliance with Group and Network Rail standards, all of which will require review, update and implementation as part of the deployment of the DR System.

Existing safety measures identified by the risk assessment process will be captured in the DR Generic Hazard Record and will be assessed to determine their effectiveness based on the engineering change and whether special arrangements / additional procedures and standards, etc. may be required during the implementation period of the change.

The Safety Requirements that emerge from the hazard identification and risk assessment process will be cross-referenced to the DR SoS Generic Hazard Record [Ref. RI1] and the DR Systems Generic Hazard Records for each DR System (where applicable).

Further information with respect to Safety Measures and Requirements is contained in the DR System Safety Plan [Ref. RI2].
10 ASSUMPTIONS

All risks, assumptions, issues and dependences are recorded in the Digital Railway Project RAID log document [Ref. RI3]. They are regularly reviewed by Lead Architects to ensure compliance with this System Definition.
Digital Railway

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