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Digital Railway – GB Generic Customer Requirements Specification for Traffic Management Systems (TMS)

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Document owner: Head of System Requirements and Integration

Version History

Issue	Date	Comments
0.1	23/03/2018	Draft for internal review
0.2	18/04/2018	Document updated to address reviewer comments
1.0	26/04/2018	Formal Issue for signature
1.1	20/11/2018	Updated to new CRS template (v0.7) and incorporated requirements agreed at the Change Review meeting on 13/11/2018
2.0	28/11/2018	Formal Issue for signature
2.1	12/03/2019	Updated to revised CRS template and incorporated requirements agreed at the Change Review meeting on 06/03/2019
3.0	15/03/2019	Formal issue for signatures

Exclusions

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

1. Full attribution of safety tagged requirements will be included in a later version.
2. Best endeavours have been used during the development of this specification to align it to the relevant Concept of Operations documents which have been updated in parallel. Final assurance of the complete alignment of this specification with the relevant industry-endorsed Concept of Operations will be achieved in a later version.
3. Sections that do not currently contain any requirements will be populated in a later version.
4. This document has been submitted for Level 3 assurance in accordance with the System Management Plan [RD14]. A response has been received with 3 Category 1 comments (i.e. there are issues associated with a fundamental concern, error, omission or question that has a

direct bearing on the acceptability of the document). These are associated with the provision of safety requirements. These, and other comments, will be addressed in a future revision of this document.

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.

1. For a list of assumptions please refer to section 4.2

Dependencies

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

1. For a list of dependencies please refer to section 4.3

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ABBREVIATIONS, ACRONYMS AND DEFINITIONS

Abbreviations are explained in full on first use within this document. A comprehensive list of abbreviations and definitions is contained in the Glossary [RI1]

REFERENCES

Dependent References

An update to one of these references requires a review to identify any potential need for an update to this document.

RD1 Digital Railway TMS Concept of Operations (details TBA)

RD2 Digital Railway – GB Generic System of Systems Customer Requirements Specification, 153819-NWR-SPE-ESE-000003, Version 5.0

RD3 Digital Railway – Traffic Management System (TMS) System Definition, 153821-NWR-REP-ESE-000004, Version 2.0

RD4 Digital Railway - Interface Requirements Specification, 153821-NWR-SPE-ESE-000013 Version 2.0

RD5 Digital Railway - Integration Fundamentals Handbook, 153819-NWR-GDN-MPM-000001 Version 1.0

RD6 Digital Railway- Customer Requirements Specification Requirements Management Plan 153819-NWR-PLN-ESE-000006 Version 2.0

RD7 Digital Railway – Customer Requirements Deployment Policy, 153819-NWR-SPE-ESE-000002, Version 1.0

RD8 Digital Railway Customer Requirements Change Control Process, 153819-NWR-SPE-ESE-000004, Version 1.0

RD9 Digital Railway – GB Generic Customer Requirements Specification for Connected Driver Advisory System (C-DAS), 153821-NWR-SPE-ESE-000010, Version 3.0

RD10 Digital Railway – GB Generic Customer Requirements Specification for ETCS Trackside, 153821-NWR-SPE-ESE-000007, Version 3.0

RD11 Digital Railway – GB Generic Customer Requirements Specification for ETCS Onboard, 153821-NWR-SPE-ESE-000008, Version 3.0

RD12 Digital Railway – GB Generic Customer Requirements Specification for Operations & Maintenance, 153819-NWR-PLN-ESE-000014, Version 2.0

RD13 Digital Railway Requirements Specification for the Traffic Management Systems (TMS), 153821-NWR-SPE-ESE-000014, Version 2.0

RD14 Digital Railway – System Management Plan, 153819-NWR-PLN-MPM-000002, Version 8.0

Informative References

These references have no material bearing on the content of this document but are referenced within it. Unless otherwise specified, the latest version should be used.

RI1 Digital Railway – Glossary of Terms & Abbreviations, 153819-NWR-SPE-ESE-000001

RI2 Digital Railway – SoS Basis of Design, 153819-NWR-REP-ESE-000002

RI3 Digital Railway – SoS Data Specification, 153831-NWR-SPE-ESE-000001

RI4 Digital Railway – Introduction to the Requirements Structure, 153819-NWR-PLN-ESE-000012

1 Introduction

1.1 Purpose

The purpose of this document is to set out the generic Customer Requirements that apply to the Traffic Management System (TMS) when it is deployed on the GB railway network. These generic Customer Requirements are intended as a baseline to ensure that the TMS solutions adopted on any individual deployment project will integrate and be compatible across route boundaries and with the generic ETCS trackside, using TMS in the context of the System of Systems Generic Baseline Architecture (see Figure 1).

All deployment projects involving the TMS will use this document as a basis of their requirements suite for this system.

1.2 Scope

This document provides the generic Customer Requirements for the TMS, including functional, non-functional and process requirements. It will be aligned to the concept of operations [RD1], which describes how the GB railway is intended to operate where this system is deployed (see exclusion 2).

Acceptable solutions to the Customer Requirements in this document are constrained by the Digital Railway Requirements contained within the 'Digital Railway Requirements Specification for the Traffic Management Systems (TMS)' [RD13] and deployment projects must comply with both the Customer and Digital Railway Requirements. The relationship between the Customer Requirements and other elements of the overall Requirements Structure for Digital Railway is explained further within the Introduction to the Requirements Structure document [RI4].

This system will not exist in isolation on the railway and will need to interact with a variety of other systems, which may include both existing systems and Digital Railway systems. The baseline System of Systems architecture is set out in the Figure 1. This document supports, and is reliant upon, the GB Generic System of Systems Customer Requirements Specification [RD2].

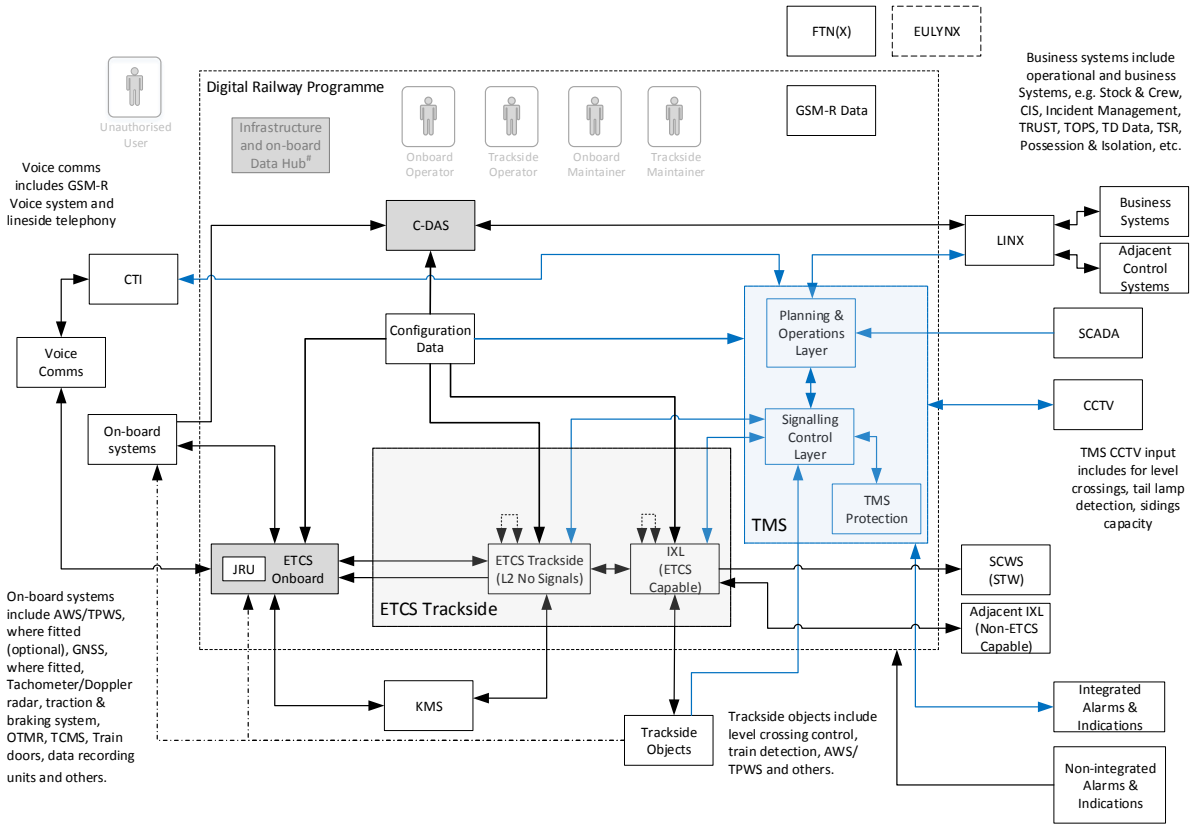

Figure 1 System of Systems architecture

The system boundary for the TMS is set out in the Traffic Management System (TMS) System Definition, [RD3], which also describes the generic environmental context in which the system is expected to exist.

This document does not set out interface requirements between the TMS and other systems as these are separately documented in the Interface Requirements Specification [RD4]. The successful implementation of the TMS is reliant upon compliance with the relevant interface requirements in [RD4].

This document does not contain details of any deployment project-specific requirements. These may be found in deployment project-specific documentation, which is subordinate to this document.

Section 2.2 of this document sets out how a deployment project will identify which of the requirements in this document are relevant to its needs.

Nothing in this document obviates any legal requirement with which parties using it must comply.

This CRS forms part of a suite of requirements specifications and therefore for a complete understanding of Digital Railway operation, should be read in conjunction with the CRSs/IRS for:

- System of Systems [RD2]
- ETCS Trackside [RD10]
- ETCS Onboard [RD11]
- C-DAS [RD9]
- Operations and Maintenance Readiness [RD12]

- Interface Requirements Specification [RD4]

The acceptance criteria applicable to the Customer Requirements within this document will be documented separately in a Verification and Validation Matrix.

1.3 Business Need for this Specification

There are many potential solutions for implementing the Digital Railway Strategy and realising the visions set out in the Concepts of Operations (note exclusion 3). However, if left totally unconstrained, there is a risk that different deployment projects could independently generate solutions that were sufficiently different as to create technical or operational compatibility issues at the railway system boundaries. Compatibility issues of this nature would inhibit the GB railway's ability to meet the objectives set out above and must, therefore, be avoided. Examples of compatibility issues could include:

- One project's Traffic Management System solution being unable to provide a second project's Traffic Management System solution with all the information needed for effective management of train services crossing the boundary between them; or,
- a train driver having to learn and apply different sets of operational procedures relating to the same underlying system across different geographical areas.

The generic Customer Requirements are intended to promote the development of technically, operationally and environmentally compatible solutions, which are safe and secure, and which could be deployed across the GB rail network in order to maximise the benefits which the industry can reap from the adoption of digital technologies.

This document is one of a suite of generic Customer Requirements Specifications for the core CCS systems and is sub ordinate to the generic System of Systems Customer Requirements Specification [RD2].

1.4 Document Maintenance

This document is owned by the DR Programme's Head of System Requirements and Integration (SR&I).

Updates may be instigated, as necessary, as indicated below:

- To incorporate any changes arising from industry consultation
- To incorporate any lessons learnt
- In response to formal change proposals
- In response to changing constraints in applicable legislation, standards or associated Digital Railway Requirements
- In response to changes in objectives set out in the Business Requirements or Concept of Operations
- At the direction of the Head of SR&I as the document owner
- When the disbanding of the SR&I team is planned, in order to transfer ownership of the document, if it is still necessary, to an alternative organisation

Potential proposers of change include, but are not limited to, duty holders, deployment project teams, suppliers and asset owners.

Proposed changes to the requirements within this document will be managed in accordance with the Requirements Change Control Process [RD8].

2. Application of this Specification

2.1 Requirements Presentation

All requirements are in the following form:

Safety Requirement text. **Unique-Identifier**

Source: Identifies where the requirement originated.

Status: Normative or Application-Specific. (*See* Section 2.2*)*.

Rationale: Shows applicability of the requirement, including why the requirement exists, who it is for, what industry benefit could be achieved, what the constraints are, and any other essential detail. Note: Cross-referencing should be used to avoid over-lengthy rationales.

Guidance: Supplementary information to support Requirement interpretation and satisfaction.

2.1.1. Safety Requirement

Where a requirement has been associated with a Safety Measure, this is identified and referenced to the hazard record number.

2.1.2. Unique Requirement Identifier

Each requirement has been identified uniquely. The requirement numbers have been generated within the DOORS database, which means that the requirement numbering may be neither sequential nor gap-free.

2.1.3. Requirement Status

Each requirement within this document is identified as either ‘Normative’ or ‘Application-Specific’.

Normative requirements are mandatory for all deployment projects.

Application-specific requirements are mandatory for all deployment projects on which the issue or subject addressed by the requirement occurs.

2.2 Identification of Applicable Requirements

The generic Customer Requirements in this document are intended to cover the vast majority of circumstances that will be encountered on the GB rail network. However, not all circumstances will be encountered by every deployment project and some deployment projects may encounter local issues that are not covered by the generic Customer Requirements Specification.

Consequently, each deployment project must ensure that it establishes and documents the appropriate set of Customer Requirements for its circumstances. The process for doing so is outlined within the Integration Fundamentals Handbook [RD5] and in detail for deployment projects in the DRP Customer Requirements Deployment Policy [RD7] and may be summarised as follows:

1. The starting point is the generic Customer Requirements Specification (i.e. this document for the TMS).
2. All normative requirements within the generic Customer Requirements Specification are applicable to every deployment project.
3. Any application-specific requirements which relate to circumstances that do not apply to the deployment project in question may be deleted and marked as 'not required' along with the rationale for their non-inclusion.
4. New Customer Requirements may be generated to address local issues which only apply to a specific deployment project but are not covered in the generic Customer Requirements Specification, provided that they do not compromise the achievement of cross-boundary compatible solutions. The rationale for the locally-developed requirement will be captured along with the requirement, including any reasons for not following a particular path.

Appendix A contains a template which deployment projects can populate to indicate which of the application-specific requirements are applicable to their particular circumstances (step 3 above).

Appendix B contains a template which deployment projects can use to record any new customer requirements they generate for their particular circumstances (step 4 above).

Note that a deployment project is not permitted to:

1. amend the wording of an existing generic Customer Requirement; or,
2. replace an existing generic Customer Requirement with a differently worded requirement relating to the same issue.

These restrictions are necessary to prevent the risk of generating a project-specific set of Customer Requirements that may not achieve a cross-boundary compatible solution.

If a deployment project considers that the wording or status of an existing Customer Requirement is incorrect, or wishes to add a new requirement to cover any local issues which apply to the deployment project but are not covered in the generic Customer Requirements Specification, then this should be raised with the System Authority via the change request process for consideration at a national level, as described in section 1.4 and in detail in the DRP Customer Requirements Change Control Process [RD8].

3 TMS Customer Requirements

3.1 Functional Requirements

This section sets out functional requirements that define, where applicable, what the system needs to accomplish.

3.1.1 Principles

The TMS shall enable dynamic re-configuration of workstations to meet operational demand. **CRS-TMS-1**	
Source:	TMS System Requirements v1.7.1
Status:	Normative
Rationale:	To allow the railway to be allocated to users dynamically in order to ensure that the optimal operating model is in place at all times.
Guidance:	As workload varies, Areas of Control (AoCs) and Zones of Control can be adjusted to avoid user overload and underload and make best use of resources. This allows areas of perturbation to be isolated, enabling the user to focus their attention on the degraded situation whilst another user manages the surrounding AoC. The TMS will interface with the existing infrastructure to enable the telecommunications and control authorisations to move with the workstation. It is envisaged that the process of reassigning AoCs will be automatically accomplished by the TMS following instigation by the user. The TMS will notify and dynamically update the telecoms system with information on AoCs assigned to a user log-on. The TMS will clearly define AoC boundaries assigned to users. Each AoC should be under the control of a TMS user at all times The TMS AoCs will not overlap. It should be possible to allow an AoC to be assigned or reassigned to a user as defined in the Route Operating Model (ROM). This functionality also enables an AoC to be transferred to another workstation within the same or a different Rail Operating Centre (ROC). The TMS should allow a user to control more than one AoC at a time. The TMS should allow a user to control an AoC for which they are competent. The TMS should notify staff if an AoC is not under active control.

The TMS shall enable the user to obtain information on the current capabilities of any section of line within their Area of Interest. **CRS-TMS-2**	
Source:	TMS System Requirements v1.7.1
Status:	Normative
Rationale:	To enable the user to make informed decisions about managing the train service.
Guidance:	Capabilities of interest to the user include, but are not limited to, the following: • Current maximum permissible linespeed; • Status of traction electrification sections;

• Lines subject to line blockages, possessions, etc.; and
• Other operational restrictions, such as defective infrastructure.
This information would be used both manually by the user, and automatically by the TMS, to inform the Current Plan and make decisions on train routing and train regulation. Some trains may be routed along their assigned path only as part of the process of managing train movement/infrastructure conflicts.

Before requesting routes to be set for a train, the TMS shall use the information available to it to check that the train is compatible with the infrastructure over which it is planned to run.

CRS-TMS-3

Source: TMS System Requirements v1.7.1

Status: Normative

Rationale: To enable the train to pass safely over the currently planned route.

Guidance: When trains are routed over infrastructure with which they are incompatible (for physical, electrical, operational or environmental reasons), there is a risk of infrastructure damage or personal injury and the likelihood of significant service disruption while the situation is resolved.
Train to infrastructure incompatibility is a form of conflict and should be managed accordingly within the TMS when an instance is identified.
As it will not always be possible for the TMS to possess all the information necessary to carry out a comprehensive check of train to infrastructure compatibility, the objective is to establish that there is no evidence of incompatibility in the available information rather than to prove that the train and infrastructure are compatible.

The TMS Human Machine Interface (HMI) shall present the user with unambiguous information to support the running of the railway.

CRS-TMS-4

Source: Reference Design Topic 14

Status: Normative

Rationale: To enable the user to perform their role efficiently and reliably, from the planning phases, through the operating phase and post-event analysis phase.

Guidance: The user should be able to access appropriate views from a range of features, including: Agreed Plan, historic running, previously re-planned paths, forecast plan, Current Plan.
The TMS should be able to indicate signalling status information to the signaller, e.g. point detection, routes set, ETCS train position reports, Signal Group Replacement Control (SGRC), Automatic Code Insertion (ACI) sub-areas, Signal Passed at Danger (SPAD) alarm sub-areas, etc. The TMS should indicate the position of trains to a user on the relevant HMI. The user should be able to search for train position information by a given attribute; this could include Head Codes, class, given locations in a given time period, origin, destination, etc.
The TMS should clearly indicate to the user when it is displaying historic train movements rather than real-time train movements.
The TMS should accommodate changes between Greenwich Mean Time (GMT) and British Summer Time (BST). Some interfacing business systems may not support daylight saving time and interfaces with these systems should be carefully considered during the design phase to minimise the risk of unexpected behaviour arising from daylight saving time changes. A Human

Factors Integration Plan (HFIP) should identify details for managing consistent information when considering daylight saving.

The TMS shall provide a range of Human Machine Interface (HMI) tools to support task demands on the user.

CRS-TMS-5

Source: TMS System Requirements v1.7.1
Reference Design Topic 14

Status: Normative

Rationale: HMI functionality and configuration are integral to achieving the benefits a TMS can offer.

Guidance: Availability and navigability should be consistent and logical across all user interfaces to enable TMS functions to be implemented in a timely manner to optimise train service running.
HMI functionality could, for example, include, but would not be limited to: line diagram, train graph, platform planner, dynamic simplifier, schedule builder, planning dialog, infrastructure dialog, conflict manager, simulation mode HMI, zone manager, notes, and search functions.

The TMS shall enable the user to manage train service limitation information.

CRS-TMS-7

Source: TMS System Requirements v1.7.1

Status: Normative

Rationale: Accurate information will support planning accuracy and conflict resolution.

Guidance: The TMS should enable limitations and constraint information relating to a specific service to be added to the TMS at any time from the planning stage to live operation.
The user should be able to identify clearly any trains with reduced capability. Constraints could include those associated with maintenance, fuel, performance characteristics, train crew, and passengers.

The TMS shall ensure that limitations applied to train services are reflected in predicted train movement views and calculations.

CRS-TMS-6

Source: TMS System Requirements v1.7.1

Status: Normative

Rationale: To enable the user to understand the current state of the railway and train movements to be predicted accurately.

Guidance: Where a limitation is identified and applied to a specific train, it is important that this limitation is considered by the TMS when forecasting future train movements or resolving conflicts.

The TMS shall enable train running information to be viewed.

CRS-TMS-8

Source: TMS System Requirements v1.7.1

Status: Normative

Rationale: The user needs to be able to see the schedule, make changes to it, and cancel train services, where operationally necessary.

Guidance: Schedule information includes:
- Platforms at which the train calls
- Platforms through which the train passes
- Platform at which the train service terminates
- Points for crew relief
- Next Booked working

Other information includes:
- Historical train movements
- Out of Gauge loads
- Q Paths, Y Paths, Suppressed Paths, Cancelled Paths, Active Paths
- Path details as defined in the timetable provided to the TMS.
- Forecast information for a train

The TMS should enable a user to identify all changes that have been made to a plan.
When cancelling a service, the TMS should enable a user either to retain or cancel the train path. Retained train paths should be removed from the forecast but viewable on demand.
The TMS should enable a user to select a single train or group of trains and cancel it/them.
The TMS should enable a user to cancel one portion of a train path, whilst retaining the rest of the train path, including starting forward and terminating short.

The TMS shall enable level crossings to be managed by the TMS user.

CRS-TMS-10

Source: TMS System Requirements v1.7.1

Status: Normative

Rationale: To reduce the risks associated with level crossing operation.

Guidance: The TMS should enable a user to identify the following information for all level crossings within their Area of Control:
1) Type
2) Name
3) Location
4) Power and operating status

The TMS should enable the user to control all available functions for each level crossing.
The TMS should not manage a level crossing that is under local control.
The TMS should enable a user to protect any monitored level crossing over which there is a need to prevent train movements.
The TMS should not request train movements over a level crossing which is protected in this way.
The TMS should show the following information for a level crossing:
1) All trains expected at the crossing within a configurable period;
2) The next train expected at the crossing; and
3) Their respective times of arrival.

The TMS should display degraded mode controls to the user only when the degraded mode is active for the crossing.
The TMS should show real-time Closed-Circuit Television (CCTV) images from

a CCTV crossing when a train is detected striking in, or when manually requested.

The TMS shall manage Current Maximum Permissible Line Speed (CMPLS) information. **CRS-TMS-11**

Source: TMS System Requirements v1.7.1

Status: Normative

Rationale: To enable CMPLS to be varied immediately due to a request or planned in advance.

Guidance: The TMS should enable the CMPLS to be applied to a specific portion of line, at a specific start time, to a specific end time, and in the direction/s which the CMPLS is applicable.
The TMS should ensure that the CMPLS cannot exceed the Permissible Line Speed.
The TMS should show the Permissible Line Speed for any given portion of line.
The TMS should allow differential speeds to be applied for different types of rolling stock.
The TMS should indicate to the user when a change in the CMPLS is due to take place.
The TMS should not change the CMPLS until all required approvals have been obtained.
The TMS should manage changes to the CMPLS across boundaries.

The TMS shall be capable of managing restrictions to prevent train movements being authorised into defined areas. **CRS-TMS-12**

Source: TMS System Requirements v1.7.1

Status: Normative

Rationale: To enable implementation and withdrawal of possessions and line blockages within the TMS area.

Guidance: The TMS should be able to receive requests for line blockage and pre-planned possessions from appropriate external systems.
The TMS should indicate visually to the user any immediate and planned line blockages and possessions.
The TMS should enable a blockage to be amended.
The TMS should enable a line blockage or possession to be relinquished from a remote terminal following confirmation that possession is no longer required.
When a line blockage or possession request has been accepted by the user and the TMS, it will be committed to the plan.
Subject to the appropriate process and approvals, the TMS should allow for recovery from a blockage where the remote user cannot relinquish the blockage due to equipment failure.
The TMS user should be able to apply, remove and override restrictions at any time when they are in control of the infrastructure area concerned.
The TMS should indicate, visually, the presence of blockages and possession.
The TMS should enable a user to request a planned line blockage or possession from a remote terminal.
The TMS should enable a user to grant a request for a planned line blockage or possession from a remote user.
The TMS should indicate to the user when a planned line blockage or

possession is due to finish.
Actual possession and blockage information should be available to any system that requires it from the TMS.

The TMS shall manage operational restrictions within the TMS area.
CRS-TMS-13

Source: TMS System Requirements v1.7.1

Status: Normative

Rationale: So that restrictions are enforced within the TMS.

Guidance: The TMS should indicate different types of restrictions that have been applied to a track section.
The TMS should represent currently active infrastructure restrictions visually.
The TMS should identify trains affected by an operational restriction.

The TMS shall identify and manage train services through the use of Train Running Numbers (TRNs).
CRS-TMS-14

Source: TMS System Requirements v1.7.1

Status: Normative

Rationale: Trains need to be uniquely identifiable to enable management of train services.

Guidance: The TMS should support the use of existing alphanumeric TRNs.
The TMS should enable a user to change a TRN prior to or during service to support operational needs such as splitting and joining.
The TMS should enable the use of new numeric TRNs in accordance with Telematics Applications for Passengers and Freight (TAF and TAP) TSIs [Refs].
The TMS should support the automatic insertion of TRNs (Automatic Code Insertion - ACI), as defined in NR/L3/SIG/10120.

The TMS shall facilitate safe and timely recovery from service affecting failures.
CRS-TMS-16

Source: TMS System Requirements v1.7.1

Status: Normative

Rationale: To expedite railway recovery to normal operation.

Guidance: Following a TMS failure or an incident on the railway, the TMS should be capable of restoring the railway in a staged manner to the planned timetable.

The TMS shall forecast train movements within its area.
CRS-TMS-18

Source: TMS System Requirements v1.7.1
Reference Design Topic 12

Status: Normative

Rationale: To enable prediction of future train positions and inform decision-making.

Guidance: The TMS should update the forecast when any element of the train plan is changed.
Deactivated train paths should not be included as part of the forecast.
The TMS should consider live train running data when forecasting future train movements. Where data concerning train positioning and speed exists in external systems, the TMS should consider this information in the forecast. This data should be referenced by the Train Running Number (TRN).
The TMS should forecast early running trains as continuing to run early until they reach a location at which they are booked to stop.
Portions of line marked as unavailable should be considered as impassable for affected trains for the planned duration of the unavailability.
Where a portion of the infrastructure is unavailable, the TMS should forecast trains to be held short of the unavailable section until the planned end time.
When a portion of line is subject to a speed restriction, the forecast should assume affected trains to be travelling at a maximum of the imposed speed for the length of the restriction.
When a train is subject to a restriction, the TMS should reflect this in the forecast.
The TMS should calculate the forecast using the Timetable Planning Rules.
The TMS should calculate when allowances in schedules can be disregarded and include this information in the forecast, e.g. when an allowance has been added for engineering work which has subsequently been cancelled.

The system shall allow the user to simulate the impact of one or more changes to the Current Plan.

CRS-TMS-19

Source: TMS System Requirements v1.7.1
Reference Design Topic 12

Status: Normative

Rationale: To enable the user to forecast and predict the outcome of any changes prior to committing to the change.

Guidance: The simulation will provide a forecast of future train running using the Current Plan, and the proposed changes.
The TMS should allow the user to simulate multiple changes before committing them to the plan.
The TMS should consider the Current Plan as base data when entering simulation mode.
The TMS should provide a numerical display for the user showing the impact of one or more simulated plan changes.
The TMS should indicate to the user any conflicts in the simulation before committing changes to the plan.

The TMS shall allow train paths to be amended.

CRS-TMS-20

Source: TMS System Requirements v1.7.1

Status: Normative

Rationale: To enable train services to be re-planned at short notice.

Guidance: The TMS should allow all details of a train path to be edited.
The TMS should prevent a train path from being edited by more than one user at a time.

When a train path is modified, the TMS should adjust all onward timing points to the destination point according to valid train running times.
The TMS should enable a train path to be suppressed.
The TMS should enable users to make the following route changes to existing train paths

- Addition of calling/timing points
- Change of calling/timing points
- Removal of calling/timing points
- Diversion
- Change of Line
- Change of platform

The TMS should enable suppressed paths in the Current Plan to be activated when required.
The TMS should enable a user to undo previously made modifications to a train service schedule.
The TMS should enable a train's point of origin to be modified by tabular and graphical means so that necessary changes can be made.
Where running a booked path is identified as mitigation for train/infrastructure compatibility issues, the TMS must prevent the user from amending the booked path.

The TMS shall have the capability to create a Very Short-Term Plan (VSTP).

CRS-TMS-66

Source: TMS System Requirements v1.7.1

Status: Normative

Rationale: To enable the train service to be re-planned at very short notice.

Guidance: The National Train Planning System would normally provide the Long-Term Plan (LTP), Short-Term Plan (STP) updates, and some VSTPs.

The TMS shall control train movements within its area.

CRS-TMS-21

Source: TMS System Requirements v1.7.1

Status: Normative

Rationale: To allow effective management of the train service.

Guidance: The TMS should enable both automatic and manual route requests to be issued to the ETCS Trackside for both permissive and non-permissive train movements.
The TMS should not allow both passenger and freight services to be run into the same permissive area as this is inconsistent with current working practice.
The TMS should enable a user to activate or deactivate automatic setting of routes for the following:

- a zone within their Area of Control (AoC).
- from a specific signal/journey origin point.
- a single train or groups of trains.
- a selected train or group of trains at a defined point along their planned path.

The TMS should, in both automatic and manual modes, send a request to the interlocking to set the route for each train.
The TMS should enable a user to request routes manually where entry and exit signals lie across two separate AoCs.

Where automatic setting of routes is deactivated, the TMS should only send route requests that have been generated manually by the user for the specified section to the interlocking.
The TMS should allow the user to respond to ETCS mode requests from an ETCS-fitted train. The response may be rejection, authorisation of one request, or authorisation of all requests within a time period from the current time.

The TMS shall plan and re-plan the timetable within its area.

CRS-TMS-22

Source: TMS System Requirements v1.7.1

Status: Normative

Rationale: To allow for planning and re-planning of the service to support the running of the timetabled train service.

Guidance: The TMS should enable receipt of the Agreed Plan from the National Train Planning System prior to the service day to which the plan is applicable.
The TMS should de-conflict the Agreed Plan received from the National Train Planning layer. The TMS should allow for real-time re-scheduling and re-planning.
The TMS should indicate to a user any missing, incomplete or inaccurate data within the plan imported from the National Train Planning System. Conflicts identified by the TMS and mitigation used should be highlighted and reported back to capacity planning.

The TMS shall only allow features to be accessed by users with the appropriate competency and authority.

CRS-TMS-23

Source: TMS System Requirements v1.7.1

Status: Normative

Rationale: User access to TMS features needs to be regulated and managed according to authority and competence.

Guidance: The TMS should enable an authorised user to create and manage user accounts and logons, including managing passwords.
The management of roles should be configurable, i.e. it should be possible to define future roles without requiring a software update.
The TMS should enable a user to select a role when logging on.
The TMS should assign functions to a user based on their assigned role.
The TMS should indicate to the user the role they are logged in to perform.
User access will be required for administration, maintenance and testing purposes, amongst others.

The TMS shall enable user settings to be managed.

CRS-TMS-26

Source: TMS System Requirements v1.7.1

Status: Normative

Rationale: To allow users to configure TMS screens.

Guidance: The TMS should enable a user to define specific preferences and save them as part of a user profile.
The TMS should enable a user to transfer to another workstation.

The TMS shall record all its system input, output, and changes of state.
CRS-TMS-27

Source: TMS System Requirements v1.7.1

Status: Normative

Rationale: To maintain a record of system input and output (both user- and automatically-generated).

Guidance: The TMS should clearly indicate when input / actions has/have been accepted by the TMS or user.
The TMS should clearly indicate when input / actions has/have been rejected by the TMS or user and the reason for the rejection.
The TMS should enforce data entry sequences where these are required.
The TMS should record all changes made to train services.

The TMS shall enable the user to transfer the required control functions for a defined section of the railway to an authorised remote user.
CRS-TMS-28

Source: TMS System Requirements v1.7.1
Reference Design Topic 06

Status: Normative

Rationale: Only one user at a time should be responsible for a section of railway.

Guidance: The remote user should have control for an agreed section of railway and be able to use the functionality of their remote terminal device.

The TMS shall prevent a route being requested by the TMS user over a section of railway controlled by a remote user.
CRS-TMS-29

Source: TMS System Requirements v1.7.1
Reference Design Topic 06

Status: Normative

Rationale: To protect trackside workers.

Guidance: The remote user should have control for the section of railway and will not be expecting any trains to be routed there that they have not authorised.

Safety
In the event of a TMS failure, the TMS shall remain in, or revert to, a known safe state.
CRS-TMS-30

Source: TMS System Requirements v1.7.1

Status: Normative

Rationale: To prevent controls for staff protection systems, restrictions and other conditions imposed by the TMS being impacted by a failure of the TMS.

Alerts on the TMS shall be presented clearly to facilitate effective responses.

CRS-TMS-31

Source: Reference Design Topic 7

Status: Normative

Rationale: An effective TMS has to be able to route alerts appropriately to the users that need to take action, and must present alerts in a coherent manner to avoid key safety and operational events being missed or obscured.

Guidance: Appropriate coding, timing, display properties, and interaction methods may be used.
'Alert' is an umbrella term to refer to any indication provided to TMS users to bring to their attention a significant safety-related or performance-related operational event.
Each user has finite attention capacity and the TMS design must be such that not too many demands are placed upon them. Users must be able to identify events and conditions in order to make appropriate and timely decisions, even under degraded modes of operation.
With conventional signalling control systems, issues are already emerging with the number of alarms being presented to users: events are being missed due to information overload.
The HMI will need to display high priority alerts clearly. These could include: Railway Emergency Call (REC), Signal Passed at Danger (SPAD), power failure, points failure, etc.
The TMS should enable a user to acknowledge alarms and alerts; lower priority alarms should be re-presented to a user once higher priority alarms have been resolved.
The presentation of alerts should follow best practice documented in standards (e.g. ISO9241, EEMUA 191) and guidance so that the usability of the TMS meets specified levels of user effectiveness, efficiency, and satisfaction.

The TMS shall enable communications between the TMS user and train drivers.

CRS-TMS-32

Source: Reference Design Topic 4

Status: Normative

Rationale: This communication functionality is necessary to run the network.

Guidance: The TMS may need to provide an extension of the Global System for Mobile Communications - Railway (GSM-R) voice terminal to enable telecoms functionality to be enacted via the TMS. This will mimic the functionality provided by the GSM-R terminals in the Rail Operating Centre (ROC).
The user should be able to communicate with the driver in accordance with functionality defined in the European Integrated Radio Enhanced Network (EIRENE) Functional Requirement Specification version 8.0.0 and in Network Rail standards.
Voice and Text (SMS) Communications will be used for communications. All text messages will be recorded in logs and be available for review when required.
Due to the flexible nature of Areas of Control, Calling Line Identification (CLI) should not be provided for outgoing calls to prevent return calls being made to an incorrect user after the control of a particular area has been transferred

between workstations. The user should be able to call a train by selecting it from the HMI (Human Machine Interface), i.e. 'click to call'.

The TMS shall enable communications between the TMS user and other operational telephones on the railway.

CRS-TMS-33

Source: Reference Design Topic 4

Status: Normative

Rationale: To allow the user to operate the telecommunication functions required to run the network.

Guidance: The user should be able to communicate with other users, which could include other TMS users; it should also be possible for calls to be made to/received from fixed lineside telephones. These could include Signal Post Telephones (SPTs), and level crossing and other crossing telephones.
Voice and Text (SMS) Communications will be used for communications.
Due to the flexible nature of Areas of Control, Calling Line Identification (CLI) should not be provided for outgoing calls to prevent return calls being made to an incorrect user after the control of a particular area has been transferred between workstations
The TMS should enable a user to use a directory 'look-up' facility to make telephone calls.

The TMS shall indicate to the user any trains or traction units that are not registered with the GSM-R system for voice communications.

CRS-TMS-34

Source: TMS System Requirements v1.7.1

Status: Normative

Rationale: To make the user is aware of any vehicles that are not registered to run on the network.

Guidance: This information should provide the TMS user with awareness on how to contact the un-registered train, if required.

The TMS shall be capable of co-ordinating conflict resolution with an adjacent TMS.

CRS-TMS-51

Source: TMS System Requirements v1.7.1

Status: Normative

Rationale: To facilitate the safe and efficient handover of trains between adjacent TMSs.

Guidance: The location of TMS boundaries will be influenced by many factors and, whilst they would ideally be located in less complex areas, this may not always be possible. Consequently, automatic conflict resolution functionality must be active between adjacent TMSs to cater for situations in which the boundary has to be located in a complex area.
There are a variety of methods by which automatic conflict resolution functionality can be provided across the boundary between adjacent Traffic Management Systems.
The following arrangements can provide a universal ‘automatic’ conflict resolution solution, irrespective of the location of the boundary between two

Traffic Management Systems:
a) Utilising its conflict resolution functionality the exit TMS can determine weighted cost values for different scenarios of train exiting its Area of Control (AoC).
b) Utilising its conflict resolution functionality, the receiving TMS can determine weighted cost values for each of the scenarios for trains entering its AoC.
c) The receiving TMS can inform the exit TMS of the results of its conflict resolution calculations for each of the scenarios.
d) The exit TMS can aggregate the results of its own weighted cost calculations and those of the receiving TMS to determine the appropriate train ordering for trains exiting its area.

The TMS shall be capable of identifying conflicts.

CRS-TMS-53

Source: TMS System Requirements v1.7.1
Reference Design Topic 11

Status: Normative

Rationale: The timely identification of conflicts enables the user or TMS to intervene in order to mitigate the performance impact of the conflict and optimal train service to be maintained.

Guidance: The TMS should detect and identify conflicts at the planning stage and also in real-time. Where conflicts are detected by the TMS, indications will be provided through the HMI.
Types of conflict the TMS could identify include occupation, availability, and route compatibility. The user should be alerted of conflicts, including ones that cannot be resolved. A conflict may simply be a violation of the minimum safe separation between trains or instances of train movement that result in a deviation from the scheduled plan for passengers, freight, rolling stock, and train crew.
'Occupation conflicts' covers cases where a train is going to encroach upon the headways, junction margins, and other timing restrictions associated with another train.
Availability conflicts occur where a train is scheduled to pass over a portion of infrastructure that is unavailable to all trains.
Route compatibility conflicts apply where the rolling stock is not compatible with the route or where a portion of infrastructure is unavailable to certain trains due to infrastructure restrictions such as platform length or traction power.

The TMS shall be capable of resolving conflicts.

CRS-TMS-54

Source: TMS System Requirements v1.7.1
Reference Design Topic 11

Status: Normative

Rationale: The timely resolution of conflicts enables the user or the TMS to intervene in order to mitigate the performance impact of the conflict, and optimal train service to be achieved in any given situation. Furthermore, timely interventions support clear communication of the updated train plan to passengers and freight services, resulting in reputational and customer satisfaction benefits.

Guidance: The TMS should provide information to support the user in managing conflicts, including the expected impact of the solutions proposed and the mode of the

resolution (automatic, semi-automatic, manual).
In automatic conflict resolution mode, when a conflict is detected, the TMS will automatically intervene to amend the plan in accordance with the chosen conflict resolution objective. The TMS will consider the resolution of any additional conflicts created as a result of solving the initial conflict, and this should influence the chosen resolution option.
In semi-automatic conflict resolution mode, the TMS will propose intervention options whenever a conflict is detected, showing the user the conflict details and a set of intervention options prioritising each conflict resolution objective. The user can select the optimal intervention for the operational circumstances and commit it to the plan or decide to resolve the conflict manually.
In manual conflict resolution mode, the TMS will present the user with the conflict details and the user will implement the appropriate intervention. The user should be capable of acknowledging and accepting conflicts that cannot be resolved.
The TMS should update predicted train times based on any conflicts.
The TMS should enable a user to view conflicts in list, tabular and graphical formats.

The TMS shall provide the functionality to replay historical train movement.

CRS-TMS-56

Source: TMS System Requirements v1.7.1

Status: Normative

Rationale: To enable the analysis of past train movement to be undertaken to support incident investigation or delay attribution.

Guidance: The TMS should clearly indicate to the user that the replay function is active and that it is not a live view.
Historical train movement data should be available to be replayed for a time period after the event agreed with the deploying route.
The TMS should provide a playback facility that allows an authorised user to replay display changes, control/data input, and displayed states/messages from a selected workstation or for a specific Area of Control, for a given start time and date.
The replay function should include the facility to speed up, slow down or pause the replay.

The TMS shall provide the user with single login capability.

CRS-TMS-55

Source: TMS System Requirements v1.7.1

Status: Normative

Rationale: To enable the user to access interfacing systems when logged into the TMS.

Guidance: The user should be able to log into the TMS and gain access to interfacing systems for which permissions have been provided. The TMS should enable the user to access multiple systems by a single login instead of having to log in to numerous interfacing systems, i.e. there should be a unified login facility.

The TMS shall enable a user to send an emergency stop message to a specified train.

CRS-TMS-70

Source: ConOps

Status: Normative

Rationale: To enable the user to make a targeted intervention to stop a particular train without adversely impacting on other train movements in the vicinity and such that the other trains can continue to operate safely.

Guidance: A specified train Stop can be requested by the user through the ETCS Trackside. The status of this request should be displayed on the TMS.

The TMS shall enable a user to send an emergency stop message to all trains within a defined area.

CRS-TMS-71

Source: ConOps

Status: Normative

Rationale: To enable the user to stop all trains through the ETCS Trackside.

Guidance: 'All Trains Stop' can be requested by the user through the ETCS Trackside. The status of this request should be displayed on the TMS. In addition, it should be possible for the user to select quickly the trains that are to be stopped.

The TMS shall be capable of sending emergency stop revocation messages.

CRS-TMS-72

Source: ConOps

Status: Normative

Rationale: Where the cancelling of routes, for instance following the operation of an emergency area stop control, leads to trains receiving emergency stop messages, the TMS needs to be able revoke the messages to allow train movements to resume.

Guidance: The TMS should be capable of supporting this on an individual train basis and for all trains within an area.

The TMS shall be able to use the operation of a Train Ready to Start (TRTS) device as a trigger for an automated response in accordance with the plan or alert the user to the operation of the device.

CRS-TMS-73

Source: ConOps

Status: Normative

Rationale: The TMS and its users need to know when trains are ready to leave (typically from a journey origin point) and require a route to be set.

Guidance: TRTS devices may be provided for the use of station, depot or yard staff or by train crew. They are typically found at major stations and at some depot exits. Their use supports the timely departure of trains whilst minimising the likelihood of infrastructure being prematurely reserved for the passage of a train which is not yet ready to depart.

The TMS shall have the capability of applying and revoking speed restrictions.

CRS-TMS-74

Source: ConOps

Status: Normative

Rationale: To enable the user to respond to changes in the maximum speed of trains that the infrastructure can support.

Guidance: Where the TMS is responsible for providing Temporary Speed Restriction (TSR) information to the ETCS Trackside, the TMS will require confirmation of receipt of the TSR information from the ETCS Trackside.

The TMS shall support the management of incidents.

CRS-TMS-75

Source: ConOps

Status: Normative

Rationale: To support the running of the train service.

Guidance: The Incident Management System (IMS) is an external system and will be the master of incident-related logs. The IMS should assign unique log/incident identity to incidents.
The TMS will interface with the IMS via the Linked Information Exchange (LINX).
The TMS should identify IMS log entries that are relevant and require actions which the TMS or the TMS user are expected to perform in order to support the management of the incident.
The TMS should be able to inform the IMS, via LINX, of the outcomes of any actions placed upon it in this way.

The TMS shall be capable of regulating the train service.

CRS-TMS-76

Source: ConOps

Status: Normative

Rationale: To support recovery from perturbation. and the implications of introducing additional train services through the Very Short-Term Plan (VSTP) process.

Guidance: The regulation process should apply pre-configured rules which will enable the automatic regulation of services.
The rules by which regulation is undertaken need to be aligned to the agreements between the Duty Holders regarding track access and operation of the network.

3.1.2 Driveability

None.

3.1.3 Degraded Operations

None.

3.1.4 Other

None.

3.2 Non-functional Requirements

This section sets out non-functional requirements, such as those relating to performance, reliability, security, competence, and training which, where applicable, place constraints on the design or implementation of the TMS. Non-functional requirements which apply generically across all systems within the System of Systems are recorded in the GB Generic System of Systems Customer Requirements Specification [RD2] and are not duplicated here.

3.2.1 System Performance

The whole life cycle of the TMS shall be considered, including the future need for replacement and upgrade of the TMS.

CRS-TMS-35

Source: TMS System Requirements v1.7.1
Reference Design Topic 13

Status: Normative

Rationale: To meet the business need for the TMS to be managed effectively throughout its life.

Guidance: The solution should not place unnecessary constraints on the ability to accommodate future needs. Upgrades already under consideration for the GB railway are: ETCS Level 3 and Automatic Train Operation (ATO).
The TMS should be capable of accommodating future growth in train services of 50% over the life of the TMS.
TMS components will enable software revisions to be loaded with the minimum of disruption to the operation of the railway. It should be possible for software-based systems to be reverted to previous configuration states within agreed timescales.
Updates will be required for software, operating system, security, databases (fixed infrastructure, asset information), etc.
It should be possible to load software during traffic operating hours for it to become active as part of a commissioning process (that may be undertaken outside of traffic operating hours) without having any impact on the operational railway. This will be done under controlled conditions and in accordance with software approval processes.

Interactions between sub-systems within the TMS and between the TMS and other systems equipment, processes, and/or people shall not give rise to unacceptable safety risks.

CRS-TMS-39

Source: TMS System Requirements v1.7.1

Status: Normative

Rationale: The complete System of Systems (SoS) must be safe.

Guidance: Interaction includes environmental compatibility and Electromagnetic Compatibility. It includes both interactions where there is an intentional interface with other systems and equipment and interaction where there is no intentional interface. The definition of 'other systems and equipment' includes other railway infrastructure systems and non-railway systems.

3.2.2 Reliability, Availability, Maintainability (RAM)

The TMS shall meet the Reliability, Availability and Maintainability (RAM) requirements specified in the Route RAM specification.

CRS-TMS-40

Source: TMS System Requirements v1.7.1

Status: Normative

Rationale: To enable the TMS to support operational use.

Guidance: The Route RAM specification will be guided by the Route Operating Model (ROM).

If the TMS suffers a service-affecting failure it shall, where possible, recover automatically without manual intervention.

CRS-TMS-42

Source: TMS System Requirements v1.7.1

Status: Normative

Rationale: To improve TMS availability: automatic recovery should be quicker than recovery requiring manual intervention.

3.2.3 Safety

None.

3.2.4 Security

The TMS shall be sufficiently robust to withstand intentional or unintentional threats that may result in damage or corruption.

CRS-TMS-37

Source: Reference Design Topic 13

Status: Normative

Rationale: To protect the TMS from intentional damage or corruption.

Guidance: The design needs to incorporate 'safe by design' principles such that unintended damage or corruption can be avoided.
Damage includes physical damage to system components and interfaces, and corruption includes any software-based threats, such as input of incorrect data or network flooding with messages.
The TMS maintenance access should be secured with sufficient physical, procedural, and technical controls to minimise security risks.
The TMS should be designed, built, and implemented using Secure Software Development Lifecycle (SSDL) methodologies to mitigate security risks appropriately.
The NR Security Assurance Framework uses a standardised risk management methodology to assess GB operational rail system risk through a rail safety and systems engineering approach.
For increased assurance, more than one assessment could be undertaken by different, independent National Cyber Security Centre (NCSC) approved or certified service providers, but that would entail an associated cost implication.

3.2.5 Information Management

Data associated with the TMS shall be stored in a secure form commensurate with its classification and intended use.

CRS-TMS-36

Source: TMS System Requirements v1.7.1

Status: Normative

Rationale: The ability to store, retrieve, and interpret relevant archived data will support the evaluation of events and improve the TMS and business processes.

Guidance: TMS generated data or data altered by the TMS should be classified as 'appropriate'.
Data stored within the TMS should be protected to appropriate levels as required by company or national policy.
The TMS should enable backup of system configuration and permanent data.
Archived TMS data should be stored for a defined period and easily retrievable by authorised users.
Data storage comes with associated cost. Therefore, it is important to understand the purpose of the data being stored. Furthermore, the ability to expand the data storage capability for the TMS easily and inexpensively is important.

The TMS shall implement data transfer and storage in accordance with the DR Systems of Systems Data Specification.

CRS-TMS-65

Source: DR SoS CRS 153819-NWR-SPE-ESE-000003
DR SoS Data Specification [RI3]

Status: Normative

Rationale: Data transfer and storage needs to be controlled.

Guidance: The DR SoS Data Specification contains the data needed to be used and generated by the TMS to function correctly as part of the Digital Railway System of Systems.
Software formats and files used within the TMS must be approved and, where possible, commonly used within the industry to avoid incompatibilities between systems. Use of standard formats will allow easy transfer of information and avoid the TMS using bespoke formats that have to be converted for use elsewhere.

3.2.6 Ergonomics and Human Factors

All tasks shall be designed to maintain levels of operational demand within acceptable limits.

CRS-TMS-44

Source: TMS System Requirements v1.7.1

Status: Normative

Rationale: To reduce the risk of human error.

Guidance: The system designers should demonstrate that user workload will not be adversely affected by the TMS.

Principles of Prevention through Engineering and Design should be used to remove human factors risks.
Effective human error analysis and mitigation should be demonstrated by the system designers.
Users will be provided with all information necessary to acquire and maintain situational awareness of the operational infrastructure (infrastructure status, including signalling and control equipment) and train position/movement (i.e. traffic picture).

3.2.7 Electromagnetic Compatibility and Environment

The installed TMS equipment shall comply with environmental standards appropriate to the environment in which it is installed.

CRS-TMS-67

Source: Industry best practice

Status: Normative

Rationale: To enable the TMS equipment to function correctly in the full range of environmental conditions it will experience and to prevent it adversely impacting on other equipment installed in the vicinity.

Guidance: Factors to be considered include Electromagnetic Compatibility, temperature, humidity, ultra-violet exposure, and the risk of exposure to (or release of) hazardous materials. See also CRS-TMS-38 regarding identification of appropriate locations for TMS equipment.

3.2.8 Health & Safety

None.

3.2.9 Operational Readiness

None.

3.2.10 Maintenance and Diagnostics

The TMS application design shall facilitate maintenance, repair and replacement, and configuration control of components.

CRS-TMS-41

Source: Reference Design Topic 13

Status: Normative

Rationale: Ease of installation and maintenance contribute to whole-life cost reduction.

Guidance: The design should enable ease of installation and maintenance activities for rapid fault resolution. This should cover a range of activities in support of the Reliability, Availability and Maintainability (RAM) requirements, including the use of pre-configured or system configured Line Replaceable Units (LRUs), site access, and local and remote access for diagnostics.

The TMS shall provide fault indications in a manner that allows for prompt remedial action to be undertaken.

CRS-TMS-43

Source: Reference Design Topic 7

Status: Normative

Rationale: To restore safe and efficient operation promptly.

Guidance: As far as is reasonably practicable, the TMS should display sufficient information to the user to enable them to detect a failure of the TMS and carry out the appropriate remedial action.

The TMS should have the ability to provide health monitoring information to local and remote users.
Alerts should be provided for non-critical TMS faults. Non-critical faults are those with the potential to have minor impact on performance or safety, or which would result in significant impact in combination with another fault. If there are redundant elements of the TMS, consideration needs to be given to how these will be tested to ensure that latent faults do not go unnoticed.

3.2.11 Competence and Training

TMS users shall be trained and competent to operate and maintain the system. **CRS-TMS-58**

Source: TM lessons learnt report (DR/TM/LL/2.0, 19.12.2017)

Status: Normative

Rationale: To enable TMS users to discharge their assigned TMS duties.

Guidance: The competencies of users should be aligned to the roles they are authorised to undertake. User training should provide the opportunity for users to train on a simulator and in groups to aid operational efficiency.

The competencies of TMS users shall be actively managed. **CRS-TMS-59**

Source: TM lessons learnt report (DR/TM/LL/2.0, 19.12.2017)

Status: Normative

Rationale: Regular assessment of user competences will support operational efficiency.

Guidance: TMS user competencies should be aligned with TMS login management and role profiles.

A separate training and assessment system shall be provided. **CRS-TMS-60**

Source: TM lessons learnt report (DR/TM/LL/2.0, 19.12.2017)

Status: Normative

Rationale: To support training and competence assessment.

Guidance: The training facility should be separate from the operational TMS and suitable for multiple role training in normal, degraded, and emergency modes of operation with simulated train movements, traffic levels, communications, and associated operational information.

3.2.12 Whole-Life Costs

None.

3.2.13 Other

None.

3.3 Process Requirements

This section sets out the process requirements that deployment projects and their suppliers will need to implement, where applicable.

3.3.1 Target Setting

The Deployment Project shall identify the functionality that is required at different stages of a TMS deployment.

CRS-TMS-48

Source: TM lessons learnt report (DR/TM/LL/2.0, 19.12.2017)
ECI TMS report

Status: Normative

Rationale: To allow for the fact that not all functionality may be available at the outset of deployment and a phased approach could be necessary.

Guidance: Projects must recognise that TMSs and geographical areas will be different and should enter into contracts allowing sufficient time for development of the functionality and the front end of the TMS to provide the right outcomes for the GB rail network. They should also consult with relevant stakeholders as part of the process of identifying the required functionality.

The Deployment Project shall produce the Reliability Availability and Maintainability (RAM) specification for the TMS.

CRS-TMS-61

Source: TMS System Requirements v1.7.1

Status: Normative

Rationale: To meet the business needs of the Deployment Project.

Guidance: Reliability, Availability and Maintainability targets will be dependent on a number of factors, including: volume of traffic, previous performance targets, resource allocation, budget, and business needs.

The Deployment Project shall establish agreements for ongoing support from the enabling systems.

CRS-TMS-49

Source: TM lessons learnt report (DR/TM/LL/2.0, 19.12.2017)

Status: Normative

Rationale: Enabling systems are essential for the TMS to operate in the railway environment.

Guidance: Enabling systems include Route Services IT (RSIT), Network Rail Telecoms (NRT), and electrical power, all of which are essential to TMS operation.

Conflict resolution objectives shall be defined for the implementation.

CRS-TMS-50

Source: TMS System Requirements v1.7.1
Reference Design Topic 11

Status: Normative

Rationale: To enable the Deployment Project to address performance considerations.

Guidance: The Deployment Project (IM or RUs) should create and maintain train prioritisation rules for application where required. These could include overall Public Performance Measure (PPM), Freight Delivery Measure (FDM), right time railway, average lateness, Cancellations and Significant Lateness (CaSL), and marking specific trains as being of higher priority.

The Deployment Project shall specify the Quality of Service (QoS) to be delivered by the Layered Information Exchange (LINX).

CRS-TMS-68

Source: Integration Fundamentals Handbook [RD5]

Status: Normative

Rationale: To ensure that the LINX is appropriately specified to support the operational needs of the TMS and the systems with which the TMS needs to exchange data.

Guidance: QoS includes ensuring that the LINX is appropriately provisioned in the required locations with the necessary capacity to handle the data traffic demands of the TMS.

The Deployment Project shall arrange for any necessary additional data services not within the Layered Information Exchange (LINX) service catalogue to be provided.

CRS-TMS-69

Source: Integration Fundamentals Handbook [RD5]

Status: Normative

Rationale: To support the effective operation of the TMS and associated systems.

Guidance: The LINX service catalogue is the master register of the data services available via LINX. The proliferation of multiple data services to handle the same categories of data should be avoided.

The presentation of alerts by the TMS shall be subject to scenario-based risk assessment, ergonomic assessment, and usability testing activities that simulate the anticipated contexts of use with representative users.

CRS-TMS-45

Source: Reference Design Topic 7

Status: Normative

Rationale: To enable specific failure modes to be simulated and tested as a measure of TMS capability, and defined responses to safety- or performance-critical events to be modelled and tested.

Guidance: The quality of the alerts system in use and the resulting user responses should be assessed before the TMS is commissioned. This allows for changes to TMS software, data configuration, process design, training or other interventions to predict and prevent safety and performance issues with the live system.
The deployment project should provide an alerts list matrix to specify and configure the routing, prioritisation, and message text for all alerts presented to users. These should also include alarms generated by the TMS and the assessment should consider how to facilitate effective user response.
Allowance should be made for current operational rules. For example, when a train passes a 'signal at danger', the TMS should request the GSM-R to send a Railway Emergency Call (REC) to bring that train, and any other train approaching the conflict point, to a standstill.
Rail Operating Centre (ROC) building alarms will also need to be considered in an assessment.

The functionality and presentation of the TMS shall be subject to scenario-based usability testing activities that simulate the anticipated contexts of use with representative users.

CRS-TMS-57

Source: TMS System Requirements v1.7.1

Status: Normative

Rationale: So that the new technology achieves measurable improvements in user effectiveness, efficiency and satisfaction.

Guidance: Users should perform operational tasks using hardware, software, and data so that whole system performance (people, processes, and technology) can be tested before use. The testing should be representative of the intended operational context of use.
Test scenarios should be informed by, and designed to close out, safety hazards and other known risks as part of appropriate safety processes.
Issues should be closed out by engineering (technology) solutions before mitigation through operational processes, training and local instructions are considered.

Analysis shall be completed to ascertain the most suitable location for the TMS hardware.

CRS-TMS-38

Source: Reference Design Topic 13

Status: Normative

Rationale: To support the Reliability, Availability and Maintainability of the TMS.

Guidance: The design should consider power, environmental conditions, asset policy, Electromagnetic Compatibility (EMC), and other factors when siting the TMS hardware. Redundancy and backup systems will also need to be considered, in accordance with company standards.
Business continuity will also be a consideration when deciding where to site equipment.

3.3.2 Standards

None.

3.3.3 Engineering Management

None.

3.3.4 Governance and Approvals

A governance model shall be developed for the sharing of operational data. **CRS-TMS-63**

Source: TM lessons learnt report (DR/TM/LL/2.0, 19.12.2017)

Status: Normative

Rationale: To address potential concerns over data sharing.

Guidance: The sharing of operational data between Infrastructure Manager (IM), Railway Undertakings (RUs), and other key stakeholders should be subject to a governance model. This model should also apply to other IMs with which the TMS interfaces.

3.3.5 Other

Unambiguous procedures shall be provided for degraded TMS conditions. **CRS-TMS-46**

Source: TMS System Requirements v1.7.1

Status: Normative

Rationale: To enable users to manage TMS degraded conditions safely and efficiently.

Guidance: Degraded TMS conditions can be split into two areas: failures involving TMS equipment and failures involving other systems interfacing to the TMS.

The Deployment Project shall have a clear migration path to operational go-live for the TMS. **CRS-TMS-47**

Source: TM lessons learnt report (DR/TM/LL/2.0, 19.12.2017)

Status: Normative

Rationale: There needs to be a clear understanding of what is required when deploying a new TMS.

Guidance: Operational readiness and acceptance criteria should be developed that clearly identifies, by role, who is accepting the solution into service.
There should be a clear and documented strategy that clarifies TMS ownership, required support, and maintenance once the TMS is deployed.
There should be recognition that TMS Entry into Service (EIS) is different from current EIS for signalling systems and should have a GB rail network readiness element.

Unambiguous procedures shall be provided for the transfer of control between the TMS user and the remote operator.

CRS-TMS-52

Source: TMS System Requirements v1.7.1
Reference Design Topic 06

Status: Normative

Rationale: Only one user should be responsible for a section of railway.

Guidance: In emergency or degraded mode working conditions, control may need to be taken back by the TMS user if the situation dictates (e.g. if the remote operator is unable to hand control back to the Rail Operating Centre (ROC) due to equipment failure).

The Deployment Project shall produce a Route Operating Model (ROM) for the TMS.

CRS-TMS-62

Source: TM lessons learnt report (DR/TM/LL/2.0, 19.12.2017)

Status: Normative

Rationale: To enable the Deployment Project to define how it intends to deploy, use, and maintain the TMS.

4 Associated Information

4.1 Open Points

The open points for this generic Customer Requirements Specification are tabulated in Table 1 below.

Table 2 Open Points

Number	Issue	Description	Identified in Version	Closed in Version
01	Glossary accuracy	The Glossary is a live document and will be updated to reflect any new acronyms and definitions introduced in this version of this specification.	0.1	
02	Conflict-free timetable	Consistency checking required with the Concept of Operations for the conflict free timetable and where will it be de-conflicted.	0.2	

4.2 Assumptions

The assumptions made in connection with this generic Customer Requirements Specification are tabulated in Table 2 below.

Table 3 Assumptions

Number	Issue	Assumption	Identified in Version	Closed in Version
A1	Message Brokers	That LINX will be used as the message broker for all deployment projects	0.1	

4.3 Dependencies

The dependencies associated with this generic Customer Requirements Specification are tabulated in Table 3 below.

Table 4 Dependencies

Number	Issue	Dependency
		None identified

4.4 Constraints

The constraints associated with this generic Customer Requirements Specification are tabulated in Table 4 below.

Table 5 Constraints

Number	Issue	Constraint
		None identified

Appendix A APPLICABILITY ASSESSMENT TEMPLATE

A.1 Guidance on Populating the Template

A deployment project wishing to record the results of their applicability assessment should copy this template into a new deployment project-specific document for population.

Insert project name into the relevant box near the top of the template.

For each Application-Specific requirement, insert the word 'Yes' in the 'Applicable' box if the issue or subject addressed by the requirement is relevant to the deployment project in question.

If the issue or subject addressed by an Application-Specific requirement is not relevant to the deployment project in question, insert the word 'No' in the 'Applicable' box.

It is not permissible to change the Applicability status of Normative requirements as these are mandatory on all deployment projects.

A.2 Feedback

Deployment projects are requested to send copies of their populated Applicability Assessment Templates to the Digital Railway System Requirements and Integration team. This will enable the team to assess the value that the industry is deriving from the Application-Specific requirements and will support future improvements to the generic Customer Requirements Specification.

A.3 Template

Deployment Project Applicability Assessment of GB Generic National Customer Requirements Specification for Traffic Management System			
Deployment Project Name			
Requirement ID	**Type**	**Status**	**Applicable**

CRS-TMS-1	Functional	Normative	Mandatory
CRS-TMS-2	Functional	Normative	Mandatory
CRS-TMS-3	Functional	Normative	Mandatory
CRS-TMS-4	Functional	Normative	Mandatory
CRS-TMS-5	Functional	Normative	Mandatory
CRS-TMS-7	Functional	Normative	Mandatory
CRS-TMS-6	Functional	Normative	Mandatory
CRS-TMS-8	Functional	Normative	Mandatory
CRS-TMS-10	Functional	Normative	Mandatory
CRS-TMS-11	Functional	Normative	Mandatory
CRS-TMS-12	Functional	Normative	Mandatory
CRS-TMS-13	Functional	Normative	Mandatory
CRS-TMS-14	Functional	Normative	Mandatory
CRS-TMS-16	Functional	Normative	Mandatory
CRS-TMS-18	Functional	Normative	Mandatory
CRS-TMS-19	Functional	Normative	Mandatory
CRS-TMS-20	Functional	Normative	Mandatory
CRS-TMS-66	Functional	Normative	Mandatory

CRS-TMS-21	Functional	Normative	Mandatory
CRS-TMS-22	Functional	Normative	Mandatory
CRS-TMS-23	Functional	Normative	Mandatory
CRS-TMS-26	Functional	Normative	Mandatory
CRS-TMS-27	Functional	Normative	Mandatory
CRS-TMS-28	Functional	Normative	Mandatory
CRS-TMS-29	Functional	Normative	Mandatory
CRS-TMS-30	Functional	Normative	Mandatory
CRS-TMS-31	Functional	Normative	Mandatory
CRS-TMS-32	Functional	Normative	Mandatory
CRS-TMS-33	Functional	Normative	Mandatory
CRS-TMS-34	Functional	Normative	Mandatory
CRS-TMS-51	Functional	Normative	Mandatory
CRS-TMS-53	Functional	Normative	Mandatory
CRS-TMS-54	Functional	Normative	Mandatory
CRS-TMS-56	Functional	Normative	Mandatory
CRS-TMS-55	Functional	Normative	Mandatory
CRS-TMS-70	Functional	Normative	Mandatory

CRS-TMS-71	Functional	Normative	Mandatory
CRS-TMS-72	Functional	Normative	Mandatory
CRS-TMS-73	Functional	Normative	Mandatory
CRS-TMS-74	Functional	Normative	Mandatory
CRS-TMS-75	Functional	Normative	Mandatory
CRS-TMS-76	Functional	Normative	Mandatory
CRS-TMS-35	Non-Functional	Normative	Mandatory
CRS-TMS-39	Non-Functional	Normative	Mandatory
CRS-TMS-40	Non-Functional	Normative	Mandatory
CRS-TMS-42	Non-Functional	Normative	Mandatory
CRS-TMS-37	Non-Functional	Normative	Mandatory
CRS-TMS-36	Non-Functional	Normative	Mandatory
CRS-TMS-65	Non-Functional	Normative	Mandatory
CRS-TMS-44	Non-Functional	Normative	Mandatory
CRS-TMS-67	Non-Functional	Normative	Mandatory
CRS-TMS-41	Non-Functional	Normative	Mandatory
CRS-TMS-43	Non-Functional	Normative	Mandatory
CRS-TMS-58	Non-Functional	Normative	Mandatory

CRS-TMS-59	Non-Functional	Normative	Mandatory
CRS-TMS-60	Non-Functional	Normative	Mandatory
CRS-TMS-48	Process	Normative	Mandatory
CRS-TMS-61	Process	Normative	Mandatory
CRS-TMS-49	Process	Normative	Mandatory
CRS-TMS-50	Process	Normative	Mandatory
CRS-TMS-68	Process	Normative	Mandatory
CRS-TMS-69	Process	Normative	Mandatory
CRS-TMS-45	Process	Normative	Mandatory
CRS-TMS-57	Process	Normative	Mandatory
CRS-TMS-38	Process	Normative	Mandatory
CRS-TMS-63	Process	Normative	Mandatory
CRS-TMS-46	Process	Normative	Mandatory
CRS-TMS-47	Process	Normative	Mandatory
CRS-TMS-52	Process	Normative	Mandatory
CRS-TMS-62	Process	Normative	Mandatory

Appendix B NEW CUSTOMER REQUIREMENTS TEMPLATE

B.1 Guidance on Populating the Template

A deployment project wishing to draft new Customer Requirements should copy this template into a new deployment project-specific document for population. New requirements should not be added to Appendix B of the generic Customer Requirements Specification itself.

Text in italics prefixed *'GN'* forms guidance for the user of this template.

Further guidance may be found in the Customer Requirements Management Plan [RD 6].

B.2 Feedback

Deployment projects are requested to send copies of any additional Customer Requirements generated to the Digital Railway System Requirements and Integration team. This will enable the team to identify future improvements to the generic Customer Requirements Specification.

B.3 Template

Safety

The requirement text goes here.

GN: It must be a clear, concise and unambiguous statement of what is required. It must include the word 'shall'.

Unique-Identifier

Source: Source statement goes here.

GN: This is a statement which identifies where the requirement originated to provide traceability of the requirement's origin. This could include references to a Concept of Operations, System of Systems Customer Requirements Specification, hazard record, or other document that sets out a high-level expression of what this system needs to achieve.

Status: Normative or Application-Specific.

GN: This will be 'Application-Specific' unless this template is being used to propose a change to the generic Customer Requirements Specification in accordance with the change process set out in section <1.x>.

Rationale: Rationale statement goes here.

GN: This explains why the requirement is needed and its application, including why the requirement exists, who it is for, what industry benefit could be achieved, what the constraints are, and any other essential detail. Cross-referencing to other documentation to avoid the need for lengthy explanations is acceptable.

Guidance: Guidance statement goes here.

GN: The guidance statement contains any supplementary information that may be of value in assisting with the interpretation of the requirement or in determining how the requirement could be satisfied.

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