



Digital Railway – Introduction to the Requirements Structure

Prepared By:
Jonathan Evans
Lead Integration Validation Engineer

JJE-281118-0007

Date: 28th November 2018

Reviewed By:
David Nicholson
System Integration and Interface Manager

DJN-291118-0042

Date: 29th November 2018

Approved By:
Rubina Greenwood
Head of System Requirements and Integration

RNG-291118-0038

Date: .29th November 2018

Working together for a better railway:



Rail Delivery Group



NetworkRail



Reference	153819-NWR-PLN-ESE-000012
Issue/Ver:	1.0
Date:	28/11/18

Electronic file reference: <https://digitalrailway.ipss-hdms.co.uk/DigitalRail/Search/QuickLink.aspx?n=153819-NWR-PLN-ESE-000012&t=3&d=&sc=Global&r=01&i=view>

Disclaimer

Group Digital Railway has used its best endeavours to ensure that the content, layout and text of this document are accurate, complete and suitable for its stated purpose. It makes no warranties, expressed or implied, that compliance with the contents of this document will be sufficient to ensure safe systems of work or operation. Group Digital Railway will not be liable to pay compensation in respect of the content or subsequent use of this document for any purpose other than its stated purpose or for any purpose other than that for which it was prepared, except where it can be shown to have acted in bad faith or there has been wilful default.

© Copyright 2018 Group Digital Railway.

This document is the property of Group Digital Railway. It shall not be reproduced in whole or in part, nor disclosed to a third party, without the written permission of Group Digital Railway.

Document owner: Rubina Greenwood, Head of System Requirements and Integration

Version History

Issue	Date	Comments
0.1	31/07/18	First draft for internal discussion
0.2	03/08/18	Second draft for stakeholder review
0.3	10/10/18	Third draft incorporating stakeholder review comments documented in 153819-NWR-PLN-ESE-000012 v0-2_C and alignment to Technical Note No.1
1.0	28/11/18	First formal issue

Exclusions

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

1. None identified.

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. None identified.

Dependencies

Reference	153819-NWR-PLN-ESE-000012
Issue/Ver:	1.0
Date:	28/11/18

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

1. This document is dependent upon the documents listed as Dependent References.

Reference	153819-NWR-PLN-ESE-000012
Issue/Ver:	1.0
Date:	28/11/18

Content

ABBREVIATIONS AND DEFINITIONS.....	5
REFERENCES.....	6
1. INTRODUCTION.....	7
1.1 Background.....	7
1.2 Purpose	8
1.3 Scope.....	9
1.4 Document Maintenance.....	9
2. ROLES AND RELATIONSHIPS WITHIN THE REQUIREMENTS STRUCTURE	10
2.1 Components of the Requirements Structure for DR and Supporting Documentation.....	10
2.2 Generic Components.....	11
2.2.1. BUSINESS REQUIREMENTS	11
2.2.2. CONCEPT OF OPERATIONS	11
2.2.3. CUSTOMER REQUIREMENTS.....	11
2.2.4. DR REQUIREMENTS	12
2.2.5. ACCEPTANCE CRITERIA	14
2.2.6. INTEGRATION FUNDAMENTALS HANDBOOK AND DEPLOYMENT GUIDES	15
2.3 Deployment-Specific Components	16
2.3.1. DEPLOYMENT OBJECTIVES	16
2.3.2. DEPLOYMENT OPERATING MODEL	17
2.3.3. DEPLOYMENT CUSTOMER REQUIREMENTS.....	17
2.3.4. DEPLOYMENT DR REQUIREMENTS	18
2.3.5. DEPLOYMENT ACCEPTANCE CRITERIA.....	19
2.4 System Architecture Configurations	20
3. GOVERNANCE ARRANGEMENTS FOR THE REQUIREMENTS STRUCTURE.....	20
3.1 Business Requirements.....	20
3.2 Concept of Operations.....	21
3.3 Customer Requirements.....	21
3.4 DR Requirements	21
APPENDIX A EXAMPLE REQUIREMENTS	22
A.1 Business Requirements.....	22
A.2 Concept of Operations.....	23
A.3 Customer Requirements.....	24
A.4 DR Requirements	25

Reference	153819-NWR-PLN-ESE-000012
Issue/Ver:	1.0
Date:	28/11/18

ABBREVIATIONS 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 [R11].

Reference	153819-NWR-PLN-ESE-000012
Issue/Ver:	1.0
Date:	28/11/18

REFERENCES

Dependent References

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

- RD1 Digital Railway Requirements Framework, 153819-NWR-PLN-ESE-000011, Version 2.0
- RD2 Digital Railway – SR&I Technical Note No.1, 153819-NWR-MEM-ESE-000001, Version 2.0, 26th September 2018
- RD3 Digital Railway – System Management Plan, 153819-NWR-PLN-MPM-000002, Version 7.0
- RD4 Digital Railway Programme – Concept of Operations Strategy, 000000-NWR-PLN-MPM-000005, Version 1.0
- RD5 Digital Railway – Integration Fundamentals Handbook, 153819-NWR-GDN-MPM-000001, Version 1.0, 25th April 2018

Informative References

These references have no material bearing on the content of this document.

- RI1 Digital Railway – Glossary of Terms and Abbreviations, 153819-NWR-SPE-ESE-000001, Issue 1.1, 31st August 2018
- RI2 Generic Outcome-Based Business Requirements for Digital Railway Technologies, 000000-NWR-PRG-MAN-000002, Issue 1.0, 25th October 2018
- RI3 Digital Railway – Integrated Concept of Operations, EB 000000-NWR-PLN-MPM-000005, Version 1.0, 15th May 2018
- RI4 Digital Railway – GB Generic System of Systems Customer Requirements Specification, 153819-NWR-SPE-ESE-000003, Version 2.0, 27th July 2018
- RI5 Digital Railway – GB Generic Customer Requirements Specification for ETCS Trackside, 153821-NWR-SPE-ESE-000007, Version 1.0, 23rd April 2018
- RI6 ETCS – Baseline 3 – GB Trackside Sub-system Requirements Specification, NEPT/ERTMS/REQ/0006, Version 2.0, 31st March 2017

Reference	153819-NWR-PLN-ESE-000012
Issue/Ver:	1.0
Date:	28/11/18

1. Introduction

1.1 Background

The Digital Railway Programme (DRP) is intended to deliver transformative improvements in performance and capacity on Britain’s railways by providing the means to accelerate the deployment of digital control technologies.

A systems engineering approach has been taken to determining and expressing the objectives, intended outcomes and critical features of the Digital Railway (DR) systems as suites of requirements. A requirements structure has been adopted for these requirements to make clear the inter-relationships between different elements of the requirements and to assist in understanding which organisations within the GB rail industry are accountable for which elements of the overall requirements suite. Figure 1 below provides a high-level overview of this structure.

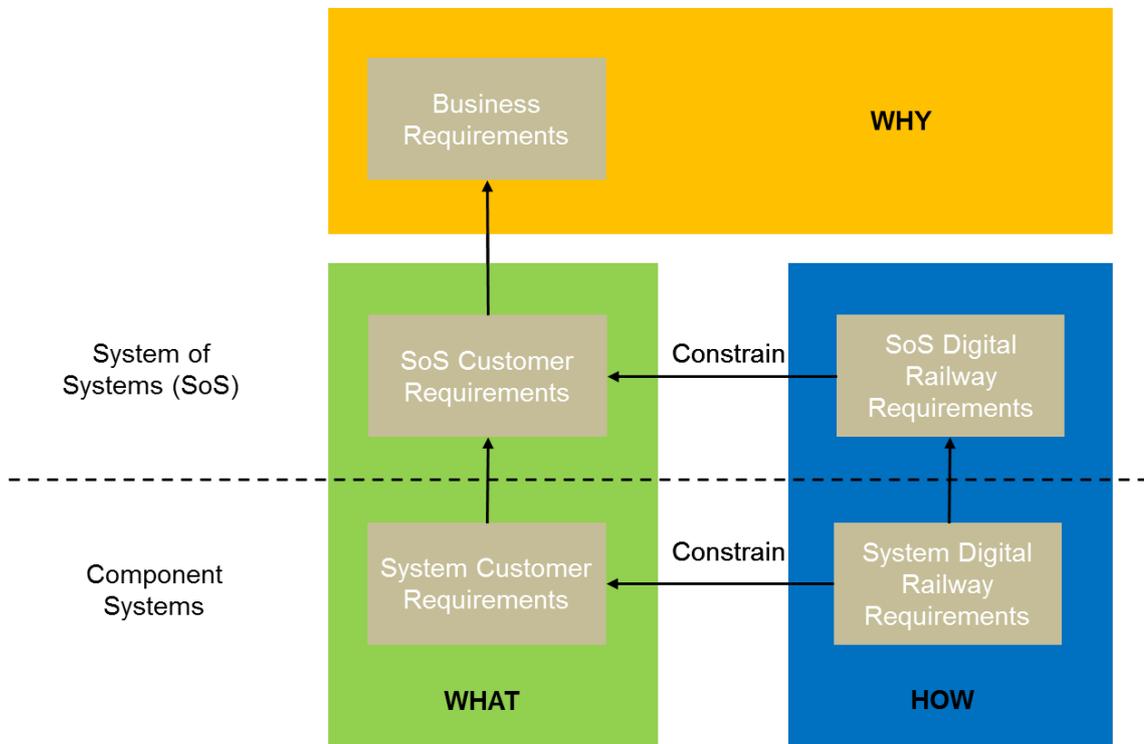


Figure 1: Digital Railway Programme Requirements Structure

From Figure 1, it can be seen that there are three basic groups of requirements within the structure:

- Business Requirements – these may be characterised as describing “why” the industry wishes to adopt a digital railway.
- Customer Requirements – these may be characterised as describing “what” capabilities the industry wants the DR systems to provide.
- Digital Railway Requirements – these may be characterised as describing “how” the DR systems are permitted to provide the desired capabilities.

Reference	153819-NWR-PLN-ESE-000012
Issue/Ver:	1.0
Date:	28/11/18

The linkages between them are indicated by the arrows and, when the structure is fully populated, provide a clear 'line of sight' from the business objectives (Business Requirements), through the desired functions and capabilities (Customer Requirements) to the constraints needed to achieve an operationally consistent railway (DR Requirements).

This document reflects the agreements reached across the DRP in respect of these three groups of requirements, including how they are named. These agreements are documented in the SR&I Technical Note No.1 [RD2].

It should be noted that these requirements suites are intended to cover the people and process requirements necessary to enable the industry to gain the benefits of deploying digital technologies, as well as covering the digital technologies themselves.

1.2 Purpose

The purpose of this document is to provide a high-level introduction to the requirements structure for DR covering:

- 1) The role of each group of requirements in the structure
- 2) The relationship between the groups of the requirements in the structure
- 3) The relationship between the requirements in the structure and standards
- 4) The parties responsible for the governance of each group of requirements in the structure
- 5) The associated documentation that supports the use of the requirements in the structure
- 6) The application of the requirements in the structure to deployment projects
- 7) The distinction between generic and deployment-specific requirements

Thus, the primary focus of this document is on describing the requirements structure, its supporting documentation and the processes surrounding these. This document does not concern itself with the actual requirements within the requirements structure or with any particular architectural solutions.

Figure 2 below shows the relationship between this document (highlighted in orange) and other key documents.

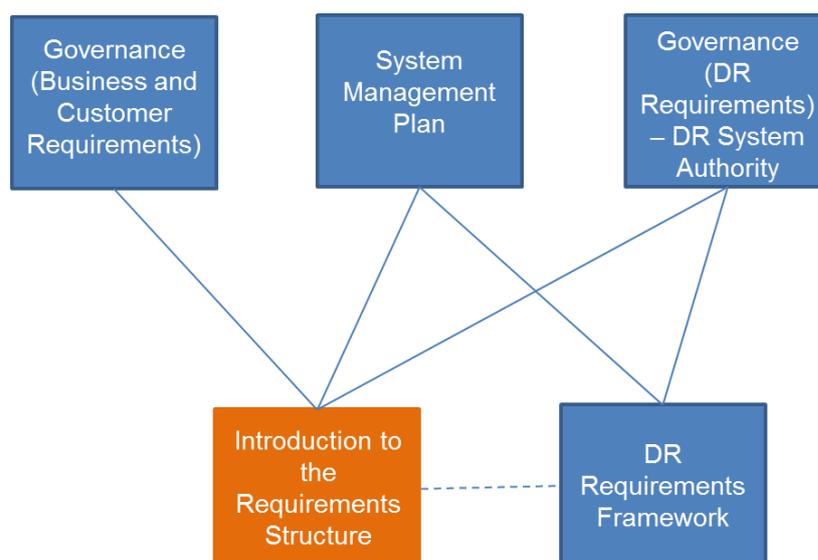


Figure 2: Document Relationships

Reference	153819-NWR-PLN-ESE-000012
Issue/Ver:	1.0
Date:	28/11/18

This document is a child of the System Management Plan [RD3], providing more detail about the requirements structure for DR. It is also a child of the documentation that sets out the governance arrangements for the groups of requirements within the requirements structure. These are being developed in parallel with this document and, thus, definitive references cannot be provided in this version.

This document is a sibling of the DR Requirements Framework [RD1], which provides more detail about the activities related to the group of 'how' requirements within the structure known as the DR Requirements.

The existence of this document does not obviate the need for a Requirements Management Plan to provide the detailed processes for management of the requirements within the structure.

1.3 Scope

The scope of this document is to describe a requirements structure for DR that is sufficiently generic to be able to accommodate any digital Command, Control and Signalling (CCS) systems in any possible architectural combination. The structure is, therefore, intended to be digital CCS system and architecture agnostic. It should be noted, however, that the population of the structure with requirements and information is likely to be undertaken in a phased manner with priority given to particular architectures and digital CCS system configurations. The nature of this prioritisation is outside the scope of this document.

This document, and the requirements structure it describes, is intended to apply equally to infrastructure and rolling stock deployment projects.

1.4 Document Maintenance

This document will be reviewed when one of the following events occurs:

- The industry governance bodies relevant to the requirements structure (see section 3) change;
- The custodians or sponsors of elements of the requirements structure (see section 2.2) change;
- A technical review identifies opportunities for process improvements in the light of lessons learnt;
- At the direction of the Head of System Requirements and Integration (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 still necessary, to an alternative organisation (probably the DR System Authority); or,
- Six months have elapsed since the last review of this document.

Any changes identified as being needed as a result of a review of this document will be incorporated subject to the agreement of the holders of the roles identified on the cover sheet. This document will then be re-issued following endorsement by the holders of the roles identified on the cover sheet.

Reference	153819-NWR-PLN-ESE-000012
Issue/Ver:	1.0
Date:	28/11/18

2. Roles and Relationships within the Requirements Structure

2.1 Components of the Requirements Structure for DR and Supporting Documentation

Figure 3 below expands the structure introduced in Figure 1 to include a range of supporting documentation and to illustrate the division between generic components to be produced by the DRP and deployment-specific components, and tasks that are to be performed by each individual deployment project.

The total requirements set for any particular deployment project comprises the applicable elements of the generic requirements set plus the deployment-specific requirements applicable to that deployment project.

All groups of requirements within the requirements structure encompass both technical and operational (people and process) requirements because the users, and the ways in which they interact with the technical equipment provided, are an essential element of the overall DR systems.

Appendix A contains examples of generic requirements from each group within the structure relating to a common theme to provide an illustration of the interpretation of the groups of requirements.

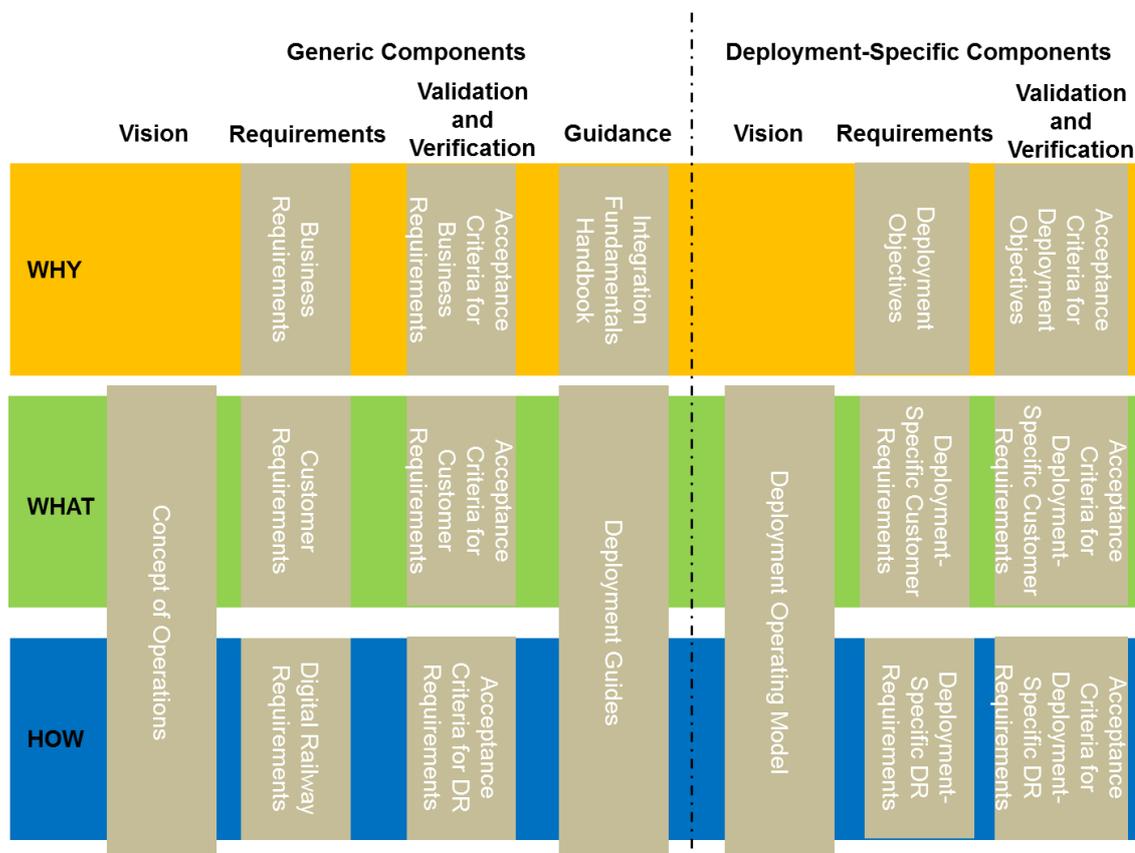


Figure 3: Detailed view of Requirements Structure for DR

Reference	153819-NWR-PLN-ESE-000012
Issue/Ver:	1.0
Date:	28/11/18

2.2 Generic Components

2.2.1. Business Requirements

'Why' requirements are defined in SR&I Technical Note No. 1 [RD2] as describing the purpose behind the proposed change. The generic Business Requirements, therefore, represent the starting point for the entire content of Figure 3. They are intended to set out the high-level objectives and motivations of the industry in adopting the Digital Railway and to align with the 11 key outcomes identified by the Department for Transport.

A single set of generic Business Requirements is expected to be applicable to all DR deployment projects irrespective of system architecture.

The Strategy, Franchising and Sponsorship team within the DRP is the custodian and sponsor of the Business Requirements.

2.2.2. Concept of Operations

The generic Concept of Operations is intended to set out the industry's vision of how the digital CCS systems will operate when deployed on the GB railway in order to achieve the objectives of the generic Business Requirements. It is intended to describe the characteristics of the digital CCS systems from the perspective of the users of those systems without selecting particular solutions or specifying explicit requirements. It will, however, inform the development of the Customer and DR Requirements. Further information may be found in the DRP Concept of Operations Strategy [RD4].

In practice, the generic Concept of Operations may be split across a series of documents, such that there is a suite of Concepts of Operations, in order to cater for differing architectural configurations or to provide system-specific information.

The Business Change team within the DRP is the custodian and sponsor of the Concept of Operations.

2.2.3. Customer Requirements

The 'What' requirements are defined in SR&I Technical Note No.1 [RD2] as performing the following functions:

- Describing the capabilities the GB rail industry wants from the deployment of DR technologies;
- Describing the functional, non-functional and process needs identified; and
- Fulfilling the needs expressed by the 'Why' requirements, i.e. providing the means to achieve the benefits required.

Thus, the generic Customer Requirements are intended to set out the functions, interfaces and capabilities, etc. that are required in order to meet the generic Business Requirements and realise the vision set out in the generic Concept of Operations.

Customer Requirements can apply to either the overall architecture of digital CCS systems being described or to individual digital CCS systems within that architecture. Typically, the functional requirements in the former category will be derived from the Concept of Operations and will express the capability of the architecture being described.

Reference	153819-NWR-PLN-ESE-000012
Issue/Ver:	1.0
Date:	28/11/18

The decomposition and apportionment of functionality between the individual digital CCS systems within the architecture then leads to the definition of the functional requirements for the individual digital CCS systems (i.e. the latter category). There is, thus, traceability between Customer Requirements which apply to the overall architecture and Customer Requirements which apply to the individual digital CCS systems. This is reflected in the relationships indicated in **Figure 1** where the requirements applicable to the architecture as a whole are described as 'System of Systems' and the requirements applicable to the individual digital CCS systems are described as 'Component Systems'. This also enables the functional implications of adopting different architectures to be understood, as a decision not to implement a particular system may prevent another system from functioning correctly if it were dependent upon receiving particular input from the absent system.

The purpose of some generic Customer Requirements, particularly non-functional ones, is to identify areas in which each deployment project needs to determine deployment-specific parameters; for example, to determine the reliability targets for a Traffic Management System (TMS), which will be influenced by the criticality of the part of the GB rail network which it controls.

The Customer Requirements also identify the high-level interface needs between digital CCS systems within a combined architecture and between digital CCS systems and other systems or actors outside the combined architecture.

The 'customers' referred to in the name of these requirements are the duty holder organisations that are responsible for the specification of the deployment project (i.e. the organisations which expect to benefit from the deployment). In some instances, the relevant duty holder will be an Infrastructure Manager (IM) – for example, for a TMS deployment – in other instances, it will be a Railway Undertaking (RU) – for example, for a European Train Control System (ETCS) Onboard fitment.

Whilst the organisation specifying a project might be one of many (e.g. a devolved Route within Network Rail or an individual RU), the generic Customer Requirements must support the objectives of the GB rail industry as a whole and, thus, align to policies, strategies and standards that apply to all of the relevant organisations. For example, generic Customer Requirements applicable to IM duty holders must align to relevant Network Rail Technical Authority policies, whilst generic Customer Requirements applicable to RU duty holders must align to relevant industry policies and agreements, such as those which are managed by the Rail Delivery Group (RDG).

The generic Customer Requirements will be presented in a series of specifications. For the individual digital CCS systems, the scope of each Customer Requirements Specification will be tailored to suit the DRP procurement strategy for the system concerned. For example, the generic Customer Requirements for the ETCS are split across two specifications – Trackside and Onboard – to reflect the fact that the IM and RU elements of the overall ETCS are generally procured separately. In this example, these two specifications must be aligned such that a train procured using the ETCS Onboard Customer Requirements Specification will be capable of operating over any ETCS-fitted infrastructure procured using the ETCS Trackside Customer Requirements Specification.

The SR&I team within the DRP is the custodian and sponsor of the Customer Requirements.

2.2.4. DR Requirements

The 'How' requirements are defined in SR&I Technical Note No. 1 [RD2] as:

- providing constraints on the realisation of the deployment under consideration;

Reference	153819-NWR-PLN-ESE-000012
Issue/Ver:	1.0
Date:	28/11/18

- providing opportunities for business benefits to be achieved;
- providing candidate material for the national standards of the future for digital CCS systems, once a sufficient level of maturity has been achieved; and
- being sufficient for integration and intra-operability. They do not prevent a supplier from providing an innovative solution, provided that it can be successfully integrated into the wider railway context in accordance with these constraints.

Consequently, the generic DR Requirements provide constraints on the permissible solutions in order to achieve compliance with legal requirements, support the realisation of the generic Concept of Operations across the digitally-equipped elements of the GB rail network, support compliance with industry technical policies, and enable the closure of open points within higher level specifications, such as the European Technical Specifications for Interoperability. Part of their role is to constrain how the Customer Requirements are achieved. Without these DR Requirements, there would be a significant risk that different deployment projects could produce solutions that are inconsistent, not technically compatible, involve significant integration costs at the boundary between projects, or require operational personnel to interact with the systems differently in different areas. These outcomes are undesirable as they would inflate the whole-life cost of running the railway.

DR Requirements address functional, non-functional, interface, operational, or process needs.

By controlling the variability in the way in which the required outcomes are achieved through the application of DR Requirements, the industry can ensure that consistency, and inter- and intra-operability is achieved by different project deployments, and support the effective management of the combined architectures of digital CCS systems throughout their life cycle. For example, DR Requirements may be needed to ensure that a common set of operational rules can be used nationwide, or so that a driver has a consistent experience when driving different fleets of digitally-equipped trains, or when driving the same digitally-equipped train through deployment areas equipped by different projects.

In the longer term, it is expected that the DR Requirements will migrate into standards such as the Rail Industry Standards managed by the Rail Safety and Standards Board (RSSB), which will ensure industry compliance with them in the long term and thus support the continued achievement of compatible, inter- and intra-operable solutions.

Further guidance on DR Requirement characteristics can be found in the DR Requirements Framework [RD1].

DR Requirements will exist for each:

- a) combined architecture of digital CCS systems being deployed;
- b) individual digital CCS system; and
- c) sub-system within a digital CCS system.

Within each digital CCS system, the DR Requirements for the system as a whole will act as parents for the DR Requirements for the sub-systems within that system. For the functional requirements, this will be achieved through the decomposition and apportionment of functions from the system to its component sub-systems. Identification of the appropriate sub-systems for any individual digital CCS system will be influenced by considerations such as which organisations are accountable for the assets (and their maintenance) within the system. Where mature structures already exist (for example, in the case of ETCS), these will continue to be used. The resultant sub-system structure may well be different to the Customer Requirements Specifications structure for the same system as the latter is driven specifically by procurement considerations.

Reference	153819-NWR-PLN-ESE-000012
Issue/Ver:	1.0
Date:	28/11/18

DR Requirements relating to the interfaces between digital CCS systems within a combined architecture and between digital CCS systems and other systems or actors outside the combined architecture will constrain how those interfaces are to be achieved. This will include the development of message protocols or data exchange formats, where appropriate.

Customer Requirements will be linked to the DR Requirements to ensure that there is a clear understanding of the constraints that apply to the realisation of each Customer Requirement. This is reflected in the horizontal arrows between the Customer Requirements and DR Requirements shown in **Figure 1**.

The SR&I team within the DRP are the initial custodians and sponsors of the DR Requirements. Their responsibilities will transfer to the Digital Railway System Authority (DRSA) once the DR Requirements suite has achieved maturity.

2.2.5. Acceptance Criteria

Those working with the requirements structure for DR will need to demonstrate that they have met the applicable requirements within the structure. This is in addition to any other acceptance processes that apply to the digital CCS systems concerned; for example, the ETCS is subject to Notified Body (NoBo) acceptance processes to confirm that the system complies with the relevant parts of the CCS Technical Specification for Interoperability (TSI) and associated European specifications, and to processes to confirm its compliance with relevant National Technical Rules.

To ensure consistency between deployments, the generic Acceptance Criteria are intended to set out the manner in which achievement of each generic requirement is to be demonstrated, including pass/fail criteria. Acceptance Criteria will be provided by the DRP for all generic requirements within the structure. These will be linked to the requirements within the requirements management database and published in Verification and Validation (V&V) matrices (one matrix per Requirements Specification). The DR Requirements Framework [RD1] contains more information on the documentation of Acceptance Criteria.

The nature of the Acceptance Criteria will depend on the requirement to which they relate. For the lower-level requirements, this could involve design reviews, demonstrations, the production of necessary processes, successful completion of specified functional tests, etc. The use of Operational Test Scenarios, as a particular form of functional test, may be appropriate where there is a need to demonstrate compatibility between different elements of a system or architecture where a common interface has been specified. For the higher-level requirements, particularly the Business Requirements, this could involve subjective assessments to provide the necessary validation; it could also be achieved by a satisfaction argument based upon the successful achievement of the relevant lower level requirements, where these exist.

DRP sponsorship and custodian arrangements for any particular set of acceptance criteria will mirror that of the requirements to which they apply.

Figure 4 below illustrates how the requirements and acceptance criteria within the requirements structure for DR relate to one another in a 'V' model format for validation purposes, with the grey boxes representing elements of the requirements structure described in this document (covering both generic and deployment-specific requirements) and the pink boxes representing stages in the life cycle of the deployed systems. The horizontal arrows indicate the validation activities against the requirements carried out at each stage in the lifecycle.

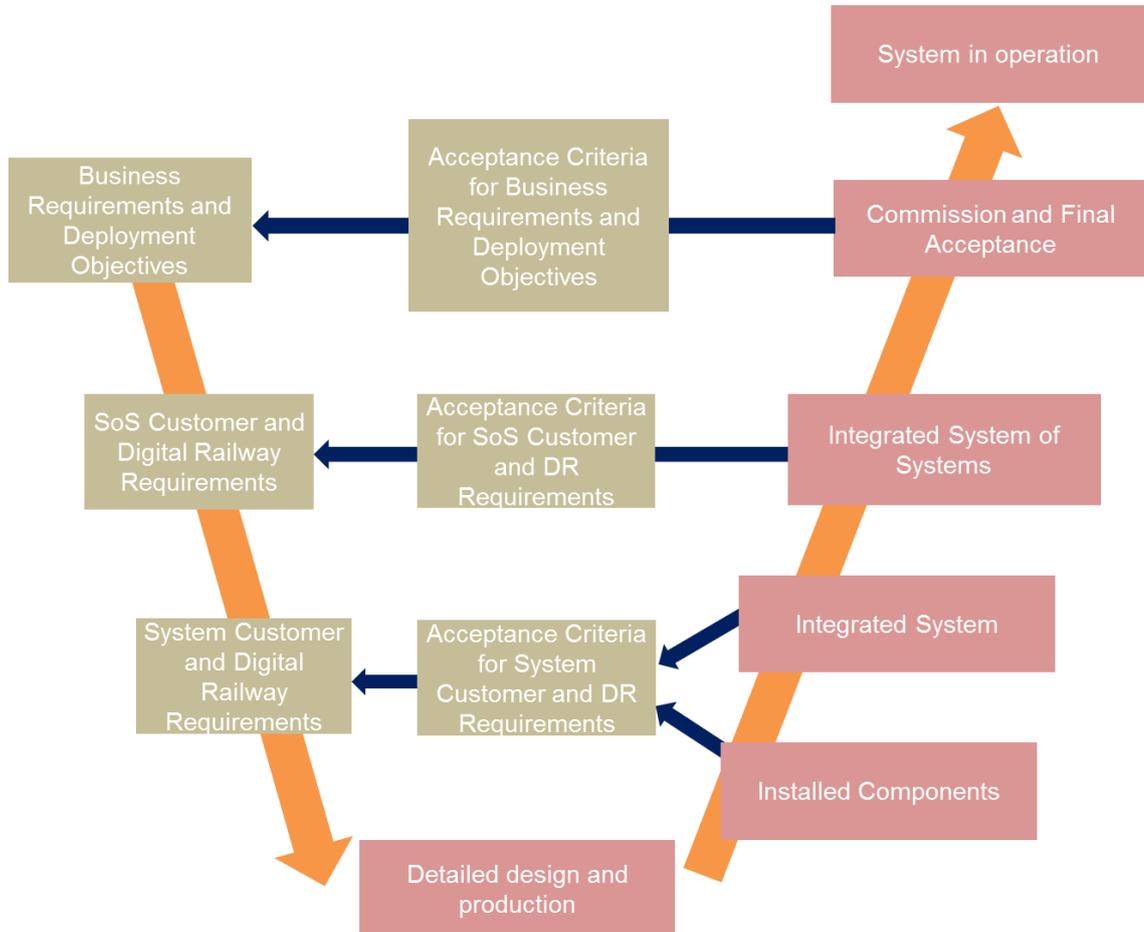


Figure 4: 'V' Life Cycle of the Requirements Structure for DR

2.2.6. Integration Fundamentals Handbook and Deployment Guides

Successful deployment of digital CCS systems will be critically dependent upon successful integration at three key levels:

- Technical integration of the digital CCS systems in the selected combined architecture;
- Integration of the selected combined architecture of digital CCS systems into the operational railway; and
- The maintenance of integration during migration from the existing operational railway to the desired end state of the operational railway.

The Integration Fundamentals Handbook [RD5] provides a high-level introduction to these concepts, and the activities needed to achieve them, for a non-technical audience. It is intended to guide deployment projects in planning and resourcing the integration activities they will need to undertake, focusing on five key themes:

- Procurement
- Programme
- Process
- Product
- People

Reference	153819-NWR-PLN-ESE-000012
Issue/Ver:	1.0
Date:	28/11/18

The Deployment Guides are a modular suite of documents, intended for a technical audience, that provide more detailed guidance on application of the requirements suites within the DR requirements structure for the benefit of those deploying, operating or managing digital CCS systems. Areas that the Deployment Guides are expected to cover include:

- Determining the appropriate architecture to address the particular needs of a deployment project (i.e. how to select which digital CCS systems are needed, and in which configurations, to meet both the generic and deployment-specific outcomes identified);
- Selection of non-mandatory requirements;
- Generation of deployment-specific requirements;
- Management of change to the suites of generic requirements within the requirements structure;
- Reference Designs, where these exist, to provide additional context to the requirements derived from them;
- Best practice guidance for application designs;
- Strategic documentation supporting the whole-life management of the deployed digital CCS systems;
- Information relevant to architectural combinations of systems (i.e. the chosen System of Systems);
- Information relevant to each of the digital CCS systems;
- Gaining authority to place digital CCS systems into service;
- Compatibility management; and
- Managing conflict between the DR Requirements and legacy industry standards where the latter have not yet been updated to take account of digital CCS systems.

The Deployment Guides will primarily address three themes from the Integration Fundamentals Handbook: namely, Process, Product and People. In addition, they will provide an element of guidance on the technical input to the procurement activity.

The fundamental intent is for them to capture all the knowledge that exists within the DR development teams that will be of value to the deployment projects and end users/owners of the digital CCS systems.

The SR&I team within the DRP are the custodians and sponsors of the Integration Fundamentals Handbook and Deployment Guides.

2.3 Deployment-Specific Components

The documentation described in this section will be developed by individual deployment projects (including their client organisations). The Deployment Guides provided by the DRP contain guidance which is intended to assist achievement of this.

2.3.1. Deployment Objectives

The Deployment Objectives are a set of required outcomes which complement (and do not contradict) the generic Business Requirements to provide a complete view of why digital CCS systems deployment is needed in any particular instance within the context of a cohesive railway network. They are likely to emerge from the development of the business case for a deployment project and it is important that they are clearly understood and documented in the early stages of the development of a project to inform subsequent activities.

Reference	153819-NWR-PLN-ESE-000012
Issue/Ver:	1.0
Date:	28/11/18

The Deployment Objectives will also provide clarity as to the relative importance of the generic Business Requirements to each deployment project, as this will vary between deployments depending upon their specific needs.

In generating Deployment Objectives, it is important to take a strategic view, not just of the deployment project being considered, but also of any previous or future projects that may have technical or operational interfaces to the current project to ensure that the outcomes being specified will enable consistent solutions to be achieved across the range of inter-related projects. Consultation with relevant stakeholders, including DR advisory forums, is recommended to ensure the successful conclusion of this process.

The Deployment Objectives should be sufficiently detailed to enable the deployment project to create the Deployment Customer Requirements suite as described in section 2.3.3.

2.3.2. Deployment Operating Model

A Deployment Operating Model complements and builds upon the generic Concept of Operations, described in section 2.2.2, to describe the vision regarding how the deployed systems will be operated and maintained. In order to preserve the ability for the railway to be operated in accordance with a single generic national Rule Book, it does not change the fundamental operational concepts set out in the generic Concept of Operations, but instead focuses on providing clarity on deployment-specific issues where multiple solutions are possible within the framework of a single generic national Rule Book. This could include issues such as:

- The locations from which an infrastructure deployment project is to be controlled
- The organisational structure to be operated for operational roles (for example in a Rail Operating Centre)
- Proposed allocation of maintenance responsibilities between duty holders, suppliers and disciplines
- Duty holder operational policies (e.g. the professional driving policy of a Railway Undertaking)

In generating a Deployment Operating Model, it is again important to take a strategic view, not just of the deployment project being considered, but also of any previous or future projects that may have technical or operational interfaces to the current project to ensure that the outcomes being specified will enable consistent solutions to be achieved across the range of inter-related projects. Consultation with relevant stakeholders, including DR advisory forums, is recommended to ensure the successful conclusion of this process.

The Deployment Operating Model should be sufficiently detailed to enable the deployment project to create the Deployment Customer Requirements suite as described in section 2.3.3.

2.3.3. Deployment Customer Requirements

The Deployment Customer Requirements suite for any particular deployment will be influenced by the Deployment Objectives and Deployment Operating Model applicable to it and will comprise of two elements:

- Applicable Customer Requirements from the generic suite
- Deployment-specific Customer Requirements

Once a deployment project has selected an architectural combination of digital CCS systems to meet its needs, all of the 'normative' generic Customer Requirements applicable to that

Reference	153819-NWR-PLN-ESE-000012
Issue/Ver:	1.0
Date:	28/11/18

architectural combination, or to the digital CCS systems within it, are applicable to the deployment project.

The deployment project will then need to determine which of the 'application-specific' generic Customer Requirements applicable to the selected architectural combination, or to the digital CCS systems within it, are relevant to the deployment.

Deployment projects must record which of the generic Customer Requirements they are applying. Where a deployment project chooses not to apply an 'application-specific' Customer Requirement, the rationale for doing so must also be recorded to enable effective assurance of the decisions made.

At a functional level, Deployment-specific Customer Requirements will be focused primarily on specifying where or when the functionality described in the generic Customer Requirements is to be applied within the deployment project (for example, to specify where permissive working is required) and should not add new, deployment-specific functionality to the system unless there is some genuinely unique feature of the railway within the project area. If there is an identified need for additional, non-unique, functionality not covered by the generic Customer Requirements then this should be identified to the custodian of the generic Customer Requirements, by the deployment project, as a proposed change request to be considered for incorporation into the generic Customer Requirements. The adoption of this approach will minimise the proliferation of similar, but separate, requirements across the GB railway and thus avoid cost inflation, additional operational complexity and training needs, etc.

At a non-functional level, Deployment-specific Customer Requirements may be written as a response to a generic Customer Requirement, where the latter places an obligation on the deployment project to do something; for example, to specify a performance target.

The custodian of the generic Customer Requirements should receive copies of all proposed Deployment-specific Customer Requirements so that they can place them in a central repository and look for opportunities to translate them into additional generic Customer Requirements where this would be beneficial for the rail industry in the longer term. This central repository of Deployment-specific Customer Requirements should be made available for other deployment projects to consult so that they can either choose to adopt an existing Deployment-specific Customer Requirement for their needs or use the existing Deployment-specific Customer Requirements as examples for their own requirement generation activity.

The processes for selecting appropriate generic Customer Requirements for a particular deployment and for generating and sharing Deployment-specific Customer Requirements are documented in greater detail in the generic Customer Requirements Specifications.

2.3.4. Deployment DR Requirements

The Deployment DR Requirements suite for any particular deployment will comprise two elements:

- Applicable DR Requirements from the generic suite
- Deployment-specific DR Requirements

It is expected that the former group will constitute the vast majority of the total, with Deployment-specific DR Requirements being created comparatively rarely in order to ensure that technically and operationally consistent solutions are adopted by deployment projects.

Once a deployment project has selected an architectural combination of digital CCS systems to meet its needs, all the 'normative' and 'generic product' generic DR Requirements

Reference	153819-NWR-PLN-ESE-000012
Issue/Ver:	1.0
Date:	28/11/18

applicable to that architectural combination, or to the digital CCS systems within it, must be applied by the deployment project.

The deployment project will then need to determine which of the 'application-specific' and 'preferred' generic DR Requirements applicable to the selected architectural combination, or to the digital CCS systems within it, are relevant to the deployment.

Deployment projects must record which of the generic DR Requirements they are applying. Where a deployment project chooses not to apply an 'application-specific' or 'preferred' DR Requirement, the rationale for doing so must also be recorded to enable effective assurance of the decisions made. If a project proposes not to apply a 'normative' or 'generic product' DR Requirement they must seek authority to do so from the DRSA as the custodian of the generic DR Requirements, in accordance with [RD1].

If projects consider that additional DR Requirements are needed for a purpose other than to constrain a Deployment-specific Customer Requirement, then they should raise this as an issue with the DRSA who, as custodian of the generic DR Requirements, will consider whether this should result in a controlled change to the generic DR Requirements suite.

If there is a need for a project to impose constraints on how a Deployment-specific Customer Requirement is to be met, then Deployment-specific DR Requirements should be written to address this. As stated previously, this is expected to be a rare occurrence. Copies of all Deployment-specific DR Requirements should be provided to the DRSA so that they can place them in a central repository and look for opportunities to translate them into additional generic DR Requirements where this would be beneficial for the rail industry in the longer term. This central repository of Deployment-specific DR Requirements should be made available for other deployment projects to consult so that they can either choose to adopt an existing Deployment-specific DR Requirement for their needs or use the existing Deployment-specific DR Requirements as examples for their own requirement generation activity.

2.3.5. Deployment Acceptance Criteria

A deployment project must apply the generic Acceptance Criteria for the following:

- Business Requirements
- Generic Customer Requirements that are applicable to the deployment project
- Generic DR Requirements that are applicable to the deployment project

For clarity, the deployment project should document which generic Acceptance Criteria it is applying.

Where projects have generated Deployment-specific Customer or DR Requirements, they will also need to generate associated Deployment-specific Acceptance Criteria for those requirements and share these with the custodians of the generic requirements at the same time as they share the deployment-specific requirements as described in sections 2.3.3 and 2.3.4. If a project adopts a Deployment-specific Customer or DR Requirement originally generated by another project, they must also adopt the associated Deployment-specific Acceptance Criteria.

It is intended that DR will provide generic safety cases that cover the deployment of systems that comply with the generic requirements. However, deployment projects will need to generate deployment-specific safety cases to cover their own deployment-specific requirements and the more deployment-specific requirements there are, the more challenging that safety case activity will be.

Reference	153819-NWR-PLN-ESE-000012
Issue/Ver:	1.0
Date:	28/11/18

2.4 System Architecture Configurations

It is anticipated that the generic Business Requirements will remain the same for all potential configurations of the digital CCS systems since these describe high-level outcomes and motivating factors that are likely to be independent of the solution adopted.

The DR Requirements Structure and supporting documentation arrangements described in sections 2.2 and 2.3 above are essentially generic and will be capable of supporting the requirements for all digital CCS systems in all possible configurations and architectural combinations.

The system configurations and architectural combinations for which the Requirements Structure is populated is expected to grow over time. Where deployment projects are seeking to adopt system configurations or architectural combinations, on either a temporary or permanent basis, for which the Requirements Structure is not fully populated, they should consult the SR&I team and DRSA for guidance on how to proceed in order to close the gaps in the generic information.

It should be noted that where a system has been specified to rely on a particular element of functionality being provided by a second system, any deployment projects implementing an architecture which contains the first system but not the second will need to adopt an alternative approach to providing the missing functionality to an equivalent service and integrity level to that achieved by the second system to enable the first system to perform correctly.

3. Governance Arrangements for the Requirements Structure

The purpose of the governance process is to ensure that the GB railway industry, in particular the duty holders within it, is satisfied that the requirements proposed for inclusion in the requirements structure for DR are fit for purpose and will achieve the intended outcomes. In addition, the governance processes will need to consider whether those generating the requirements have gathered sufficient assurance evidence that appropriate development processes have been followed in generating the proposed requirements and can demonstrate traceability to the relevant other elements of the requirements structure as indicated by the arrows in **Figure 1**.

Governance processes will apply both to the initial generation of the requirements suites and to any changes to the approved requirements suites.

There is also a need to ensure that any Deployment-specific requirements do not compromise the achievement of the objectives of the generic requirements either within the deployment project concerned or within other deployment projects. Deployment projects will, therefore, need to seek approval for Deployment-specific Customer and DR Requirements through the same governance processes as apply to the generic Customer and DR Requirements.

The following sections provide an overview of the governance responsibilities for each of the elements of the requirements structure. The governance processes associated with each element will be documented separately by the responsible parties.

3.1 Business Requirements

The Business Requirements need to be governed at a senior level within the DRP governance structure with the engagement of all industry stakeholders, reflecting their role in setting out the objectives of, and motivations for, adopting the Digital Railway. It is intended

Reference	153819-NWR-PLN-ESE-000012
Issue/Ver:	1.0
Date:	28/11/18

that the governance of the Business Requirements will be provided via the DR Programme Board.

3.2 Concept of Operations

Governance for the Concept of Operations will be provided by the Systems and Operations Board, with the engagement of relevant industry stakeholders from both operational and asset management contexts.

3.3 Customer Requirements

The Customer Requirements are expressions of the functionality and capabilities to be provided by the application of DR technologies and the governance arrangements for them will be provided by the Digital Railway Systems Authority (DRSA) using a suitably competent group with appropriate industry representation (subject to change control for this being agreed within the DRP).

In addition, there is a close relationship with the DR Requirements, which determine how the Customer Requirements can be met; thus, the governance arrangements need to enable that relationship to be maintained as requirements in either element change.

3.4 DR Requirements

The industry must assure itself that the DR Requirements proposed are appropriate for, and will be effective in, achieving the objectives of consistent inter- and intra-operable solutions across the GB railway network that can be effectively managed throughout their lifecycle.

The close relationship with the Customer Requirements must also be maintained as requirements change.

Governance for the DR Requirements will be provided by the DRSA using the Requirements, Issues and Configuration Management Working Group (RICMWG), which is a suitably competent group with appropriate industry representation. Further details of the governance arrangements for DR Requirements can be found in the DR Requirements Framework document [RD1].

Reference	153819-NWR-PLN-ESE-000012
Issue/Ver:	1.0
Date:	28/11/18

Appendix A EXAMPLE REQUIREMENTS

This appendix presents a specimen set of material relating to a single illustrative example of functionality that may be provided through the digital CCS systems. It is intended to provide a tangible illustration of what each element of the requirements structure provides and how they relate to one another.

The example scenario chosen concerns ways in which DR solutions can mitigate the risk of a train being routed onto infrastructure with which it is not compatible.

The material has been taken from the documentation listed in the References section of this document with additional material created, where necessary, to fill any gaps in order to create a complete picture. This appendix is not intended to be referred to as an actual requirements specification for the functionality described and any suggestions made in the commentary regarding potential change to existing requirements do not obviate the need for those changes to be considered through the relevant change control processes.

A.1 Business Requirements

The following proposed Business Requirement, sourced from [RI2], is relevant to the chosen scenario.

Requirement - *The DR solution shall enable improved safety and security.*

Rationale - *For safety to facilitate fewer Signal Passed at Danger (SPAD) equivalents and less trackside work (Vignette 3.1, programme mandate for safety benefits and DR Strategy Enhanced safety benefit). Improved security will be required as the railway becomes more reliant on connected digital systems along with the assurance that this can be achieved by implementing the Directive on Security of Network and Information Systems (NISD) ((EU 2016/1148).*

Guidance - *Although Britain has one of the safest railways in Europe, an even higher level of safety and security can be provided for passengers, members of the public, railway staff, and GB railway industry assets.*

This could be achieved through better information for drivers:

- *The asset-intensive safety control system that was built around lineside signals could give way to a digital, authorised speed display in the cab, cutting costs and carbon.*
- *Drivers would have a clearer view of the track ahead, with minimal distracting factors. (e.g. signal sighting and boards on the Trans Pennine network could be replaced by in-cab indication).*
- *Trains could be driven closer together, at optimum speeds, by drivers who have the flexibility to operate across the network (could be achieved via ATO).*

Signalling on the network currently involves a mixture of different forms, systems and processes. By giving precise information about the location of trains, drivers can be provided with a much richer source of information on which to base decisions, while other tools could

Reference	153819-NWR-PLN-ESE-000012
Issue/Ver:	1.0
Date:	28/11/18

provide signallers with a range of options for running trains, maximising their ability to respond quickly and effectively to delays.

The reduction of lineside assets could cut down the number of times (and their duration) that track workers need to access the operational railway either with or without possessions. Possession management could also be improved.

There has been a growing threat from both organised crime and other threat actors attempting to penetrate various Railway Systems to seek monetary, monetary or political effect. Businesses identified as operators of essential services will have to take:

- appropriate and proportionate technical and organisational measures to manage the risks posed to the security of network and information systems in the provision of their service; and
- appropriate measures to prevent or minimise the impact of incidents affecting the security of the network and information systems used in the provision of their service.

A.2 Concept of Operations

One of the ways in which the Integrated Concept of Operations [RI3] responds to the above proposed Business Requirement is to advocate the provision of routing information to the driver to enable them to recognise when undesirable events may be about to occur and take appropriate action. The following statements from [RI3] address this:

<p>Information on the ETCS DMI</p> <p>Information about the MA is displayed on the DMI and the driver must control the train in accordance with the information displayed. When the train is moving under the supervision of ETCS the train driver is provided with:</p> <ul style="list-style-type: none"> • An indication that an MA has been granted; • The current extent of the MA; • The actual and the maximum allowable speed for the train; <p>Track condition information (e.g. neutral sections, traction changeovers, radio holes); and, Routing information (text messages).</p> <p>The driver is responsible for controlling the speed of the train in accordance with any special conditions not supervised by ETCS as per the information received at booking on (see section xxx).</p>	SOS-014
<p>If the train is routed onto a line where, if routed incorrectly, there is a potential for gauge infringement, traction incompatibility or major journey disruption, routing information will be provided in the form of a text message displayed on the ETCS DMI. The driver considers the information in the text message and will not depart if the routing is incorrect.</p>	ETCS-00340
<p>If the train is routed onto a line where, if routed incorrectly, there is a potential for gauge infringement, traction incompatibility or major journey disruption, routing information is provided in the form of a text message displayed on the ETCS DMI. The driver considers the information in the text message and will stop the train before entering the incompatible route if the routing is incorrect.</p>	ETCS-00410

It could be argued that the Concept of Operations is too detailed in this area as it specifies the solution to be adopted – text messages – rather than identifying only that routing information

Reference	153819-NWR-PLN-ESE-000012
Issue/Ver:	1.0
Date:	28/11/18

may be required. It is also not fully consistent with the previously agreed industry position about level of provision of routing text messages developed as part of the ETCS Reference Design.

A.3 Customer Requirements

At the System of Systems (SoS) level, the following DR SoS Customer Requirement (from [R14]) is relevant to the provision of routing information to the driver:

Scenario: Provide Information to Driver

Updates to any element of information relevant for the driver (such as Movement Authority, advisory speed, current speed, train operation mode, etc.), or information being transmitted to the driver (such as text messages), needs to be displayed to the driver in a timely manner.

The Digital Railway System shall provide all required operational information, including a Movement Authority limit, to the driver.

CRS-SoS-20

Source: Scenarios:: Provide Information to Driver::Provide Information
 Scenarios::Provide Information to Driver::Collate Information
 Scenarios::Safely Operate the Train::Provide Information to Driver Status:
 Normative

Rationale: *During operation, the driver of a rail vehicle needs to have operational information such as the operating mode, current speed, Movement Authority, maximum speed and recommended speed. This allows the driver to drive the rail vehicle safely and efficiently.*

Guidance: *Any information relevant to operating a rail vehicle safely should be provided to the driver in a timely and consistent manner.*

Functional apportionment indicates that the provision of safety-critical information to the driver must be achieved through the ETCS and results in the ETCS Trackside Customer Requirements Specification [R15] containing the following relevant requirement:

The ETCS Trackside shall provide the on-board with sufficient information for the safe management of the train by the driver.

CRS-ETCS(T)-2

Source: ETCS Reference Design process

Status: Normative

Rationale: *When operating with cab signalling, all the information required by the driver should be provided on the cab display. The requirement for route knowledge or reference to a route book should be minimised. The need for the driver to identify and interpret lineside signage should be limited to those occasions when the information cannot be provided in the cab. For operational reasons the driver should not be encouraged to react by reducing speed purely because information (e.g. extent of MA) is not available on the cab display.*

Guidance: *The driver needs information on the permissible speed of the train, the distance to travel, the route the train will follow (where critical), and any track related*

Reference	153819-NWR-PLN-ESE-000012
Issue/Ver:	1.0
Date:	28/11/18

actions (e.g. neutral sections).

There are scenarios when a message may be displayed at the entry to OS or FS requiring the driver to manage the speed of the rear of the train - these should be minimised.

The extent of a movement authority sent to the on-board needs to be of sufficient length (subject to availability) to allow the driver to continue to manage the train at the permissible speed or at the advisory speed from C-DAS - the update of the movement authority needs to avoid the driver misinterpreting how far the train may travel.

There may be occasions where the in cab display needs to be supplemented by lineside signs such as to mark the end of a movement in SR (Stop Marker) or the stopping location when a release speed is applied (Location Marker).

The meaning of a movement authority to a driver needs to be agreed with a consistent set on underlying rules for the issue of the MA (interlocking principles).

For both of the above requirements the acceptance criteria could be based upon satisfaction arguments that all of the linked DR Requirements have been met or upon the completion of a driveability assessment demonstrating that the driver is provided with the information necessary for the safe management of the train.

This could potentially be expanded upon by adding an explicit Customer Requirement regarding the provision and configuration of routing text messages within the ETCS Trackside so that they can be transmitted to the ETCS Onboard for display to the driver.

A.4 DR Requirements

A potential DR Requirement applicable to ETCS regarding this functionality could be as follows:

The ETCS solution shall mitigate misrouting through the provision of text messages to the driver on the approach to critical divergences where significant hazards exist.

ESR-XXX

Status: Normative

Rationale: The provision of supplementary information to the driver via the ETCS will assist them in identifying possible routing errors and offer the opportunity to stop the train before an undesirable situation occurs. The text message functionality available within ETCS has been identified by the industry as the best way to achieve this.

Guidance: Trains are sometimes routed in error onto lines with which they are not compatible. With the ETCS, some existing methods of mitigating these errors will be lost. This functionality is only provided for those routes where a significant hazard could arise if a misrouting event occurs; junctions where this applies are called "critical divergences". The ETCS Trackside sub-system requirements set out the criteria by which it is possible to determine whether any particular junction is a critical divergence.

This requirement sets out how the ETCS meets the Customer needs set out in CRS-ETCS(T)-2 with regard to routing information.

The acceptance criteria for this requirement could be based upon a satisfaction argument that all the linked sub-system requirements have been met.

There are several relevant DR Requirements at a Sub-system level and the following have been selected for illustrative purposes from [RI6]:

Reference	153819-NWR-PLN-ESE-000012
Issue/Ver:	1.0
Date:	28/11/18

The Trackside sub-system shall transmit a routing text message to the train when a Movement Authority (MA) over an announced route is first sent to the train.

ETrckSS-404

Status: Generic Product

Rationale: Transmission of the routing text message and MA separately could lead to one of them being received late, or not at all, resulting in an incomplete and confusing presentation of information on the DMI.

The Trackside sub-system shall configure the text of all routing text messages to commence with 'Route'.

ETrckSS-790

Status: Normative

Rationale: To assist the driver in recognising the purpose of the message by providing a common prefix.

Safety

Where a more restrictive structure gauge applies to a route beyond a divergence, such that a misrouted train could not be stopped before encountering a restricted structure, the application design shall configure the route containing the restriction to be an announced route.

ETrckSS-827

Status: Application-Specific

Rationale: Hazard analysis has identified this situation as a critical divergence. Safety requirement addressing hazards V-H108 and V-H110.

ETrckSS-404 sets out when the routing text message is to be sent to the train, which is about characterising how the functionality is to be configured. ETrckSS-790 sets out how the routing text message is to be structured. ETrckSS-827 sets out how to determine whether a routing text message is required for a particular divergence. Thus, it can be seen that these are all examples of 'how' requirements characteristic of the DR Requirements domain.

The proposed acceptance criteria for these three requirements are as follows:

- ETrckSS-404: Demonstration report that shows that the required sequence of events occurs either in real world testing or a simulated environment
- ETrckSS-790: Design review report to demonstrate the common prefix has been implemented
- ETrckSS-827: Design review report demonstrating that the deployment project area has been assessed to identify whether each divergence could result in the hazard described occurring

Digital Railway



Working together for a better railway:



Rail Delivery Group



NetworkRail

