X2Rail-1

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Deliverable D5.2
Moving Block Operational and Engineering Rules

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Change history

Version	Date	Release Status	Notes
1.0	18/04/2019	First Release	First Release for review by TMT
2.0	04/06/2019	Second Release	Second Release following TMT and WP review
3.0	17/07/19	Third Release	Final Issue
4.0	19/11/19	Fourth Release	After JU Expert Review

Executive Summary

This Operational and Engineering Rules deliverable is one of a group of documents produced by the Shift2Rail project X2Rail-1, by WP5 Moving Block, in accordance with the X2Rail-1 Grant Agreement:

- **D5.1 Moving Block System Specification** - defines the behaviour of the ETCS Level 3 Moving Block system.
- **D5.2 Moving Block Operational and Engineering Rules** (this document) - defines additional Operational and Engineering Rules required for an ETCS Level 3 Moving Block system.
- **D5.3 Moving Block Preliminary Safety Analysis** - describes hazards identified as a result of migrating from ETCS Level 2 to an ETCS Level 3 Moving Block System and the mitigation for those hazards.
- **D5.4 Moving Block Application Analysis** which describes the application of ETCS Level 3 Moving Block systems to different railway types.

These documents are all Deliverables from X2Rail-1, with further work intended in both X2Rail-3 and X2Rail-5. This document is intended to be used as follows:

1) As a basis for further operational and engineering rules analysis within X2Rail-3
2) As a start point for work on enhancing the OPE TSI with rules for ETCS L3 Moving Block

The group of documents are all relative to ETCS Level 2. The work has aimed to minimise the changes required beyond ETCS Level 2. Anything which is the same as ETCS Level 2 is not described, except where some description is required to provide context.

This group of documents covers different ETCS L3 Moving Block system types. A high-level description of these different system types can be found in D5.1 section 4 High Level Principles. The rules are written so that a mixture of different system types could be used.

The rules do not cover the complete system scope. Some areas are being addressed by other projects within Shift2Rail. Section 3 defines the scope of these documents and provides some assumptions about other system components.

Before using these documents as the basis of procurement for a deployment, the following should be considered:

- There is a presumption that the usual requirements for a Level 2 ETCS solution will be applied in conjunction with the usual engineering and operational rules for such

a solution. Since, with the exception of the harmonised operational rules, these are not documented for Level 2, the authors have used their judgement as to what can be assumed and what needs to be explicitly stated for a Level 3 deployment.

- The Hazard Analysis has only considered the introduction of Level 3 at a conceptual level and has not, as yet, considered any issues identified during the development of the requirements and rules. The analysis indicates which requirements and rules may mitigate the hazards; however, there is no evidence that the hazards are mitigated to a tolerable level and this will be the subject of further work.
- Whilst the requirements and consequential rules have been produced in a logical manner, using the expert knowledge of the working group, they have not been proven by structured analysis, demonstration or implementation and, as such, are unassured. Work has been initiated to undertake further analysis during X2RAIL-3.

As originally planned, the work is not finished in X2Rail-1. Further work is proposed to be carried out within the follow-on project X2Rail-3 and later X2Rail-5. The topics for further work in X2Rail-3 are listed in section 7 Future Work.

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1 Objective

The objective of this document is to identify and define the proposed additions required to existing Operational and Engineering Rules to support the cost-effective implementation of ETCS Level 3 Moving Block Systems. The additions are based on the difference from a typical, European, implementation of ETCS Level 2. Some of the Operational and Engineering Rules in this document may be considered as candidates for inclusion in the [OPE TSI] and [CCS TSI], whilst others may be more applicable as guidance towards the delivery and operation of Level 3 projects.

Operational Rules are concerned with operational aspects needed for enabling Level 3 operations. However, it is worth noting that many of these will be associated with operations applied to Level 2 railways and cover issues of greater importance in Level 3 and exceptions to normal operations.

Other examples of areas where new rules may be required are:

- transition into or out of an ETCS L3 Moving Block System area;
- mixed operation of fitted and unfitted trains;
- shunting operations within ETCS L3 Moving Block System areas;
- handling a failed train on a railway without Trackside Train Detection.

Engineering Rules are concerned with the system configuration of ETCS L3 Moving Block Systems so that safety and/or operational performance are/is achieved, for example:

- performance in bottleneck areas;
- maximum capacity on plain line;
- minimal equipment fitted to the trackside infrastructure.

2 Background

2.1 Shift2Rail Background

This document has been produced within Shift2Rail IP2 "Advanced Traffic Management and Control Systems". The work is part of the work on Technical Demonstrator TD2.3 Moving Block.

The document has been produced within the X2Rail-1 Work Package 5: Moving Block.

2.2 NGTC Background

The work in X2Rail-1 WP5 Moving Block has taken notice of the results of the "Next Generation of Train Control systems" (NGTC) project. The approach using analysis of scenarios follows from the work in the NGTC project [NGTCD51]. The principal difference is that the work in X2Rail-1 WP5 Moving Block has explicitly addressed the implementation of Moving Block using ETCS Level 3.

2.3 ETCS Reference

The work in X2Rail-1 WP5 Moving Block addresses the implementation of Moving Block signalling using ETCS Level 3. The term "ETCS Level 3 Moving Block" is used to mean a signalling system where Moving Block is implemented using ETCS Level 3.

The work in X2Rail-1 WP5 Moving Block has taken notice of the following specific objective from the introduction to the Description of Work in Annex 1 of the X2Rail-1 Grant Agreement:

'To ensure the backward compatibility of ERTMS/ETCS technologies, notwithstanding of the required functional enrichment of the future signalling and control systems.'

In order to develop the Operational and Engineering Rules included in this document, both the [OPE TSI] and the [CCS TSI] have been used as a starting point.

The baseline of ETCS Level 2 used is:

a) The CCS TSI which defines ETCS Baseline 3 Release 2, as defined in TSI Commission regulation (EU) 2016/919, of 27 May 2016 [CCS-TSI]

b) The OPE TSI, as defined in Commission Regulation (EU) 2015/995 of 8 June 2015 [OPE TSI]

Note: the proposed Operational & Engineering Rules in this document include additional rationale and guidance. Aligned to the OPE TSI (Annex A), they also define when rules are expected to be non-harmonised.

c) Change Request 940, as controlled by ERA [CR940], which concerns the behaviour of the system regarding the reporting of Train Integrity.

2.4 Architecture Assumptions

In accordance with minimising the impact on Baseline 3 Release 2 [CCS TSI], the work in X2Rail-1 WP5 has assumed the system architecture for ETCS remains unchanged. This architecture is summarised in Figure 1.

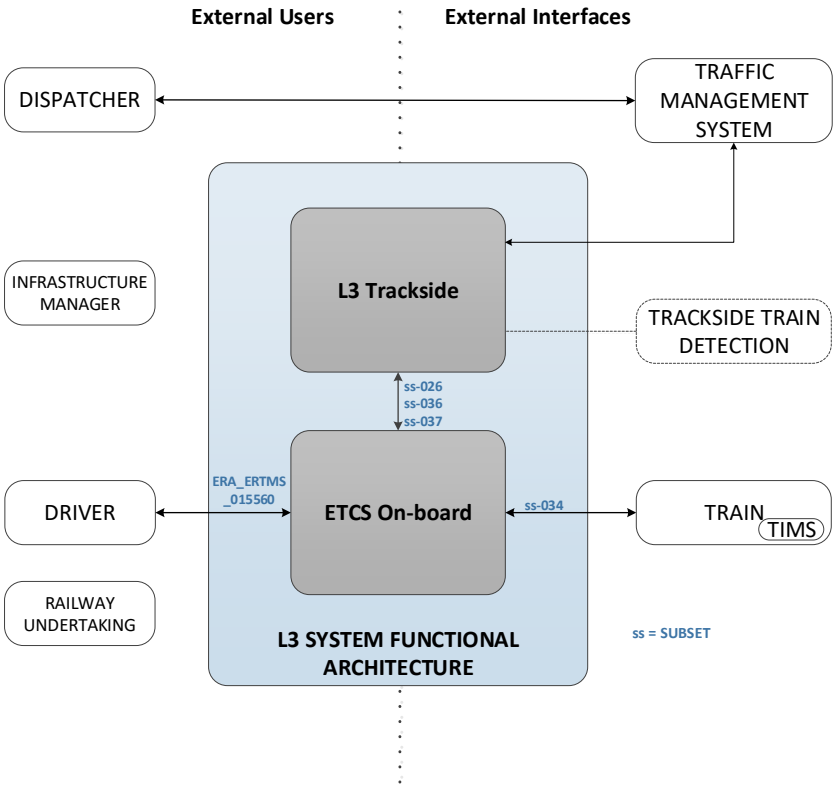

Figure 1 - Generic ETCS Level 3 Moving Block System Functional Architecture

From Figure 1 the key external actors in this system are:

- Dispatcher – the operator of the Traffic Management System
- Infrastructure Manager – the body responsible for the operation of the Railway and maintenance of infrastructure
- Driver – the operator of the train
- Railway Undertaking – Operator passenger/freight train service

Note that this architecture is aligned with that developed by X2Rail-1 WP2: Technical coordination and System Coherence [D2.1].

Operational Rules refer to the users of the system (e.g. Driver and Dispatcher), whilst Engineering Rules concern the configuration of the system (normally applied at the time of project implementation which detail choices to be made or the arrangement of hardware, e.g. balises).

In this document, the L3 Trackside includes functionality traditionally considered part of the interlocking as well as the RBC functionality. The System Architecture in the ETCS Specifications [BL3 R2] does not consider the interlocking as part of the ETCS system. In an ETCS Level 2 system, although there is no defined interface between RBC and Interlocking, the separation of functions is clearer. In an ETCS Level 3 Moving Block system, Track Status is derived primarily from Train Position Reports, rather than Trackside Train Detection, and therefore the Track Status function is required to be in scope. This is shown in Figure 2 below. Throughout this document, the term "L3 Trackside" is used, which encompasses the Track Status Management function.

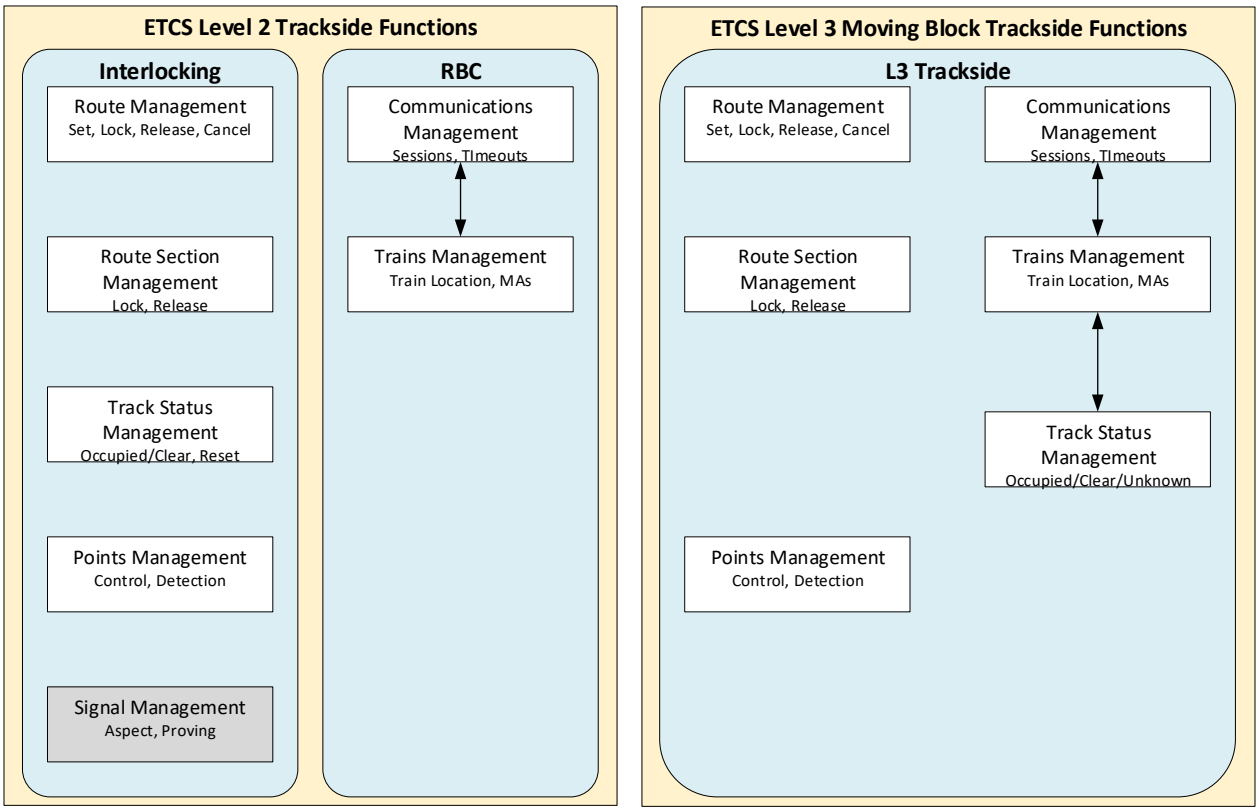

Figure 2 – Comparison of Functional Architectures for ETCS Level 2 and ETCS Level 3 Moving Block

Note that this architecture is aligned with that developed by X2Rail-1 WP2: Technical coordination and System Coherence [D2.1].

3 Scope

3.1 Document Scope

The Rules within this document are only those which are beyond the Rules for ETCS Level 2. There are no documented Rules for ETCS Level 2 Trackside, so this means that the Rules in this document are those perceived by the WP5 experts to be those beyond ETCS Level 2 as implemented today.

Operational Rules are required to provide the Driver and/or the Dispatcher with clear procedures to use for managing normal and degraded situations. Where it is not possible to define a harmonised rule due to different national procedures or application features, the need for an application-specific Operational Rule to be produced has been identified. For the purposes of the document it is assumed that the Operational and Engineering Rules applicable to an ETCS Level 2 railway exist and are applied.

Engineering Rules determine the system configuration so that safety and/or operational performance are/is achieved. The Engineering Rules described in this document are in addition to those in Subset-040 [SS040] and constrain ETCS application to providing a safe and consistent deployment of Level 3.

In the following, a rule represents something that must be obeyed if it is applicable to the concerned scenario and, where optional, has been selected by the Infrastructure Manager for implementation. Each rule is provided together with a rationale, explaining the reason for the rule, and guidance, which gives supplementary information to support the correct interpretation of the rule and its fulfilment.

Each rule is identified by a Unique Id, structured as follows:

<Type>-<Section>-<Number>

where:

<Type> is “OPE” or “ENG” for D5.2;

<Section> is an abbreviation within the document for a section of rules; and

<Number> is a number unique for the whole section.

The rules proposed align with the high-level principles of the Level 3 system outlined in the D5.1 Moving Block System Specification.

There are companion documents for other aspects of ETCS L3 Moving Block Systems.

Rules related with requirements and hazards have been identified by traceability between the companion documents, as shown in figure 2.

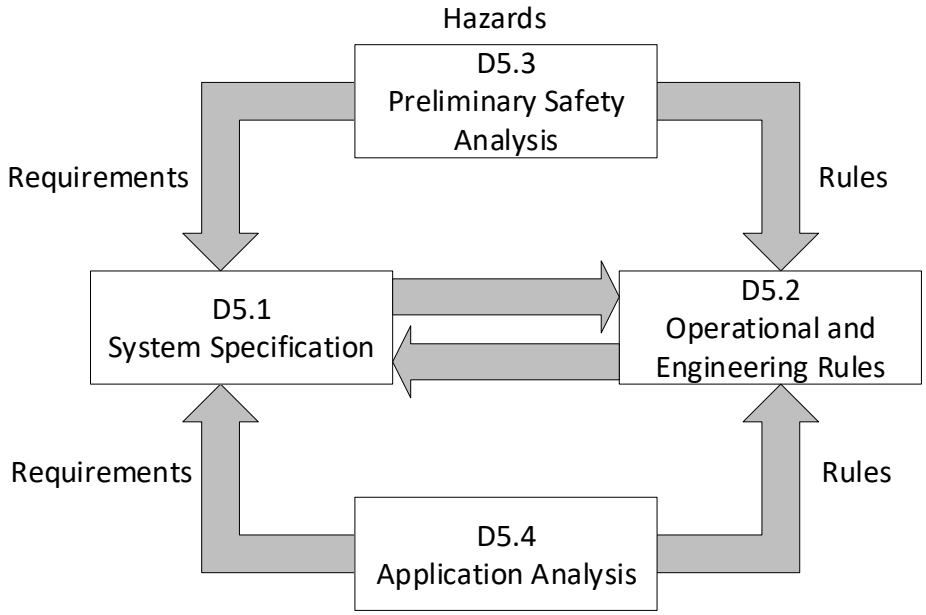

Figure 3 - Traceability between Deliverables

D5.4 contains analysis of the Requirements (D5.1) and Rules (D5.2) as applied to different railway types.

The following table summarises the set of companion documents:

X2Rail-1 Deliverable	Title	Notes
D5.1	Moving Block System Specification	Defines System Requirements for an ETCS L3 Moving Block System, where those requirements are beyond what is required for an ETCS Level 2 system.
D5.2	Moving Block Operational and Engineering Rules	Defines Operational and Engineering Rules for an ETCS L3 Moving Block System, where those rules are beyond what is required for an ETCS Level 2 system.

D5.3	Moving Block Preliminary Safety Analysis	Contains hazard analysis of an ETCS L3 Moving Block System.
D5.4	Moving Block Application Report	Analysis of applying the ETCS L3 Moving Block system to different railway types (Urban/Suburban, High Speed, Overlay and Low Traffic/Freight).

3.2 Application Scope

3.2.1 Railway Types

The aim of this document is to identify and define the proposed changes to Operational and Engineering Rules that can be applied to different railway types.

Within the Grant Agreement, the following types of railway are explicitly listed for WP5 Moving Block (See Deliverable 5.4 for complete definition):

- Urban / Suburban Railways
- Overlay Systems
- High Speed Lines
- Low Traffic and Freight Lines

In theory, a unique MB-based system (i.e. a Full MB system) is able to implement whatever type of railway application, but when it comes to determining the best trade-off between benefits and costs of this implementation, each railway application addresses a specific MB-based system as the best possible one, among the four types defined in this document. The intention is for one system/product to be able to support all of the above railway types. However, there will be differences in the way the L3 Trackside is applied to different types of railway. These differences are identified and analysed in D5.4.

3.2.2 Grade of Automation

The ETCS architecture shown in Figure 1 includes a Driver. The work on Operational and Engineering Rules has assumed that there will be a Driver present. Therefore, this system is

specified to be able to support Grades of Automation up to GoA2. It is not intended to cover systems without a driver, GoA3/4.

3.3 System Scope, Assumptions & Constraints

See the equivalent section in D5.1.

4 Methodology

In order to establish the Requirements, Operational Rules and Engineering Rules for an ETCS Level 3 Moving Block system, the Work Package considered a series of Scenarios, covering both normal and degraded operation of the railway. These scenarios were working documents, not deliverables, and were used as the basis for establishing the Requirements, Operational and Engineering Rules and for the Preliminary Safety Analysis.

Figure 4 provides an overview of the process followed:

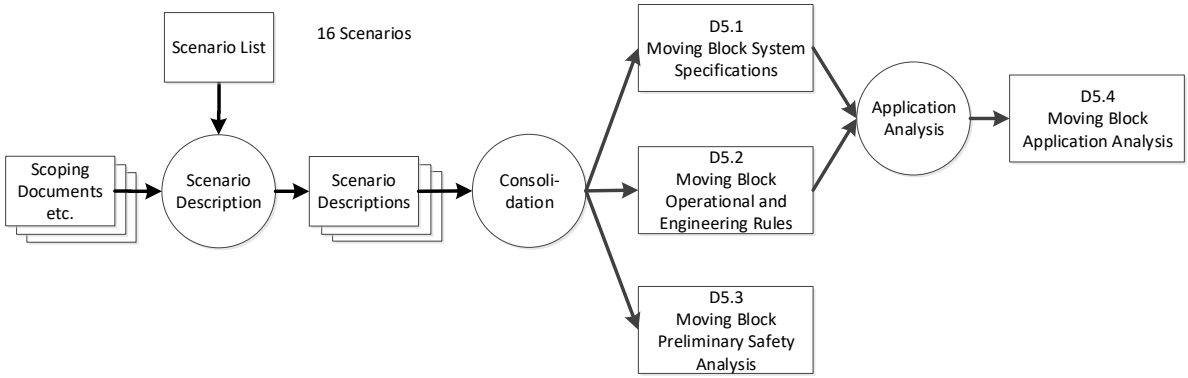

Figure 4 – Process Overview

The following scenarios were analysed:

Scenario
Trackside Initialisation
Start of Train
Normal Train Movement
Transitions
Handover
On Sight Movement
End of Mission
Reversing
Splitting
Joining
Shunting
Mixed Traffic

Communications Failure
Loss of Train Integrity
Recovery of a Failed Train
Override

For each Scenario, the behaviour of the system was examined, with a focus on Track Status. The base System Type in the scenario analysis was Full Moving Block, with no Trackside Train Detection. The analysis also examined the impact of the other three Moving Block system types. The objective was to understand the differences from ETCS Level 2.

After consideration, some topics were not examined by the scenario analysis, as they were determined to be unchanged from ETCS Level 2. For example:

- Temporary Speed Restriction (TSR) management
- Emergency Stop Areas

The argument for the completeness of the analysis is based on the coverage of those aspects of the ETCS Level 3 Moving Block railway which are different from an ETCS Level 2 railway.

5 ETCS Level 3 Moving Block System Types

See the equivalent section in D5.1.

6 Operational Rules

This section provides Operational Rules for an ETCS Level 3 Moving Block system, where they are in addition to the existing Operation and Traffic Management TSI [OPE TSI]. The section is structured into sub-sections, using the Operational Scenarios which were used by the Working Group as a development tool for the Rules and Requirements.

A number of new or revised Operational Rules have been identified which apply to multiple scenarios concerning the operation of trains in Level 3. These generic rules are listed at the start of this section.

The Operation and Traffic Management TSI [OPE TSI] allows each application to decide on how the Dispatcher and Driver will manage scenarios where there is no interoperability or safety requirement for them to be managed in a harmonised manner. Scenarios in this document where it is the responsibility of the Infrastructure Manager to define the operational rules to be applied, if any, are identified using the phrase 'in accordance with non-harmonised rules'.

6.1 Operational Generic Rules

This section provides 'generic' rules for an ETCS Level 3 Moving Block system, where they are in addition to the existing Operation and Traffic Management TSI [OPE TSI]. Generic rules are valid across multiple scenarios.

OPE-Generic-1

Where the system permits, the Dispatcher shall, in accordance with non-harmonised rules, clear a piece of track with Unknown status.

Rationale:

A section of track with Unknown status could be an operational hindrance as, for example, it could contain points which cannot be moved.

Guidance:

The Dispatcher may need staff and/or Driver's assistance to make sure that no parts of a train have been left behind before clearing the area. Where the Dispatcher has created a "non-sweepable" Unknown area to require all Drivers to proceed On Sight due to a hazard adjacent to the line, then this would allow it to be removed.

D5.1 Requirements: REQ-TrackStatus-8

OPE-Generic-2

The Driver shall only confirm train integrity in accordance with non-harmonised Operational Rules.

Rationale:

Rules are needed to define conditions and responsibilities for the Driver to confirm train integrity in a safe way. The rule may be that the Driver is forbidden to undertake the action.

Guidance:

The risks of a Driver confirming integrity in error should be considered before allowing the Driver to undertake this action. The Driver could confirm integrity themselves, with a shunter, a member of platform staff, or by means of a technical solution such as a back-up system. In Level 3 the system relies on position reports from the train to establish the status of the track. The Dispatcher might authorise a train without integrity confirmed to proceed and request that the Driver stops at a platform or other operationally convenient location in order to confirm train integrity.

D5.1 Requirements: REQ-LossTI-9

OPE-Generic-3

When asked by the Dispatcher to report the location of the train, the Driver shall do so in accordance with non-harmonised rules.

Rationale:

Drivers may need to report the location of the train in various situations, e.g. if starting with an unknown position, or detecting obstacles in the track. On an ETCS Level 3 Moving Block Railway, the number of assets on the track is reduced. Geographical position information can be used by the Driver to report train location to the Dispatcher, for example, for Staff Responsible or Override movements.

Guidance:

For reporting the location of the train, drivers may use unique trackside references as well as geographical position information, if available. The provision of geographical position information on the DMI requires the L3 Trackside to transmit the relevant information. In some locations this may not be possible, and the Driver will need to refer to trackside features.

D5.1 Requirements: REQ-StartTrain-3

OPE-Generic-4

Where required, the Driver shall, in accordance with non-harmonized rules, and in line with [SS091], follow a safe process for determining and entering the train length on the DMI.

Rationale:

Whilst train length is safety critical in all ETCS Levels, it is more critical in Level 3. This is because, in the absence of Trackside Train Detection, the train length information is used to release the railway behind a train when a new train position report with integrity confirmed is received.

If the train length entered is shorter than the real train length, this increases the risk of collision, as a following train might be issued a Movement Authority based on the reported train length.

If the train length entered is longer than the real train length, this reduces the capacity of the railway, as the railway behind the train will be released based on the reported train length.

Guidance:

The train length needs to be entered or confirmed whenever Train Data is entered during Start of Mission or when the length changes as a result of splitting or joining, during rescue movements, etc.

The entry of train length can be automated for fixed consist trains, or trains which are a combination of fixed consists. This reduces the chance of human error when entering train length.

For variable consist trains, it may still be necessary for the Driver to manually enter the train length. The Driver must have a clear process for establishing the length of the train (this may require a physical check or information supplied by others).

In both cases, the train length entered should represent the length of the train. It is not necessary to add a safety margin. A safety margin will be added by the L3 Trackside.

For a train which varies in length because of the opening and closing of the gaps between railway vehicles, the train length at maximum extension should be used.

D5.1 Requirements: None

OPE-Generic-5

Drivers shall not move trains in SB mode unless in accordance with non-harmonised rules.

Rationale:

A single movement in SB mode (limited by D_NVROLL) will normally be allowed for within the safety margins established at End of Mission. Repeated movements could lead to the train moving outside the protected, Unknown Area.

Guidance:

Movements in SB mode should not normally be allowed unless there is a good operational reason, such as splitting or joining, or to move a train clear of a balise or big metal mass in order to perform Start of Mission.

D5.1 Requirements: None

OPE-Generic-6

The Dispatcher shall, in accordance with non-harmonised rules, create or extend an Unknown Area flagged as “Sweepable” or “Non-sweepable”.

Rationale:

In certain circumstances the L3 Trackside may not be able to automatically set an Unknown Area, for example in presence of an unexpected obstruction. Input from the Dispatcher is required. Depending on the reason for creating the Unknown area the non-harmonised rules may require that the Unknown area remains in place after the passage of a train and hence should be flagged as “Non-sweepable”.

Guidance:

The non-harmonised rules need to describe how the Dispatcher establishes a protected area (using Unknown). Reasons for creating an Unknown area as “Non-sweepable” might be to protect a section of line with a reported potential hazard, e.g. land slide; a failed level crossing; or a trespass incident. In these cases the Drivers may need to be advised and then authorised to proceed in On Sight.

D5.1 Requirements: REQ-TrackStatus-5

6.2 Trackside Initialisation

6.2.1 Introduction

On a Level 3 railway, the Location of trains is determined by position reports received from the trains, which are recorded and evaluated by the L3 Trackside. When the system is initialised, the L3 Trackside has to consider the whole railway as Unknown/Occupied until it can establish the Location of all trains/vehicles, particularly those that are not communicating. This section considers the issues to be addressed by Operational Rules to support the safe and efficient initialisation of the system and resumption of normal train operations.

6.2.2 Rules

OPE-TrackInit-1

The Infrastructure Manager shall define the non-harmonised procedures for initialising or restart of the L3 Trackside.

Rationale:

The initialisation or restart of the trackside hardware is likely to be the same as for Level 2. Establishing the state of the railway is more complicated, and the process will depend on whether or not TTD is provided. There are risks of resuming normal operation until reasonable steps have been undertaken to confirm the occupation status of the railway. Until established otherwise, the whole railway will be treated as being in an Unknown state.

Guidance:

In the absence of TTD, it may be appropriate for operational procedures to require the connection of all known trains and that the L3 Trackside has recorded their Location before the system is instructed that the remainder of the railway is Clear. Where TTD or other systems allow the absence of trains to be proven, the arrangements for using this information to set the status from Unknown to Clear may require the confirmation from the Dispatcher or others. Sections which remain Unknown will need to be confirmed Clear through sweeping.

When the L3 Trackside restarts, Drivers and Dispatchers need to be aware of the time it may take for a train to re-establish a safe communication session, typically up to 5 minutes. Calls from Drivers could distract a Dispatcher during the initialisation process and the Infrastructure Manager could put in place an Operational Rule requiring the Dispatcher to make a voice broadcast prior to re-initialisation of the system, advising Drivers not to contact them for a specified period of time (e.g. ten minutes), except in an emergency.

D5.1 Requirements: None

OPE-TrackInit-2

Where the system permits and in accordance with non-harmonised rules, the person in charge of the work (e.g. Maintenance Engineer, Testing Engineer) and/or the Dispatcher shall enter information about trains and obstructions in the area.

Rationale:

The system may allow the Dispatcher to define areas as Unknown. The system may also allow the Dispatcher to place reminders recording details of the trains/obstructions in addition to setting the track occupancy status.

Guidance:

The marking of areas as Unknown may be used during system initialisation, when the Dispatcher is authorising the use of Override or to manage non-communicating train movements. The setting of areas as Unknown needs to follow a safe and robust process to avoid causing emergency brake interventions on trains which previously had an MA into the area or failing to set the area where a train is, or may be, to Unknown. Such reminders can assist the Dispatcher with planning sweeping movements to avoid sending trains through areas known to be occupied.

D5.1 Requirements: REQ-TrackStatus-5

OPE-TrackInit-3

Where the system permits and in accordance with non-harmonised rules, the Dispatcher shall, having entered the details of all vehicles and obstructions, instruct the system to set all other areas to Clear.

Rationale:

The need to sweep all the lines may be operationally unacceptable and by storing the Location of all vehicles, the remainder of the line can be assumed to be Clear.

Guidance:

The project must consider the risks of vehicles not being recorded and how the Dispatcher will inform the system that all the known vehicles have been entered correctly. Non-harmonised rules may require the Dispatcher to record the track status as Occupied for movements already authorised. This may require independent checks.

D5.1 Requirements: REQ-TrackInit-4

OPE-TrackInit-4

The Dispatcher shall if required by non-harmonised rules, instruct all train drivers, by voice radio call or other means, to stop and confirm all trains at a stand prior to a restart of the system.

Rationale:

Trains running in Staff Responsible mode do not have an MA and may not be communicating their position to the L3 Trackside. Advising all Drivers of the need to stop and the reason will avoid unnecessary radio calls to the Dispatcher and support the safe, efficient recovery of the signalling system. Stored train Location information can be used to restore the system to normal operation more efficiently. If there is the potential of trains moving, then it may not be safe to rely on the stored information.

Guidance:

Having all trains at a stand with the Drivers aware not to seek to move the train simplifies the process of restarting the system and reduces the risk of sections being declared Clear when they are not. Examples of when re-initialisation is required include: need to restart the system to load new configuration data; requirement to switch to a standby system which does not maintain a copy of the current data; necessity to update the system following re-arrangement of infrastructure within a control area.

D5.1 Requirements: None

OPE-TrackInit-5

After completing initialisation of the L3 Trackside, the Responsible Person shall confirm to the L3 Trackside that the procedure is complete, in accordance with non-harmonised rules.

Rationale:

The Responsible Person of initialising the L3 Trackside has to confirm when the procedure has concluded. They have the authority to confirm that all the obstacles on the railway are known to the L3 Trackside. Only after this has occurred can the L3 Trackside authorise Movement Authorities for trains.

Guidance:

The rules may take account of other sources of information about the location of trains. The Responsible Person needs to be identified by the Infrastructure Manager and could be a Maintainer, a Tester or the Dispatcher depending on why the system requires initialisation or reset.

D5.1 Requirements: REQ-TrackInit-3

6.3 Start of Train

6.3.1 Introduction

When trains undertake Start of Mission, it is not always possible to identify their Location uniquely or determine that there are no other trains in front of them. One key operational difference from Level 2 is that the movement of trains which are unable to report train integrity confirmed (due to failure or absence of TIMS) needs to be managed differently, considering the operational impact of a train moving without integrity confirmed.

6.3.2 Rules

OPE-StartTrain-1

At Start of Mission or following a change in train length (e.g. splitting and joining), the Driver shall check that the Train Integrity Monitoring System (TIMS), where fitted, is operational.

Rationale:

This is to avoid having degraded operational performance due to a train starting a mission without integrity confirmed.

Guidance:

The Driver will need to check train integrity in accordance with procedures relevant to the fitted TIMS. Since the task of the Driver at Start of Mission includes a number of other checks, a Railway Undertaking may consider specifying that if the TIMS is not available that an alarm is sounded, or a message is displayed when the desk is opened. On routes without TTD, the provision of operational TIMS eliminates the operational impact of needing to sweep behind the train.

D5.1 Requirements: None

OPE-StartTrain-2

Non-harmonised Operational Rules shall define under which circumstances the Driver is allowed to move a train which is not able to report integrity confirmed.

Rationale:

This is to avoid a train leaving the area behind it as Unknown, with consequent operational impact on the railway.

Guidance:

Movement of a train without integrity confirmed is application specific. A train unable to confirm its integrity will not be able to update the L3 Trackside with the information that it has left a section of line, resulting in the line behind the train remaining Unknown. Declaring the section Clear requires a sufficient level of safety integrity through the use of TTD or sweep processes. Until the line behind the train can be declared Clear, there will be operational delays.

D5.1 Requirements: REQ-FirstMA-2; REQ-LossTI-10

OPE-StartTrain-3

The Dispatcher shall not authorise Override to be used for a train with an unknown or ambiguous position, unless being used to move the train to read a balise group and, thereby, report from a known position.

Rationale:

At Start of Mission, use of Override should be avoided for a train with an unknown or ambiguous position because the Location and movement of such a train is unknown to the L3 Trackside and may interfere with other (known) movements. Note – an ambiguous position in this context is where the L3 Trackside receives a valid position which could refer to more than one location, e.g. after a divergence.

Guidance:

The position of the train could possibly be resolved by the Driver reporting a lineside reference point to the Dispatcher and the Dispatcher then trying to reserve a path for the train before permitting the Driver to use Override. If it is possible for the Dispatcher to inform the L3 Trackside about the (approximate) position of the train, it might not be necessary to use Override as the L3 Trackside may be able to give SR Authorisation. The authorisation for a driver to use Override where the data communication is not available is not affected by this rule if the train has a valid position.

D5.1 Requirements: None

OPE-StartTrain-4

Where required in non-harmonised rules, after receiving notification of a train reporting an invalid/unknown position, the Dispatcher shall contact the Driver and determine an estimated location for the train.

Rationale:

A train with an unknown/invalid position is a hazard to the L3 Trackside, as such its location must be determined as quickly as possible by the Dispatcher.

Guidance:

None.

D5.1 Requirements: REQ-StartTrain-3

OPE-StartTrain-5

Where required in non-harmonised rules, after determining an estimated position of the train with the Driver, the Dispatcher shall enter the location into the L3 Trackside.

Rationale:

This is to enable the L3 Trackside to then protect the train by creating an Unknown Area.

Guidance:

None.

D5.1 Requirements: REQ-StartTrain-4; REQ-TMS-1

6.4 Normal Train Movement

No new additional Operational Rules have been identified for normal train movements on a Level 3 railway.

6.5 Level Transitions

6.5.1 Introduction

It is undesirable for trains to enter a Level 3 Only area if they cannot report train integrity confirmed due to the operational penalties of needing to sweep the track behind the train. Rules need to address the scenarios where a train is detected as not being fit to enter a Level 3 Only area and when a train may enter a Level 3 Only area in a degraded situation. Transitions out of Level 3

areas are not significantly different from those out of Level 2 areas except where the train is unable to report integrity confirmed, in which case, rules may be required to manage its movement.

6.5.2 Rules

OPE-LevelTrans-1

Where TIMS operational status is indicated to the Driver and a fault is showing, the Driver shall not enter a Level 3 Only area unless permitted to do so by the Dispatcher, in accordance with non-harmonised rules.

Rationale:

The operational impact of a train operating in a Level 3 Only area without reporting train integrity confirmed is significant.

Guidance:

The Infrastructure Manager may conclude that, at certain locations, it is acceptable for trains to proceed into a Level 3 Only area with no fitted TIMS or with a faulty TIMS, and that they must be diverted, or the service terminated. The Infrastructure Manager may provide announcement signs for Level 3 areas to supplement the Driver's knowledge of the route or the announcement on the DMI may be considered sufficient.

D5.1 Requirements: REQ-LossTI-8

OPE-LevelTrans-2

When TIMS is not working or the train is not reporting integrity confirmed, the Dispatcher shall apply non-harmonised rules whether to authorise a train to enter a Level 3 Only area.

Rationale:

In those circumstances when the system will not issue an MA into a Level 3 Only area because a train has not reported integrity confirmed, the Dispatcher will need to authorise the Driver to use the Override procedure. Once the train enters the Level 3 Only area, it will be managed in accordance with loss of train integrity Operational Rules.

Guidance:

Whilst this situation is undesirable, there may occasionally be unavoidable circumstances whereby a train enters a Level 3 Only area without having TIMS working or installed. This rule applies when the MA is first issued into the Level 3 Only area, subsequent loss of train integrity will be handled as if the train was in a Level 3 Only area.

D5.1 Requirements: REQ-LossTI-10; REQ-LossTI-4

6.6 Handover

No new additional Operational Rules have been identified for performing a Handover procedure on a Level 3 railway.

6.7 On Sight

6.7.1 Introduction

Where the L3 Trackside cannot establish track occupancy status, i.e. that the track is Clear, trains will need to sweep the area in On Sight mode. Rules need to state what information the Driver needs prior to the system offering On Sight mode and what checks the Dispatcher should make before authorising the movement. The use of On Sight mode for trains to enter an occupied line for the purposes of joining or to check for infrastructure defects is unchanged from Level 1/2.

6.7.2 Rules

OPE-OS-1

When sweeping an area in ETCS Level 3 On Sight mode, the Driver shall, in accordance with non-harmonised rules, follow operational procedures.

Rationale:

In order to sweep, the Driver may have to consider additional checks that are different to those for On Sight when this is used to join with another train or pass over failed infrastructure.

Guidance:

This is application-specific. Normally, it is expected that the track will be Clear, but the Driver should always consider that there may be an obstruction.

D5.1 Requirements: None

OPE-OS-2

When asked to confirm the line is Clear, the Driver shall, in accordance with non-harmonised rules, observe the track and confirm the status of sections of track joining/diverging from the line over which the train is passing.

Rationale:

On an ETCS L3 Moving Block Railway, where sections contain points, it is normally necessary for a train to sweep each route through the points before the whole of the Unknown Area, including the points, can be confirmed Clear. Where the Driver can observe that short sections of line are Clear then, subject to engineering facilities, it may be possible to declare them Clear.

Guidance:

The prime purpose of a sweeping movement is to confirm the line travelled by the train is Clear and reset the trackside record. It can also be used to reset TTD equipment and where the Infrastructure Manager allows the Driver to confirm that branches are Clear, then consideration should be given to the visibility in each direction of travel (driving cab design) and poor visibility/darkness.

D5.1 Requirements: None

OPE-OS-3

When advised by the Driver that a section of line has been examined and observed clear, the Dispatcher shall, in accordance with non-harmonised rules, clear the status of sections of track joining/diverging from the line over which the train passed where the system allows.

Rationale:

Where sections contain points, it is normally necessary for a train to sweep each route through the points before the whole of the Unknown Area, including the points, can be confirmed Clear. Where the Driver can observe that short sections of line are Clear then, subject to non-harmonised rules, it may be possible for the Dispatcher to declare them Clear.

Guidance:

When deciding if, and when, the Driver is allowed to confirm that branches are Clear, the Infrastructure Manager should consider the visibility in each direction of travel (driving cab design) and poor visibility/darkness.

D5.1 Requirements: REQ-TrackStatus-8

OPE-OS-4

The Dispatcher shall, in accordance with non-harmonised rules, advise the Driver of any specific checks prior to authorising a move in ETCS Level 3 On Sight mode.

Rationale:

In order to sweep, the Driver may be asked to check branches from the route the train is following and report back to the Dispatcher.

Guidance:

Where the system allows branches from the route to be cleared following a sweeping movement, with or without the Dispatcher's confirmation, there needs to be a clear understanding of what the Driver is expected to check. This could be through the use of ETCS Written Order 05 (OBLIGATION TO RUN UNDER RESTRICTIONS) which includes an optional requirement for the results to be reported back.

D5.1 Requirements: REQ-MA-3

OPE-OS-5

Upon receipt of a request from the L3 Trackside to extend a Movement Authority in an Unknown Area the Dispatcher shall accept or reject the request, in accordance with non-harmonised rules.

Rationale:

Depending on the L3 Trackside configuration, extension of the MA into an Unknown Area may always require authorisation from the Dispatcher.

Guidance:

None.

D5.1 Requirements: REQ-MA-9

6.8 End of Mission

No new additional Operational Rules have been identified for performing an End of Mission procedure on a Level 3 railway. It is assumed that existing rules regarding leaving trains with brakes applied and secured at the end of a mission are sufficient.

6.9 Reversing

No new additional Operational Rules have been identified for performing reversing procedures on a Level 3 railway.

6.10 Splitting

No new additional Operational Rules have been identified for performing a splitting procedure on a Level 3 railway. In accordance with the harmonised Operational Rules, the preparer/driver is already required to update the train length when the train formation is changed.

6.11 Joining

No new additional Operational Rules have been identified for performing a joining procedure on a Level 3 railway. In accordance with the harmonised Operational Rules, the preparer/driver is already required to update the train length when the train formation is changed.

6.12 Shunting

6.12.1 Introduction

For the L3 Trackside to monitor the Location of all trains and vehicles, it is necessary for them to be communicating. Entry into Shunting mode causes the train to disconnect for the movement and, hence, non-harmonised rules are required regarding shunting authorisation and the resumption of normal operation when shunting is complete.

6.12.2 Rules

OPE-SH-1

The Dispatcher shall, in accordance with non-harmonised rules, activate temporary shunting areas, where needed.

Rationale:

Shunting activities need to be protected from authorised train movements and vice versa.

Guidance:

In addition to conditions which can be checked by the L3 Trackside, the activation of a shunting area in L3 may require the Dispatcher to confirm to the L3 Trackside that no movement which is unknown to the L3 Trackside is in progress. A temporary shunting area is one configured in the L3 Trackside which, when activated, may impose interlocking controls such as preventing points being moved or routes being set, and enables the L3 Trackside to authorise SH when requested by an ETCS On-board.

D5.1 Requirements: REQ-SH-2

OPE-SH-2

The Dispatcher shall, in accordance with non-harmonised rules, deactivate temporary shunting areas.

Rationale:

Before deactivating a shunting area, it should be clearly determined that all shunting activities within that area have been completed.

Guidance:

In addition to conditions which can be checked by the L3 Trackside when deactivating shunting areas, the Dispatcher may need to confirm that shunting movements are terminated. A temporary shunting area is one configured in the L3 Trackside which, when activated may impose interlocking controls such as preventing points being moved or routes being set and enables the L3 Trackside to authorise SH when requested by an ETCS On-board.

D5.1 Requirements: REQ-SH-2

OPE-SH-3

The Dispatcher shall, in accordance with non-harmonised rules, allow trains to enter a shunting area.

Rationale:

Shunting activities must be protected from other trains entering the area. Trains entering the area must also be protected from shunting activities in progress. Whilst the basic principles are likely to be the same for temporary and permanent shunting areas, there may be changes in detail, depending on the technical solutions employed at each location.

Guidance:

Before allowing a train to enter a shunting area, the Dispatcher will check that the route is secured for the movement. Infrastructure Managers could consider deploying TTD in regular shunting areas to reduce the Dispatcher's workload. The Dispatcher may also instruct the Driver to continue the movement until the train is completely within the shunting area.

D5.1 Requirements: REQ-MA-3

6.13 Mixed Traffic

No new additional Operational Rules have been identified for train movements on a Level 3 overlay/underlay railway.

6.14 Communication Failure

6.14.1 Introduction

For a system which relies on train reports, situations where communication is not available need to be managed, since the location of a non-communicating train may not be available. This section describes the non-harmonised rules required to allow trains into areas where there is no radio coverage due to a failure of part of the system.

6.14.2 Rules

OPE-LossComms-1

The Dispatcher shall, in accordance with non-harmonised rules, protect the movement of a non-communicating train.

Rationale:

Movement of a non-communicating train must be safe and controlled by the Driver and the Dispatcher working together.

Guidance:

The detail of how the movement of a non-communicating train could be protected is application specific. The Unknown Area may be extended, and the Driver be allowed to move up to a specific location within the Unknown Area or to where it is expected communication will be regained. It is important that a train is not allowed to move to an area that the L3 Trackside considers to be Clear.

D5.1 Requirements: REQ-TrackStatus-5

OPE-LossComms-2

The Dispatcher shall, in accordance with non-harmonised rules, activate a pre-defined temporary radio hole.

Rationale:

Depending on the communication architecture, the failure of system elements may prevent communication. The loss of communication will result in a loss of train position reports generating safe reactions within the L3 Trackside which may be undesirable or unnecessary. Informing the system that a radio hole exists manages this issue.

Guidance:

In the event that the radio network is not working, the Dispatcher can activate a pre-defined radio hole. The procedure to be followed will depend on the specific application, including the facilities provided within the L3 Trackside. It may be advantageous to activate a temporary EoA Exclusion Areas covering the whole radio hole.

D5.1 Requirements: REQ-RadioHole-1

OPE-LossComms-3

The Dispatcher shall, in accordance with non-harmonised rules, deactivate a temporary radio hole.

Rationale:

This is to reinstate normal operations and thus operational performance on the railway.

Guidance:

The Dispatcher will need to check that all the necessary conditions are fulfilled prior to deactivating the temporary radio hole. Any trains already holding a Movement Authority through the radio hole will continue unaffected.

D5.1 Requirements: REQ-RadioHole-1

OPE-LossComms-4

When alerted by the L3 Trackside that a train has been in a radio hole for longer than expected, the Dispatcher shall apply non-harmonised rules.

Rationale:

A train detected as not having left a radio hole within the normal period of time may need assistance.

Guidance:

The action to be taken may depend on alternative communication systems and whether TTD is provided.

D5.1 Requirements: REQ-RadioHole-5

6.15 Loss of train integrity

6.15.1 Introduction

The loss of train integrity may occur for a number of reasons but in the event that a train is unintentionally divided the Dispatcher needs to take relevant steps to protect the potentially hazardous situation.

6.15.2 Rules

OPE-LossTI-1

When advised of loss of train integrity, the Dispatcher shall, in accordance with non-harmonised rules, protect the area in which a train division may have occurred.

Rationale:

A Level 3 system primarily relies on position reports including integrity information from trains to establish the status of the railway and to decide when a Movement Authority may be issued. If a train reports that it is divided, then the Dispatcher needs to be alerted so they can take appropriate action.

Guidance:

The required actions may be to contact the Driver, to issue an emergency stop order to other trains in the area, to make an emergency voice call or to establish an Unknown Area to prevent other trains approaching the divided train. The rules should take account of the potential that a division of the train is caused by the derailment of part of the train which may be obstructing adjacent lines.

D5.1 Requirements: None

OPE-LossTI-2

When advised of loss of train integrity through an in-cab indication, the Driver shall follow non-harmonised rules.

Rationale:

A Level 3 system primarily relies on position reports including integrity information from trains to establish the status of the railway and to decide when a Movement Authority may be issued. If a train reports that it is divided, then the Driver needs to react in an appropriate manner.

Guidance:

The required actions may be to stop the train, to contact the Dispatcher, to visually inspect the system, and/or reset the TIMS.

D5.1 Requirements: REQ-LossTI-8

6.16 Recovery

6.16.1 Introduction

When trains fail, they may not be able to communicate their position and integrity status. If they are rescued by other trains, then the ETCS Train Data may not be complete, leading to the L3 Trackside being unable to determine when the railway is Clear. Non-harmonised Operational Rules will be required to manage the rescue of failed trains.

6.16.2 Rules

OPE-REC-1

The Driver of the rescue train shall, in accordance with non-harmonised rules, confirm train integrity combined train when having reached a standstill at a station or designated location previously agreed with the Dispatcher.

Rationale:

A rescue train cannot report train integrity confirmed for the complete train; the Driver of the rescue train has to confirm it.

Guidance:

The Rule should include the conditions under which the Driver of the rescue train is allowed to confirm train integrity. It is expected that the location at which the Driver will confirm train integrity will be agreed in advance with the Dispatcher who may need to provide protection to the Driver to enable them to walk to the rear of the train. This could be, for example, by the Driver checking the rear of the train or this being done by additional staff in a station or yard. In Level 3, the Location of a train is solely dependent on the position and integrity report from the train – an erroneous integrity confirmation by the Driver could lead to the line remaining obstructed but considered Clear.

D5.1 Requirements: REQ-FirstMA-2

6.17 SR Movement

No new additional Operational Rules have been identified for SR mode on a Level 3 railway.

7 Engineering Rules

This section provides Engineering Rules for an ETCS Level 3 Moving Block system, where they are in addition to those required for ETCS Level 2. Since there is no complete, documented set of Engineering Rules for an ETCS Level 2 application, the working group have documented rules which they believe to be an enhancement of, or in addition to, those normally applied on Level 2 projects.

The section is structured into sub-sections, using the Operational Scenarios which were used by the Working Group as a development tool for the Rules and Requirements.

A number of new or revised Engineering Rules have been identified which apply to multiple scenarios concerning the operation of trains in Level 3. These are listed at the start of this section of this document.

7.1 Engineering Generic Rules

This section provides 'generic' rules for an ETCS Level 3 Moving Block system, where they are in addition to the existing engineering rules for ETCS (Generic Engineering Rules). Generic rules are valid across multiple scenarios.

ENG-Generic-1

The L3 Trackside shall be configured to update an MA only in accordance with application-specific operational needs.

Rationale:

On an ETCS Level 3 Moving Block railway the End of Authority can be at an arbitrary location on the track. Therefore, rules may be required to avoid unnecessary MA extensions over short distances.

Guidance:

A specific minimum distance for MA extension should be established, as well as a minimum time interval to send an update. Where this constraint is not required the distance and time could be set to zero. The periods could be dynamic.

D5.1 Requirements: REQ-MA-6

ENG-Generic-2

Infrastructure Managers shall define EoA exclusion area where the system shall not bring any part of a train to a stand due to it reaching an EoA.

Rationale:

On an ETCS Level 3 Moving Block railway the End of Authority can be at an arbitrary location on the track. Therefore, depending on the application, rules may be required to avoid trains stopping in areas where it is not considered safe or suitable.

Guidance:

Examples include avoiding MAs that end inside a tunnel, over a level crossing, junctions or any other areas where stopping a train is considered undesirable from a safety or operational perspective. Where it is unacceptable for a train to stop with a pantograph in a powerless section, the engineering of the EoA Exclusion area should take account of potential positions of the pantograph. Note: Non-stopping areas transmitted by ETCS only provide information to the driver.

D5.1 Requirements: REQ-EoAExclusionArea-1

ENG-Generic-3

A release point shall be defined following a divergence where the rear of a train, including any additional margin, will be sufficiently clear of another movement.

Rationale:

To improve capacity it is desirable to release points as soon as a train has cleared them. The portion of route up to the release point will be released when the Confirmed Safe Rear End of the train has passed the release point. In Level 2 this function would be achieved through train detection boundaries.

Guidance:

The identification of release points is application specific. A release point must be at or beyond a point of conflict, e.g. fouling point for points. Positioning of the release point can impact performance by influencing when routes are released.

D5.1 Requirements: REQ-PTS-2

ENG-Generic-4

The Infrastructure Managers shall define the maximum length of an Unknown Area that can be safely cleared by the L3 Trackside without sweeping or visual inspection.

Rationale:

This is to avoid needing to sweep short lengths of an Unknown Area left due to differences in the reported train length after shunting, splitting or joining.

Guidance:

The length of the Unknown Area that can be cleared without sweeping needs to be established based on the vehicles using the railway and could be the length of the shortest vehicle operating on the railway.

D5.1 Requirements: REQ-TrackStatus-11

ENG-Generic-5

Where the accurate determination of the rear of the train is required to avoid operational impact, the L3 Trackside engineering shall consider project specific mitigations to manage the location error within train position reports.

Rationale:

This is to avoid the impact on the operational performance of the line due to the assumed train position locking points or crossings.

Guidance:

This is project specific but could include, for example, the use of TTD around points or complex switching and crossings or having balise groups close enough to the End of Mission areas to minimise the confidence interval in train position reporting to the L3 Trackside. This may apply where trains regularly undertake End of Mission or stop at platforms or in loops with a requirement for other trains to pass or use other routes. In deciding whether to provide extra facilities, consideration should be given to the likelihood that a train is unable to report integrity confirmed.

D5.1 Requirements: REQ-TTD-2

ENG-Generic-6

The Infrastructure Manager shall establish the application-specific values for the safety and other margins to be applied to the front and/or rear of the train location in different situations.

Rationale:

Depending on the application, it may be desirable to add operational margins at the rear. When End of Mission occurs, the rear margin may need re-evaluation and a front margin is created to take account of D_NVROLL and operational procedures when a train is in SB mode, such as coupling. The specification for Cold Movement Detection and value of D_NVOVTRP could be considered.

Guidance:

The factors to be considered and rules for establishing the margins will be developed in X2RAIL-3.

D5.1 Requirements: REQ-TrainLoc-3; REQ-TrainLoc-4; REQ-EoM-3; REQ-EoM-4

ENG-Generic-7

The Infrastructure Manager shall establish the application specific rules for establishing where Movement Authorities may end and the boundaries of track state areas when Fixed Virtual Block is deployed.

Rationale:

The configuration of the system when using FVB and/or TTD depends on the operational needs of the railway.

Guidance:

The design should take account of the required train movements including where End of Mission and Start of Mission will occur, where splitting and joining may occur and the required capacity of the railway.

D5.1 Requirements: REQ-FVB-1

ENG-Generic-8

The Infrastructure Manager shall establish the value of the timer to be applied when a TTD reports as not being Clear, and no train is recorded on it after which the TTD area will be treated as Unknown.

Rationale:

TTD reports and train position reports may not be simultaneous, and the system needs to be configured to allow for the potential delays before adopting a safe reaction.

Guidance:

L2 implementations often use the TTD report of a train entering a TTD section and the train position report to confirm that only one train has entered a portion of the railway. In the event the reports are not consistent emergency stop messages may be sent.

D5.1 Requirements: REQ-TTD-1

ENG-Generic-9

The Infrastructure Manager shall decide whether an Unknown Area created due to a faulty TTD may be treated as Clear following sweeping or other checks.

Rationale:

In the event of failure of a TTD, the area will be considered as Unknown even though the L3 Trackside may be able to monitor the passage of trains using Position Reports. Since TTD is often provided for degraded scenarios where the Position Reports cannot be regarded as a safe proof of the absence of obstruction, when the system is working normally the TTD could be overridden.

Guidance:

The operational advantages of relying solely on Position Reports in the event of a TTD failure could be significant, however in establishing that the TTD status can be “ignored” the Infrastructure Manager should consider robust processes, such as sweeping, to confirm it is just a TTD failure and not an obstruction on the railway.

D5.1 Requirements: REQ-TTD-4

7.2 Trackside Initialisation

7.2.1 Introduction

On a Level 3 railway the Location of trains is determined by position reports received from the trains which are recorded and evaluated by the L3 Trackside. When the system is initialised, the L3 Trackside has to consider the whole railway as not Clear until it can establish the Location of all trains/vehicles, particularly those that are not communicating. This section considers the issues to be addressed by Engineering Rules to support the safe and efficient initialisation of the system and resumption of normal train operations. The Infrastructure Manager needs to understand the risks and put in place appropriate procedures and technical controls.

7.2.2 Rules

ENG-TrackInit-1

Infrastructure Managers shall select which information is to be stored by the L3 Trackside and establish for how long it can be used safely when the L3 Trackside is re-initialised.

Rationale:

Stored information may no longer be valid and may require confirmation. The rules for which information must be stored and for how long it will be used need to be the subject of site-specific assessment.

Guidance:

In circumstances in which the system cannot be sure that all the stored information is still relevant, then either it should be confirmed by the Dispatcher, or all the information discarded, and the status of the railway treated as Unknown.

Information which may be relevant to store includes:

Train details and last train position report (NID_ENGINE, Estimated Front End, L_DOUBTUNDER, L_DOUBTOVER, integrity status, L_TRAININT, L_TRAIN), speed, validated Train Data, issued MA, time of last position report);

Train Location and track status (Unknown Areas, Reserved Areas, CRE/CSRE for each communicating train, active shunting areas);

Temporary Speed Restriction data (if not available from another system).

In assessing how long information may be considered valid, it should be considered whether the information can be used to prevent a potentially obstructed section being declared Clear (due to human error) or whether it will be used to enable the system to establish a section is not obstructed. In the former the information may be considered valid for longer whereas in the latter a short time period is recommended based on the amount and extent of train movements which may have occurred.

D5.1 Requirements: REQ-TrackInit-2; REQ-TrainLoc-9

7.3 Start of Train

7.3.1 Introduction

When trains undertake Start of Mission, it is not always possible to identify their Location uniquely. Engineering Rules need to define when a train with an unknown position or not reporting integrity confirmed can be authorised to move by the L3 Trackside.

7.3.2 Rules

ENG-StartTrain-1

The Infrastructure Manager shall configure the L3 Trackside options for authorising a train without integrity confirmed to move within or enter a L3 area.

Rationale:

This is for operational reasons and to avoid leaving the area behind the train in an Unknown state.

Guidance:

The Infrastructure Manager may decide that trains without integrity confirmed may not be authorised to move until extra controls are in place. The configuration options should include:

Issue an MA irrespective of integrity status,

Do not issue an MA unless integrity is confirmed,

Only issue an MA when no integrity is confirmed with the Dispatcher's authorisation.

D5.1 Requirements: REQ-LossTI-10; REQ-FirstMA-2

ENG-StartTrain-2

When the L3 Trackside is engineered, a margin shall be established for the minimum length of vehicle that could be present in the L3 area.

Rationale:

The L3 Trackside will use the minimum vehicle length as a margin when clearing Unknown Areas.

Guidance:

This rule is obviously dependant on project specific requirements.

D5.1 Requirements: REQ-TrackStatus-11; REQ-TrackStatus-5

7.4 Normal Train Movement

No new additional Engineering Rules have been identified for normal train movements on a Level 3 railway.

7.5 Level Transitions

7.5.1 Introduction

It is undesirable for trains to enter a Level 3 Only area if they cannot report train integrity confirmed due to the operational penalties of needing to sweep the track behind the train. Rules need to address the scenarios where a train is detected as not being fit to enter a Level 3 Only area and when a train may enter a Level 3 Only area in a degraded situation. Transitions out of Level 3 areas are not significantly different from those out of Level 2 areas except where the train is unable to report integrity confirmed, in which case, rules may be required to manage its movement.

7.5.2 Rules

ENG-LevelTrans-1

The Infrastructure Manager shall engineer a means for the L3 Trackside to monitor trains entering the L3 Only area.

Rationale:

This is to prevent a train from entering the L3 Only area unnoticed by the L3 Trackside and support establishing track status.

Guidance:

This can be done by engineering, such as a small TTD at the border or other means that are application specific. The provision of TTD either side of the border allows the L3 Trackside to monitor the progress of trains and confirm that a “ghost” train has not followed an authorised movement. The provision of balises, which are known to the L3 Trackside, can be used to help establish the correct position of all trains transitioning.

D5.1 Requirements: REQ-LevelTrans-1

7.6 Handover

7.6.1 Introduction

The transfer from one L3 Trackside to another in Level 3 is influenced by the reliance on the train reporting integrity confirmed. Engineering Rules are required to minimise the impact of a train not reporting integrity confirmed passing through the border.

7.6.2 Rules

ENG-HO-1

The furthest balise group(s) in the Accepting area required to be known to the Handing Over RBC shall be placed at a distance from the border not less than the maximum train length allowed to run on the line, plus a margin.

Rationale:

In compliance with the L2-based ERTMS/ETCS system, a balise group with such an engineered position allows the Handing Over RBC to disconnect any reporting train passing the border. Furthermore, the foreseen margin could be computed so that the Handing Over RBC is able to detect a train reporting integrity confirmed having passed the border with its CRE, which allows it to regard the Handing Over area as Clear. Should the CRE still be localised in that area, a suitable sweeping procedure will be performed in order to allow a new Handover Procedure to be activated for a following train, or alternatively, the following train can perform the Handover procedure in On Sight mode.

Guidance:

The margin could be calculated taking in account at least the following:

the maximum speed of the line;

the number of position report repetitions defined in Appendix A3.1 of SS26 [SS026];

the frequency of position reports;

the frequency of TIMS confirmations.

Where there are divergences beyond the Handing Over border, the extent of the balises known to the Handing Over RBC should consider all potential routes.

D5.1 Requirements: REQ-HO-3

7.7 On sight

7.7.1 Introduction

Where the L3 Trackside cannot establish track occupancy status, i.e. that the track is Clear, trains will need to sweep the area in On Sight mode. Engineering Rules need to address the management of sections of adjacent line over which a sweeping train will not pass.

7.7.2 Rules

ENG-OS-1

Where non-harmonised rules allow a Driver to confirm that short divergences are Clear after the main route has been swept, the system shall be configurable as to which branches may be cleared.

Rationale:

To avoid the need to sweep every route through a set of points, it may be deemed safe for the passage of a train on one route, with an observant Driver, to also set the divergences to Clear.

Guidance:

The configuration choice should not be inconsistent with that used in Level 2 or where lineside signals are provided following axle counter failure or similar. The Infrastructure Manager needs to specify whether branches cannot be cleared, can be cleared automatically or can be cleared with Dispatcher's confirmation.

D5.1 Requirements: None

7.8 End of Mission

7.8.1 Introduction

When a train completes a journey and the Driver closes the desk, an End of Mission position report is sent by the ETCS On-board and the train disconnects. The L3 Trackside needs to be able to manage situations where the train did not report integrity confirmed after standstill and make allowance through appropriate engineering rules for subsequent small movements which may occur.

7.8.2 Rules

ENG-EoM-1

A margin shall be engineered in the L3 Trackside to establish safely the Location of a train that has disconnected after an End of Mission procedure.

Rationale:

This is to protect the area in which the train might be situated (when not in communication) and avoid collisions with other trains. Since the train might move a short distance undetected, the margin is added.

Guidance:

This margin should identify the right balance for each specific part of the line between safety (use a high value) and performance (mitigate the risks of unduly occupying parts of the track due to margins locking points or crossings). This margin should include at least the National Value for standstill supervision (D_NVROLL) and the distance to brake the train. The margin may not be the same at all locations and in all circumstances (further work is planned in X2RAIL-3).

D5.1 Requirements: REQ-EoM-3; REQ-EoM-4

ENG-EoM-2

The Infrastructure Manager shall consider the provision of TTD in areas where trains are regularly left without a communication session.

Rationale:

Trains not in communication will be regarded as Unknown Areas which may be propagated. Even though trains will normally be provided with Cold Movement Detection, that is only useful once the train reconnects and it may have safety benefits to detect the movement of trains which should not be moved.

Guidance:

TTD should be considered for both where trains are regularly left not in communication and for the running lines in the vicinity in order to detect runaways particularly if the gradient is favourable.

D5.1 Requirements: None

7.9 Reversing

No new additional Engineering Rules have been identified for performing a Reversing procedure on a Level 3 railway.

7.10 Splitting

No new additional Engineering Rules have been identified for performing a splitting procedure on a Level 3 railway.

7.11 Joining

No new additional Engineering Rules have been identified for performing a Joining procedure on a Level 3 railway.

7.12 Shunting

7.12.1 Introduction

For the L3 Trackside to monitor the Location of all trains and vehicles, it is necessary for them to be communicating. Entry into Shunting mode causes the train to disconnect and, hence, this should only be permitted where the L3 Trackside has been configured to manage the extent of the movement in Shunting mode and protect other train movements. Engineering Rules are required regarding the authorisation of shunting (through permanent or temporary shunting areas) and the resumption of normal operation when shunting is completed.

7.12.2 Rules

ENG-SH-1
The Infrastructure Manager shall define temporary shunting areas in the L3 Trackside where operationally required.

Rationale:

Temporary shunting areas are predefined areas in which shunting is allowed. This is to protect shunting activities from other authorised train movements and to protect authorised train movements from shunting activities.

Guidance:

One possibility could be to pre-configure in the L3 Trackside a set of areas where movements in SH mode could take place and allow the Dispatcher to activate and link them where needed, thus resulting in larger shunting areas. Infrastructure Managers could restrict the extent of shunting areas to areas where corresponding protection means such as, for example, derailing points, balises with "Danger for Shunting Information" or TTD are available. A similar method may be used to manage shunting in Level 2, however the reliance on train position reports means that shunting has to be more tightly controlled.

D5.1 Requirements: REQ-SH-1

7.13 Mixed Traffic

7.13.1 Introduction

To enable a mixture of trains operating in Level 3 and legacy trains to operate on a line, the L3 Trackside needs to be able to combine the reports received from trains reporting integrity confirmed with information received from the Trackside Train Detection and to enable consistent movement authorisations to be issued.

7.13.2 Rules

ENG-MixedTraffic-1

A Level 3 Overlay system in a mixed traffic area shall be engineered to align the Trackside Train Detection system boundaries with the Fixed Virtual Blocks.

Rationale:

This minimises the risk of trains that are unknown to the Level 3 Overlay system being able to 'hide' between two communicating ETCS trains and be a danger for the ETCS train authorised into a route already occupied by another ETCS train.

Guidance:

It is still possible to further subdivide a TTD section into several Virtual Blocks for use with trains operating in Level 3. The analysis in X2RAIL-3 may develop further application guidance.

D5.1 Requirements: None

7.14 Communication Failure

7.14.1 Introduction

For a system which relies on train reports, the management of situations where communication is not available needs to be managed. The L3 Trackside will normally apply controls or timers to generate safe reactions if communication is lost for too long. Where it is known that a train needs to pass through an area where there is no radio coverage due to a failure of part of the system, Engineering Rules will be required to inhibit the controls/timers in order to enable its movement.

7.14.2 Rules

ENG-LossComms-1

The Infrastructure Manager shall establish the value of a mute timer within the L3 Trackside to detect a loss of regular train position reports.

Rationale:

The L3 Trackside needs to establish when a train is not providing sufficient train position reports (possibly due to communications failure) in order to take safe reactions. Since communications can be lost and re-established during normal operation, a suitable delay is required before the L3 Trackside reacts.

Guidance:

The timer is restarted whenever a message is received from a train. The timer expires when the configured value is reached without receipt of a further message. If the timer expires, the L3 Trackside will treat this train as having lost communications. The value of the mute timer will be longer than the variable T_NVCONTACT and less than the communication session expiry, as defined in [SS026]. Use of the mute timer in this range permits a faster reaction to a loss of communications between a train and the L3 Trackside, when compared with waiting for communication session expiry. It should be possible to disable the mute timer if detection of communication session expiry is sufficient. For the mute timer to be applicable, T_NVCONTACT should not be set to infinity and should be significantly less than the communication expiry session time in [SS026], and M_NVCONTACT should not be set to 'no reaction'.

D5.1 Requirements: REQ-LossComms-1

ENG-LossComms-2

The Infrastructure Manager shall engineer for each Radio Hole the time allowed for a train to pass through the Radio Hole before the system reacts by alerting the Dispatcher.

Rationale:

In the event that a train takes an excessive time to pass through a Radio Hole the Dispatcher may need to take other measures to confirm that there has not been an accident.

Guidance:

The time could be established automatically or by user input. To avoid unnecessary alerts, the lowest speed profile through the area is used reduced by 20% to allow for acceleration, braking and drivability is recommended.

D5.1 Requirements: REQ-RadioHole-3

- ENG-LossComms-3
- The Infrastructure Manager shall engineer pre-defined Temporary Radio Holes which may be activated in the event of failure of communication system elements.

Rationale:

In the event that part of the communications system fails the Dispatcher needs to be able to instruct the L3 Trackside to not take a reaction if position reports are not received from a train.

Guidance:

The allocation of these Temporary Radio Holes depends on the communications architecture and likely interruptions to service due to failure.

D5.1 Requirements: REQ-RadioHole-1

7.15 Loss of train integrity

7.15.1 Introduction

The loss of train integrity may occur for a number of reasons but in the event that a train is unintentionally divided the Dispatcher needs to take relevant steps to protect the potentially hazardous situation.

7.15.2 Rules

ENG-LossTI-1

The length of the 'No integrity info' timer used by the L3 Trackside shall be configured according to project specific requirements.

Rationale:

The timer enables the L3 Trackside to react when a position report other than 'No integrity information available' has not been received within a set time.

Guidance:

Further analysis of the need and application of this function will be undertaken in X2RAIL-3.

D5.1 Requirements: REQ-LossTI-5

ENG-LossTI-2

The Infrastructure Manager shall determine whether to apply Propagation of Unknown Track Status and configure the L3 Trackside according to project specific requirements.

Rationale:

Propagation is to provide protection in the event that railway vehicles roll backwards after loss of train integrity.

Guidance:

This might depend on the nature of the rolling stock permitted to run on a railway. If the rolling stock can be assured to become stationary in the event of loss of integrity, then propagation may not be required. If the rolling stock includes vehicles which are not assured to become stationary, then it might be required to protect the area in rear of the train which has lost integrity.

If Propagation is applied, there will also need to be configurable parameters to define the extent of the propagation.

D5.1 Requirements: REQ-TrackStatus-9; REQ-HO-2

ENG-LossTI-3

The Infrastructure Manager shall configure the L3 Trackside to accept confirmation of integrity by the Driver if this is required by the project.

Rationale:

Confirmation of integrity by the Driver introduces risk into the L3 System, in terms of both the risk of the Driver preforming the procedure and the risk of it being confirmed incorrectly. The L3 Trackside is specified to either accept or ignore integrity confirmation by the Driver. This must be configured on a project by project basis.

Guidance:

None.

D5.1 Requirements: REQ-LossTI-9; REQ-FirstMA-2

ENG-LossTI-4

The Infrastructure Manager shall configure whether the L3 Trackside authorises a Movement Authority for a train reporting ‘loss of integrity’ or ‘No integrity information available’ in excess of a period of time.

Rationale:

Movement of a train without integrity within the L3 area could have significant impact on the operational availability. In some situations however it may be required, for example to move a train without integrity into a siding.

Guidance:

The implementation of CR940 means that position reports may contain "No integrity information available" and a reaction is only required if sufficient time elapses between reports with integrity confirmed.

D5.1 Requirements: REQ-LossTI-10; REQ-FIrstMA-2

ENG-LossTI-5

The reaction the L3 Trackside takes when a train reports loss of integrity shall be engineered according to project specific requirements.

Rationale:

Depending on project specific requirements, the L3 Trackside can be configured to take a safe reaction including: update the MA, allow the train to reach the end of the MA without extending it, stop the train, protecting other movements, etc.

Guidance:

In considering whether to send an emergency stop message the movement of the train should be considered and whether passengers or staff may be exposed to risk due to an emergency stop or collision of the divided parts of the train. In particular sending an emergency stop message should be avoided if the train is in RV to escape a, potentially, greater hazard.

D5.1 Requirements: REQ-LossTI-4

7.16 Recovery

7.16.1 Introduction

When trains fail, they may not be able to communicate their position and integrity status. If they are rescued by other trains, then the ETCS Train Data may not be complete, leading to the L3 Trackside being unable to determine when the railway is Clear. Non-harmonised Operational Rules will be required to manage the rescue of failed trains.

7.16.2 Rules

ENG-REC-1

The L3 Trackside shall be engineered to either:

a) Automatically extend a Movement Authority into Unknown Areas

or

b) require confirmation via the Traffic Management System before extending a Movement Authority into Unknown Areas

Rationale:

This functionality enables the L3 Trackside to automatically authorise trains to sweep Unknown Areas, thus improving availability of the railway and minimising the workload of the Dispatcher. However, for some railways this functionality may not be desirable as authorisation by a Dispatcher may be preferred.

Guidance:

Each Infrastructure Manager must decide, in conjunction with the Railway Undertakings, which option should be chosen. This may be affected by whether TTD is provided. In some countries drivers are expected to accept an On Sight movement authority and drive cautiously checking for vehicles or other significant obstructions without having been previously advised. Other countries require the Driver to be aware of reason for the On Sight movement authority due to knowledge of the timetable, verbal communications, text messages or other means.

D5.1 Requirements: REQ-MA-9

7.17 SR Movement

7.17.1Introduction

There are scenarios where it may be necessary to move a train in SR mode. For example, if a train does not have a valid position, it will be necessary to let that train move so that it can determine a valid position. Another possible scenario is when a train has a valid position but cannot obtain a Movement Authority and it is necessary to move the train.

The Dispatcher will be requested to validate or enter the value of SR distance. A maximum permitted SR distance should be configured to ensure that the SR distance provided to the train is safe.

7.17.2Rules

ENG-MovSR-1

The Infrastructure Manager shall determine the maximum SR Distance permitted.

Rationale:

SR Mode is required in order to move non-communicating trains, or trains without a valid location. All train movements in SR must be protected. Some Infrastructure Managers may determine that limiting the SR Distance reduces risk of operational errors.

Guidance:

The operational advantage of moving trains in SR is that it is possible to move trains in degraded situations. Long SR distance authorisations may increase the risk of operational errors.

D5.1 Requirements: REQ-MovSR-~~21~~; REQ-MovSR-~~32~~; REQ-Reserved-1

8 Future Work

The following items have been identified as part of the work as requiring further work in X2RAIL-3.

8.1 Harmonisation of Operational Rules

The Operational Rules in this deliverable were identified from the development of System Requirements and in response to Hazards identified.

Due to the variations in operational practices of the Railways it was not possible to identify a single way of working that was acceptable to all the members.

The consequence is that for over 90% of the areas identified as requiring operational rules the solution will be non-harmonised.

It is proposed that during X2RAIL-3, WP4 will engage with the Operational Rules Harmonisation Group seeking to enhance the Appendix to the OPE TSI.

8.2 Engineering of margins

During this project phase there have been many discussions about the parameters to be considered when calculating the Safety Margin. This has principally taken place as part of the development of the System Requirements.

Following these discussions, it was also mentioned that in some instances the Margin had a safety origin, whereas in other scenarios it provides for performance or operational stability. The margin is not always needed and, thus, it is completely dependent on the specific situation.

Trying to close the pending open points regarding this function, some more work will be done during next project phase including the following tasks:

a) Identify the scenarios where a margin is needed and its rationale

b) Perform an assessment about the parameters that could be useful to consider for each situation previously identified

c) Develop Engineering Rules to support Infrastructure Manager in engineering the (safety) margins.

8.3 Propagation of Unknown areas

When the communication session with a train is terminated the L3 Trackside has no knowledge of any future movements of the train. As time progresses the certainty that the train has not moved/been moved reduces and it may be necessary to take precautions.

The rules for applying propagation and supporting rationale will be developed as part of future work.

9 Conclusions

This Deliverable covers the identified Operational and Engineering Rules arising from the identification of the System Requirements and the Preliminary Hazard Analysis.

The majority of the Operational Rules are marked as “non-harmonised”. A future workstream is proposed to work with other groups to harmonise the Operational Rules with a view to inclusion within Appendix A of the OPE TSI. The Engineering Rules have been derived to address configuration or engineering needs to support the System Requirements. The guidance for each of the rules will need to be expanded once further analysis on the requirements has been undertaken as part of future work.

As previously stated, the content of this Deliverable should not be applied without further analysis and development. The proposed work in X2RAIL-3 is intended to complete the development of the rules.

10 References

[OPE TSI] Commission Regulation (EU) 2015/995, of 8 June 2015, concerning the technical specification for interoperability relating to the 'operation and traffic management' subsystem of the rail system in the European Union.

[CCS TSI] TSI Commission regulation (EU) 2016/919, of 27 May 2016, on the technical specification for interoperability relating to the 'control-command and signalling' subsystems of the rail system in the European Union.
Set of specifications # 3 (ETCS baseline 3 and GSM-R baseline 1).

This set of specifications is colloquially referred to as "Baseline 3 Release 2".

[GLO] X2Rail-1 Integrated Glossary.

[SS026] Subset 26, ETCS System Requirements, see [CCS TSI] for version.

[SS040] Subset 40, Dimensioning and Engineering Rules, see [CCS TSI] for version.

[SS091] Subset 91, Safety Requirements for the Technical Interoperability of ETCS in Levels 1 & 2, see [CCS TSI] for version.

[D2.1] X2Rail-1 Deliverable D2.1 "Reference Architecture"
This was developed by X2Rail-1 WP2.

[D5.1] X2Rail-1 Deliverable D5.1 "Moving Block System Specifications".

[D5.3] X2Rail-1 Deliverable D5.3 "Moving Block Preliminary Safety Analysis".

[D5.4] X2Rail-1 Deliverable D5.4 "Moving Block Application Report".

[NGTCD5152] "D5.1 Moving Block Principles"
"D5.2 Validation of Moving Block Principles"
Deliverables from EU project: Next Generation of Train Control systems
Seventh Framework Programme EC Contract Number: FP7 605402