X2Rail-3

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Deliverable D4.2

Moving Block Specifications

Part 3 – System Specification

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1 Background

The present document constitutes Deliverable D4.2 “Moving Block Specifications” in the framework of the Project titled “Advanced Signalling, Automation and Communication System (IP2 and IP5) – Prototyping the future by means of capacity increase, autonomy and flexible communication” (Project Acronym: X2Rail-3; Grant Agreement No 826141).

This deliverable is made up of several different parts.

This is Part 3 – System Specification. See Part 1 – Introduction for a list of the different Parts of this Deliverable.

This part contains requirements for the L3 Moving Block System. Most of these requirements are for the L3 Trackside. Many of these requirements are concerned with Track State. There is an introduction to Track State concepts in Section 2.2 below.

2 System Context

2.1 Scope

The scope of D4.2 is defined in Part 2 System Definition. This section provides an introduction to specific topics which are important to understanding of the Requirements contained within Part 3.

2.2 Track State

2.2.1 Introduction

An important feature of ETCS Level 3 is that the Track State is determined primarily based on Train Position Reports, compared with Trackside Train Detection (TTD) in traditional signalling systems and systems based on ETCS Level 1 or 2.

The L3 Trackside needs to have accurate and up to date information about the Track State for its complete Area of Control, in order to be able to authorise train movements in a safe way.

In order to achieve this, the L3 Trackside will need to store information regarding Track State. For example, if a train changes to NP mode, and therefore stops communicating with the L3 Trackside, the train is still present and still represents an obstruction on the railway.

A corollary of the above is that there must also be Operational Rules which prevent the movement of non-communicating railway vehicles without protection being in place within the L3 Trackside, unless the system is specifically engineered to be used by non-communicating trains, for example by using Trackside Train Detection.

The Track State is made up of Track Status and Reserved Status. The relationships are shown in Figure 1 below, with further descriptions in following subsections:

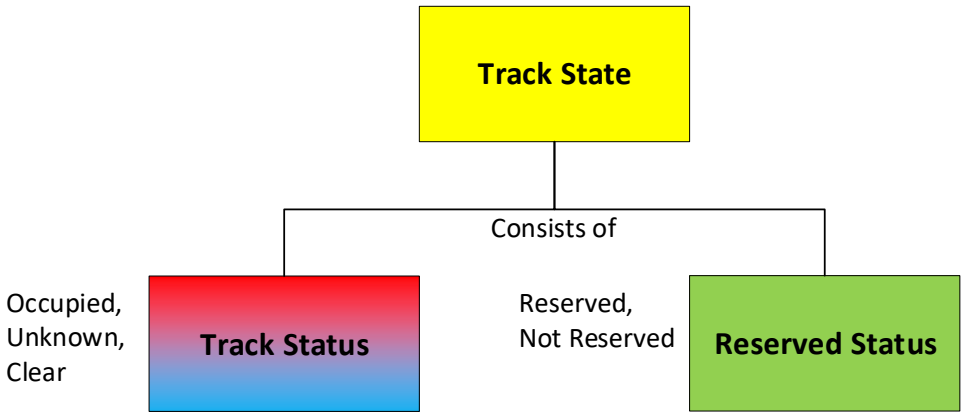

Figure 1: Track State components

A number of diagrams are used to explain the functionality of the L3 Trackside, Table 2 gives a key to the symbols used:

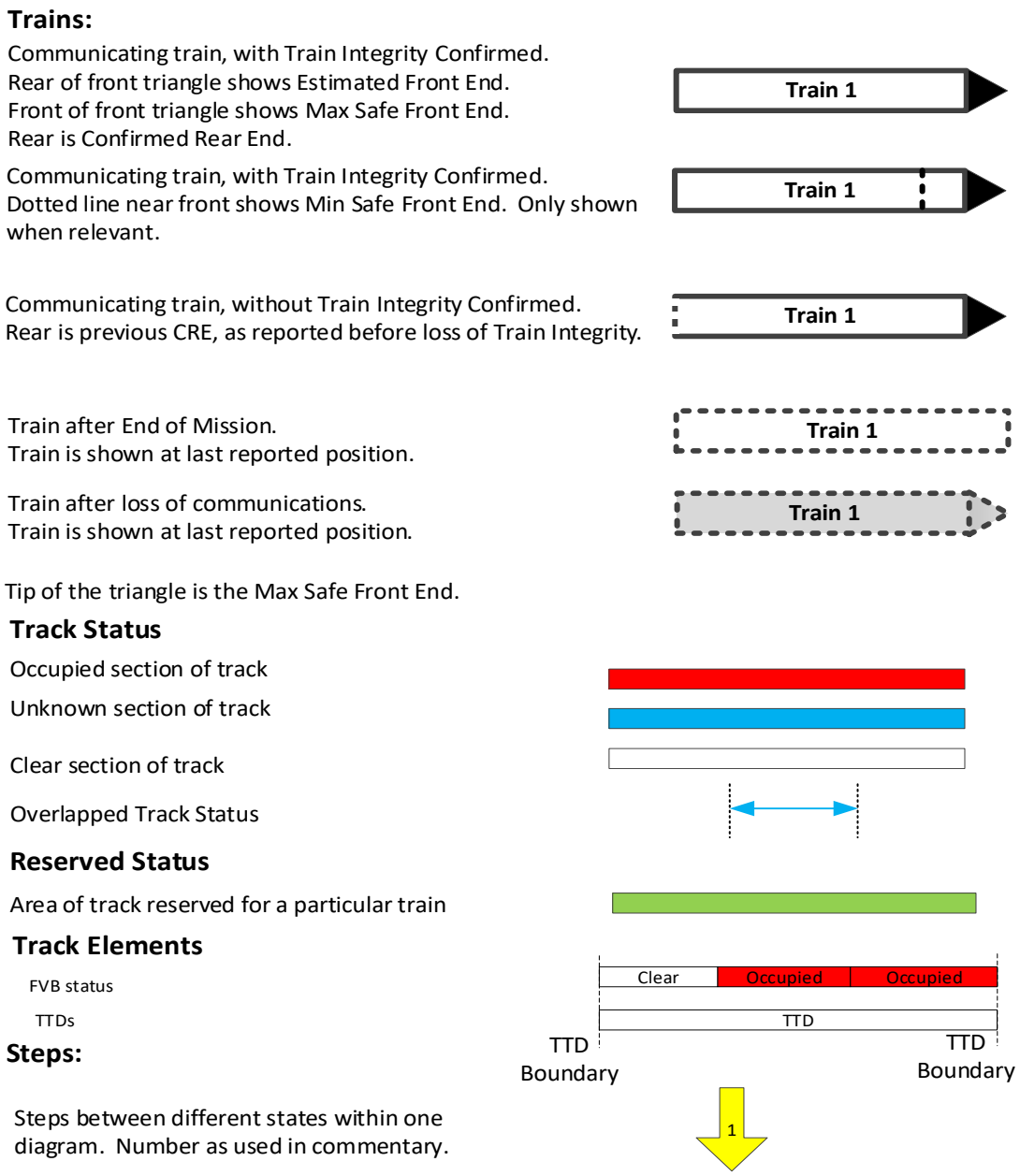

Figure 2: Key to diagrams

2.2.2 Track Status and Reserved Status

The Track State is made up of two components:

1. **Track Status**
   This represents the information held within the L3 Trackside about whether track is occupied or not. Any area of the track within the L3 Trackside Area of Control can be:
   - **Occupied** The L3 Trackside considers that there is an obstacle on the track consisting of a communicating train with Train Integrity confirmed.
   - **Clear** The L3 Trackside considers that there are no obstacles present on the track.
   - **Unknown** The L3 Trackside is unsure whether there is a train or obstacle present on the track, or sure that there is a train, but does not know the location of the train within the Unknown area.
2. **Reserved Status**
   This represents the information held within the L3 Trackside about whether track is reserved for a train or not. If any part of the track within the L3 Trackside Area of Control is reserved for a train the Reserved Status is Reserved.

Track Status and Reserved Status are independently determined by the L3 Trackside.

- Track Status is determined from Train Position Reports, together with other inputs from the TMS, and from TTD if TTD is used.
- Reserved Status is determined in response to a request to permit a train to move or if there is a need to extend or shorten the path assigned to a train.

2.2.3 Track Status and Reserved Status in Full Moving Block

In a system using Full Moving Block (FMB), for a train reporting Train Integrity confirmed:

- The Track Status Area for a train is from the Maximum Safe Front End (MSFE) of the train to the Confirmed Rear End (CRE) of the train.
- The Reserved Status Area for a train is from the Maximum Safe Front End (MSFE) of the train up to the end of the area reserved for the train within the L3 Trackside.

In this document, the MA for a train is always shown up to the end of the Reserved Status Area for the train. In practice, for example because of limitations in the size of MAs, the MA may not extend to the end of the Reserved Status Area.

The Track Status Area for a train represents the area where the train could be, at the time of the most recent Train Position Report as shown in Figure 3:

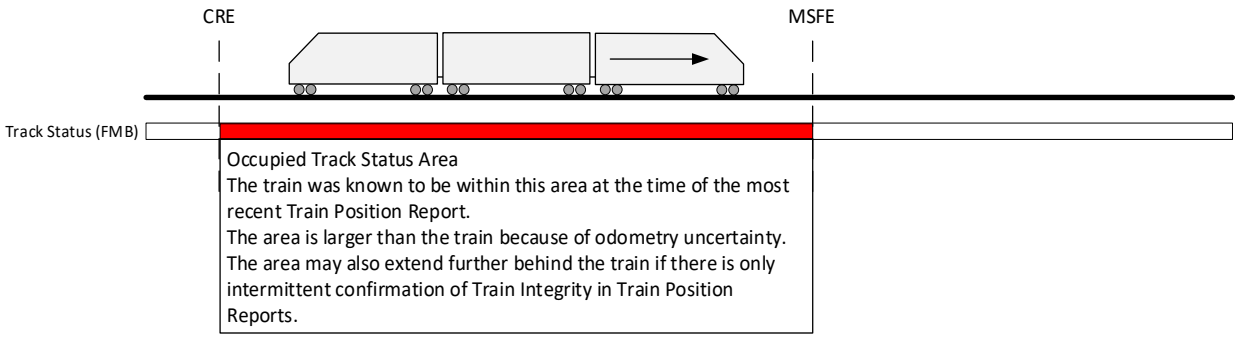

Figure 3: Full Moving Block Track Status Area for a train

The Reserved Status Area for a train represents the area into which the train is authorised to move, as shown in Figure 4:

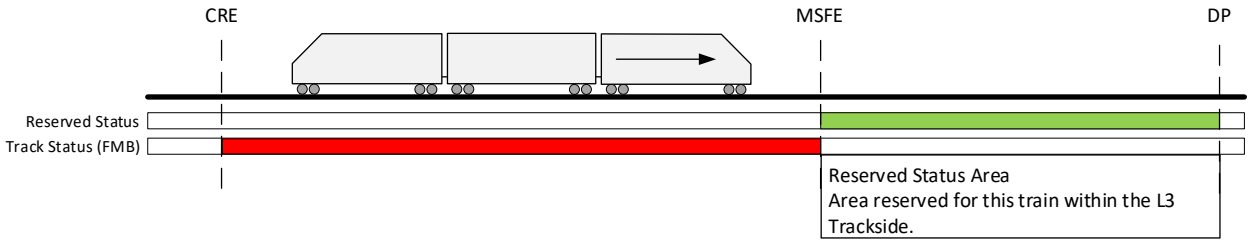

Figure 4: Full Moving Block Reserved Status Area for a train

Together, the Track Status Area and the Reserved Status Area represent the area of the railway where a train is expected to be, as shown in Figure 5:

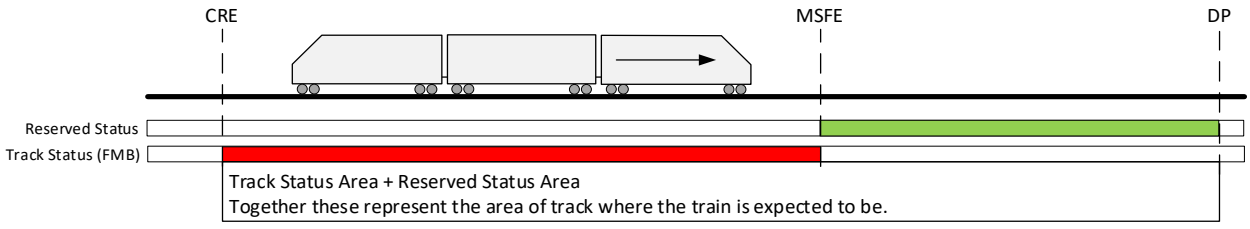

Figure 5: Full Moving Block Track Status and Reserved Status Areas for a train

The rear of the Reserved Status Area will be at the front of the Track Status Area associated with that train, as shown in Figure 5. The handling of Reversing Areas is an exception to this rule – see section 3.15.

The Track Status Area could be Occupied, as shown, or could be Unknown, for example if the train has lost Train Integrity.

2.2.4 Track Status and Reserved Status in Fixed Virtual Blocks

In a system using Fixed Virtual Blocks (FVB), each Fixed Virtual Block will have a Status Occupied, Unknown or Clear. Track Status is mapped on to Fixed Virtual Blocks.

- The Fixed Virtual Blocks with Status “Occupied” for a train will be from the Fixed Virtual Block containing the Maximum Safe Front End (MSFE) of the train up to the Fixed Virtual Block containing the Confirmed Rear End (CRE) of the train.

The Occupied Fixed Virtual Blocks for a train represent the area where the train could be, at the time of the most recent Train Position Report, as shown in Figure 6:

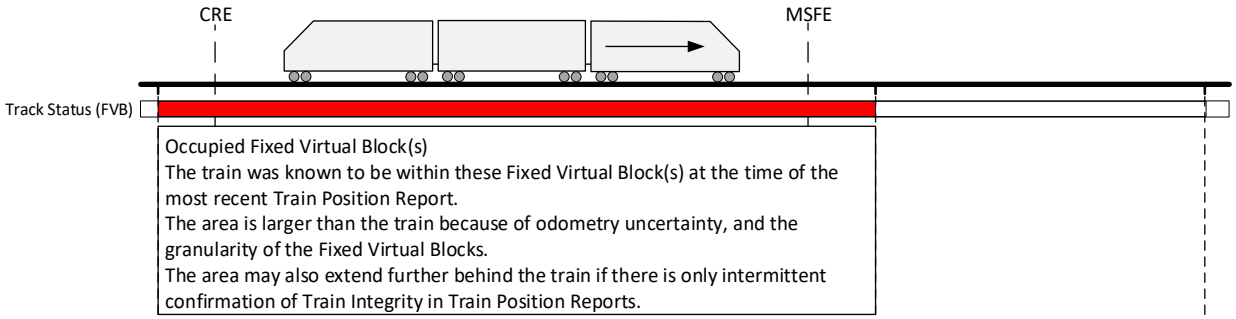

Figure 6: Fixed Virtual Block Track Status Area for a train

The Reserved Status Area for a train represents the area into which the train is authorised to move, as shown in Figure 7:

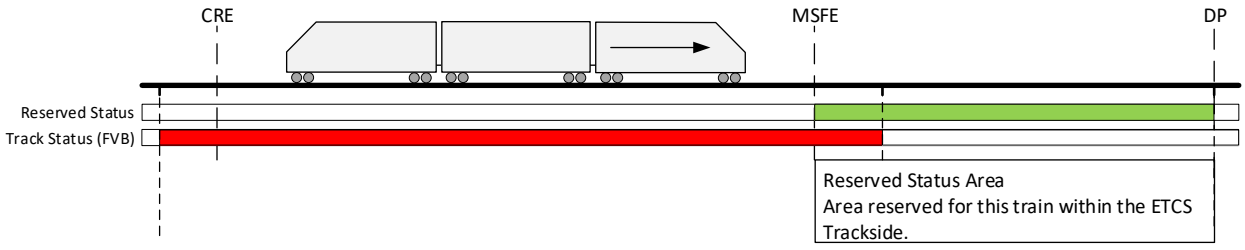

Figure 7: Fixed Virtual Block Reserved Status Area for a train

Together, the Occupied Fixed Virtual Blocks and the Reserved Status Area represent the area of the railway where a train is expected to be, as shown in Figure 8:

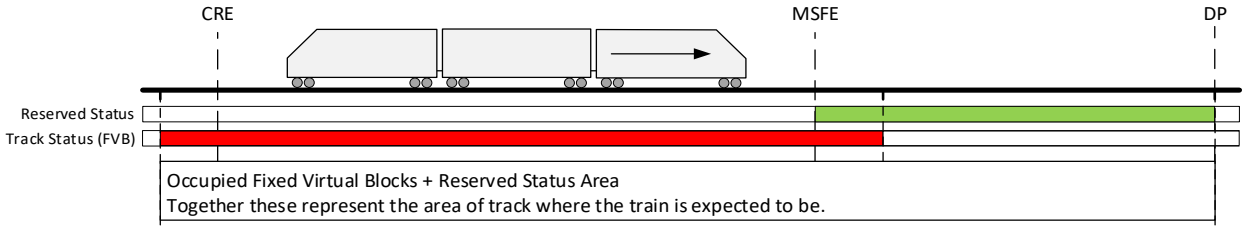

Figure 8: Fixed Virtual Block Track Status and Reserved Status Areas for a train

Reserved Status is not mapped on to Fixed Virtual Blocks. The rear of the Reserved Status Area for a train will be at the Max Safe Front End of the train. As a result, there will be an overlap between the Fixed Virtual Blocks with Status "Occupied" for a train, and the Reserved Status Area for a train, as shown in Figure 7 and Figure 8. The handling of Reversing Areas is an exception to this rule – see section 3.15.

The Status of the Fixed Virtual Blocks could be Occupied, as shown, or could be Unknown, for example if the train has lost Train Integrity.

2.2.5 Determination of Track Status

Track Status can be considered as a collection of Track Status Areas, each of which can be Occupied or Unknown. Any area of track which is not covered by a Track Status Area, Occupied or Unknown, is Clear. An Occupied Track Status Area is always for a specific train. An Unknown Track Status Area may be for a specific train, but may also be for another reason, not associated with a specific train, such as an Unknown Track Status Area created by the Dispatcher, or an Unknown Track Status Area corresponding to an Active Temporary Shunting Area. An Unknown Track Status Area created by the Dispatcher can be Sweepable or Non-Sweepable.

There is only one reason for an Occupied Track Status Area, as shown in Table 1:

Track Status Area Occupied Reason	Notes	Section(s) for Requirements
Reporting train with Train Integrity confirmed	L3 Trackside has received at least one Train Position Report, with Train Integrity Confirmed.	Section 3.1 Section 3.2

Table 1 – Track Status Area Occupied Reasons

There are several reasons for an Unknown Track Status Area, as shown in Table 2:

Track Status Area Unknown Reasons	Notes	Section(s) for Requirements
Reporting train without Train Integrity confirmed	L3 Trackside has received at least one Train Position Report, with Train Integrity is lost, or Train Integrity has never been confirmed.	Section 3.17 Section 3.9
Train is no longer in communication	L3 Trackside was receiving Train Position Reports, but is no longer doing so, and so the train is treated as having lost communications	Section 3.12 Section 3.14
Train has performed End of Mission	L3 Trackside has received an End of Mission message	Section 3.16
Unknown area created via TMS	The Dispatcher has created an Unknown Track Status Area via the TMS. Can be Sweepable or Non-Sweepable	Section 3.2
Unknown Area created by L3 Trackside at Initialisation	At initialisation of the L3 Trackside, the complete Area of Control is Unknown	Section 3.19
Occupied TTD with no Train Position Report	Optionally, a TTD input is Occupied, but there is no corresponding Train Position Report	Section 3.5
Active Shunting Area	All track within an Active Shunting Area is Unknown	Section 3.21

Table 2 – Track Status Area Unknown Reasons

The individual Track Status Areas can overlap with each other, and are created, modified, or removed according to several different inputs to the L3 Trackside. Table 3 summarises the main inputs and their effect:

Source of Input	Input	Effect	Section(s) for Requirements	Notes
Responsible Person	Confirms initialisation completed	Remove Unknown Areas created at Initialisation	Section 3.19	Can be input via TMS
TMS	Create Unknown Area	Create Unknown Area	Section 3.2	Can be Sweepable or Non-Sweepable

Source of Input	Input	Effect	Section(s) for Requirements	Notes
TMS	Modify Unknown Area	Modify Unknown Area	Section 3.2	Can extend or reduce Unknown Area
TMS	Remove Unknown Area	Remove Unknown Area	Section 3.2	
TMS	Activate Temporary Shunting Area	Create Unknown Areas covering the Active Shunting Area	Section 3.21	
TMS	Deactivate Temporary Shunting Area	Remove Unknown Areas created for Active Shunting Area	Section 3.21	
TMS	Active Predefined Radio Hole	Active Radio Hole	Section 3.14	A train within an Active Radio Hole for longer than the defined time is treated as for loss of communications
TMS / Responsible Person	Supply location for train	Possibly modify Unknown Track Status Area	Section 3.9	Reaction will depend on whether location supplied for train is within an existing Unknown area, or not.
TMS	Authorised override of TTD	Remove Unknown which has been created because of an Occupied TTD without a corresponding Train Position Report.	Section 3.5	

Source of Input	Input	Effect	Section(s) for Requirements	Notes
Train	New Validated Train Data message	Potentially update Track Status Area for train	Section 3.17	A change in the value of L_TRAIN is treated as Loss of Train Integrity
Train	Start of Mission Train Position Report	Create Track Status Area for train	Section 3.9	
Train	New Train Position Report	Update Track Status Areas for the train which reported it position or for a different train	Section 3.1 Section 3.2 Section 3.17	• See Section 3.17 for rules around Loss of Train Integrity • New Train Position Report can “sweep” Unknown Track Status Areas.
Train	End of Mission Train Position Report	Change Track Status Area associated with this train to Unknown	Section 3.16	
L3 Trackside	Communications Timeout	Change Track Status Area associated with this train to Unknown and extend it to cover corresponding Reserved Status Area	Section 3.12	Two levels of timeout, depending if Communications Mute Timer is used.

Source of Input	Input	Effect	Section(s) for Requirements	Notes
TTD	TTD State	1) Adjust Track Status Area for trains partially within Clear TTD. 2) If there are no trains reporting within Occupied TTD it is optional to create Unknown Track Status Area	Section 3.5	
External device	External device e.g. Landslide detector of fallen objects detector	Create an Unknown Track Status Area	Section 3.5	

Table 3 – Inputs for Track Status Areas

The L3 Trackside will use rules to create a “Consolidated Track Status” which takes account of the overlapping Track Status Areas created from different sources, as shown in Figure 9:

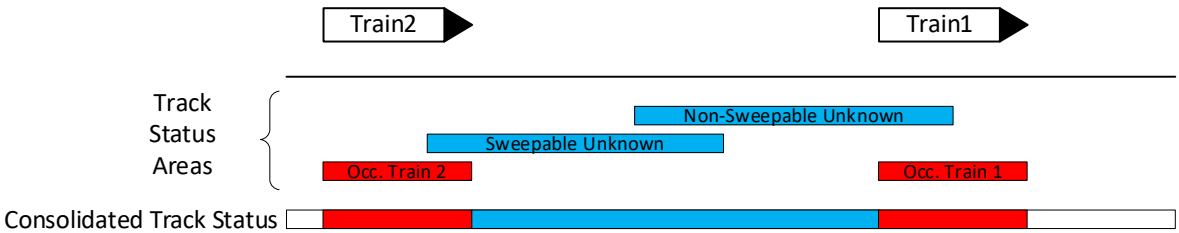

Figure 9: Full Moving Block Consolidated Track Status

The requirements to create the Consolidated Track Status are in section 3.2.

If Fixed Virtual Blocks are used, the L3 Trackside will use rules to map the “Consolidated Track Status” onto the Fixed Virtual Blocks, as shown in Figure 10:

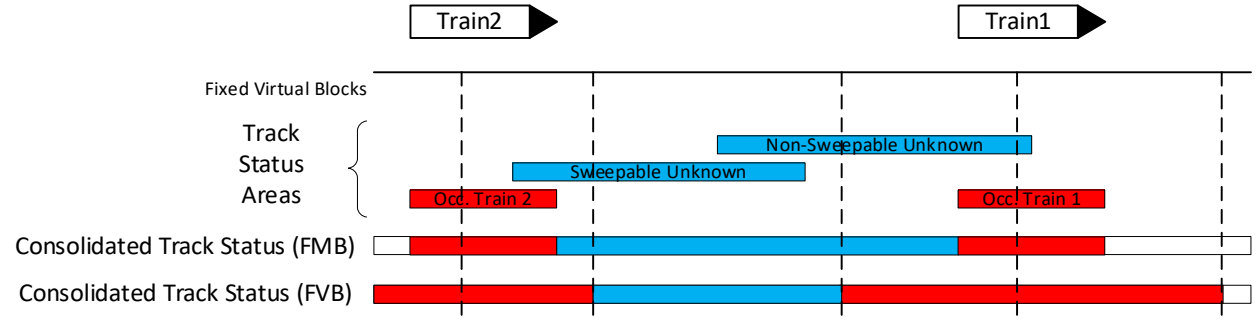

Figure 10: Fixed Virtual Block Consolidated Track Status

The requirements to map Track Status onto Fixed Virtual Blocks are in section 3.2.

2.2.6 Data Stored for Track Status Areas

The L3 Trackside will store data for each Track Status Area as in Table 4:

Data Item	Type or Possible Values	Notes
Status	Occupied, Unknown	Clear areas of track are where there are no areas of Occupied or Unknown
Extent	Definition of the extent of the Track Status Area	The extent of the Track Status Area, consisting of a start point, an end point, and the path from start point to end point. An exception to the rule is the Shunting Areas which can be more complex than a path.
TrainLength	As for L_TRAIN	The length of train associated with this area, if any. Note this is not the same as the length of the Extent of the Track Status Area.
Train ID	As for NID_ENGINE	The NID_ENGINE of train associated with this Track Status Area, if any.
ReasonUnknown	List of possible reasons for Unknown	The reason for the Unknown Track Status Area, if the Status is Unknown. See Table 2

Data Item	Type or Possible Values	Notes
Sweepable	Boolean	Whether an Unknown Track Status Area is Sweepable or Non-Sweepable.

Table 4 – Data Stored for Track Status Areas

2.2.7 Determination of Reserved Status

Reserved Status can be considered as a collection of Reserved Status Areas. A Reserved Status Area is always for a specific train, even if the Train ID is not yet known, e.g. at transition.

There are three reasons for a Reserved Status Area to exist, listed in Table 5:

Reserved Status Area Reasons	Notes	Section(s) for Requirements
The L3 Trackside will issue an SR Authorisation to a train	Can be for a train with or without a known location.	Section 3.3 Section 3.10
The L3 Trackside will issue a new or extended Movement Authority to a train	Can include an On-Sight Mode Profile, which can overlap Track Status Areas which are Unknown or Occupied	Section 3.3
The L3 Trackside may retain a Reserved Status Area behind a train in a Reversing Area	A train within a Reversing Area may be authorised to reverse, so that area should not be made available to other trains.	Section 3.15

Table 5 - Reserved Status Area Reasons

The individual Reserved Status Areas can overlap Track Status Areas which are Unknown or Occupied. Reserved Status Areas do not overlap with each other.

Reserved Status Areas are created or extended in response to a request to permit a train to move, for example if an MA Request is received from a train. Reserved Status Areas can be reduced following a request to shorten an authorisation, for example if there is a co-operative shortening of a Movement Authority. Table 6 summarises the Reserved Status Area functions:

Input from L3 Trackside	Effect	Section(s) for Requirements	Notes
Create Reserved Status Area	Create new Reserved Status Area	Section 3.3 Section 3.7 Section 3.11	Required for first MA, or to create SR Authorisation
Update Reserved Status Area	Update rear of existing Reserved Status Area	Section 3.3 Section 3.15	In most situations, the rear of the Reserved Status Area is updated when a new Train Position Report is received. There is an exception (if configured) for Reversing Areas, where it might not be updated until the train has left the Reversing Area.
Extend Reserved Status Area	Update front of existing Reserved Status Area	Section 3.3 Section 3.7	Reserved Status Area can be extended as required. This could be up to the next obstruction.
Reduce Reserved Status Area	Update front of existing Reserved Status Area or the rear if using the optional Reserved Status Area for Reversing	Section 3.3	Reserved Status Area can be reduced e.g. if an MA is shortened
Remove Reserved Status Area	Remove existing Reserved Status Area	Section 3.12 Section 3.16	Applies at End of Mission, and at Loss of Communications if the ETCS session is lost. May also apply if a train is re-routed.

Table 6 - Reserved Status Area Functions

Any area of track which is not covered by a Reserved Status Area is Not Reserved.

2.2.8 Data Stored for Reserved Status Areas

The L3 Trackside will store data for each Reserved Status Area as in Table 7:

Data Item	Type or Possible Values	Notes
Extent	Definition of the extent of the Reserved Status Area	The extent of the Reserved Status Area, consisting of a start point, an end point, and the path from start point to end point.
Train ID	As for NID_ENGINE	The NID_ENGINE of train for which the Reserved Status Area is reserved in case there is a NID_ENGINE associated to the area.

Table 7 – Data Stored for Reserved Status Areas

2.3 Margin

Within a Moving Block Signalling System, it is a key objective that one train may follow another. The Movement Authority for a following train can be up to the rear of the preceding train:

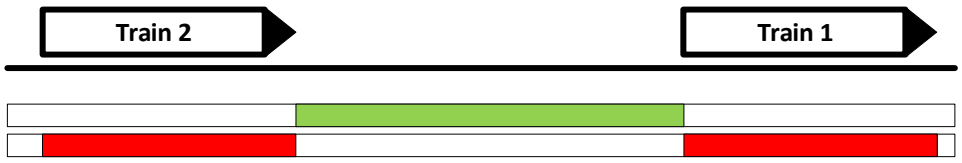

Figure 11: One Train Following Another – Full Moving Block

This also applies within a Fixed Virtual Block system, where the Movement Authority for a following train can be up to the boundary of the Fixed Virtual Block occupied by a preceding train:

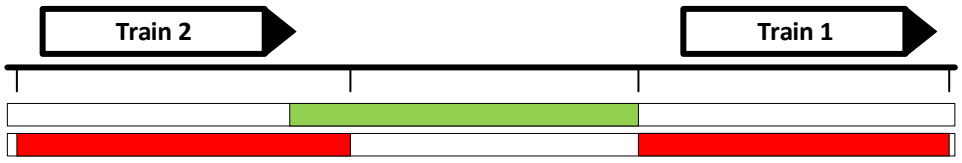

Figure 12: One Train Following Another – Fixed Virtual Blocks

It is necessary to ensure that the risk of collision is sufficiently mitigated, including if the preceding train is stopped, or even rolling backwards.

The requirements in section 3.7 regarding the issuing of Movement Authorities make use of the concept of an “L3 Margin”. This will be a distance defined when the system is engineered, and then used by the L3 Trackside when issuing Movement Authorities.

In the case where one train is following another, the L3 Margin will be used within the L3 Trackside as follows:

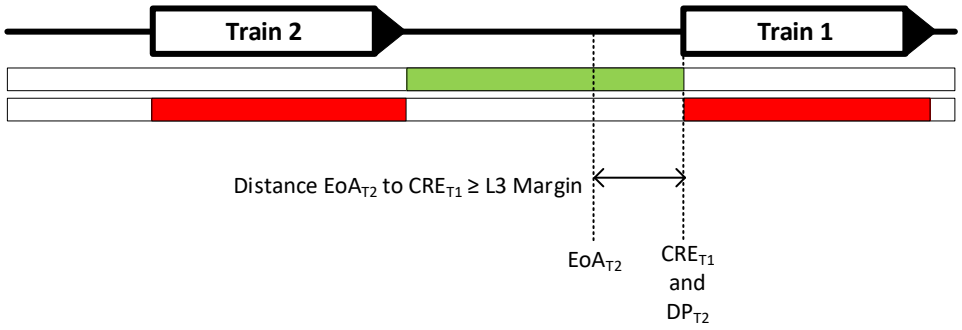

Figure 13: Use of L3 Margin

The risk of collision is not fully mitigated. However, for there to be a collision, two failures are required:

1) Train 1 is rolling or has rolled backwards and overpassed the CRE
2) Train 2 overpasses the End of Authority given via a Movement Authority

Even if both occur, the trains may not collide depending on how far they go beyond the EOA/CRE and if this is in total more than the L3 Margin.

There are additional mitigations:

1) The odometry uncertainty will make it unlikely that Train 2 approaches exactly up to the End of Authority, and so unlikely that Train 2 overpasses its End of Authority
2) If Train 1 is a reporting train, as shown, then it will send Train Position Reports indicating that it has moved backwards into the Movement Authority of Train 2. The L3 Trackside shall react to this situation, for example by shortening the Movement Authority of Train 2.

There is an Engineering Rule in Part 5, which requires that the value of L3 Margin is engineered. There is associated Guidance with that Engineering Rule.

2.4 Propagation

The concept of Propagation is based on the idea that an area of track with Unknown Track Status may need to increase, possibly after a period of time, to allow for the fact that any railway vehicles in the area which is Unknown may move without knowledge of the L3 Trackside system.

Within a traditional signalling system, with 100% Trackside Train Detection (TTD), any movement which crosses a TTD boundary is likely to be detected. Without TTD, movements of non-reporting rail vehicles will not be detected by the L3 Trackside.

For stationary vehicles, the period of time before propagation is applied could be associated with the length of time for which railway vehicle brakes can be expected to remain active, and so keep the vehicle(s) stationary.

There are no requirements for the propagation of Unknown Track Status, for example following End of Mission, or following Loss of Train Integrity. The rationale for this is:

1) In places where vehicles are regularly parked, for example in sidings, there may be other measures to prevent rolling vehicles moving such that they are in conflict with other movements.
   For example, this might include the use of trap points, or of derailers.

2) In places where vehicles are regularly stationary, for example in stations, there may be other measures to detect and mitigate the effect of rolling vehicles, for example by the use of Trackside Train Detection in station areas.

If these measures are used, there is no additional requirement to use Propagation as a mitigation against collision.

If hazard analysis on a particular railway identifies that the remaining risk of unexpected vehicle movement causing a collision is still not acceptable, then the L3 Trackside system can include a Propagation algorithm. However, it should be noted that:

- propagation may not provide full mitigation. A moving vehicle may not follow any propagation algorithm which is defined. For example, a moving vehicle might move before any timer defined in a propagation algorithm has elapsed, or might move further than any distance limit defined in a propagation algorithm.

- propagation may unduly impact railway operations.

3 System Requirements

This chapter provides System Requirements for an ETCS Level 3 Moving Block system based on Baseline 3 Release 2 [BL3 R2] with Change Request 940 [CR940], where these requirements are in addition to the requirements for an ETCS Level 2 system.

The chapter is structured into different high-level topics relevant to the operation in ETCS Level 3. The following sub-sections contain an overview of the system functionality and the detailed system requirements.

The first sub-sections contain generic requirements, relevant in all operational scenarios, listed in Table 8:

Sub-Section	Notes
3.1 Train location	Requirements for the processing of Train Position Reports to determine Train Location
3.2 Track Status	Requirements for the determination of Track Status Occupied / Clear / Unknown
3.3 Reserved Status	Requirements for Reserved status for areas where trains are authorised to run
3.4 Fixed Virtual Blocks	Additional requirements for systems using Fixed Virtual Blocks
3.5 Trackside Train Detection	Additional requirements for systems using Trackside Train Detection

Table 8 – Structure of Requirements

The terms defined in these first sub-sections are then used in the remainder of the document.

Later sub-sections contain requirements relevant to specific operational scenarios or degraded modes.

Each requirement has been structured in four different parts:

- ID: each item is given a Unique Id, structured as follows:
  <Type>-<Section>-<Number>
  where:
  <Type> is “REQ” for this part of D4.2
  <Section> is an abbreviation within the document for a section of requirements
  <Number> is a number unique to the document section
- Requirement: this is the text of the requirement to define the system behaviour
- Rationale:
  this is the reasoning explaining why and in which situations this requirement is needed
- Guidance:
  this is a proposal for the requirement implementation or other aspects to be considered during its implementation. The Guidance is not mandatory.

Requirements which are in blue text like this paragraph are related to proposed changes defined within the companion Deliverable D4.3 Future Moving Block Architectures [X2R3-D4.3]. Therefore they are not applicable, only suggestions for future improvements.

3.1 Train location

3.1.1 Introduction

This section contains requirements relating to the processing of Train Position Reports by the L3 Trackside, in order for the L3 Trackside to determine the location of trains within its Area of Control and associating each of them with a Track Status Area being either Occupied or Unknown.

During normal operation trains are located by position reports received by the L3 Trackside. As such, there is a fundamental principle:

> *The L3 Trackside must be aware of all locations that are potentially occupied by rail vehicles*

For the purposes of L3, a Ghost Train is defined as follows:

> *A Ghost Train is a Railway Vehicle within the Area of Control, which is not known to the L3 Trackside.*

The L3 Trackside will be responsible for maintaining knowledge about the location of all Rail Vehicles within the Area of Control. This means:

a) Interpreting Train Position Reports, to determine the area of railway occupied by each train, taking account of the information in the Train Position Report regarding Train Integrity status, and Train Length

b) Maintaining records of locations of trains which perform an End of Mission within the Area of Control, or which otherwise cease to communicate with the L3 Trackside.

A train has a Known Location within the L3 Trackside if:

a) The L3 Trackside has received a Train Position Report with LRBG not set to “Unknown”
b) The L3 Trackside recognises the LRBG received in the Train Position Report from configuration data
c) The L3 Trackside has derived an unambiguous location from the Train Position Report data

3.1.2 Requirements

REQ-TrainLoc-1 [X2R1 D5.1: REQ-TrainLoc-1]

The L3 Trackside shall determine and retain the location of all trains within its Area of Control.

Rationale:

It is critical that within a L3 System where the means of locating trains is via Train Position Reports, the L3 System maintains a record of the locations of trains within its Area of Control. This is required in order for the L3 Trackside to be able to authorise train movements.

Guidance:

Reporting trains will provide their location through Train Position Reports. This does not prevent other systems providing additional information on train location such as TTD.

This requirement implies the retention of information about trains which have ceased communications within the Area of Control.

In order to meet this requirement, extra considerations will be required

- at the boundaries of the Area of Control. See section 3.18 Level Transition and section 3.20 Handover
- when trains are joined and split. See section 3.22 Joining and section 3.23 Splitting
- for a train inside a Radio Hole. See section 3.14 Radio Hole

Operational Rules: None

Engineering Rules: None

REQ-TrainLoc-2 [X2R1 D5.1: REQ-TrainLoc-10]

The L3 Trackside shall report the Train Location and status for all trains within its Area of Control to the Traffic Management System.

Rationale:

This is to provide the Traffic Management System with information about the location of trains and their status so that Dispatchers can be aware of them.

Guidance:

In any exchange of information with the TMS, the L3 Trackside shall include the Train ID so that the train can be identified.

The Status of trains can consist of the following information (though information provided are application specific):

- Train Speed
- Mode
- Train Integrity status.

The Dispatcher will use the reported information to decide upon subsequent action to take in normal and degraded operations. The action taken is project specific, this may include:

- routing a train to a different destination, e.g. to a siding
- not allowing a train to enter the L3 area, e.g. train without Train Integrity
- instruct the L3 Trackside to authorise/not authorise a train to move.

Operational Rules: None.

Engineering Rules: None.

REQ-TrainLoc-3	[X2R1 D5.1: REQ-TrainLoc-2]

The L3 Trackside shall consider the Train Location to be from the Max Safe Front End to the Confirmed Rear End of the train.

Rationale:

This is to determine the Train Location of the train, from the Trackside point of view.

Guidance:

Figure 14 defines Max Safe Front End and Confirmed Rear End based on the parameters within a Train Position Report:

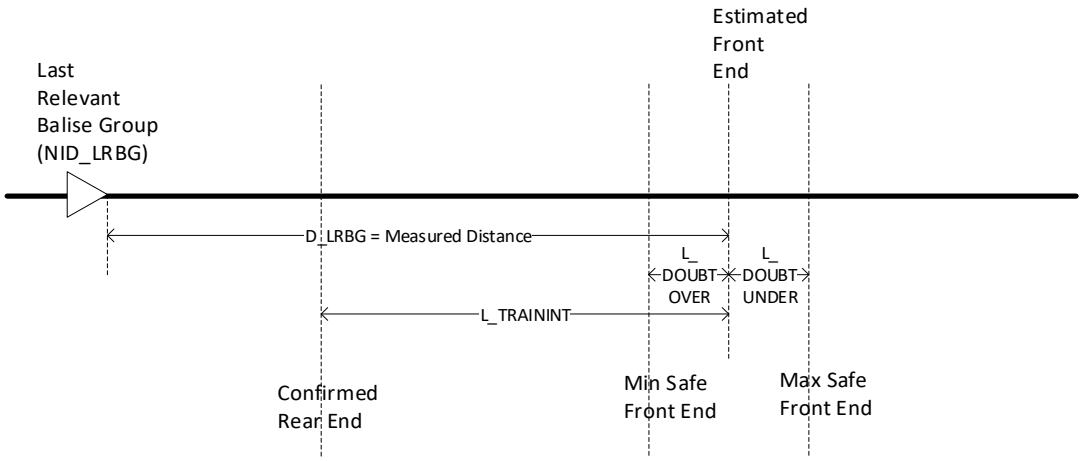

Figure 14: Definition of Confirmed Rear End from Position Report

The Max Safe Front End is derived by the L3 Trackside from Train Position Reports and is updated whether or not Train Integrity is confirmed, even if train reports inside a Radio Hole (see section 3.14).

The Confirmed Rear End is derived by the L3 Trackside from Train Position Reports and is only updated if Train Integrity is confirmed in a new Train Position Report, even if train reports inside a Radio Hole (see section 3.14).

Figure 15 shows how the Train Location is represented in the remainder of this document:

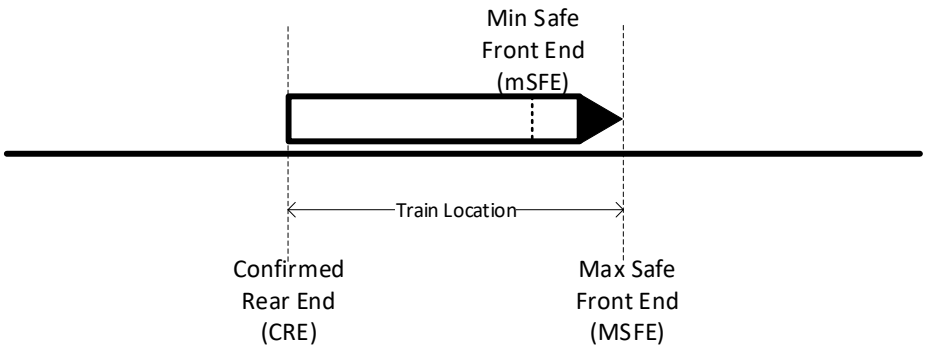

Figure 15: Train Location from L3 Trackside viewpoint

Operational Rules: None

Engineering Rules: None

REQ-TrainLoc-4	[New Requirement]

When receiving a position report from a train, then the L3 Trackside shall update the Max Safe Front End for this train from the information in that position report.

Rationale:

The L3 Trackside uses the information in position reports to establish and maintain the location of trains in its area. The Track Status Area associated with a train can be Occupied or Unknown.

Guidance:

The Max Safe Front End, Estimated Front End and Min Safe Front End of the train can be updated with every position report received.

Figure 16 shows how the Max Safe Front End is updated with a new train position report.

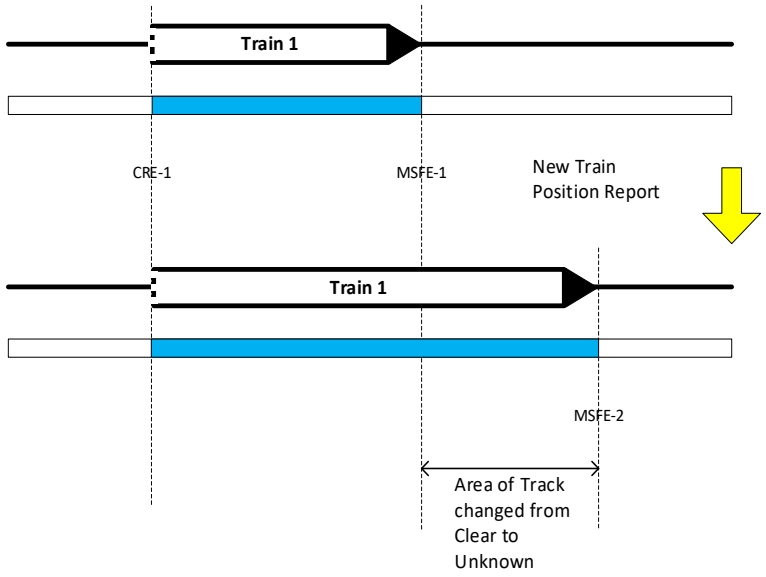

Figure 16: Max Safe Front End is updated with new Train Position Report

Operational Rules: None

Engineering Rules: None

REQ-TrainLoc-5	[New Requirement]

When receiving a position report from a train in FS/OS mode where the Train Integrity is confirmed by external device, then the L3 Trackside shall update the Confirmed Rear End for this train from the information in that position report.

Rationale:

The L3 Trackside uses the information in position reports to establish and maintain the location of trains in its area. The Track Status Area associated with a train can be Occupied or Unknown.

Guidance:

The Confirmed Rear End is not known until receiving a position report with Train Integrity confirmed from which the L3 Trackside can locate the rear of the train in the track.

Figure 17 shows how the CRE is updated with a new train position report with Train Integrity Confirmed.

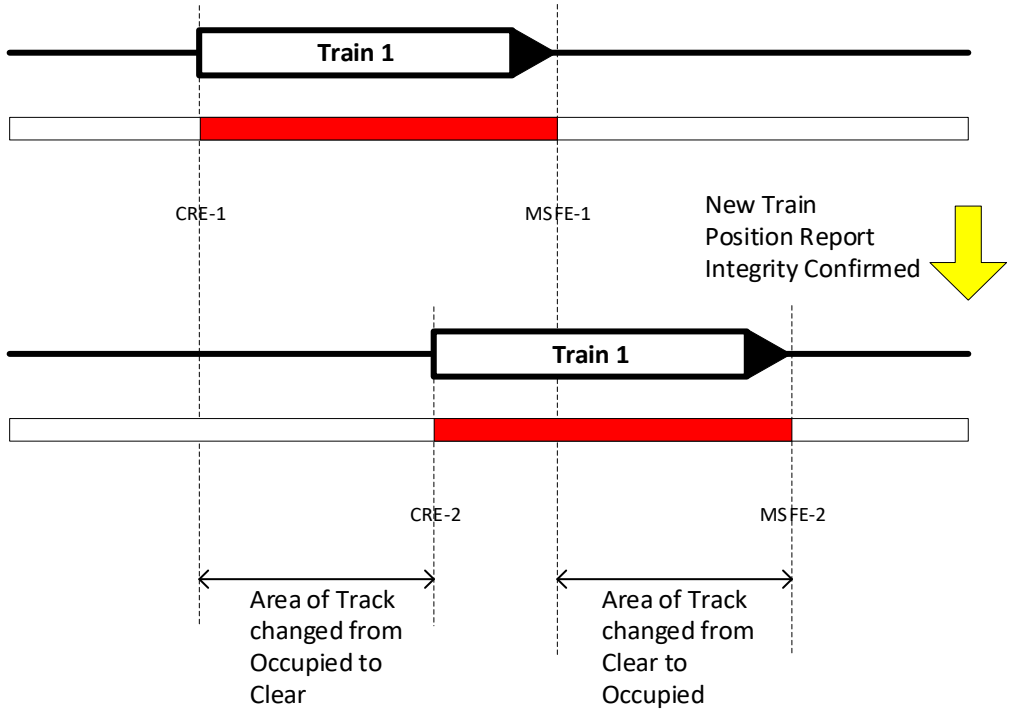

Figure 17: CRE is updated with new Train Position Report, Integrity Confirmed

Operational Rules: None

Engineering Rules: None

REQ-TrainLoc-6 [New Requirement]

When receiving a position report from a train in FS/OS mode where the Train Integrity is confirmed by driver, then the L3 Trackside shall, if configured for this, update the Confirmed Rear End for this train from the information in that position report.

Rationale:

The L3 Trackside uses the information in position reports to establish and maintain the location of trains in its area. The Track Status Area associated with a train can be Occupied or Unknown.

Guidance:

The Confirmed Rear End is not known until receiving a position report with Train Integrity confirmed from which the L3 Trackside can locate the rear of the train in the track. If configured to accept confirmation of Integrity by the Driver, the L3 Trackside shall update the CRE to the new location when this is received.

Operational Rules: OPE-Generic-2

Engineering Rules: ENG-LossTI-3

REQ-TrainLoc-7 [X2R1 D5.1: REQ-TrainLoc-5]

The L3 Trackside shall be able to request the ETCS On-board to report train position as soon as its Confirmed Rear End is in advance of a specified location.

Rationale:

This is to improve performance of the system, for example by enabling release of infrastructure as soon as the CRE is clear of a release point.

Guidance:

If the system allows configuring such value, it could be used by the L3 Trackside to ask the ETCS On-board to inform about when it has passed special locations such as points or level crossing, speeding up the release of these portions of track. The proposal is to modify the variable Q_LGTLOC used in packet 58 ‘Position Report Parameters’ (qualifier that tells the ETCS On-board whether the train has to report its position when the Max Safe Front End or when the min safe rear end has over passed the location defined by D_LOC) in order to allow this reporting based on the Confirmed Rear End of the train.

This requirement could also be used to trigger disconnection of a train from the Handing Over L3 Trackside during Handover.

This requirement is dependent on a Change Request to the ETCS Baseline. See “Proposed Changes” section in D4.3 [X2R3-D4.3].

Operational Rules: None

Engineering Rules: None

REQ-TrainLoc-8	[X2R1 D5.1: REQ-StartTrain-8]

If a train reports a position that is unexpected or in conflict with other train movements, the L3 Trackside shall react to transition the system to a safe state.

Rationale:

There are several scenarios where a position report from a train may require immediate action from the L3 Trackside in order to avoid a potential hazard:

- A train reporting a position in an area previously considered clear, e.g. at Start of Mission
- A train reporting a position locating it within a Reserved Status Area for another train.

Guidance:

The specific reaction applied will depend on the scenario and application specific requirements. Possible reactions include:

- shortening of the Movement Authority for one or multiple trains
- sending an Unconditional Emergency Stop message to one or multiple trains.

Note that the Track Status is updated by other requirements.

Operational Rules: None

Engineering Rules: None

REQ-TrainLoc-9	[New Requirement]

If a train reports a position that is unexpected or in conflict with other train movements, the L3 Trackside shall alert the TMS to the situation.

Rationale:

There are several scenarios where an unexpected position report from a train may require additional intervention from the TMS in order to manage the degraded situation.

Guidance:

A similar situation could occur in a L2 railway. However, the situation is more severe in a L3 area, where TTD may not be present and the L3 Trackside is reliant upon trains reporting their position to separate traffic safely.

Operational Rules: None

Engineering Rules: None

REQ-TrainLoc-10 [X2R1 D5.1: REQ-TrainLoc-7]

The L3 Trackside shall ignore Train Position Reports from Non-Leading or Sleeping engines to establish Train Location.

Rationale:

Train Position Reports from Non-Leading or Sleeping engines can be expected to occur.

Guidance:

Any ETCS On-board in Non-Leading or Sleeping mode is assumed to be part of another fully protected train.

It is optional whether or not the L3 Trackside maintains the communications session with the Non-Leading or Sleeping engine.

Train Position Reports from an ETCS On-board in Non-Leading or Sleeping can be used for representation purposes, in which case they will need to be transmitted from the L3 Trackside to the TMS.

Operational Rules: None

Engineering Rules: None

REQ-TrainLoc-11 [X2R1 D5.1: REQ-TrainLoc-9]

The L3 Trackside shall store valid information for all trains within its Area of Control. The following information shall be stored:

a) Train ID (NID_ENGINE)

b) Train length (L_TRAIN)

c) Most recent Train Position Report

d) Most recent Confirmed Rear End.

Rationale:

This is to enable the L3 Trackside to, for example:

- Clear an Unknown area when a train performs Start of Mission (see section 3.9)
- Recognise a train which has regained communications as the same train which lost communications (see section 3.13).

Guidance:

None.

Operational Rules: None

Engineering Rules: ENG-TrackInit-1

REQ-TrainLoc-12 [New Requirement]

The L3 Trackside shall store information together with a timestamp.

Rationale:

By means of this timestamp it will be possible to know the age of stored information. This will be a factor in deciding whether it can be used e.g. during Trackside Initialisation or for debugging errors.

Guidance:

The details of what information is stored is covered by other requirements.

Operational Rules: None

Engineering Rules: None

REQ-TrainLoc-13 [New Requirement]

When after Start of Mission receiving a new set Validated Train Data from a train where the train length is longer than the train length which is stored for this train, the L3 Trackside shall adjust the extent of the Track Status Area associated with the location of this train accordingly.

Rationale:

This is to establish the area where the train is located according to the information provided by the train.

Guidance:

When the train reports new Validated Train Data, Train Integrity is considered lost. If this is after joining, the involved trains may already have reported that integrity is lost.

In case this results in extending the location of a train over a previously Clear area, the L3 Trackside reactions after such event are project specific, e.g. do not authorise an MA until the Dispatcher acknowledges to do so.

Operational Rules: None

Engineering Rules: None

REQ-TrainLoc-14 [New Requirement]

When receiving new Validated Train Data from a train where the train length is longer than the train length which is stored for this train, and the new location established for this train extends into a previously Clear area of track by more than the L3 Margin, the L3 Trackside shall alert the TMS to the situation.

Rationale:

The Dispatcher must be made aware of situations that could be erroneous or potentially hazardous.

Guidance:

A small adjustment of the train length, i.e. less than the L3 Margin, should not cause problems. When joining trains, a new reported train length should cover all of the two joining trains. In case the new train length extends into a Reserved Status Area, this will anyway cause the L3 Trackside to react. See REQ-TrainLoc-8.

Operational Rules: None

Engineering Rules: None

3.2 Track Status

3.2.1 Introduction

This section contains requirements relating to the processing required for the L3 Trackside to determine the Track Status within its Area of Control. Train Location section determines the extend of the Track Status Areas and this section is about the Status of the Area. For an introduction to Track Status, see section 2.2 above.

3.2.2 Requirements

REQ-TrackStatus-1 [X2R1 D5.1: REQ-TrackStatus-1]

The L3 Trackside shall determine the Consolidated Track Status of the entire track within the Area of Control.

Rationale:

It is critical that within a system where the means of locating trains is via Train Position Reports, the Trackside maintains an up to date record of the Track Status within its Area of Control.

Guidance:

Every area of track within the Area of Control will be Occupied, Unknown or Clear.

Operational Rules: None

Engineering Rules: None

REQ-TrackStatus-2	[X2R1 D5.1: REQ-TrackStatus-16]

The L3 Trackside shall construct Consolidated Track Status for the complete Area of Control from the separate Track Status Areas. The algorithm for creating Consolidated Track Status shall give precedence to Occupied over Unknown.

Rationale:

Occupied is considered to have precedence over Unknown, as it is more restrictive.

Guidance:

Overlap of Occupied and Unknown Track Status Areas may occur when sweeping is performed by a by train reporting Train Integrity confirmed, or when splitting and joining movements are undertaken.

Handling the (part of the) location of a train that extends over the border of a L3 Area is project specific, i.e. if the location is truncated at the border or not.

Operational Rules: None

Engineering Rules: None

REQ-TrackStatus-3	[X2R1 D5.1: REQ-TrackStatus-2]

When receiving a message from a train with the information ‘Train integrity confirmed by external device’ for which the area associated with the location of this train has Track Status Unknown, the L3 Trackside shall change the Track Status for that area to Occupied.

Rationale:

This is required in order for the L3 Trackside to maintain the Track Status within its Area of Control.

Guidance:

Unless the position of a train is not known to the L3 Trackside, it will always have established an Unknown Track Status Area for a train before it confirms integrity, e.g. when receiving Validated Train Data. If the position is established later on, e.g. after the Dispatcher has assigned a position to the train, the L3 Trackside will still

first create an Unknown Track Status Area and then change it to Occupied when integrity is confirmed.

Figure 18 shows the relationship between Train Location and the Occupied Track Status Area for an individual train with Train Integrity confirmed within a track which is otherwise Clear:

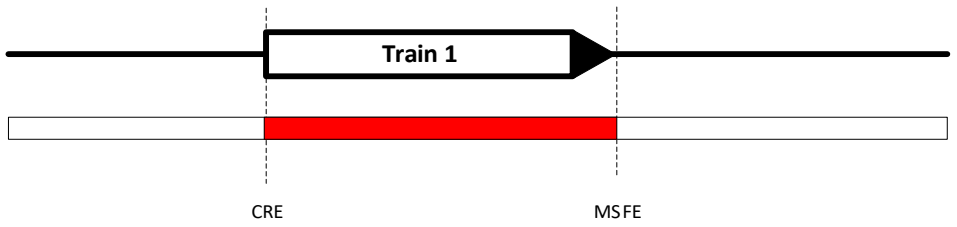

Figure 18: Occupied Track Status Area from Train Location

Operational Rules: None

Engineering Rules: None

REQ-TrackStatus-4 [New Requirement]

When receiving a report from a train with the information ‘Train integrity confirmed by driver’ for which the Track Status Area associated with the location of the train has Track Status Unknown, if configured for this, the L3 Trackside shall change the Track Status for that area to Occupied.

Rationale:

This is required in order for the L3 Trackside to maintain the Track Status within its Area of Control.

Guidance:

This is the same as when integrity is confirmed by external device (TIMS). However, projects may decide not to accept driver confirmation of Train Integrity.

Operational Rules: None

Engineering Rules: None

REQ-TrackStatus-5	[X2R1 D5.1: REQ-TrackStatus-4]

When receiving a position report from a train with the Min Safe Front End in an Unknown Track Status Area that can be swept, then the L3 Trackside shall reduce that Unknown Track Status Area for the part of it up to the Min Safe Front End of that train.

Rationale:

Sweeping is performed by the Min Safe Front End (mSFE) of a train, as it cannot be guaranteed that there is no obstruction between the mSFE and the Max Safe Front End (MSFE) which is the Confidence Interval where the front of the train can be.

Guidance:

Figure 19 shows the relationship between Train Location and the Occupied Track Status Area for a train with Train Integrity confirmed in a Sweepable Unknown Track Status Area ahead of the train:

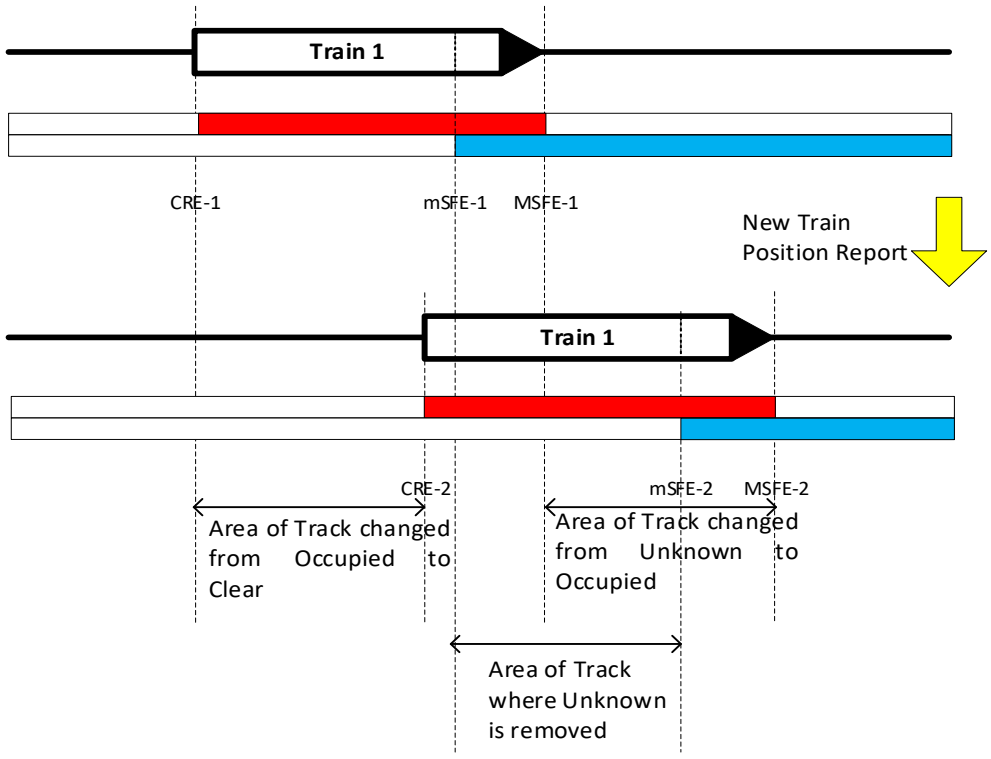

Figure 19: Train with Train Integrity confirmed Sweeping an Unknown Track Status Area

Figure 20 shows the relationship between Train Location and the Unknown Track Status Area for a train without Train Integrity confirmed in a Sweepable Unknown Track Status Area ahead of the train. The train is sweeping the area in front of the train and extending the one created as train is reporting without Train Integrity Confirmed:

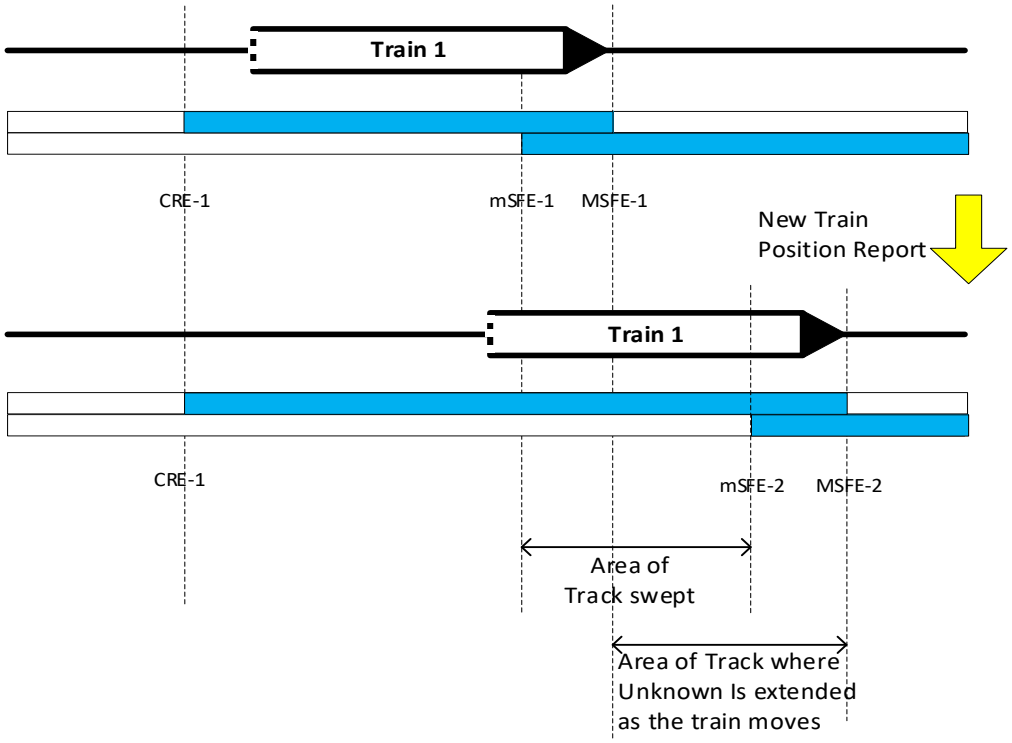

Figure 20: Train without Train Integrity Confirmed Sweeping an Unknown Track Status Area

The passage of a train through a Sweepable Unknown Track Status Area results in sweeping of that Unknown Track Status Area.

Operational Rules: None

Engineering Rules: None

REQ-TrackStatus-6	[X2R1 D5.1: REQ-TrackStatus-5]

On request from the TMS, the L3 Trackside shall create an Unknown Track Status Area flagged as Sweepable provided the area is longer than the configurable minimum length.

Rationale:

This is to allow the L3 Trackside to have all relevant information concerning obstructions.

Guidance:

For example, this can be used in the degraded situation of a non-communicating train. A train without communications has to be moved inside an Unknown Track Status Area, so that the L3 Trackside is aware that this area is protected for a specific train.

The Unknown Track Status Area may be created automatically by the TMS, or via dispatcher interaction with the TMS.

Unknown areas can be created independent of the current Track Status in that area, i.e. they can overlap existing areas of Unknown or Occupied.

The Sweepable Unknown Track Status Area needs to be longer than the configurable minimum length for removal of Unknown, defined in ENG-StartTrain-2.

Operational Rules: OPE-TrackInit-2; OPE-Generic-6; OPE-LossComms-1; OPE-LossTI-1

Engineering Rules: None

REQ-TrackStatus-7	[X2R1 D5.1: REQ-TrackStatus-6]

On request from the TMS, the L3 Trackside shall create an Unknown Track Status Area flagged as Non-Sweepable.

Rationale:

When the TMS requests a Non-Sweepable Unknown Track Status Area, it may be for a reason that would make it unsuitable to be swept e.g. a known permanent obstacle on the line.

Guidance:

Non-Sweepable Unknown Track Status Areas will only be cleared at the request of the TMS. The L3 Trackside will retain a Non-Sweepable Unknown Track Status Areas after traversal by a train which has confirmed Train Integrity.

The Unknown Track Status Area may be created automatically by the TMS, or via Dispatcher interaction with the TMS.

Unknown Track Status Areas can be created independent of the current Track Status in that area, i.e. they can overlap existing areas of Unknown or Occupied.

For example, creating Unknown Track Status Areas in parts of the track might be due to external systems detecting fallen objects, or landslides.

Operational Rules: OPE-TrackInit-2, OPE-Generic-6; OPE-LossComms-1; OPE-LossTI-1

Engineering Rules: None

REQ-TrackStatus-8	[New Requirement]

Unknown Track Status Areas created by L3 Trackside without being requested by TMS shall be flagged as Sweepable, or Non-Sweepable.

Rationale:

When the L3 Trackside creates an Unknown Track Status Area, it needs to be flagged Sweepable or Non-Sweepable.

Guidance:

Many of the reasons for creating an Unknown Track Status Area would result in it being flagged as Sweepable, e.g. Loss of Communications and Loss of integrity. However, in some circumstances the L3 Trackside may need to flag an Unknown Track Status Area as Non-Sweepable. The exact circumstances for this are project specific.

For example, the L3 Trackside could create a Sweepable or Non-Sweepable Unknown Track Status Area at the request of external systems detecting fallen objects, or landslides. However, this is project specific.

Operational Rules: None

Engineering Rules: None

REQ-TrackStatus-9 [X2R1 D5.1: REQ-TrackStatus-15]

If an Unknown Track Status Area is created that is in conflict with other train movements, the L3 Trackside shall react to transition the system to a safe state.

Rationale:

A new Unknown Track Status Area within a Reserved Status Area for a train may require urgent action from the L3 Trackside in order to avoid a hazard.

Guidance:

The specific reaction applied will depend on the scenario and application specific requirements. Possible reactions include shortening of the Movement Authority for another train; sending an Unconditional Emergency Stop to one or multiple trains etc.

Operational Rules: None

Engineering Rules: None

REQ-TrackStatus-10 [X2R1 D5.1: REQ-TrackStatus-8]

On request from the TMS, the L3 Trackside shall remove or reduce Unknown Track Status Areas.

Rationale:

L3 Trackside allows the TMS to remove or reduce Unknown Track Status Areas based on the result of operational procedures.

Guidance:

For example, some Infrastructure Managers may permit Unknown Track Status Areas to be removed or reduced based on the observations of a Driver sweeping on an adjacent line.

Projects may, if providing the necessary information, allow the Dispatcher via TMS to remove or reduce parts of an Unknown Track Status Area, e.g. by stating a certain length to be removed.

In case there is a train length stored for an Unknown Track Status Area requested for removal, it is recommended that the L3 Trackside prevents removing this Unknown area unless the removal is supported by some additional measure(s).

Robust operational procedures are required in order to permit the Dispatcher, via the TMS, to remove or reduce Unknown Track Status Areas.

In case of overlapping Track Status Areas additional conditions might be taken into account when removing or deleting an Unknown Track Status Area.

Operational Rules: OPE-Generic-1, OPE-OS-3

Engineering Rules: None

REQ-TrackStatus-11 [X2R1 D5.1: REQ-TrackStatus-14]

The L3 Trackside shall manage the overlap of multiple Unknown Track Status Areas and only remove them when it is safe to do so.

Rationale:

Unknown Track Status Areas may be created due to a number of actions: degraded situations (Loss of Integrity, Loss of Communications), TMS intervention, Shunting etc. It is critical that the L3 Trackside manages the overlap of these different areas and only removes them when their own conditions for removal are fulfilled.

Guidance:

Some mechanisms, for example Sweeping, may remove multiple overlapping Unknown Track Status Areas.

The situation may arise where a “Non-Sweepable” Unknown Track Status Area is overlapped with a “Sweepable” Unknown Track Status Area. In the event of a sweeping train traversing this combined area, the L3 Trackside will ensure only the Sweepable Unknown Track Status Area is removed.

Operational Rules: None

Engineering Rules: None

REQ-TrackStatus-12	[X2R1 D5.1: REQ-TrackStatus-11]

The L3 Trackside shall automatically clear Sweepable Unknown Track Status Areas that are shorter than a configurable minimum length, except if this Unknown Track Status Area has been created to protect the front end of a train at Start of Mission.

Rationale:

This is to avoid having small Unknown Track Status Areas that have to be swept when it is known that there cannot be a vehicle inside them. The exception is because the configured distance could be larger than the Unknown Track Status Area created to protect the front of a train at Start of Mission before having received Validated Train Data.

Guidance:

Small Unknown Track Status Areas could arise from splitting and joining procedures, or from sweeping. Unknown Track Status Areas flagged as Non-Sweepable can only be removed at the request of the TMS.

For example, this requirement could apply to cross-over areas, as given in Figure 21:

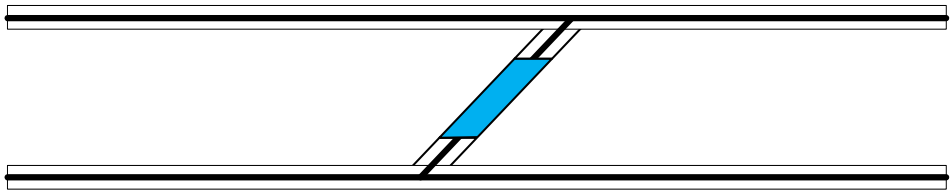

Figure 21: Short unknown area at crossover

The configurable minimum length could be related to the length of the shortest vehicle that could be running on the line. The Unknown Track Status Area can be removed, regardless of the status of adjacent areas.

The Unknown Track Status Area created to protect the front end of a train at Start of Mission should not be removed by this mechanism. Instead, this Unknown Track Status Area will increase in extent when Validated Train Data is received, and then be removed when the train reports with Integrity Confirmed.

Operational Rules: None

Engineering Rules: ENG-Generic-4;

REQ-TrackStatus-13 [X2R1 D5.1: REQ-TrackStatus-12]

The L3 Trackside shall report the Track Status for all track within its Area of Control to the TMS.

Rationale:

This is to provide the TMS with information about the Track Status.

Guidance:

This information can be used by the TMS during normal operation, and also to manage degraded situations.

The information reported to the TMS will be dependent on the design of the TMS. As a minimum, it should be the Consolidated Track Status. If the TMS is able to accept more information, it could also include the collection Track Status Areas.

Operational Rules: None

Engineering Rules: None

REQ-TrackStatus-14 [X2R1 D5.1: REQ-TrackStatus-13]

The L3 Trackside shall store and update data for all the Track Status Areas within its Area of Control in accordance with the following table:

Data item	**Type or Possible Values**	**Notes**
Status	Occupied or Unknown	
Extent	Definition of the extent of the Track Status Area	Will consist of a start point, and end point, and the path from start point to end point May contain additional information to relate Extent to Train Location.
TrainLength	As for L_TRAIN	The length of train associated with this Track Status Area, if any. Note this is not the same as the length of the extent of the area.

Data item	Type or Possible Values	Notes
Train ID	As for NID_ENGINE	The NID_ENGINE of the train associated with this area, if any.
ReasonUnknown	From enumerated list see Table 2	If the Track Status Area is Unknown, then the reason why it is Unknown
Sweepable	Boolean	Whether an Unknown Track Status Area is Sweepable or Non-Sweepable.

Table 9 – Track Status Area Stored Data

Rationale:

The Stored Data will be used by recovery mechanisms, for example at Start of Mission, recovery after loss of integrity etc.

Guidance:

Stored Data for Track Status Area can be used in the following situations:

a) Joining/Splitting: The Length of trains involved in Splitting and Joining is recorded, and the L3 Trackside ensures that the full length is accounted for before and after the procedure

b) Start of Mission: Comparing the new train length to the stored train length for an Unknown Track Status Area, and removing the Unknown Track Status Area if the train lengths match

c) Recovery after loss of Communications (new session): New train length received is compared with that stored to check that it is the same train reconnecting.

The enumerated list of reasons for an Unknown Track Status Area will include the reasons listed in Table 2 – Track Status Area Unknown Reasons.

Operational Rules: None

Engineering Rules: None

REQ-TrackStatus-15	[New Requirement]

After receiving a position report with integrity confirmed from a train located inside an Unknown Track Status Area, following reception of new Validated Train Data, the L3 Trackside shall remove the Unknown Track Status Area if the train reports an L_TRAIN which is equal to the stored train length associated with the Unknown Track Status Area, plus or minus a tolerance.

Rationale:

The Unknown Track Status Area can be removed if the reported train length accounts for all the stored train length associated with the Unknown Track Status Area.

Guidance:

This requirement is applicable to Splitting, Joining and Start of Mission scenarios.

In case of Joining, there are two Unknown Track Status Areas, each associated with a train, and the stored train length used for the comparison is the sum of the stored train lengths associated with each Unknown Track Status Area, plus or minus a tolerance. If the checks pass, both Unknown Track Status Areas are removed.

The tolerance used for the comparison is the same as that defined for the configurable minimum length of Unknown Track Status Area, as defined in ENG-StartTrain-2 and REQ-TrackStatus-12.

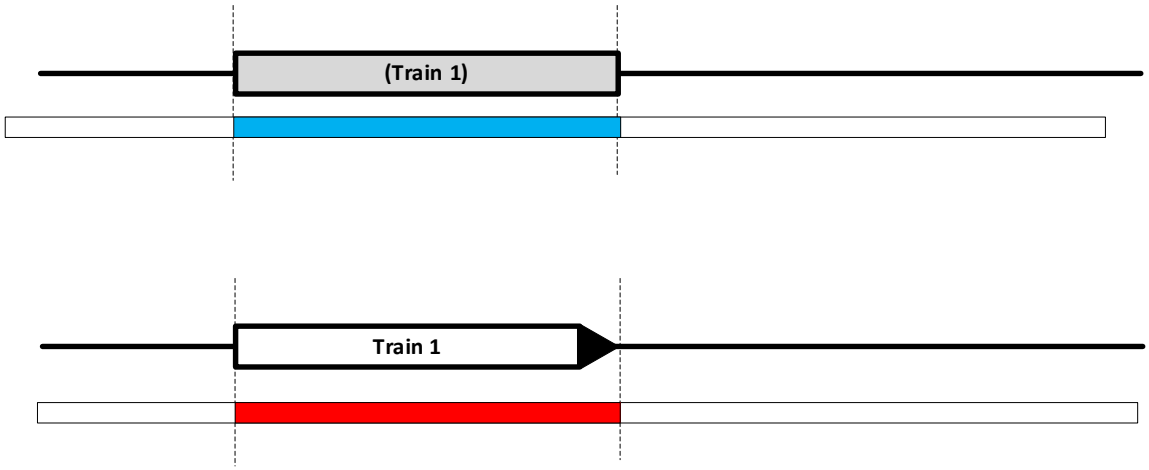

Figure 22: Track Status when L_TRAIN matches the stored train length and Train Integrity is Confirmed

Operational Rules: None

Engineering Rules: None

REQ-TrackStatus-16 [New Requirement]

After receiving a position report with integrity confirmed from a train located inside an Unknown Track Status Area, following reception of new Validated Train Data, the L3 Trackside shall remove the area with Track Status Unknown between the train's Max Safe Rear End and its Min Safe Front End if the train reports an L_TRAIN which is not equal to the stored train length associated with the Unknown Track Status Area, plus or minus a tolerance.

Rationale:

The Unknown Track Status Area cannot be fully removed if the reported train length does not account for all the stored train length associated with the Unknown Track Status Area.

Guidance:

In case of Joining, there are two Unknown Track Status Areas, each associated with a train, and the stored train length used for the comparison is the sum of the stored train lengths associated with each Unknown Track Status Area.

The application of this requirement and creating an Occupied Track Status Area may result in the remaining Unknown Track Status Area being split into two. The L3 Trackside will need to manage these remaining Unknown Track Status Areas and the stored length associated with them must be shared between them.

Figure 23 shows the train having confirmed integrity, and the reduction in the area of Unknown remaining:

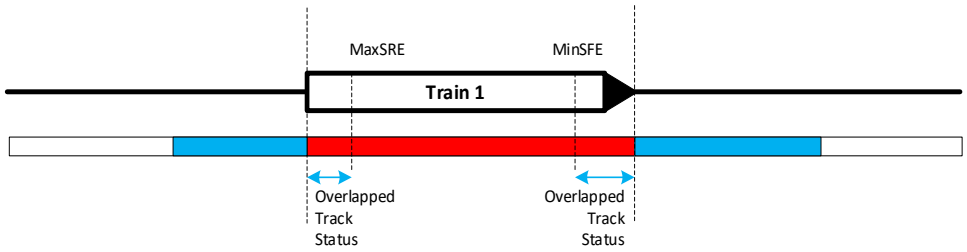

Figure 23: Train confirming Integrity inside Unknown Track Status Area, with overlap of Track Status

Operational Rules: None

Engineering Rules: None

REQ-TrackStatus-17	[New Requirement]

After receiving a position report with integrity confirmed from a train located inside an Unknown Track Status Area, following reception of new Validated Train Data, the L3 Trackside shall subtract the length of the train from the length stored for the remaining Unknown Track Status Area if the train reports an L_TRAIN which is not equal to the stored train length associated with the Unknown Track Status Area, plus or minus a tolerance.

Rationale:

As the reported train length does not account for all the stored train length, an Unknown Track Status Area remains. The stored train length associated with the remaining area must be updated to account for the train having confirmed integrity.

Guidance:

In case of Joining, there are two Unknown Track Status Areas, each associated with a train, and the stored train length used for the comparison is the sum of the stored train lengths associated with each Unknown Track Status Area.

The reported L_TRAIN could be larger than the stored L_TRAIN because of inaccuracy within the train length measurement.

Operational Rules: None

Engineering Rules: None

REQ-TrackStatus-18 [New Requirement]

When the L3 Trackside considers the communication session with a train is terminated, the L3 Trackside shall change the Track Status Area associated with this train from Occupied to Unknown, except if the train is completely located inside an Active Shunting Area.

Rationale:

This is the area where the train could be located, and as such needs to be protected by an Unknown Track Status Area.

Guidance:

This requirement applies in the following situations:

- End of Mission
- Handover
- Transition out of the L3 area
- Other reasons for session termination

For a train that was reporting Train Integrity confirmed, the Unknown Track Status Area will be from the CRE to the Max Safe Front End.

For a train located completely inside an Active Shunting Area, an Unknown area does not need to be created since there is already an Unknown area associated with this Active Shunting Area which will protect the train.

If a train is partially located inside an Active Shunting Area, it is project specific whether the L3 Trackside authorises the transition to Shunting Mode. Similarly, it is project specific how the L3 Trackside subsequently manages the overlapping Unknown Track Status Area that is created for the location of this train.

Operational Rules: None

Engineering Rules: None

REQ-TrackStatus-19 [New Requirement]]

When the L3 Trackside considers the communication session is terminated with a train completely located inside an Active Shunting Area, then the L3 Trackside shall remove the Occupied area of track associated with this train.

Rationale:

For a train completely within a Shunting Area, protection after End of Mission will be provided by the Unknown Track Status Area associated with the Shunting Area.

Guidance:

For a train whose location is fully inside an Active Shunting Area when it reports EoM, the Occupied Track Status Area corresponding to the Train Location is removed but no additional Unknown Track Status Area is created, since the train is already in an Unknown Track Status Area and the L3 Trackside will not know where the train moves to while in SH mode.

This requirement also applies in a degraded situation when the L3 Trackside considers the communication session is terminated without receiving EoM message.

Operational Rules: None

Engineering Rules: None

3.3 Reserved Status

3.3.1 Introduction

This section contains requirements relating to the reserving of an area of track for the movement of trains by the L3 Trackside.

An area of track must be Reserved before the L3 Trackside authorises a particular train to move through that area. The Reserved state is separate to the states defined for Track Status.

An area of the track will be Reserved within the L3 Trackside before:

- The L3 Trackside sends a Movement Authority to a train for that area of track
- The L3 Trackside authorises a Staff Responsible movement
- The L3 Trackside sends Route Related Information as part of handover to an adjacent L3 Trackside.

An area of track remains Reserved in rear of a train if the L3 Trackside has authorised a RV movement.

3.3.2 Requirements

REQ-Reserved-1	[X2R1 D5.1: REQ-Reserved-1]

The L3 Trackside shall establish or extend a Reserved Status Area for the area where a train will be authorised to run.

Rationale:

This is to avoid points movement or other potential conflict with other trains.

The Reserved Status Area is established or extended within the L3 Trackside before a Movement Authority or SR Distance is issued to a train.

Guidance:

This includes:

a) Movement Authority, including up to any Danger Point, and any Overlap

b) Staff Responsible distance if issued via the L3 Trackside

c) Reversing distance.

Except in the case of authorised reversing, a train is not permitted to move backwards, and so the track behind the train is not Reserved except in this case. See section 3.15 Reverse movement.

When one train is following another, the L3 Trackside can extend the Reserved Status Area for the following train without any further input from the TMS.

When a train is to be authorised into a new Route, the Reserved Status Area can only be extended following a request from the TMS

Figure 24 shows an Area of Track with Reserved Status Area ahead of a train:

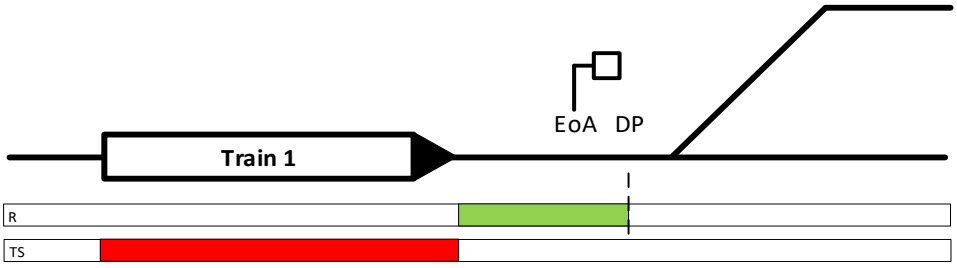

Figure 24: Reserved Status Area for a single train

If the L3 Trackside permits more than one train within a single route, as shown in Figure 25:

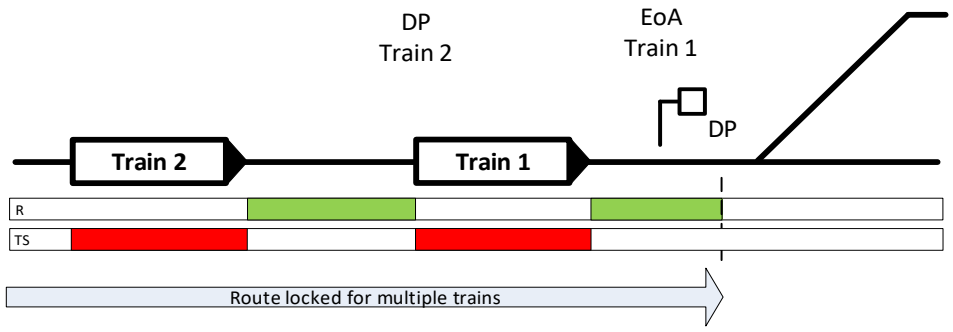

Figure 25: Reserved Status Areas for two trains following one another4

Operational Rules: None

Engineering Rules: ENG-MovSR-1

REQ-Reserved-2 [New Requirement]

Following a request from the TMS, the L3 Trackside shall be able to reduce or remove an existing Reserved Status Area of track only after adjusting any given authorisation accordingly.

Rationale:

For various reasons, e.g. operational, the TMS needs the possibility to reduce or remove a Reserved Status Area.

Guidance:

How the L3 Trackside reduces or removes a Reserved Status Area is project specific, e.g. depending on the situation. However, before reducing or removing a Reserved Status Area, the L3 Trackside may need to withdraw a given authorisation, as in Level 2 systems.

Operational Rules: None

Engineering Rules: ENG-MovSR-1

REQ-Reserved-3	[X2R1 D5.1: REQ-Reserved-2]

The L3 Trackside shall report the Reserved Status for all track within its Area of Control to the TMS.

Rationale:

This is to enable the Traffic Management System to represent for the Dispatcher the Reserved Status Area for the movement of every train in the Area of Control.

Guidance:

None.

Operational Rules: None

Engineering Rules: None

REQ-Reserved-4	[X2R1 D5.1: REQ-Reserved-3]

The L3 Trackside shall update the Reserved Status Area for a communicating train when a new Train Position Report is received.

Rationale:

This is required in order for the L3 Trackside to maintain the Reserved Status within its Area of Control.

Guidance:

Figure 26 shows the Reserved Status Area update for an individual train:

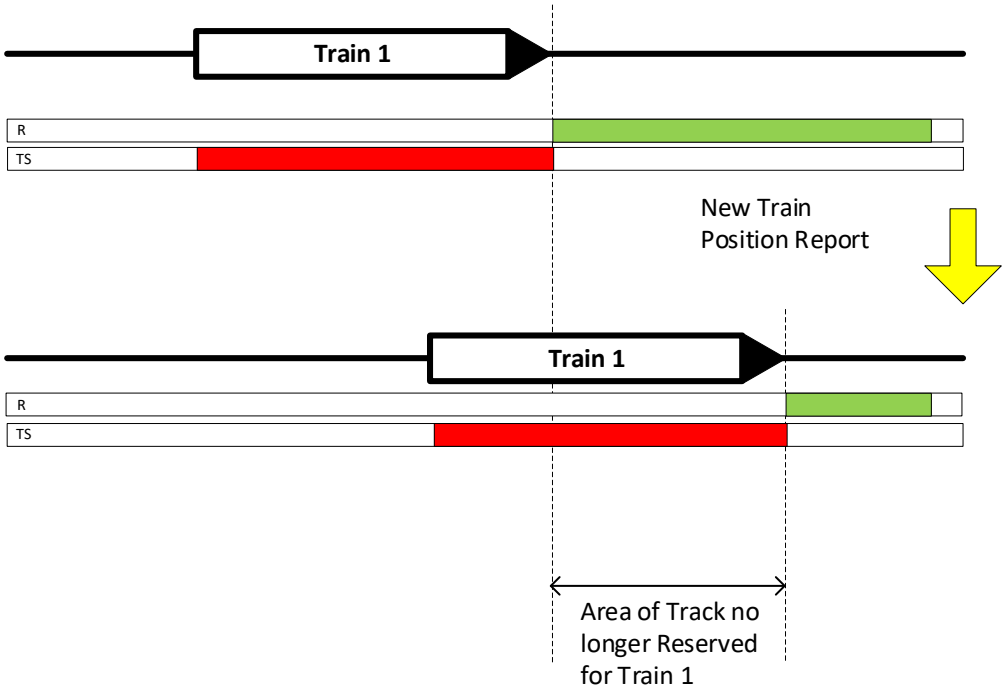

Figure 26: Reserved Status Area update for new Train Position Report

Operational Rules: None

Engineering Rules: None

REQ-Reserved-5 [New Requirement]

The L3 Trackside shall ensure an area of track is only Reserved for a single train.

Rationale:

Reserved Status Areas cannot overlap, due to the risk of collision.

Guidance:

None.

Operational Rules: None

Engineering Rules: None

REQ-Reserved-6 [New Requirement]

The L3 Trackside shall update the stored data associated with the Reserved Status Areas in its Area of Control.

Rationale:

Stored Information can aid with initialising the L3 Trackside after a restart.

Guidance:

Stored information about Reserved Status Areas can be used during trackside initialisation to create Unknown Track Status Areas for where trains had been authorised before the system was restarted. This is useful as trains may not have stopped at their last reported position and it may take time before a train is able to reconnect and report a new position.

The stored data includes:

a) the extent of the Reserved Status Area

b) the Train ID associated with it.

Operational Rules: None

Engineering Rules: None

3.4 Fixed Virtual Blocks

3.4.1 Introduction

This section contains requirements relating to ETCS Level 3 Moving Block systems which are configured to use Fixed Virtual Blocks.

Fixed Virtual Blocks may be used to provide both:

a) Predefined areas of track, each with Status Occupied / Clear / Unknown

and:

b) Predefined locations for the end of Reserved Status Areas.

In a system with Fixed Virtual Blocks, it is necessary to engineer the Fixed Virtual Blocks.

It is assumed that infrastructure elements such as point ends (between the point toe and fouling points) and diamond crossings (between fouling points) are entirely within a single Fixed Virtual Block. For further information, see section 3.6 Points Control.

Each Fixed Virtual Block has a Status, which will be:

- Occupied The Fixed Virtual Block contains all or part of one or more Occupied Track Status Areas
- Unknown The Fixed Virtual Block does not contain any part of an Occupied Track Status Area, but it does contain all or part of one or more Unknown Track Status Areas.
- Clear The Fixed Virtual Block does not contain any part of any Occupied or Unknown Track Status Areas.

All requirements specific to systems using Fixed Virtual Block start with the wording:

"For a system using Fixed Virtual Blocks…"

3.4.2 Requirements

REQ-FVB-1 [X2R1 D5.1: REQ-FVB-1]

For a system using Fixed Virtual Blocks, the L3 Trackside shall determine the Status of all the Fixed Virtual Blocks within the Area of Control by applying the following algorithm:

If there is any part of the Consolidated Track Status which is Occupied within the FVB:
Then
The FVB has Status Occupied
Elseif there is any part of the Consolidated Track Status which is Unknown within the FVB
the FVB has Status Unknown
Else
the FVB has Status Clear
Endif

Rationale:

In a system using Fixed Virtual Blocks, Track Status Areas must be determined at the level of Fixed Virtual Blocks. This is required in order for the L3 Trackside to authorise train movement.

Guidance:

Every Fixed Virtual Block will be Occupied, Unknown or Clear. The algorithm can be considered to be a mapping of the Consolidated Track Status derived through Moving Block principles onto the Fixed Virtual Blocks.

Figure 27 illustrates the derivation for an area of Consolidated Track Status which is Occupied:

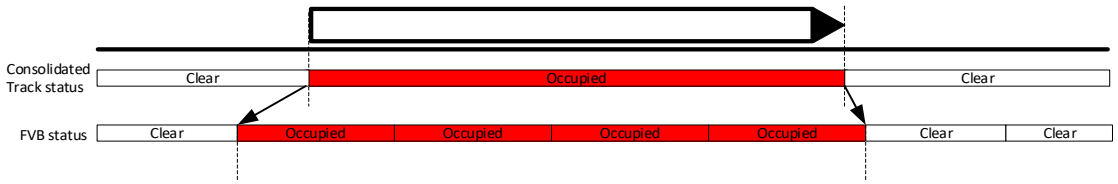

Figure 27: Consolidated Track Status Occupied mapped to Fixed Virtual Block Status

This also means that a Fixed Virtual Block which has all or part of two different areas of Consolidated Track Status which are Occupied, will have status Occupied, as shown in Figure 28:

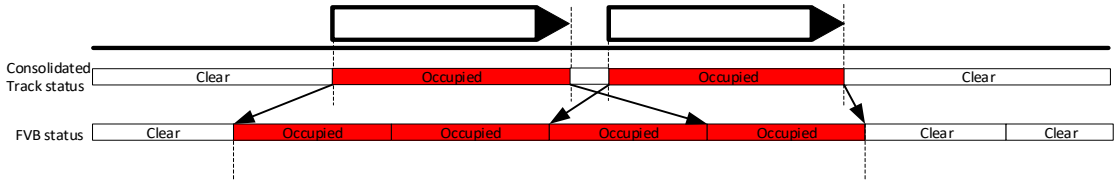

Figure 28: Fixed Virtual Block Status with multiple trains

Figure 29 illustrates the derivation of the Fixed Virtual Block status for an area of Consolidated Track Status which is Unknown:

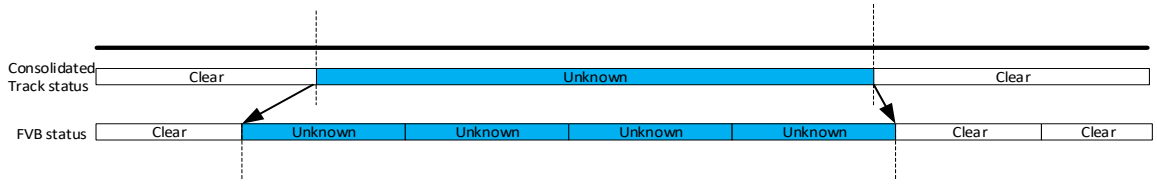

Figure 29: Consolidated Track Status Unknown mapped to Fixed Virtual Block Status

Operational Rules: None

Engineering Rules: ENG-Generic-7

3.5 Trackside Train Detection

3.5.1 Introduction

This section contains requirements relating to ETCS Level 3 Moving Block systems which are engineered to use Trackside Train Detection.

The L3 Trackside can operate without Trackside Train Detection. However, some systems may use Trackside Train Detection, and so the L3 Trackside is also defined so that it can support this. The system could be equipped with Trackside Train Detection only in specific locations, or throughout the Area of Control. Section Part 2 System Definition describes different ETCS Level 3 Moving Block System Types, with and without Trackside Train Detection.

Trackside Train Detection may be used for the following:

- To detect and permit movement of trains not equipped with TIMS, in a Mixed Traffic scheme
- To reduce the performance impact of trains operating without Train Integrity confirmed in the L3 area (either due to loss of integrity or a lack of TIMS equipment being fitted)
- To detect the entry of unfitted trains (trains without ETCS On-board) or other non-communicating railway vehicles at the boundaries of the Area of Control
- To detect occupation of the track in a Temporary Shunting Area, or in other areas where trains are joined, split, perform End of Mission
- To achieve faster release of points and crossings, level crossings etc.
- To assist with faster recovery from degraded situations, to avoid the need for “sweeping” a section of the railway in On Sight mode.

Infrastructure elements such as points and diamond crossings must be entirely within a single Trackside Train Detection section, as in the railway today.

For ETCS Level 3 Moving Block systems using Fixed Virtual Blocks, the TTD boundaries must also be Fixed Virtual Block boundaries, as shown in Figure 30:

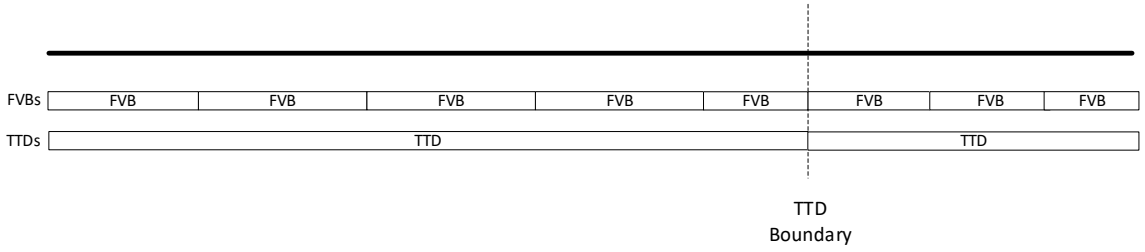

Figure 30: Fixed Virtual Blocks with TTD

All requirements specific to systems using Trackside Train Detection start with the wording:

"For a system using Trackside Train Detection…"

3.5.2 Requirements

REQ-TTD-1	[X2R1 D5.1: REQ-TTD-1]

For a system using Trackside Train Detection, the L3 Trackside shall be able to manage the lack of synchronisation between TTD occupancy and Train Position Reports for a train during normal operation.

Rationale:

For a train during normal movement, it will occur that the train physically occupies a TTD before it has reported its position within the TTD boundary (or vice versa). The L3 Trackside must correlate these two events, such that it does not react in an overly restrictive manner to what is normal behaviour.

Guidance:

The L3 Trackside could use a variety of technical solutions to correlate TTD occupancy to Train Position Reports. For example:

- Sending a Conditional Emergency Stop when a TTD is occupied, to stop a train that is approaching a boundary of the TTD if it is not the one that occupied the TTD
- Use of a delay timer, to account for lack of synchronisation between Train Position Reports and TTD occupancy. If a train is still not detected when the timer expires, the L3 Trackside would react suitably
- Tracking of TTD occupancy and correlation with Train Position Reporting, to ensure a normal sequence is observed

Note: a combination of these techniques may be used, depending on project specific requirements.

Operational Rules: None

Engineering Rules: None

REQ-TTD-2	[X2R1 D5.1: REQ-TTD-2]

For a system using TTD, if the Max Safe Front End reported by a train is located in a clear TTD section while the Min Safe Front End is in an occupied TTD, then the L3 Trackside shall clear the Track Status for this train inside this clear TTD section.

Rationale:

TTD information can be used to improve performance of the system, but this should not result in a train being removed from the Track State view of the Area of Control.

Guidance:

This could be used to release points and level crossings faster.

During application of this requirement, it shall be ensured that train is not completely removed from the Track State view of the Area of Control. This could occur due to latency between TTD operation and Train Position Reports.

Care must be taken to allow for the overhang of vehicles at the boundary between an occupied and a clear TTD.

Full Moving Block, Clear TTD in front of train

A clear Trackside Train Detection (TTD) section in front of a train can shorten the occupied part of the Track Status at the front of the train, as shown in Figure 31:

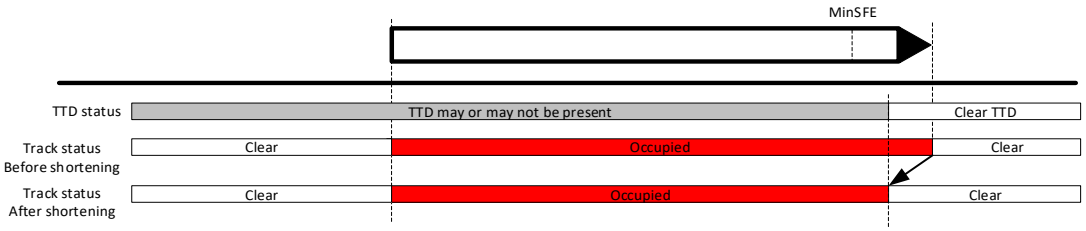

Figure 31: Shortening of front of Track Occupancy due to clear TTD (FMB)

The Figure 32 shows the situation where the Min Safe Front End is reported within the Clear TTD:

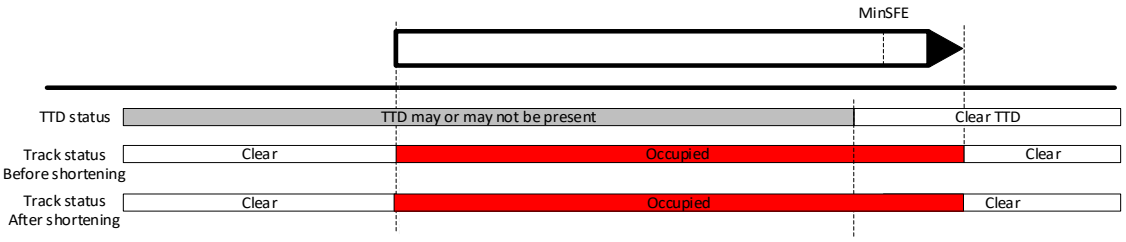

Figure 32: Track Occupied in clear TTD due to position report (FMB)

Fixed Virtual Blocks, Clear TTD in front of train

A clear Trackside Train Detection (TTD) section in front of a train results in a Clear FVB, if the Min Safe Front End is reported within the Clear, as shown in Figure 33:

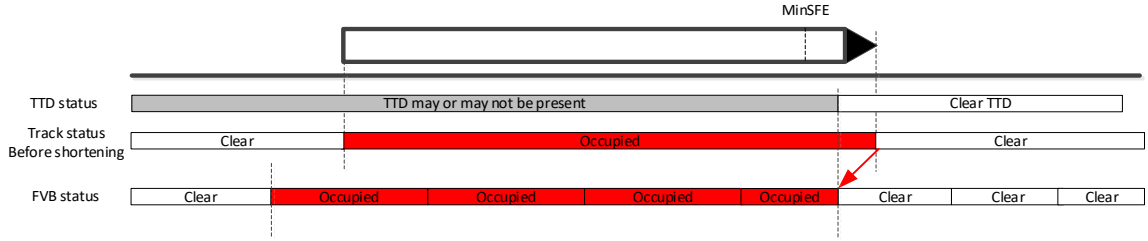

Figure 33: Shortening of front of Track Occupancy due to clear TTD (FVB)

The Figure 34 shows the situation where the Min Safe Front End is reported within the Clear TTD

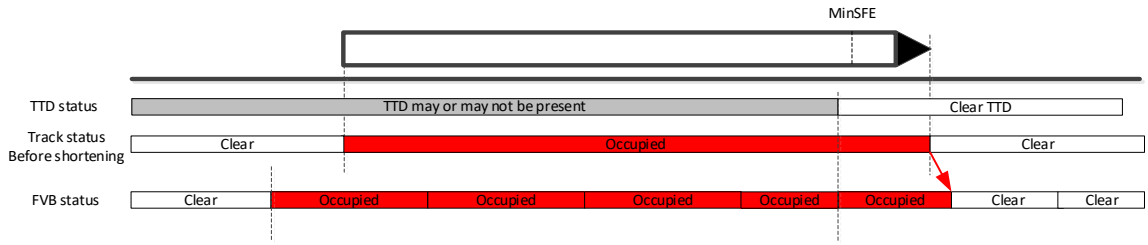

Figure 34: Track Occupied in clear TTD due to position report (FVB)

Operational Rules: None

Engineering Rules: None

REQ-TTD-3	[New Requirement]

For a system using TTD, if the min Safe Rear End reported by a train is located in a clear TTD section while the max Safe Rear End is in an occupied TTD, then the L3 Trackside shall clear the Track Status for this train inside this clear TTD section.

Rationale:

TTD information can be used to improve performance of the system, but this should not result in a train being removed from the Track State view of the Area of Control.

Guidance:

This could be used to release points and level crossings faster.

During application of this requirement, it shall be ensured that train is not completely removed from the Track State view of the Area of Control. This could occur due to latency between TTD operation and Train Position Reports.

Care must be taken to allow for the overhang of vehicles at the boundary between an occupied and a clear TTD.

Full Moving Block, Clear TTD in rear of train

A clear Trackside Train Detection (TTD) section in rear of a train shortens the occupied part of the Track Status at the rear of the train, as shown in Figure 35:

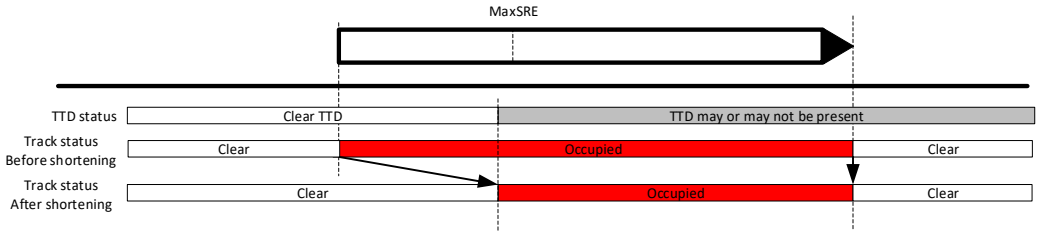

Figure 35: Shortening of rear of Track Occupancy due to clear TTD (FMB)

In order to avoid a train being completely removed, this shortening is only applied up to the Max Safe Rear End.

Figure 36 shows the situation where the Max Safe Rear End is reported within the Clear TTD:

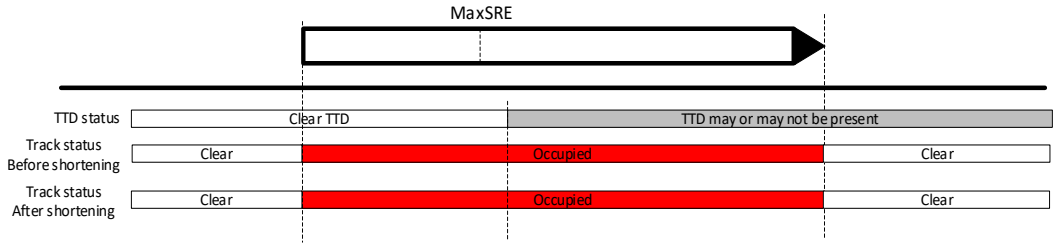

Figure 36: No shortening of rear of Track Occupancy due to clear TTD (FMB)

Fixed Virtual Blocks, Clear TTD in rear of train

A clear L3 Trackside Train Detection (TTD) section in rear of a train results in a Clear FVB, even if that FVB is partially or completely within the Train Location, as shown in Figure 37:

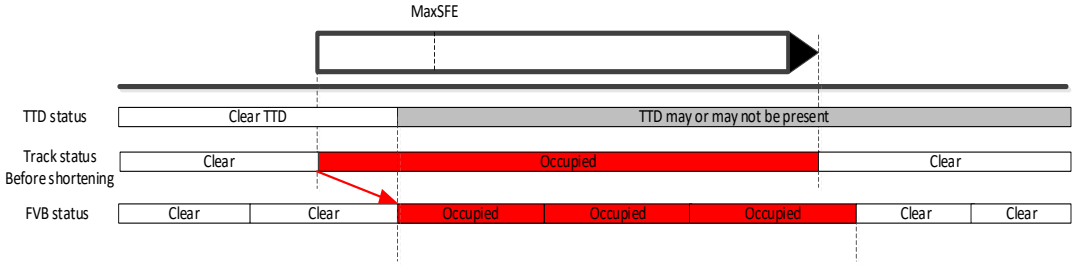

Figure 37: Shortening of rear of Track Occupancy due to clear TTD (FVB)

Operational Rules: None

Engineering Rules: ENG-Generic-5

REQ-TTD-4 [New Requirement]

When using TTD to clear Occupied parts of Track Status, the L3 Trackside shall ensure the resulting Occupied Track Status Area is not shorter than L_TRAIN for the train located in this area of track.

Rationale:

In the case of a train reporting extreme doubt in its position, it could occur that the location of the Max Safe Rear End and Min Safe Front End overlap. Applying shortening could result in the remaining Occupied area being less than L_TRAIN or the train disappearing completely in the event of a failure of TTD.

Guidance:

If the application of shortening the Track Status Area results in the area being less than L_TRAIN, it is project specific what alternative action the L3 Trackside takes. For example, an application may decide to not apply any shortening to the Track Status or apply equal shortening to the front and rear whilst maintaining a length of L_TRAIN.

Operational Rules: None

Engineering Rules: None

REQ-TTD-5 [X2R1 D5.1: REQ-TTD-3]

For a system using TTD, the L3 Trackside shall be able to remove all or part of an Unknown Track Status Area corresponding to a TTD section which is Clear. The following situations will act as exceptions to this mechanism:

a) the Unknown area has been created at the request of the TMS and marked as Non-Sweepable

b) the Unknown area is due to an Active Shunting Area

c) if the train is reporting with its Min Safe Front End in the TTD section

Rationale:

TTD information can be used to clear the line under degraded situations.

Guidance:

With TTD, there is no need for sweeping to clear Unknown Track Status Areas as TTD can be used as an alternative.

Only the part of the Unknown Track Status Area corresponding to the TTD section can be removed according to this requirement. This might mean that part of the Unknown Track Status Area may remain.

Operational Rules: None

Engineering Rules: None

REQ-TTD-6 [X2R1 D5.1: REQ-TTD-4]

The L3 Trackside shall be able to remove an Unknown Track Status Area caused by a faulty TTD, if it can be sure that no train is located over it and the TMS has authorised the operation.

Rationale:

In L3 operation, when all train movements are supervised by ETCS On-board with position reporting, a faulty TTD can be detected, dependent on the states of the neighbouring TTD's and position reports of other trains.

Guidance:

This function could be used to improve the reliability of the system and overrule false occupation reported by TTD (e.g. malfunctioning axle counters). This function will not be possible if the TTD is used to detect non-communicating trains, for example at interlocking borders and in mixed traffic areas. The function could be used to alert other systems (e.g. TMS, maintenance etc.) of a faulty TTD.

Operational Rules: None

Engineering Rules: ENG-Generic-8

REQ-TTD-7 [New Requirement]

For a system using Trackside Train Detection, the L3 Trackside shall be able to detect an unexpected TTD occupancy and change the Track Status to Unknown for that area of the track.

Rationale:

A TTD occupancy not associated with any expected train movement should be considered a Hazard, as such the L3 Trackside needs to protect other train movements by transitioning the Track Status for this area to Unknown.

Guidance:

In general, an "unexpected" TTD occupancy is one not in sequence with other TTD occupancies, that cannot be attributed to a normal train movement. The L3 Trackside should take into account whether the area covered by the TTD is Reserved for a train.

Operational Rules: None

Engineering Rules: None

3.6 Points Control

3.6.1 Introduction

This section contains requirements relating to the movement of points or other moveable infrastructure.

Points will be controlled by the L3 Trackside in the normal way, for example by the setting of Routes. This section only contains additional requirements for L3 relating to the locking of points, and the override procedure to move points if they are locked.

Points are locked by Track Status if any part of the area defined by the Fouling Points and the Point Toe has status Unknown or Occupied. This area is defined by rail topology and is individual for each set of points.

Points are locked by Reserved Status if any part of the area defined by the associated Release Points has status Reserved. This area is defined by design, and can cover several sets of points, and can also cover diamond crossings.

3.6.2 Requirements

REQ-PTS-1 [X2R1 D5.1: REQ-PTS-1]

The L3 Trackside shall prevent movement of points within an Unknown or Occupied Track Status Area, or within a Reserved Status Area, unless using an operational procedure.

Rationale:

To avoid a point movement while there is a train over it or about to pass over it.

Guidance:

All points in an Unknown or Occupied Track Status Area, or within a Reserved Status Area, must remain locked, unless they are moved under an operational procedure.

Points are within an Unknown or Occupied Track Status Area, or within Reserved Status Area, if any part of the track between the Fouling Points and the Point Toe is within an Unknown or Occupied Track Status Area, or within a Reserved Status Area.

Figure 38 below shows the area between Fouling Points and the Point Toe:

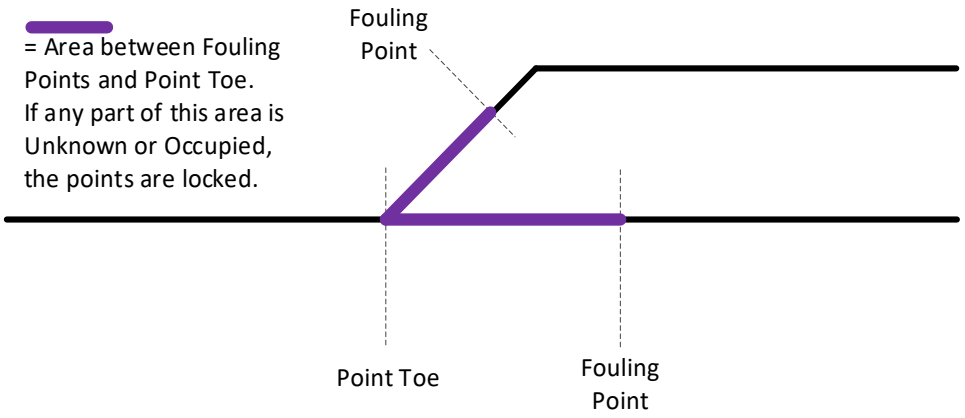

Figure 38: Area where Track Status Unknown or Occupied lock Points

Operational Rules: None

Engineering Rules: None

REQ-PTS-2	[X2R1 D5.1: REQ-PTS-2]

The L3 Trackside shall be configured with Release Points to enable Points to be moved when the area of track containing the Points has Consolidated Track Status Clear and does not contain any part of a Reserved Status Area.

Rationale:

This requirement enables movement of points when they are no longer locked for train movements.

Guidance:

In order to meet this requirement, it is necessary to define the area of track containing the points.

This can be done by defining Release Points, as shown in Figure 39 below for a single set of points:

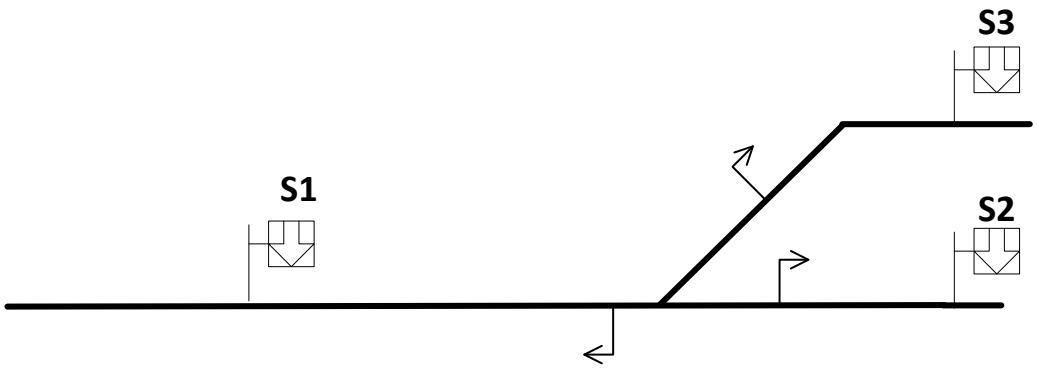

Figure 39: Release Points at a simple junction

Release Points are engineered and can cover more than one set of points. They can also cover diamond crossings. Figure 40 below shows a double junction, with Release Points for the complete junction.

Release Points after divergences must be at or beyond the Fouling Point. Release Points after convergences must be at or beyond the toe of the point.

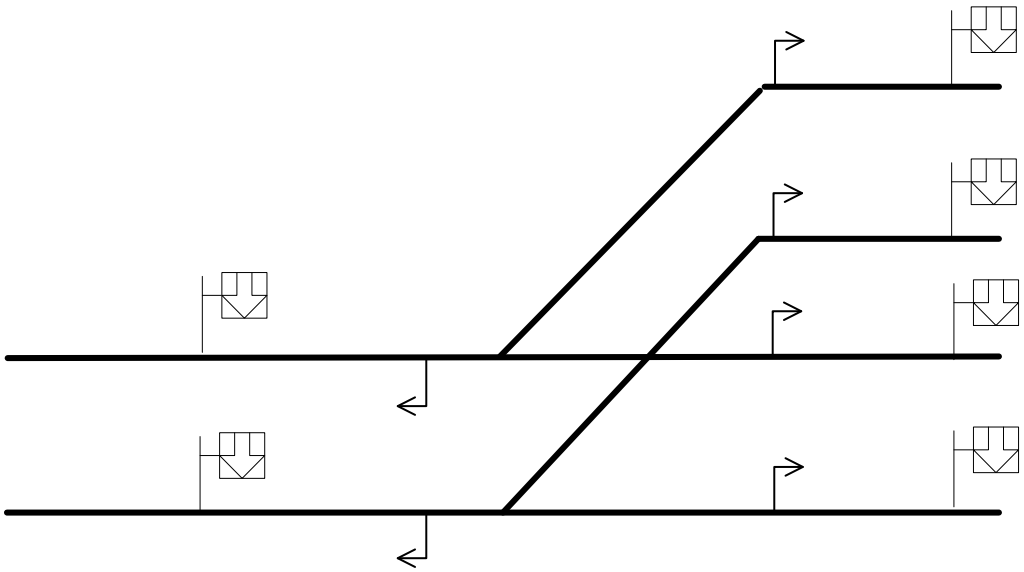

Figure 40: Release Points at a double junction

It is a design decision whether or not to include further Release Points.

When the Confirmed Rear End of a train passes the Release Point, the Track Status Area for the train will be updated to be clear of the area of track containing the points, and so the points can be released for movement.

For a system with Fixed Virtual Blocks, the Release Points must be at Fixed Virtual Block boundaries.

For a system with Trackside Train Detection, the Release Points could be at Trackside Train Detection boundaries. In this case, they must be at or beyond the Clearance Points.

Operational Rules: None

Engineering Rules: ENG-Generic-3, ENG-FVB-1; ENG-TTD-1;

REQ-PTS-3	[X2R1 D5.1: REQ-PTS-3]

On request from the TMS, the L3 Trackside shall be able to move points for which all or parts of it is in an area with Track Status Unknown or Occupied, or both.

Rationale:

In order to allow the TMS to move a train to a different location in a degraded situation or in a Shunting area, it may be necessary for the L3 Trackside to move points which are locked by Track Status Unknown or Occupied.

Guidance:

If Trackside Train Detection is present at the points, then this may be used to determine if the area over the points is free from railway vehicles. Figure 41 gives an example of a set of points partially within an area of Unknown.

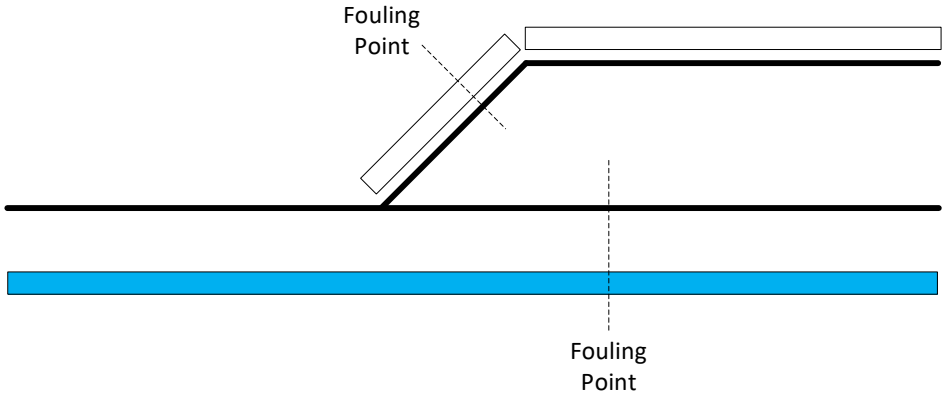

Figure 41: Points Area with Consolidated Track Status Unknown

The TMS may request to move points that are in an Unknown or Occupied Track Status Area, however for an MA to be issued with OS mode profile the points must be locked and detected. If this is not possible, an SR movement would be required instead.

Operational Rules: OPE-Generic-7

Engineering Rules: None

REQ-PTS-4	[X2R1 D5.1: REQ-PTS-4]

When a train is sweeping a set of points, the L3 Trackside shall remove or reduce a Sweepable Unknown Track Status Area from the alternate leg of the points as far as the Fouling Point, in addition to the path that the train takes.

Rationale:

When a train traverses a set of points, it occupies the alternate leg as far as the Fouling Point (due to overhang of the bodyshell from the bogies). As such the L3 Trackside can consider the area up to the Fouling Point swept if the sweeping train successfully traverses it.

Guidance:

Figure 42 illustrates the passage of a Sweeping train through set of points in an Unknown Track Status Area:

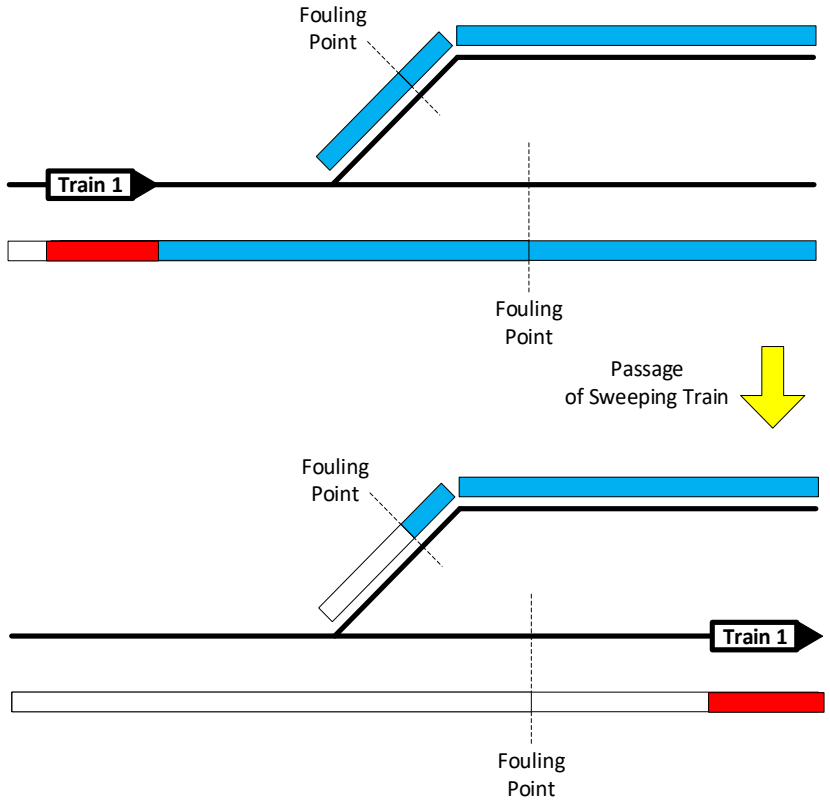

Figure 42: Passage of Sweeping train across Points inside Unknown Track Status Area

Operational Rules: None

Engineering Rules: None

3.7 Movement Authorities

3.7.1 Introduction

This section uses the concept of a Route, which is a path through the railway which is authorised for the passage of one or more trains.

The L3 Trackside can issue a Movement Authority to a train, up to the next obstruction, which can be a fixed or dynamic location.

For an ETCS Level 3 system using Full Moving Block, Movement Authorities can be to an arbitrary location, for example determined by the rear of a preceding train.

For an ETCS Level 3 system using Fixed Virtual Blocks, with some exceptions e.g. sweeping or joining, the Movement Authorities will be to fixed pre-determined locations, at the boundaries of the fixed blocks.

A Movement Authority without an On Sight Mode Profile can be extended to the next obstruction, which can include:

- The end of the authorised route
- The end of the track (special case of first bullet)
- For an ETCS Level 3 system using Full Moving Block, the location determined from the rear of a preceding train
- For an ETCS Level 3 system using Fixed Virtual Blocks, the border of a Fixed Virtual Block
- The boundary of an Unknown Track Status Area, unless continuing with OS mode profile
- The limits of a Reserved Status Area, for example associated with a Reversing Area
- The boundary of an End of Authority Exclusion Area, depending on conditions.

A Movement Authority with an On Sight Mode Profile can be extended beyond the next obstruction.

A value of an “L3 Margin” to be applied between trains will be defined by the Infrastructure Manager. See Engineering Rules in Part 5.

The extent of the Movement Authority will also be limited by Engineering Rules, as in Level 2.

For an ETCS Level 3 system using Full Moving Block, given that the Movement Authority can extend to the rear of the preceding train, there is the potential for the Movement Authority to be regularly updated for a train where the one in advance is moving away from it. This situation could cause the Movement Authority of the train in rear to be frequently updated by only a few meters at a time. To avoid the nuisance to the driver of frequent Movement Authority update, the L3 Trackside is able to limit the updates to those that are meaningful to operation of the railway.

The TIMS refresh rate could have an impact on performance in terms of how often the CRE is updated. This is not only relevant for a quick update of MAs but also to provide a quick release of

points or to minimise the Unknown Track Status Area after an End of Mission (due to the CRE being located far behind the actual train location)

3.7.2 Requirements

REQ-MA-1 [X2R1 D5.1: REQ-MA-1]

The L3 Trackside shall only issue Movement Authorities to trains which have a known location.

Rationale:

The L3 Trackside must know the location of trains before it can issue them with a Movement Authority. This requirement is similar to that for a L2 System, however in the case of a L3 System without TTD it is more critical due to the complete reliance on Train Position Reports.

Guidance:

The term known location is from the L3 Trackside point of view, as defined in section 3.1 Train location.

Operational Rules: None

Engineering Rules: None

REQ-MA-2 [X2R1 D5.1: REQ-MA-2]

The L3 Trackside shall be able to issue a Movement Authority without a mode profile for a train up to the next obstruction.

Rationale:

This is to enable the maximum possible Movement Authority without a mode profile to be issued.

Guidance:

The Reserved Status Area will be created before the Movement Authority is extended.

The end of the locked Route is an obstruction for all ETCS Level 3 system types. For a Full Moving Block system, the Confirmed Rear End of the preceding train is an obstruction, as shown in Figure 43:

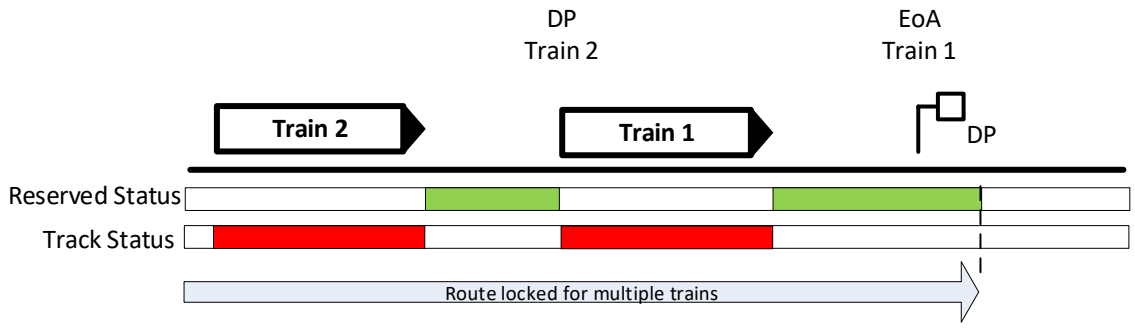

Figure 43: Two trains in the same route (FMB)

For a Fixed Virtual Block system, the rear of the Fixed Virtual Block occupied by the Confirmed Rear End of the preceding train is an obstruction, as shown in Figure 44:

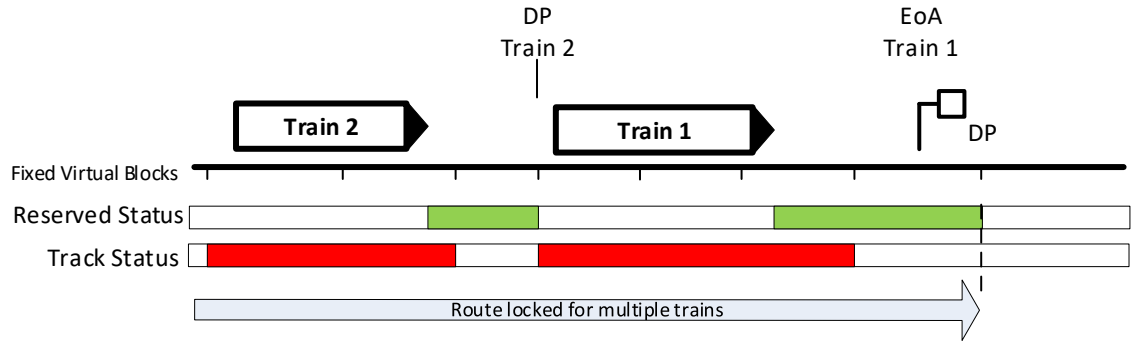

Figure 44: Two trains in the same route (FVB)

The Movement Authority will be subject to Engineering Rules, as in Level 2, and may not necessarily reach the next obstruction.

Operational Rules: None

Engineering Rules: None

REQ-MA-3	[New Requirement]

When providing a Movement Authority without a mode profile to a train following another train, the L3 Trackside shall use the following rules for the Movement Authority:

1) Danger Point should should be at or in rear of the CRE of the preceding train
2) There should be at least the distance of the L3 Margin between the EoA and the CRE

Rationale:

The CRE of the preceding train represents the further location where the Danger Point for the following train can be set.

The requirement uses L3 Margin whether Train 1 is stationary or moving. It is necessary to protect both trains if Train 1 is stationary and may roll back. It is included if Train 1 is moving in order to simplify the rule.

A train in Full Supervision should not be authorised to enter the area where a preceding train could enter by rolling backwards, hence the EoA is set a distance of L3 Margin from the CRE of the preceding train.

Applying L3 Margin between the Danger Point and End of Authority for Train 2 reduces the need for the L3 Trackside to react if Train 1 were to roll back.

Guidance:

This requirement is summarised in Figure 45:

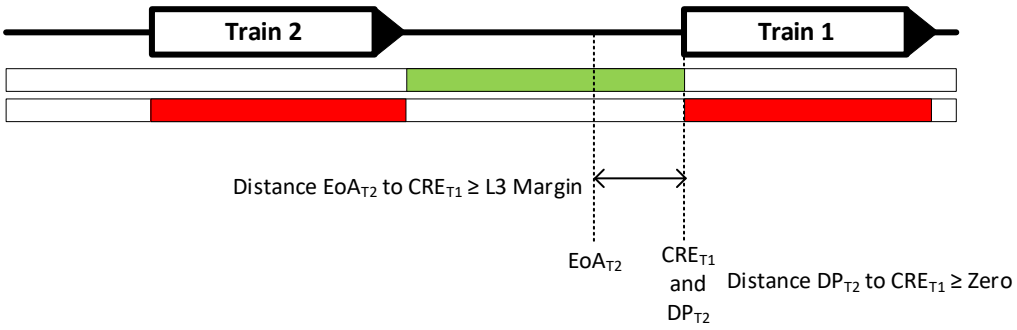

Figure 45: MA for one train following another

The DP may be greater than zero distance from the CRE of the forward train, in order to further reduce risk, after a risk assessment. The Release Speed may be set to zero, in order to further reduce risk, after a risk assessment.

If it is required to optimise for capacity, then it may be possible to create an algorithm for the application of L3 Margin between the Danger Point and End of Authority for Train 2, based on the speed of Train 1.

A solution with L3 Margin always added behind Train 1, and $EoA_{T2} = DP_{T2}$ is consistent with the End of Authority and Danger Point rules, as shown in Figure 46:

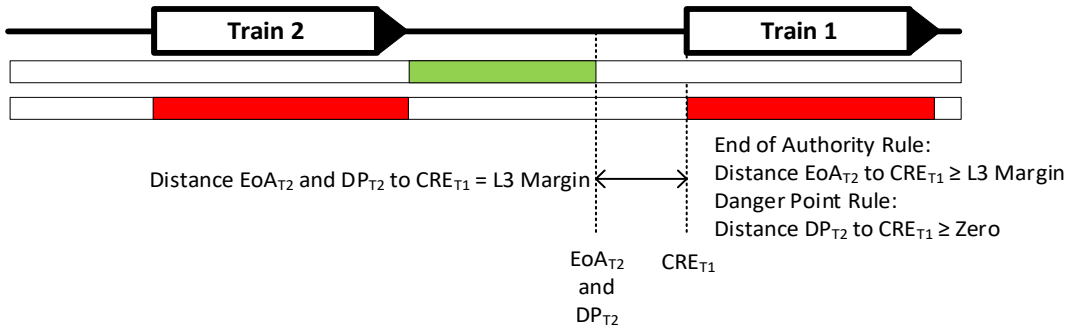

Figure 46: Solution always using L3 Margin behind preceding train

When the EoA is at the end of a Route, then the DP, EoA and Release Speed will be as engineered, in the same way as for Level 2, as shown in Figure 47:

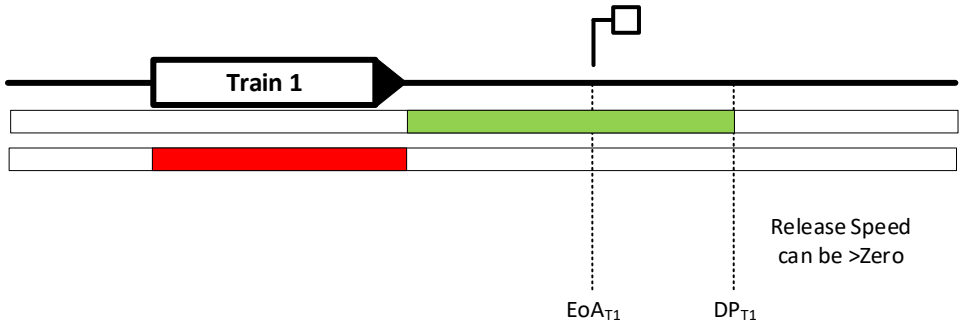

Figure 47: MA as engineered at end of a Route

Operational Rules: None

Engineering Rules: ENG-Generic-6

REQ-MA-4	[New Requirement]

When providing a Movement Authority without a mode profile for a train up to the boundary of an Unknown area, the L3 Trackside shall use the following rules for the Movement Authority:

1) Danger Point should Point should be at or in rear of the CRE of the preceding train
2) There should be at least the distance of the L3 Margin between the EoA and the CRE

Rationale:

The Unknown area could contain another train, for example after End of Mission.

A train in Full Supervision should not be authorised to enter the area where a preceding train could enter by rolling backwards, hence the EoA is set a distance of L3 Margin from the boundary of the Unknown area.

Guidance:

This requirement is summarised in Figure 48:

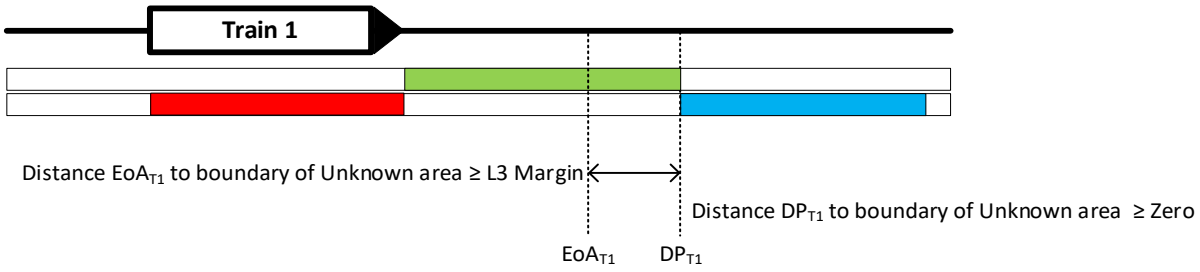

Figure 48: MA for train approaching Unknown area

The Release Speed may be set to zero, in order to further reduce risk, after a risk assessment.

Operational Rules: None

Engineering Rules: ENG-Generic-6

REQ-MA-5	[X2R1 D5.1: REQ-MA-3]

The L3 Trackside shall be able to issue Movement Authorities with mode profile On Sight over Unknown or Occupied Track Status Areas.

Rationale:

Unknown Track Status Areas may contain railway vehicles or other obstructions, so it is necessary for trains to proceed in On Sight mode.

Occupied Track Status Areas will contain at least one train, so it is necessary for trains to proceed in On Sight mode.

Guidance:

The passage of a train in On Sight mode, over a Sweepable Unknown Track Status Area, results in sweeping the track. The track will become Clear after the passage of a train with Train Integrity confirmed.

Extension of a Movement Authority in On Sight mode over an Occupied Track Status Area may be required in order to perform joining of trains. The location of the EoA when being authorised into an Occupied Track Status Area is project specific but should be such that it does not overlap with another Reserved Status Area (for example that of a Train to be Joined).

Operational Rules: OPE-OS-4; OPE-SH-3

Engineering Rules: None

REQ-MA-6	[New Requirement]

When providing a Movement Authority with an On-Sight mode profile to a train entering an Unknown or Occupied area, the L3 Trackside shall provide an On-Sight Mode Profile from a minimum distance of the L3 Margin from the CRE of the preceding train.

Rationale:

The On-Sight Mode Profile should start before the area where a preceding train could enter by rolling backwards.

Guidance:

This requirement is summarised in Figure 49 and Figure 50:

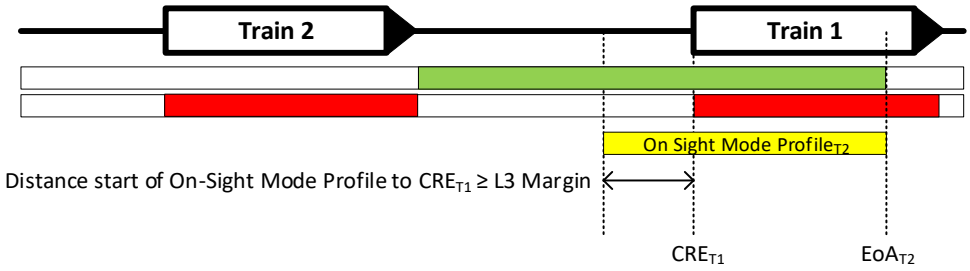

Figure 49: MA for train approaching a preceding train

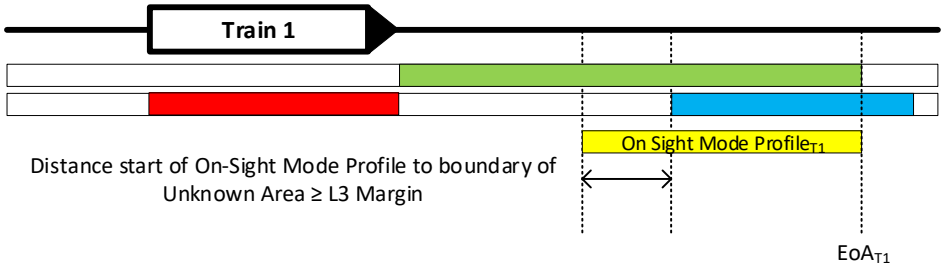

Figure 50: MA for train approaching an Unknown Area

In Figure 49, the End of Authority for Train 2 will be within Train 1 or beyond depending, on whether there is a Reserved Status Area for Train 1, see REQ-Reserved-5.

In the case where the train is already within the Unknown area, for example at Start of Mission within an Unknown area, this requirement does not apply.

Operational Rules: None

Engineering Rules: ENG-Generic-6

REQ-MA-7	[X2R1 D5.1: REQ-MA-4]

The L3 Trackside shall be able to issue a FS Movement Authority for a train to follow another train along the same path.

Rationale:

This is to allow multiple trains into the same route, thus facilitating railway operation for several trains travelling in the same direction one after another.

Guidance:

The same Route could be requested by the Traffic Management System. Subsequent trains will be allowed to enter the route when conditions are fulfilled and, in this way, follow the train in front in the moment it clears part of the track.

Operational Rules: None

Engineering Rules: None

REQ-MA-8	[X2R1 D5.1: REQ-MA-5]

For a system using Trackside Train Detection, the L3 Trackside shall allow multiple trains to enter in the same Trackside Train Detection section.

Rationale:

This is to facilitate railway operation, for example increasing the capacity of the line, or reducing the amount of Trackside Train Detection equipment required for a given capacity.

Guidance:

This requirement applies to both Full Moving Block and Fixed Virtual Block systems. Figure 51 illustrates this for a system with Fixed Virtual Blocks:

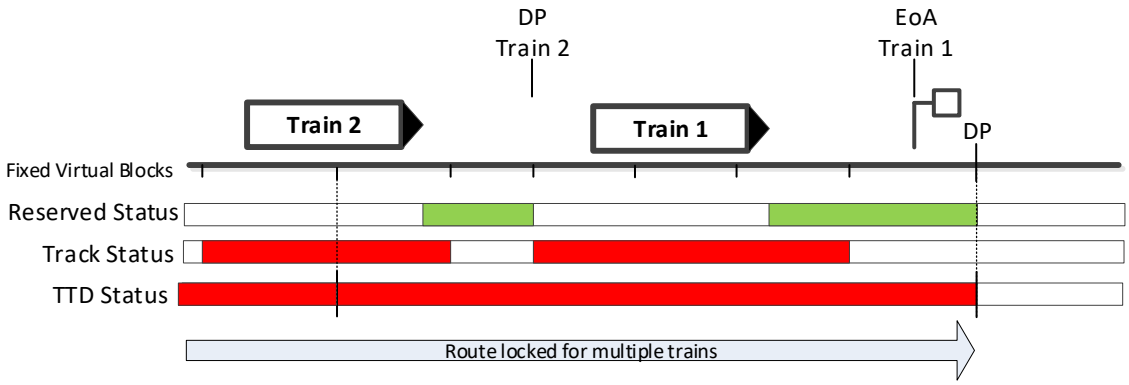

Figure 51: Two trains in the same route (FVB with TTD)

Operational Rules: None

Engineering Rules: None

REQ-MA-9	[X2R1 D5.1: REQ-MA-6]

The L3 Trackside shall be configurable to only issue Movement Authority updates relevant for operation of the railway.

Rationale:

Changes to the Movement Authority issued to a train cause recalculation of the speed supervision on board, and the results are displayed in the planning area. Frequent changes to the Movement Authority can therefore lead to distraction of the Driver. In accordance with 7.4.1.1 of ERA_ERTMS_015560, v3.60 [15560], if the train is in Target Speed Monitoring for the EoA then a sound is played each time the Most Restrictive Displayed Target is updated. The configuration should allow the Infrastructure Manager to prevent changes in the extent/content of Movement Authorities until a period of time has elapsed or the change in the extent of the MA has exceeded the predefined threshold.

Guidance:

A threshold, based on time or distance, could be established such that only MA updates that exceed these limits are issued. The Infrastructure Manager should select the time and distance criteria for sending updates of MA. The distance should be selected to reflect the type of railway and would be shorter for a frequent service. Exceptions to the time and distance selected may be required to allow for short MA extensions to be sent to allow a train to complete a mission.

In implementing such limits on the MA update, it will be important to bear in mind the potential impact this may have on ATO operation (if fitted). Limiting the MA update may result in degrading the service due to suboptimal speed curves being followed. Careful analysis therefore needs to take place to ensure the impact is minimised. An alternative, that would require a change to the current ETCS baseline [BL3 R2], would be to decouple the update of the MA from the alerts that the Driver receives.

Operational Rules: None

Engineering Rules: None

REQ-MA-10 [X2R1 D5.1: REQ-MA-7]

The L3 Trackside shall report the Movement Authorities issued to trains to the Traffic Management System.

Rationale:

This is so that the Traffic Management System has information on the Movement Authorities issued.

Guidance:

The report to the TMS will include the complete information about Movement Authorities.

Operational Rules: None

Engineering Rules: None

REQ-MA-11 [X2R1 D5.1: REQ-MA-8]

The L3 Trackside shall include Linking Information in Movement Authorities issued to trains.

Rationale:

Linking information improves the accuracy of position reports received from a train. Given the reliance on Train Position Reports in ETCS Level 3 Moving Block, it is critical that Linking Information is included.

Guidance:

None.

Operational Rules: None

Engineering Rules: ENG-Generic-9

REQ-MA-12 [X2R1 D5.1: REQ-MA-9]

If an area of track within a Reserved Status Area becomes Unknown before the L3 Trackside has authorised a train to proceed into that area, the L3 Trackside shall either:

a) include an OS mode profile for the Unknown Track Status Area

or

b) restrict the Authorisation to the start of the Unknown area

or

c) do not send the authorisation to the train

In addition, or alternately, the L3 Trackside shall inform the Traffic Management System of the situation.

Rationale:

An Unknown Track Status Area in a Reserved Area where a train is not yet authorised to run is not an immediate Hazard to the train. The train could be automatically authorised by L3 Trackside to sweep the Unknown Track Status Area or only after Dispatcher confirmation, depending on specific application requirements.

Guidance:

Projects may decide that the L3 Trackside should take an automatic reaction as well as informing the Dispatcher, or only inform the Dispatcher and await their input before the L3 Trackside takes further action.

Operational Rules: OPE-OS-5

Engineering Rules: ENG-OS-1

3.8 EoA Exclusion Area

3.8.1 Introduction

There may be areas of the railway where it is desirable that trains are not stopped by the authorisations from the L3 Trackside.

For example, consider:

- Powerless sections
- Level crossings
- Some tunnels or viaducts
- Points

By default, a Movement Authority can be extended to any location in the railway, and so a mechanism is required to ensure that a Movement Authority is not permitted to extend part way into an area where trains are not to be stopped.

This is called an “End of Authority (EoA) Exclusion Area”. When an EoA Exclusion Area is defined, the Level 3 Trackside will ensure that a train is able to completely leave the EoA Exclusion Area before extending the Movement Authority beyond the EoA Exclusion Area. This must consider the length of the train, to ensure its rear end does not infringe the EoA Exclusion Area.

Note that EoA Exclusion Areas are a separate concept to Non Stopping Areas as already defined in the ETCS specifications (SUBSET 026 3.12.1.3 [BL3 R2]). Non Stopping Areas are a type of track condition and, once transmitted to the ETCS On-Board, are handled by the train. By contrast, an EoA Exclusion Area is a L3 Trackside concept and the train will not be aware of it being imposed.

It may be beneficial to define concurrent Non Stopping Areas so that the ETCS On-Board can display the Non-Stopping areas to the Driver. The End of Authority Exclusion Area is then used by the L3 Trackside to ensure that any MA issued permits the train to proceed beyond the area, and the Non-Stopping area is used by the On-Board on the display to the Driver.

3.8.2 Requirements

REQ-EoAExclusionArea-1	[X2R1 D5.1: REQ-EoAExclusionArea-1]

The L3 Trackside shall use End of Authority Exclusion Areas defined in configuration data.

Rationale:

This is to avoid blocking points or level crossings with a train at standstill, preventing electric trains from stopping at powerless sections and any other operational issues resulting from stopping the train in certain areas of the track.

Guidance:

EoA Exclusion Areas need to be configured depending on the scenario. In addition, EoA Exclusion Areas could impact the performance of the line by over impeding the update of Movement Authorities and hence, at its extreme, impacting the service headway. Therefore, detailed analysis is required when configuring these areas.

Operational Rules: None

Engineering Rules: ENG-Generic-2

REQ-EoAExclusionArea-2	[X2R1 D5.1: REQ-EoAExclusionArea-2]

For a train approaching an EoA Exclusion Area, the L3 Trackside shall only issue an MA such that the train can proceed beyond the EoA Exclusion Area and stop with its rear end clear of the area, taking into account the length of the train and the defined L3 Margin distance.

Rationale:

This is to avoid the train having an MA finishing with any part of the train in an EoA Exclusion Area.

Guidance:

With ETCS Level 3 Full Moving Block, the L3 Trackside can potentially issue a Movement Authority to any location on the track. At certain locations it may not be suitable for a train to stop here. EoA Exclusion Areas enable these areas to be defined in the L3 Trackside and managed so that no part of a train stops in the area. Examples of where these areas may be defined are:

a) Tunnels and viaducts

b) Powerless sections

c) Points and Crossings (in particular at entry/exit of a station).

Figure 52 illustrates an example of an EoA Exclusion Area in operation:

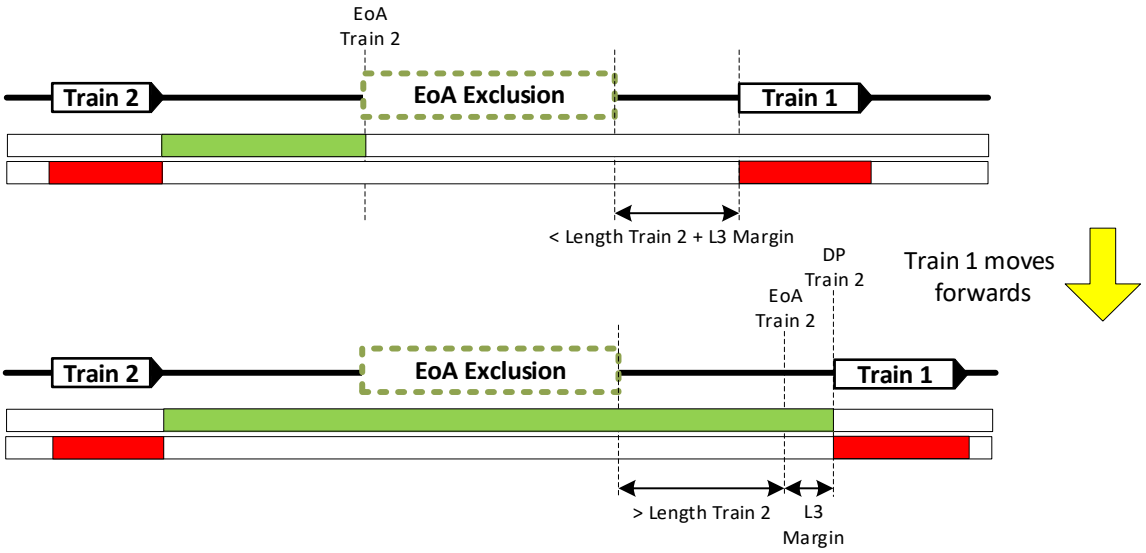

Figure 52: Example of an EoA Exclusion Area

Operational Rules: None

Engineering Rules: None

3.9 Start of Train

3.9.1 Introduction

The Start of Mission for a train in the L3 Area is similar to the procedure for a L2 area. However, there are differences due to trains only being detected when they send position reports.

When a train establishes a communication session with the L3 Trackside in the L3 Area, the L3 Trackside compares the information from the train to its history of that location of the track. If the received data matches that which has been previously stored, and the data stored is still valid, the L3 Trackside will decide that the train is the same and the previous Unknown Track Status Area is changed to an Occupied Track Status Area after having received confirmation of Train Integrity.

If the received data does not match, then only that part of the track corresponding to the newly received train data will become an Occupied Track Status Area, and any remaining Unknown Track Status Area will remain.

The L3 Trackside must be able to manage trains that are reporting Unknown or Invalid position during the Start of Mission. The efficiency of Start of Mission of a train which has entered 'No Power' mode within the area of control can be increased by using Cold Movement Detection.

3.9.2 Requirements

REQ-StartTrain-1 [X2R1 D5.1: REQ-StartTrain-1]

The L3 Trackside shall always accept a train during Start of Mission.

Rationale:

Regardless of if a train has an invalid/unknown position, the L3 Trackside shall accept and maintain a connection. For a train reporting a valid position, the L3 Trackside can determine whether or not this is within the Area of Control of the L3 Trackside. This requirement is to avoid hazards such as having a Ghost Train moving in the L3 area.

Guidance:

It could be configured to eventually disconnect the train after a timeout. Alternatively, the TMS could request the L3 Trackside to disconnect the communication if the train is not within its area of control.

Operational Rules: None

Engineering Rules: None

REQ-StartTrain-2 [X2R1 D5.1: REQ-StartTrain-3]

The L3 Trackside shall alert the TMS of a train that, in the Start of Mission position report, is reporting an invalid or unknown position, or a valid position from an NID_BG not known to the L3 Trackside.

Rationale:

A train reporting an invalid or unknown position may need to be located manually by the Traffic Management System. A train with an NID_BG not known to the L3 Trackside may need to be disconnected. As such the TMS needs to be made aware of this.

Guidance:

If the L3 Trackside is able to locate the train by some other means, then the TMS will not need to be notified.

Operational Rules: OPE-StartTrain-4; OPE-Generic-3

Engineering Rules: None

REQ-StartTrain-3 [X2R1 D5.1: REQ-StartTrain-4]

The L3 Trackside shall accept from the TMS a position assigned by the Dispatcher for a train which is reporting an invalid or unknown position, if this position lies within an existing Unknown Track Status Area.

Rationale:

This is to allow the TMS to locate the train on the track when the train position is otherwise not available. The position given by the TMS for the train should lie within an existing Unknown Track Status Area. If it does not, then either the dispatcher has made a mistake with the position entry, or there has been an undetected movement of the train.

Guidance:

The TMS will need to be able to provide the Dispatcher with facilities to enter a position of a train which is reporting an invalid or unknown position. This could be done by assigning a position for the front or rear end of the train. The L3 Trackside will then check that this position is within an existing Unknown Track Status Area and alert the Dispatcher via TMS if it is not. The event of the train not being located inside an existing Unknown Track Status Area should be highly unlikely, due to the L3 Trackside mechanisms for managing degraded situations and the operational rules for managing the movement of non-communicating trains.

The L3 Trackside could use Stored Information for Unknown Track Status Areas and compare this with data received from the train to aid with locating it in the L3 Area. The details of this are project specific.

For a system with TTD, this may help the system locate the train.

Operational Rules: OPE-StartTrain-3; OPE-StartTrain-4; OPE-StartTrain-5

Engineering Rules: None

REQ-StartTrain-4 [New Requirement]

The L3 Trackside shall alert the Dispatcher via the TMS about an approximate position assigned by the Dispatcher for a train which is reporting an invalid or unknown position, if this position lies outside an existing Unknown Track Status Area.

Rationale:

If the position assigned for a train by the Dispatcher is not inside any Unknown Track Status Area, then either the dispatcher has made a mistake with the position entry, or there has been an undetected movement of the train.

Guidance:

In addition to alerting the TMS to the situation, the L3 Trackside may be designed to take additional actions.
The Dispatcher might then, following specific operational rules project specific, either create an Unknown area to allocate the assigned location or assign a new location to that train.

Operational Rules: None

Engineering Rules: None

REQ-StartTrain-5 [New Requirement]

When accepting a position assigned for a train from the TMS, the L3 Trackside shall associate the train with the Unknown Track Status Area in which the train is positioned.

Rationale:

This is for the L3 Trackside to be able to recover the associated Unknown Track Status Area when receiving a position report with integrity confirmed after the train has read a balise group.

Guidance:

A train can only be given a position from the TMS in an area with Track Status Unknown.

Operational Rules: None

Engineering Rules: None

REQ-StartTrain-6	[X2R1 D5.1: REQ-StartTrain-5]

The L3 Trackside shall compare the new train data and train location information reported by a train performing Start of Mission against the information stored for the same location for a previous train.

Rationale:

This is to determine whether the train performing Start of Mission is the same train for which data was stored for the Unknown Track Status Area.

Guidance:

The mechanism should be designed so that comparison when a train has changed direction results in a match, so long as the train length is matched.

Operational Rules: None

Engineering Rules: None

REQ-StartTrain-7 [X2R1 D5.1: REQ-StartTrain-7]

If the L3 Trackside determines that the train location information from a train after performing Start of Mission does not match the stored information associated with the Unknown Track Status Area in which the train is located, then the L3 Trackside shall remove the Unknown corresponding to the area from the Min Safe Front End to the Max Safe Rear End of that train.

Rationale:

This is to ensure that any areas where there are remaining railway vehicles are protected by an Unknown Track Status Area.

Guidance:

Figure 53 below shows an example where the Train Location information does not match, and the Unknown Track Status Area is retained, except between the Min Safe Front End and Max Safe Rear End. This can result in a partial overlap of Occupied and Unknown at the front and/or rear end of the train. For the front part of the train REQ-TrackStatus-10 might apply and there will not be overlap of Track Status Areas.

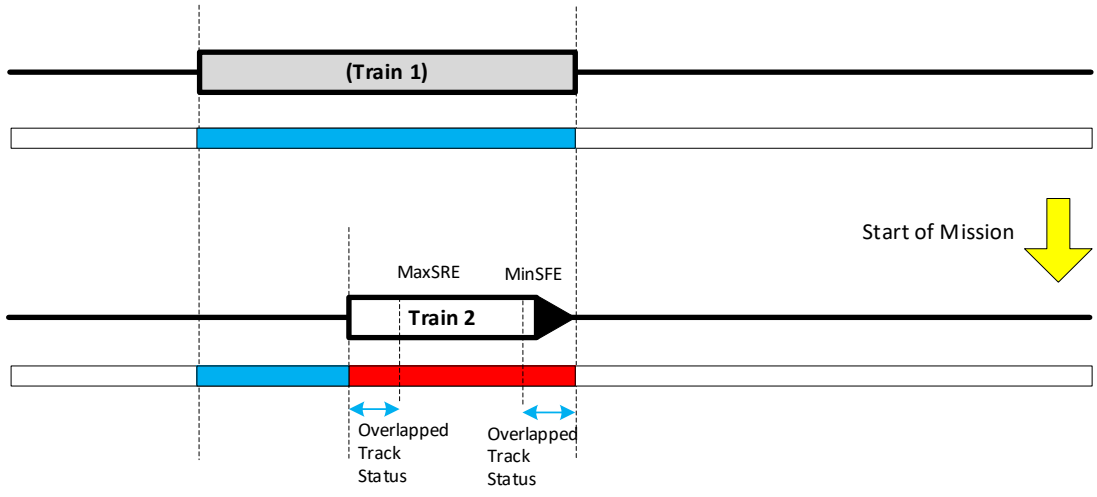

Figure 53: Start of Mission with Train Location which does not match

It is possible that the new Occupied Track Status Area can completely remove the Unknown Track Status Area. The new Occupied Track Status Area may also result in the existing Unknown Track Status Area being split into two separate areas. The L3 Trackside will need to manage these remaining Unknown Track Status Areas and the stored length associated with them should be shared between them.

Operational Rules: None

Engineering Rules: None

REQ-StartTrain-8 [New Requirement]

If a train, which has not yet sent Validated Train data, reports a position with both the Min Safe Front End and the Max Safe Front End in an area of track considered Clear, then the L3 Trackside shall create an Unknown Track Status Area for the front end of this train from the reported Min Safe Front End to Max Safe Front End.

Rationale:

A train reporting an unexpected position at Start of Mission is a potential hazard to the operation of the railway, and so the L3 Trackside must react immediately.

Guidance:

If Validated Train data has not yet been received, only the Estimated Front End and its Confidence Interval are known to the L3 Trackside.

This requirement details the minimum action the L3 Trackside must take. Specific applications may wish to apply additional measures, such as creating an area of unknown with a default length. This default length could be related to the configurable minimum length for the L3 Trackside automatically removing areas of unknown.

Figure 54 illustrates the L3 Trackside creating an Unknown Track Status Area for a train that reports outside any existing Unknown Track Status Area:

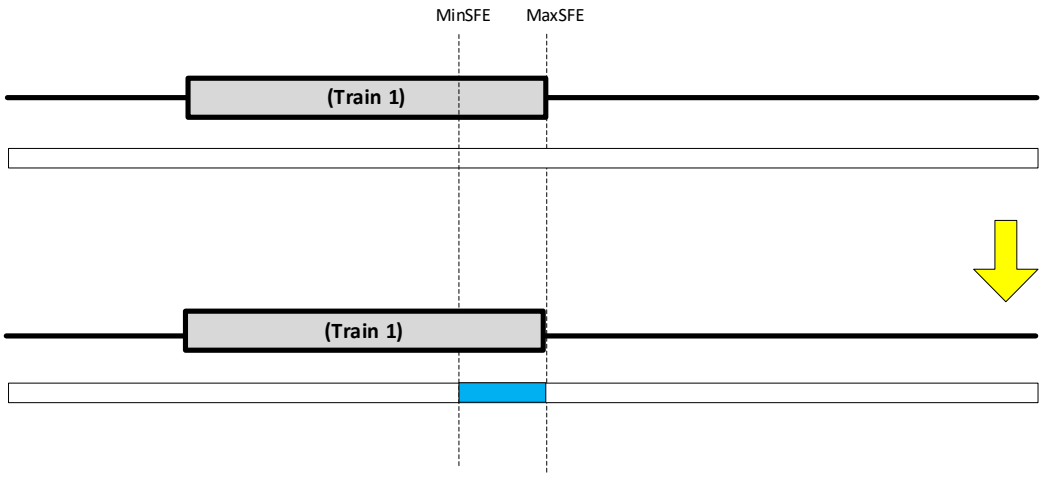

Figure 54: Train reports Estimated Front End and Confidence Interval in an area of Clear Track Status

Operational Rules: None

Engineering Rules: None

REQ-StartTrain-9 [New Requirement]

If a train, which has not yet sent Validated Train data, reports a position with a Confidence Interval which is partly in an Unknown Track Status Area and the Estimated Front End outside this Unknown Track Status Area, then the L3 Trackside shall extend this Unknown Track Status Area to the boundary of the reported Confidence Interval for the Estimated Front End of this train.

Rationale:

All trains must be protected by a Track Status Area created by the L3 Trackside. If a train reports at Start of Mission outside an existing Unknown Track Status Area, this area must be extended to protect the train's position.

Guidance:

As an example, during Splitting a train might have moved away ending up outside the Unknown Track Status Area created when reporting End of Mission. This must be considered when the train reports at Start of Mission. A change in the reported Confidence Interval (due to changing cabs) could be a possible reason for the reported train location being partially outside the existing Unknown Track Status Area.

Figure 55 illustrates an example of the L3 Trackside extending an existing Unknown Track Status Area:

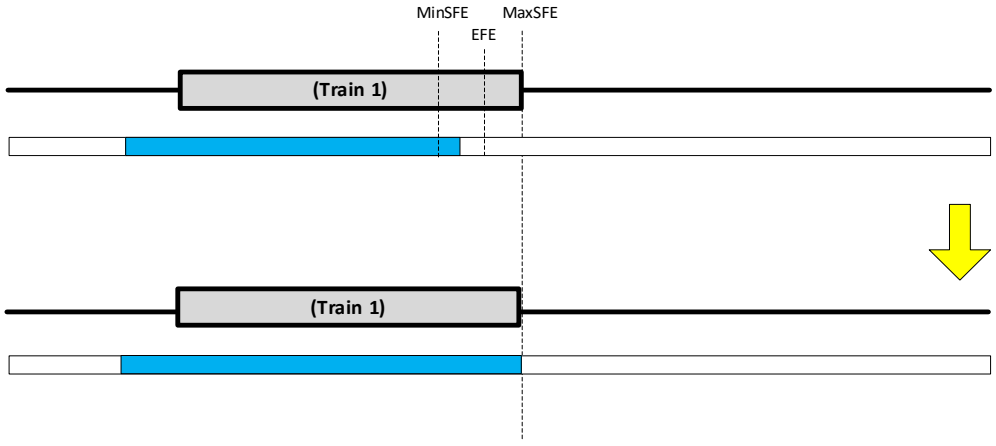

Figure 55: Train reports Estimated Front End and Confidence Interval partially inside existing Unknown Track Status Area

Operational Rules: None

Engineering Rules: None

REQ-StartTrain-10 [New Requirement]

When receiving Validated Train Data from a train which is not associated with an Unknown Track Status Area except for the Estimated Front End of this train, then the L3 Trackside shall extend this Unknown Track Status Area with the reported Train Length to the Min Safe Rear End.

Rationale:

This is to protect a train reporting an unexpected position. When extending this Unknown Track Status Area, it may overlap an existing area to which this train should have been associated.

Guidance:

Figure 56 gives an illustration of the L3 Trackside extending the Unknown Track Status Area initially created when Validated Train Data is received:

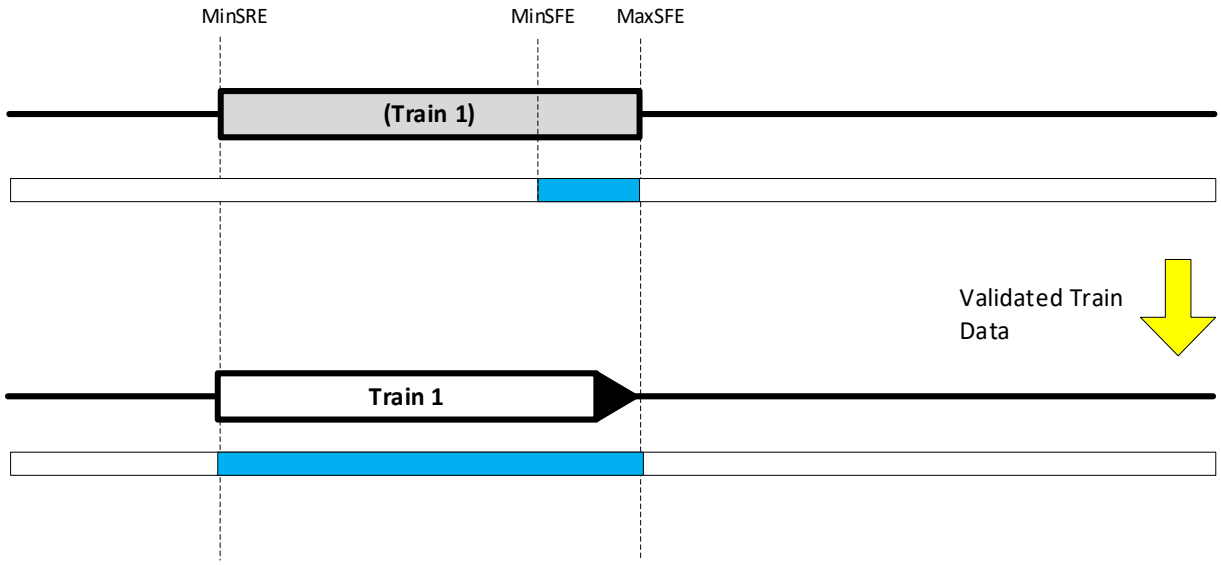

Figure 56: L3 Trackside receives Validated Train Data for a train and updates Track Status

The Unknown area created from Max Safe Front End to Min Safe Front End is the minimum extend needed, but projects may decide to extend of the Unknown area beyond the Min SRE.

Operational Rules: None

Engineering Rules: None

REQ-StartTrain-11 [New Requirement]

If the L3 Trackside receives Validated Train Data from a train with a position within an Unknown Track Status Area for which the stored train length is less than what was reported by this train, then the L3 Trackside shall alert the TMS to the situation.

Rationale:

If the length reported by a train is greater than expected by the L3 Trackside for an Unknown Track Status Area, it may mean there is another train operating in the area. This needs to be brought to the attention of the TMS.

Guidance:

An inconsistency in the reported length from a train and the length stored by the L3 Trackside could be due to an error in the stored data, or failure in the application of Operational Rules. The L3 Trackside may decide to take a protective reaction, such as extending an Unknown Track Status Area to cover the train location. This reaction is project specific.

Operational Rules: None

Engineering Rules: None

REQ-StartTrain-12 [New Requirement]

The L3 Trackside shall maintain the communication session with a train reporting an LRBG at Start of Mission with an ID set to ‘unknown’ or an ID which is not known to the L3 Trackside, unless requested by the TMS to terminate the session with this train.

Rationale:

This is to avoid the potential hazard of having a Ghost Train moving in the L3 Area.

Guidance:

The L3 Trackside will alert the TMS/Dispatcher on this situation and the Dispatcher may then either assign the train a position or conclude that this train is not in the L3 Trackside and request that the session is terminated.

Operational Rules: None

Engineering Rules: None

REQ-StartTrain-13 [New Requirement]

On request from the TMS, the L3 Trackside shall order the train to terminate the communication session.

Rationale:

It is beneficial to maintain the session with a train even if the train does not have a known position, as for the L3 Trackside this is the only means of being aware of the train. However, if a train is determined to be incorrectly connected to the L3 Trackside (e.g. it is confirmed to not be inside the Area of Control and there is not an ongoing Handover for that train) then the L3 Trackside needs the ability to disconnect and free the communication session for another train.

Guidance:

Projects may decide there are specific circumstances where the L3 Trackside can decide to disconnect a particular train, for example in Level Transition/Handover scenarios.

Operational Rules: None

Engineering Rules: None

REQ-StartTrain-14 [New Requirement]

The L3 Trackside shall, if configured, alert the TMS of a train which terminated its communication session without sending Validated Train Data to the L3 Trackside.

Rationale:

If a train disconnects without having sent Validated Train Data, then the L3 Trackside may be required to react by alerting the Dispatcher, as no L_TRAIN has been received to establish the location for this train.

Guidance:

The Dispatcher, following non-harmonised rules, may need to contact the Driver to ensure e.g. where this train is, whether it was a Driver’s mistake, etc.

Operational Rules: None

Engineering Rules: None

REQ-StartTrain-15	[New Requirement]

The L3 Trackside shall, if configured, alert the TMS about communicating trains for which the L3 Trackside has not received Validated Train Data after a defined timeout.

Rationale:

This is to enable an action that may be required when Validated Train Data has not been received from a communicating train.

Guidance:

The Dispatcher, following non-harmonised rules, may need to contact the Driver to ensure e.g. where this train is, whether it was a Driver's mistake, a train failure, etc.

Operational Rules: None

Engineering Rules: None

3.10 SR Movement

3.10.1 Introduction

Staff Responsible (SR) mode is the primary means of moving non-communicating trains or communicating trains without a known location. Authorisation to move in SR mode must therefore follow a defined procedure which is out of the scope of this document.

The Use of Staff Responsible can be categorised into three scenarios:

1) **Train without connection to the L3 Trackside:** In this scenario, the Driver must use the Override function to enter SR, as it cannot be authorised by the L3 Trackside. The Dispatcher may be able to establish a location for the train from the Driver and create an Unknown Track Status Area to protect the train and its subsequent movement. No additional functionality is required from the L3 Trackside.
2) **Train has a connection to the L3 Trackside but cannot be located due to invalid/unknown position**: In this scenario, the Dispatcher must enter an estimate for the train location to the L3 Trackside and protect the path the train will take with an Unknown Track Status Area. The L3 Trackside can then authorise the train for movement in SR with an SR distance to the end of the Unknown Track Status Area. The objective of this operation is to permit the train to move such that it can establish a known location.
3) **Train has a connection to the L3 Trackside and can be located, but it is not possible to issue an MA**: In this scenario, the L3 Trackside can calculate the SR distance and a list of Balises that can be passed before authorising the train for movement in SR.

In the third scenario, there is the possibility that the L3 Trackside is still not able to authorise SR movement (due to an obstruction for example). In this case, the driver must still use the override functionality following operational procedures.

3.10.2 Requirements

REQ-MovSR-1 [New Requirement]

Following an MA Request from a train located in rear of an adjacent Unknown Track Status Area created by the TMS and not used for another train, the L3 Trackside shall be able to provide an SR Authorisation to this train with the distance to run limited to the Unknown Track Status Area.

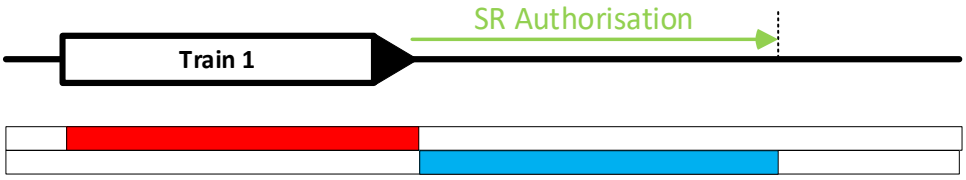

Figure 57: SR Authorisation up to the end of an Unknown area

Rationale:

This is to enable a train to pass an area which cannot be reserved, for example if points are not controlled.

Guidance:

This requirement applies both to trains with a known position and to trains with a position assigned by TMS/Dispatcher. However, it should be noted that the location for a train that moves from a position given by the Dispatcher will not be updated until the L3 Trackside receives a position report with a known LRBG.

The distance permitted to move in an SR Authorisation is based on the extent of an area in front of the train which is used to protect this movement.

Projects may decide on providing a shorter distance than that of the area in front of a train if the SR authorisation is intended for the train to read a balise group and get a known LRBG. In that case, it is recommended to give a distance such that the train can pass at least one balise group, or two if the first is a single balise group.

Projects may also decide on a longer distance when, in front of a train, there is a short Unknown Track Status Area followed by a Reserved Area intended for the same train.

Operational Rules: None

Engineering Rules: ENG-MovSR-1

REQ-MovSR-2 [X2R1 D5.1: REQ-MovSR-3]

For a train with a known location, the L3 Trackside shall maintain the previous CRE of a train in SR mode from when the train reports in SR until the train transitions out of SR to FS/OS mode and reports with Train Integrity confirmed.

Rationale:

When the train is in SR mode, Balise Linking information is not available. As a result, the CRE is not updated until the train transitions to FS.

There is a risk that the CRE is updated incorrectly due to the train relocation function.

Guidance:

For trains with a known location, but which have not confirmed Train Integrity, there will be no CRE. In this case the Track Status will be Unknown, and the previous boundary of the Unknown Track Status Area should be maintained, as described by the functionality in section 3.17 Loss of Train Integrity.

Operational Rules: None

Engineering Rules: None

REQ-MovSR-3 [New Requirement]

Following an MA Request from a train with a position given by the Dispatcher in rear of an adjacent Reserved Status Area, the L3 Trackside shall be able to provide an SR Authorisation to this train with the distance to run within the Reserved Status Area.

Rationale:

This is for moving a train in SR mode to read a balise group and establish a known position.

Guidance:

The distance permitted to move in an SR Authorisation is based on the extent of an area in front of the train which is used to protect this movement.

Projects may decide on providing a shorter distance than that of the Reserved Area in front of a train if the SR authorisation is intended for the train to read a balise group and get a known LRBG. In that case, it is recommended to give a distance such that the train can pass at least one balise group, or two if the first is a single balise group.

Operational Rules: None

Engineering Rules: ENG-MovSR-1

REQ-MovSR-4 [New Requirement]

When giving an SR Authorisation to a train with a position given by the Dispatcher, the L3 Trackside shall, if possible, include a list of balise groups the train is allowed to pass in the given authorisation.

Rationale:

Providing a list of balises together with an SR Authorisation reduces the potential risk that a train moves in a track where it is not expected to be, especially when there is no TTD.

Guidance:

The number of balise groups provided to be included in this list is project specific but should include the balise groups expected to be passed when moving in SR mode, if any.

Operational Rules: None

Engineering Rules: None

REQ-MovSR-5 [New Requirement]

When giving an SR Authorisation for a Reserved Status Area to a train with a position given by the Dispatcher, the L3 Trackside shall extend the Unknown Track Status Area associated with this train to the end of the Reserved Status Area.

Rationale:

This is to protect the movement of the train and to allow for the L3 Trackside to recover the Unknown Track Status Area when receiving a position report with integrity confirmed after the train has read a balise group.

Guidance:

None.

Operational Rules: None

Engineering Rules: None

3.11 First MA

3.11.1 Introduction

This section includes requirements which are specific to the first Movement Authority issued to a train.

3.11.2 Requirements

REQ-FirstMA-1 [X2R1 D5.1: REQ-FirstMA-1]

The L3 Trackside shall be able to send a first FS Movement Authority to a train anywhere in the Area of Control, so long as the conditions for sending a Movement Authority are fulfilled.

Rationale:

The first FS Movement Authority can be sent with the train located anywhere in the line since L3 Trackside knows the Consolidated Track Status of the Area of Control.

Guidance:

The conditions for sending a Movement Authority are defined in section 3.7.

Operational Rules: None

Engineering Rules: None

REQ-FirstMA-2 [X2R1 D5.1: REQ-FirstMA-2]

The L3 Trackside shall be able to, if configured, provide the first MA for a train even if there is no integrity information or the integrity is confirmed by driver.

Rationale:

This is to enable trains without integrity to still be moved under the supervision of ETCS. This may be to move them into a siding so that the impact to operations is minimised. However, this could have operational impact on a following train in case integrity remains unconfirmed.

Guidance:

The Infrastructure Manager may wish to configure the L3 Trackside such that the Traffic Management System must first authorise the Movement Authority, having been notified of the train requesting a Movement Authority without confirmation of Train Integrity.

Confirmation may also be required if the Train Integrity is confirmed by the Driver, rather than by TIMS.

This requirement applies both in the situation of a train performing Start of Mission, or a train approaching the L3 Area in a Transition scenario.

Operational Rules: OPE-StartTrain-2; OPE-REC-1

Engineering Rules: ENG-Generic-10; ENG-LossTI-3; ENG-LossTI-4

3.12 Loss of Communication

3.12.1 Introduction

Following Loss of Communications, the area of track in front of the train is considered to have Track Status Unknown, as the train may be anywhere between the last Confirmed Rear End of the train and the most recent End of Authority.

If the communication session is restored, then the Track Status will be recovered, after checks that the new communications are for the same train, same length – as explained in section 3.9.

If the communication session is not restored, or communication is restored but the train is not recognised as the same train, then the Track Status will remain Unknown, and it will need to be cleared by some other method.

3.12.2 Requirements

REQ-LossComms-1	[X2R1 D5.1: REQ-LossComms-1]

The L3 Trackside if configured, shall for each train with which it has an active communication session be able to supervise a defined timeout (a Mute Timer) after which the communication with this train is considered lost.

Rationale:

This is to enable the L3 Trackside to react faster to the potential loss of communication with an ETCS On-board than the timeout in the ETCS specifications. The ETCS specification timer of 5 minutes might be considered too long for some ETCS Level 3 Moving Block systems.

Guidance:

This is an optional functionality to be defined at application level based on the needs of the system. The value of the Mute timer will be longer than the variable T_NVCONTACT and shorter than the communication session expiry, as defined in [SS026].

Operational Rules: None

Engineering Rules: ENG-LossComms-1

REQ-LossComms-2	[New Requirement]

When receiving a message from a train and if the use of a Mute Timer is configured, the L3 Trackside shall (re-)start the Mute Timer for this train.

Rationale:

This is for the L3 Trackside to be able to react if a message from the train is not received within a configured time.

Guidance:

If a Mute Timer is configured it is only active when there is a communication session with the train.

Operational Rules: None

Engineering Rules: ENG-LossComms-1

REQ-LossComms-3	[X2R1 D5.1: REQ-LossComms-2]

The L3 Trackside will maintain the communication session with ETCS On-board as active even when the Mute timer has expired until the maximum time to maintain a communication session as specified in SUBSET-026 [BL3 R2] has elapsed.

Rationale:

Between the expiry of the Mute timer and the expiry of the session timer, the L3 Trackside will treat the train as having lost communications. However, it will maintain the session during this period in case the train regains communications.

Guidance:

This requirement is already part of the ETCS specifications [BL3 R2]. However, it is important to reiterate this behaviour of the L3 Trackside due to the new Mute timer functionality introduced.

Operational Rules: None

Engineering Rules: None

REQ-LossComms-4 [X2R1 D5.1: REQ-LossComms-3]

When the Mute timer expires for a train which has not been sent Reversing Area Information, nor entered an announced Radio Hole, then the L3 Trackside shall change the Track Status Area associated with the train to Unknown and extend this Area until the end of the Reserved Status Area for the train.

Rationale:

This is the area where the non-communicating train could be located, and as such needs to be protected.

Guidance:

If the extent of the MA sent to the train is less than the full Reserved Status Area, then the extension of the Track Status Area may only be to the end of the MA sent to the train.

The criteria for establishing whether a train has entered a Radio Hole are project specific and could include the train having received radio hole track condition information from the L3 Trackside.

Operational Rules: None

Engineering Rules: None

REQ-LossComms-5 [X2R1 D5.1: REQ-LossComms-4]

If the Mute timer is not considered for use on a particular application, the L3 Trackside shall react when the session timer expires by setting the Track Status Area associated with the train to Unknown and extend this Area until the end of the Reserved Status Area for that train.

Rationale:

This is so that, even for applications not utilising the Mute timer functionality, the Trackside is protected when communications with a train expire according to the existing session expiry timer in the ETCS specifications [BL3 R2].

Guidance:

Whether or not to use the Mute timer will depend on whether it is required to detect loss of communications before expiry of the session timer. This in turn will depend on traffic density and the typical speed of trains.

Operational Rules: None

Engineering Rules: None

REQ-LossComms-6	[New Requirement]

When the L3 Trackside considers the communication session with a train is terminated, then the L3 Trackside shall remove any Reserved Status Area associated with this train.

Rationale:

If the session is terminated with a train, it is no longer necessary to keep any remaining Reserved Status Area associated with this train as the authorisation to use it is deleted in the ETCS On-Board.

Guidance:

This requirement applies in multiple situations, for example:

- session termination at End of Mission
- session termination due to expiration of the maximum time to maintain a communication session

Operational Rules: None

Engineering Rules: None

3.13 Recovery management after loss of communication

3.13.1 Introduction

Fast recovery of the railway state after a train has lost communication is key to ensuring availability of the ETCS Level 3 Moving Block system. After a train reconnects following loss of communications, the Track Status can be recovered from Unknown to enable continuation of normal railway operation. The use of stored information can enable track with Track Status previously considered ‘Unknown’ to be cleared.

The method based on stored information depends upon the train reconnecting being recognised as identical to the one that originally lost communications.

In recovery from a loss of communications two scenarios can occur:

- reconnection within the same session
- reconnection after session expiry.

Reconnection after session expiry is in principle the same as a train performing Start of Mission (described in section 3.9 Start of Train). However, the L3 Trackside considers this scenario differently due to the following:

- The Unknown Track Status Area could be large, as it extends from the previous CRE to the End of Authority

- The session expired rather than being terminated.

If the train reconnecting cannot be confirmed as the same train as the one that lost communications, for example due to a difference in the train data, then the Track Status must be recovered using different procedures, such as running a train in On Sight to sweep the Unknown Track Status Area.

3.13.2 Requirements

REQ-RecoveryMgmt-1	[X2R1 D5.1: REQ-RecoveryMgmt-1]

The L3 Trackside shall consider a train which starts communicating with the L3 Trackside within the same communications session as previously used for the train as the same train, so long as no change in train data has occurred.

Rationale:

The L3 Trackside is certain that this is the same train, as it is using the same communication session. The Track Status of the affected area can be recovered and the train can continue to run.

Guidance:

This situation will either occur after expiry of the mute timer in REQ-LossComms-1, but before expiry of the communications session, or when a train exits a Radio Hole before the Radio Hole timer expires, i.e. before the train is treated as if there is a loss of communication.

The changes in Track Status following recovery of communications are provided in requirement REQ-RecoveryMgmt-3 below.

It can be assumed that it is the same train if the train continues to report Train Integrity, because Change Request 940 [CR940] ensures that Train Integrity reporting can only be done if the train data has been acknowledged. If the train is still reporting integrity, and train data has not been revalidated, then no change of train length has occurred.

Operational Rules: None

Engineering Rules: None

REQ-RecoveryMgmt-2	[X2R1 D5.1: REQ-RecoveryMgmt-2]

The L3 Trackside shall consider a train reconnecting with a new communications session as the same train after passing the following checks:

a) the train has the same ID (NID_ENGINE) AND

b) the train has the same length (L_TRAIN).

Rationale:

If the L3 Trackside is certain that this is the same train, the Track Status of the associated area can be recovered and the train can continue to run.

Guidance:

This situation will occur after expiry of the session timer referred to in REQ-LossComms-3, if the ETCS On-board closes the connection and redials the L3 Trackside, during an initialisation of the L3 Trackside, or when a train exits a Radio Hole before the Radio Hole timer expires, i.e. before the train is treated as if there is a loss of communication.

This situation is similar to Start of Train, i.e. that the train is associated with an Unknown Track Status Area in the track.

The changes in Track Status following recovery of communications are provided in requirement REQ-RecoveryMgmt-3 below.

Operational Rules: None

Engineering Rules: None

REQ-RecoveryMgmt-3	[X2R1 D5.1: REQ-RecoveryMgmt-3]

If the L3 Trackside determines that the same train has reconnected and confirmed Integrity, the L3 Trackside shall update the Unknown Track Status Area associated with this train, resulting from the Loss of Communications to an Occupied Track Status Area with an extent corresponding to the new train location.

Rationale:

If the L3 Trackside is certain that this is the same train, after loss of communications or Trackside Initialisation, the train location can be determined based on train position information and the rest of the affected Unknown Track Status Area can be cleared.

Guidance:

When the Unknown Track Status Area resulting from the Loss of Communications is updated to an Occupied Track Status Area corresponding to the new train location, then that parts of the Unknown Track Status Area not within the Occupied Track Status Area will become Clear. Figure 58 highlights the areas of track that will transition Unknown to Clear, and Unknown to Occupied:

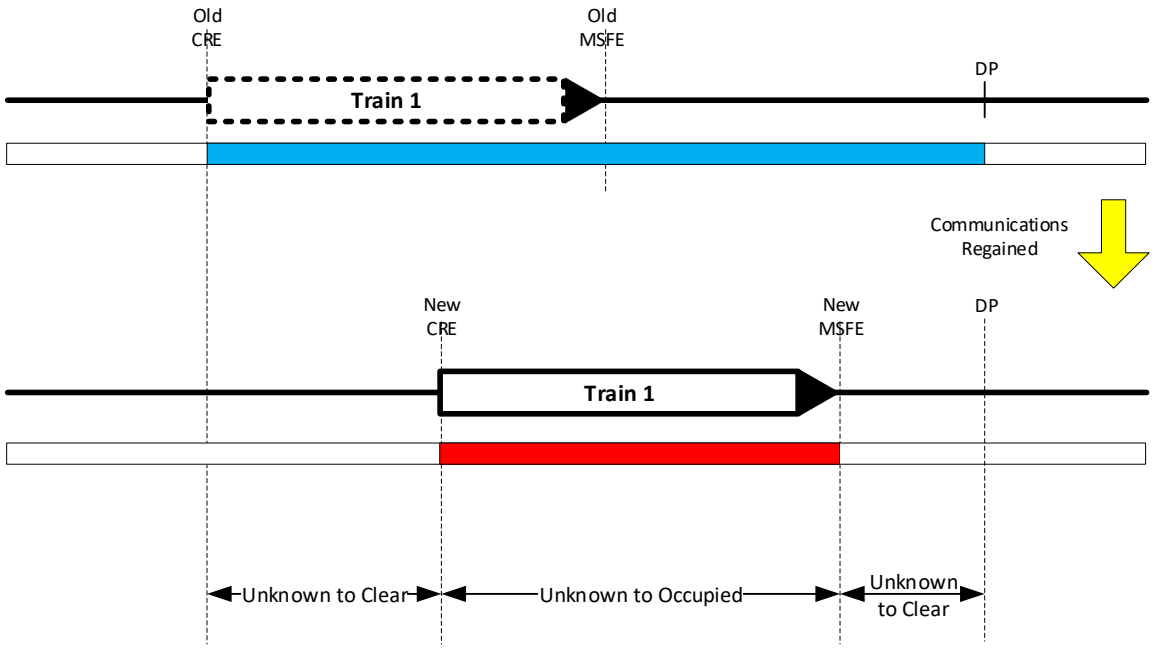

Figure 58: Unknown to Clear and Occupied following reconnection of communications

If, before the loss of communications, there was part of a Sweepable Unknown Track Status Area between the previous CRE and the new mSFE, that would be removed.

If, before the loss of communications, there was part of a Sweepable Unknown Track Status Area in front of the new mSFE, that would remain.

Operational Rules: None

Engineering Rules: None

3.14 Radio Hole

3.14.1 Introduction

Due to the reliance on radio communication, the L3 Trackside must manage the issue of Radio Holes in a safe manner. The lack of TTD requires additional system functionality over that defined at ETCS L2.

The L3 Trackside can handle two types of Radio Hole:

a) Permanent: present in the communications system since the L3 Trackside was commissioned

b) Temporary: occur after the L3 Trackside is commissioned. These may be transient or become permanent.

Temporary Radio Holes are predefined in the L3 Trackside when the system is commissioned, according to the location of radio transmitters and their coverage of the railway. They are then activated or deactivated by the TMS when a failure of the radio network infrastructure occurs.

To manage a Radio Hole, the L3 Trackside has two key functionalities:

a) An End of Authority Exclusion Area will be defined such that a train cannot obtain an EoA within the Radio Hole

b) The L3 Trackside will store information regarding when a train enters a Radio Hole, and alert the Traffic Management System if, after a pre-set timer has expired, the train has not reported clear of the area.

The concept of Radio Holes is already present in the existing ETCS specifications as a type of track condition transmitted to the ETCS On-board from the Trackside. It is expected that this functionality is implemented in parallel to the L3 Trackside functionality described here.

3.14.2 Requirements

REQ-RadioHole-1 [X2R1 D5.1: REQ-RadioHole-1]

On request from the TMS, the L3 Trackside shall activate or deactivate predefined Temporary Radio Holes.

Rationale:

Since this is a temporary issue, the trigger to activate the Temporary Radio Hole has to come from the Traffic Management System.

Guidance:

This is an optional requirement. Temporary Radio Holes are predefined in the L3 Trackside, ready for activation by the TMS if required.

Operational Rules: OPE-LossComms-2; OPE-LossComms-3

Engineering Rules: ENG-RadioHole-2

REQ-RadioHole-2 [X2R1 D5.1: REQ-RadioHole-2]

The L3 Trackside shall establish an End of Authority Exclusion Area for each Radio Hole.

Rationale:

To avoid a train reaching an End of Authority in a Radio Hole and not being able to proceed (except in SR).

Guidance:

None.

Operational Rules: None

Engineering Rules: None

REQ-RadioHole-3 [New Requirement]

The L3 Trackside shall remove the End of Authority Exclusion Area created for a Temporary Radio Hole if the Radio Hole is deactivated.

Rationale:

To return to normal operation once the Radio Hole does not longer exits.

Guidance:

None.

Operational Rules: None

Engineering Rules: None

REQ-RadioHole-4 [New Requirement]

The L3 Trackside shall start the Radio Hole timer when a train enters a Radio Hole.

Rationale:

This is to monitor a train that has entered a Radio Hole and alert the Dispatcher if the train does not emerge from it before the Radio Hole timer expires.

Guidance:

The criteria for determining when a train has entered a Radio Hole are project specific and could include (not exhaustive):

- the reception of a position report with the max safe front end having passed the start location of the Radio Hole.
- Mute timer expiry following sending radio hole track condition information to the train.

Projects may decide to re-start the Radio Hole timer if the train reports again and its Min Safe Front End has not yet entered the Radio Hole.

Operational Rules: None

Engineering Rules: ENG-RadioHole-1

REQ-RadioHole-5	[New Requirement]

While the L3 Trackside considers that a train is inside a Radio Hole, the L3 Trackside shall stop supervising the following timers:

- Mute timer Section 3.12
- Integrity Wait Timer 3.17
- ETCS session timer Section 3.12

Rationale:

When a train is in a Radio Hole there is no point waiting for messages from it.

Guidance:

When the L3 Trackside stops supervising a timer, no reaction is taken if the timer subsequently expires.

If any message is received while the train is in a Radio Hole, projects may decide to use it i.e. update train location but not for re-starting the timers mentioned in this requirement.

Operational Rules: None

Engineering Rules: None

REQ-RadioHole-6	[X2R1 D5.1: REQ-RadioHole-4]

Upon expiry of the Radio Hole timer, the L3 Trackside shall treat the train the same as for loss of communications.

Rationale:

This is because there could be a train unable to contact the L3 Trackside to proceed with its movement: either because it has suffered a failure within the Radio Hole, or it has failed to reconnect upon exiting the Radio Hole.

Guidance:

Figure 59 below shows the creation of the Unknown Track Status Area after expiry of a Radio Hole Timer:

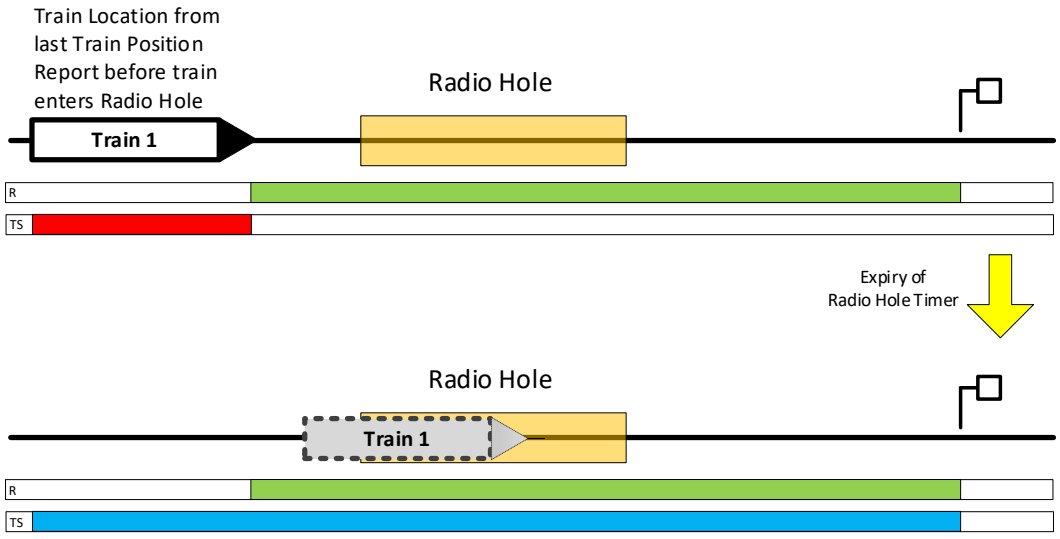

Figure 59: Unknown Area after expiry of Radio Hole Timer

Operational Rules: None

Engineering Rules: None

REQ-RadioHole-7	[X2R1 D5.1: REQ-RadioHole-5]

Upon expiry of the Radio Hole timer, the L3 Trackside shall inform the TMS that a train has not emerged from a Radio Hole.

Rationale:

This is because there could be a train unable to contact the L3 Trackside to proceed with its movement: either because it has suffered a failure within the Radio Hole, or it has failed to reconnect upon exiting the Radio Hole.

Guidance:

Alternatively, operational procedures can be defined based on an application specific solution or use TTD at the borders of the Permanent Radio Hole area.

Operational Rules: OPE-LossComms-4

Engineering Rules: None

REQ-RadioHole-8	[New Requirement]

The L3 Trackside shall stop the Radio Hole timer when a train has left a Radio Hole.

Rationale:

This is to avoid a reaction by the L3 Trackside when the train has managed to exit the Radio Hole.

Guidance:

The criteria for determining when a train has left a Radio Hole are project specific and could include the detection of the Max or Min Safe Front End of the train at or beyond the boundary of the Radio Hole.

Operational Rules: None

Engineering Rules: ENG-RadioHole-1

3.15 Reverse movement

3.15.1 Introduction

Due to the fact that Movement Authorities can be issued up to the rear of a preceding train, reversing in L3 needs additional consideration. Prior to a train being authorised to commence a reversing manoeuvre, the L3 Trackside shall ensure that there is a Reserved Status Area for the train in rear of the train, to avoid it being authorised for use by another train.

This section covers movements in RV mode.

3.15.2 Requirements

REQ-Rev-1 [X2R1 D5.1: REQ-Rev-1]

When a train has been given Reversing Area information, the L3 Trackside shall prevent authorising other trains into the area where the train may reverse.

Rationale:

This is to avoid sending a Movement Authority into an area where a train has already been authorised to reverse.

Guidance:

This can be achieved by retaining the Reserved Status Area in rear of the Reversing Area reserved until the train has passed the end of the Reversing Area. This location is referred to as the “Boundary for Reversing”. The L3 Trackside will start maintaining the Reserved Status Area at this location when the trFain's MSFE has passed this location. Projects may decide alternative mechanisms for protecting a train that may perform reversing.

Figure 60 illustrates the extent of the Reserved Status Area to be retained, including the Reversing area, Reversing distance and an additional Reversing Margin. The Reversing Margin considers the length of the train permitted to reverse and an estimated distance for the train to brake to stop if overpassing the permitted reversing distance.

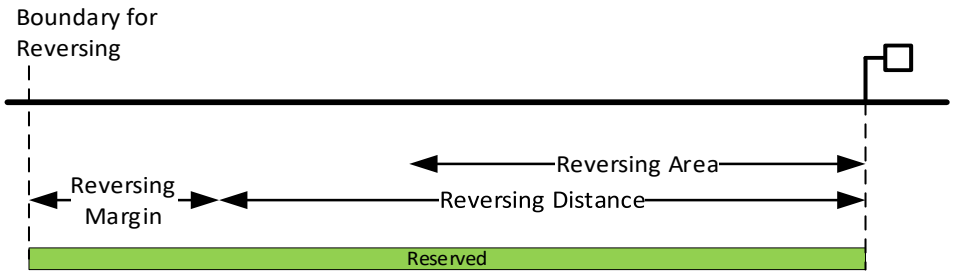

Figure 60: Reserved Status Area for a Reversing Area

Figure 61 shows the exception for updating a Reserved Status Area for a train with its Max Safe Front End past the Boundary for Reversing:

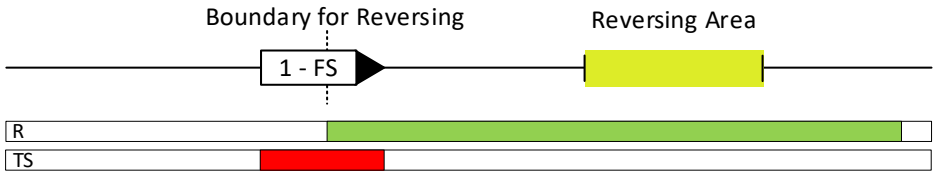

Figure 61: Explanation of Reserved Area for a train having passed the Boundary for Reversing

In the special case of a train performing SoM, with a Reversing Area in advance of its location and its CRE past the Boundary for Reversing, the L3 Trackside may have to establish the Reserved Area to start at the Boundary for Reversing. This is illustrated in Figure 62. Alternatively, projects may decide to use an alternative solution to this problem.

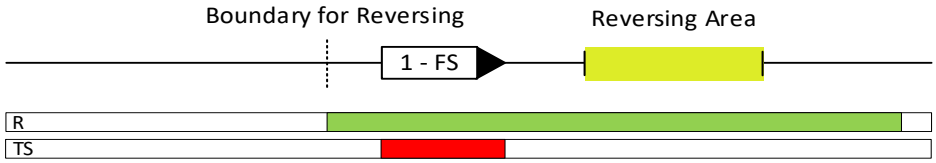

Figure 62: Explanation of relation between Boundary for Reversing and Reversing Area

Operational Rules: None

Engineering Rules: None

REQ-Rev-2 [X2R1 D5.1: REQ-Rev-2]

The L3 Trackside shall only extend the permission to reverse (by increasing the Reversing Distance) when the extension is already covered by the Reserved Status Area in rear of the train.

Rationale:

This is to avoid unforeseen impact on other movements.

Guidance:

The L3 Trackside may decide to only give the first part of the possible Reversing Distance and extend it later, if needed. However, if the full Reversing Distance was not reserved at first, then it is not possible to extend it unless also this part is Reserved.

Operational Rules: None

Engineering Rules: None

REQ-Rev-3 [X2R1 D5.1: REQ-Rev-3]

When a train has proceeded beyond the Reversing Area, the L3 Trackside shall release the Reserved Status Area behind the train.

Rationale:

This is to release this part of the railway for other train movements.

Guidance:

None.

Operational Rules: None

Engineering Rules: None

REQ-Rev-4	[New Requirement]

When receiving a position report from a train in RV mode, the L3 Trackside shall change the Track Status to Unknown for the area from the Max Safe Front End to the Boundary for Reversing.

Rationale:

A train in RV mode will no longer report integrity confirmation, nor will linking information be available. As such, its exact position will not be known. In addition, setting this area of track to Unknown protects the train for when it performs EoM after completing the Reverse Movement, when the Reserved Area is removed.

Guidance:

Once a train has reported in RV mode, its position can no longer be accurately located. As such, the L3 Trackside should consider the possible area it occupies as Unknown. This also ensures that when the train performs an EoM and subsequent SoM, a second train is not authorised into the area the first train will subsequently be authorised for. As the train continues to send position reports, the Unknown area extent can be updated with the reported Max Safe Front End.

When a train reports in RV mode, the L3 Trackside could decide to shorten the Reserved Status Area for the train by shortening the area in front of the train to the Max Safe Front End of this train. This is left as project specific whether the L3 Trackside decides to do this.

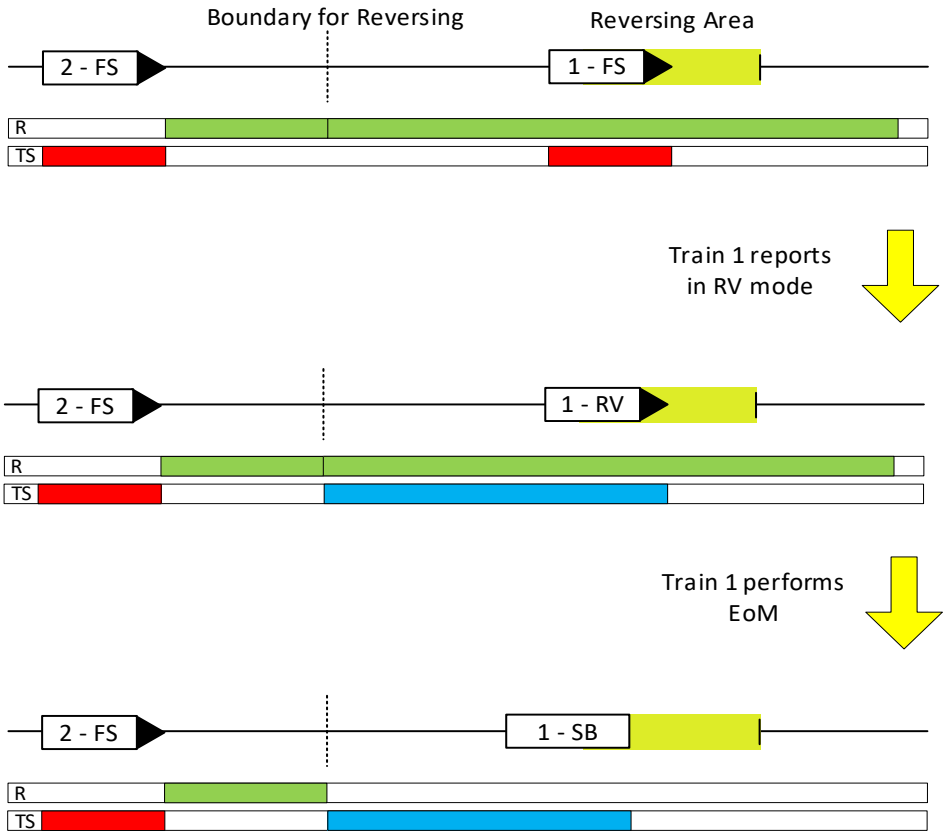

Figure 63: Update of Track Status following a train reporting in RV mode

Operational Rules: None

Engineering Rules: None

REQ-Rev-5	[New Requirement]

When the mute timer expires for a train which has received Reversing Area Information, has reported beyond the Boundary for Reversing but not reported with its Estimated Front End beyond the Reversing Area, then the L3 Trackside shall change the Track Status to Unknown for the location associated with the train and extend this area until to the Boundary for Reversing.

Rationale:

If communications are lost with a train that has received Reversing Area Information, the train may perform reversing with the L3 Trackside unaware. As such, the L3 Trackside needs to protect all of the area where the train could reverse.

Guidance:

Figure 64 gives an overview the reaction taken by the L3 Trackside when this situation occurs. Note that the exact extent of the Reserved Status Area for a train in this scenario is project specific, depending on what mechanisms are used to protect a train passing a Reversing area. In this example, the Reserved Status Area is maintained at the Boundary for Reversing, but this is a project specific implementation decision.

The Unknown Track Status Area extends from the Boundary for Reversing to the end of the Reserved Status Area. This is achieved through the application of this requirement and REQ-LossComms-4.

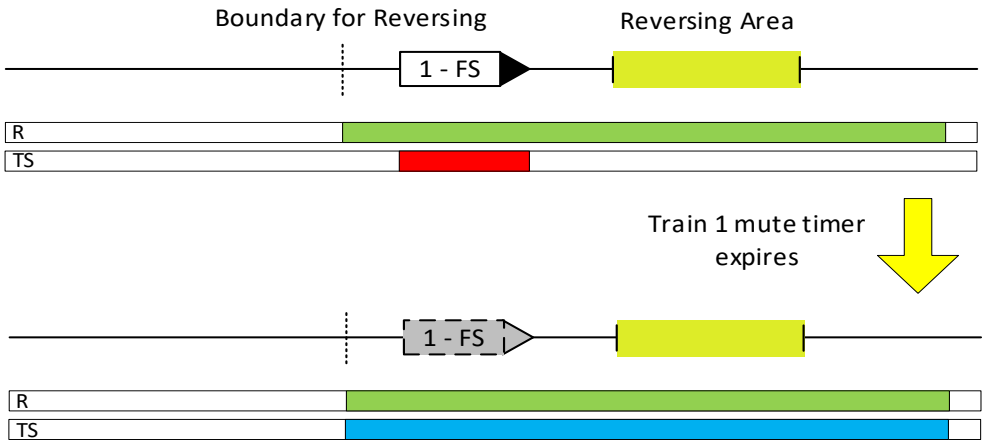

Figure 64: Mute Timer Expiry for a train that has received Reversing Area Information.

Operational Rules: None

Engineering Rules: None

3.16 End of Mission

3.16.1 Introduction

The L3 Trackside will need to store the train location when a train performs End of Mission, as defined in section 3.1.

The purpose of storing this information is to permit matching when the train next performs a Start of Mission, thus enabling the Track Status to be changed from Unknown to Occupied.

Lack of Train Integrity information has a significant impact on the performance of the line during End of Mission. It is important that the L3 Trackside receives a recent Train Position Report with the Integrity Confirmed just prior to End of Mission. If this does not occur, then there is the potential for a large area of the railway remaining unavailable, due to the CRE being a large distance in rear of the train. This could have significant operational impact if the CRE remains over points and crossings.

3.16.2 Requirements

REQ-EoM-1 [X2R1 D5.1: REQ-EoM-1]

The L3 Trackside shall update the stored information of the train performing the EoM.

Rationale:

This is to provide a quick recovery of the system when the train performs a SoM again.

Guidance:

See REQ-TrainLoc-11 and REQ-TrackStatus-14 for the information stored.

Operational Rules: None

Engineering Rules: None

REQ-EoM-2 [New Requirement]

When receiving an End of Mission message from a train which is completely located inside an Active Shunting Area, then the L3 Trackside shall remove the Track Status Area associated with this train.

Rationale:

For a train completely within an Active Shunting Area, protection after End of Mission will be provided by the Unknown area associated with this Active Shunting Area.

Guidance:

For a train whose location is fully inside an Active Shunting Area when it reports EoM, the Occupied area corresponding to the Train Location is removed but no additional area of Unknown needs to be created, since the train is already in an Unknown area and the L3 Trackside will not know where the train moves to while in SH mode.

Operational Rules: None

Engineering Rules: None

REQ-EoM-3 [X2R1 D5.1: REQ-EoM-5]

When the L3 Trackside receives an End of Mission message, then the L3 Trackside shall remove any associated Reserved Status Area associated with this train.

Rationale:

After performing End of Mission, the train is no longer authorised to move, and so it is no longer necessary to reserve track for the train to move.

Guidance:

None.

Operational Rules: None

Engineering Rules: None

REQ-EoM-4	[X2R1 D5.1: REQ-EoM-6]

The L3 Trackside shall be able to cope with differences in the confidence interval provided in the position report of a train that reported End of Mission even when related to the same train position.

Rationale:

This is due to an ambiguity in the ETCS specifications around how to calculate the train location accuracy when linking information is deleted due to the change to SB mode. This issue is currently subject of a CR in the ERA CCM Process [CRProcess]. As long as the CR is not solved, both behaviours described in the CR (recalculate or not the confidence interval) could be expected. Even if the CR is solved, the ambiguity already exists in the current specifications. Therefore, the L3 Trackside shall be able to deal with On-boards regardless of how they solve the issue.

Guidance:

The L3 Trackside will not apply a safe reaction if a train reports a different confidence interval without the train moving (Different L_DOUBTOVER and L_DOUBTUNDER with the same D_LRBG and LRBG). It is also recommended not to update the train location when the confidence interval changes for the reasons mentioned above.

Operational Rules: None

Engineering Rules: None

3.17 Loss of Train Integrity

3.17.1 Introduction

Following Loss of Train Integrity by a train, the Track Status Area for the train will change to be an Unknown Track Status Area.

If Train Integrity is restored, then if the train length is unchanged, the Track Status Area for the train will change to be an Occupied Track Status Area, based on the new Train Position Report.

If Train Integrity is not restored, then the Track Status Area for the train will be maintained as an Unknown Track Status Area, and it will need to be cleared by some other method.

3.17.2 Requirements

REQ-LossTI-1 [X2R1 D5.1: REQ-LossTI-2]

When receiving a position report from a train with the information ‘Train integrity lost’, the L3 Trackside shall change the Track Status Area associated with this train to Unknown.

Rationale:

This is to protect the rear end of the train and other trains from collision. Once the Unknown Track Status Area is established, recovery mechanisms can be applied such as sweeping etc.

Guidance:

In this situation, the Track Status for the location of the train changes to Unknown. The location is updated by other requirements, changing the front end from the information in the position report while the rear end is maintained.

Operational Rules: None

Engineering Rules: None

REQ-LossTI-2 [New Requirement]

When the L3 Trackside considers that the integrity is lost for a train, the L3 Trackside shall change the Track Status Area associated with this train to Unknown.

Rationale:

This is to protect the rear end of the train and other trains from collision. Once the Unknown area is established, recovery mechanisms can be applied such as sweeping etc.

Guidance:

The L3 Trackside considers that Train Integrity is lost for a train if not receiving a position report with ‘Train integrity confirmed by external device’ for a configurable time, or if receiving new Validated Train Data. Projects may decide on a different reaction compared to when a train reports that integrity is lost.

Operational Rules: None

Engineering Rules: None

REQ-LossTI-3	[X2R1 D5.1: REQ-LossTI-4]

When the L3 Trackside considers that the Train Irentegrity is lost for a train, the L3 Trackside shall react as configured.

Rationale:

Loss of Integrity is a degraded mode of operation that the L3 Trackside must protect and attempt to recover from.

Guidance:

A project could decide for the L3 Trackside to have different reactions according to whether it is a reported loss of integrity or an assumed loss of integrity (expiry of Integrity Wait Timer or receiving new Validated Train Data).

The reaction taken by the L3 Trackside will depend on application specific requirements. The following non-exhaustive list gives some examples:

- Cause the train to Trip
- Create an additional margin behind the train
- The Movement Authority may be shortened/updated
- Alternatively, the L3 Trackside could be configured to take no action.

Note that the first option (tripping the train) could result in a Hazard whereby if a train is tripped in a Reversing Area it would be unable to reverse.

It is important to note that a reported loss of Integrity may be part of an intentional splitting operation, and so any reaction taken by the L3 Trackside needs to balance safety with operational performance. In order for the L3 Trackside to distinguish between intentional loss of integrity (during splitting) and unintentional, additional, application specific, information could be used. This could include for example: The reported speed of the train, the location where the loss of integrity occurs. Note that if the L3 Trackside is not configured to distinguish between an intentional and unintentional Loss of Integrity, and the reaction to a Loss of Integrity is quite severe (e.g. sending of a UES) this could have an impact on operations.

Some L3 Tracksides may be configured to receive input from the TMS, notifying them of the expected Splitting operation occurring in a certain area. This could be used by the L3 Trackside to determine what reaction to take at a reported Loss of Integrity. The configuration of this is project specific and it cannot be assumed that all L3 Trackside have this functionality.

In addition to a configurable reaction for the L3 Trackside, a reaction for the ETCS On-Board could also be configured. This reaction could be managed using National Values in the same way as supervision of safe radio connections. This function would require a change to current ETCS specifications. See “Proposed Changes” section in D4.3 [X2R3-D4.3].

In most cases, when Train Integrity is lost, the rolling stock will apply the brakes.

Operational Rules: OPE-LevelTrans-2

Engineering Rules: ENG-LossTI-5

REQ-LossTI-4	[X2R1 D5.1: REQ-LossTI-5]

The L3 Trackside shall consider the Train Integrity as lost when ‘No train integrity information’ is reported longer than a configurable time (Integrity Wait Timer).

Rationale:

This is to implement a reaction in case ‘No train integrity information’ is reported for a long period of time.

Guidance:

Once Train Integrity is considered Lost by the L3 Trackside, the mechanism in REQ-LossTI-2 and REQ-LossTI-3 is applied.

It is application specific whether to implement this function. The timer will have a special value that means the function is disabled.

Note that using this timer the Driver will not be aware of the train Integrity being treated as Lost by the L3 Trackside and as such cannot be expected to react in any manner.

If the L3 Trackside is configured not to accept Train Integrity confirmed by Driver, and Train Integrity confirmed by Driver is reported, then the L3 Trackside will treat this as “No train integrity information”.

Operational Rules: None

Engineering Rules: ENG-LossTI-1

REQ-LossTI-5 [New Requirement]

When receiving a message from a train with the information ‘Train integrity confirmed by external device’, the L3 Trackside shall start/restart the Integrity Wait Timer.

Rationale:

This is for the L3 Trackside to implement an appropriate reaction in case a train does not send a position report with integrity confirmed by external device within the configured time.

Guidance:

The L3 Trackside does not start the Integrity Wait Timer when driver confirms integrity.

It is application specific whether to implement the Integrity Wait Timer.

Operational Rules: None

Engineering Rules: ENG-LossTI-1

REQ-LossTI-6 [New Requirement]

When receiving a message from a train with the information ‘Train integrity confirmed by Driver’, if the L3 Trackside is configured to accept confirmation by Driver and the Integrity Wait Timer is running, then the L3 Trackside shall stop the Integrity Wait Timer.

Rationale:

If the Driver has confirmed Train Integrity, it is not necessary to supervise the Integrity Wait Timer.

Guidance:

It is application specific whether to implement the Integrity Wait Timer.

Operational Rules: None

Engineering Rules: ENG-LossTI-1

REQ-LossTI-7	[X2R1 D5.1: REQ-LossTI-8]

After a loss of integrity, the driver shall be made aware of the situation via an indication in the cab.

Rationale:

This is to inform the driver that there is a loss of integrity. In this way, Driver can take appropriate measures according to operational procedures defined.

Guidance:

As TIMS is a separate system to the ETCS On-Board, there is opportunity to display the status of Train Integrity derived by the TIMS equipment to the driver through alternative means e.g. through a separate indication in the cab.

The TIMS information could be displayed to the driver via the DMI, however this implies a change in the current ETCS specifications. See “Proposed Changes” section in D4.3 [X2R3-D4.3].

Operational Rules: OPE-LossTI-2

Engineering Rules: None

REQ-LossTI-8	[X2R1 D5.1: REQ-LossTI-9]

The L3 Trackside shall be able to be configured whether to accept Train Integrity confirmation by the driver.

Rationale:

It is configurable whether to accept confirmation of integrity by the driver, as some Infrastructure Managers may not want to accept the risk associated with this procedure.

Guidance:

If confirmation of Integrity by the driver is not accepted, then the L3 Trackside can ignore any reports with Train Integrity Confirmed by Driver.

Operational Rules: OPE-Generic-2

Engineering Rules: ENG-LossTI-3

REQ-LossTI-9 [X2R1 D5.1: REQ-LossTI-10]

The L3 Trackside shall be configurable as to whether it authorises a Movement Authority for a train that has lost Integrity.

Rationale:

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

Guidance:

It is proposed that this requirement is configured once for the entire L3 Area.

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 authority of the Dispatcher.

This requirement would also apply to trains arriving at the L3 area boundary without Train Integrity Confirmed.

Operational Rules: OPE-StartTrain-2; OPE-LevelTrans-2

Engineering Rules: ENG-Generic-10; ENG-LossTI-4

REQ-LossTI-10 [X2R1 D5.1: REQ-LossTI-11]

If the L3 Trackside receives Validated Train Data for a train with a train length different from previously reported within the same communication session, then the L3 Trackside shall consider the train as having lost Integrity.

Rationale:

If the train reports loss of Train Integrity as a result of joining or splitting, then this will already result in the Track Status becoming Unknown. This requirement is to catch the situation where the new train length is received before the loss of Train Integrity.

Guidance:

When new train data is entered, the ETCS on-board will not confirm Train Integrity until the new train data is acknowledged by the L3 Trackside. This behaviour is as defined in Change Request 940 [CR940].

Operational Rules: None

Engineering Rules: None

3.18 Level Transition

3.18.1 Introduction

Level Transition functionality is performed in the same way as in L2. However, operating in L3 brings additional challenges, in particular due to the lack of TTD. The issue to be solved in L3 is related to the detection of possible non-communicating trains that attempt to enter the L3 area.

3.18.2 Requirements

REQ-LevelTrans-1 [X2R1 D5.1: REQ-LevelTrans-1]

The L3 Trackside shall have means to detect non-communicating trains about to enter the L3 area.

Rationale:

This is to prevent a train from entering the L3 area unnoticed by the L3 Trackside.

Guidance:

This can be done by scheme engineering, such as a short section ofTTD at the border or other means that are application specific.

Operational Rules: None

Engineering Rules: ENG-LevelTrans-1

REQ-LevelTrans-2	[X2R1 D5.1: REQ-StartTrain-2]

For a train that has been authorised to leave the L3 Area, the L3 Trackside shall maintain the communication session with a train reporting a position with an LRBG which is not known to the L3 Trackside, while the CRE of this train is still located in the L3 Area, or until the L3 Trackside decides that it is suitable to terminate the session with this train, or until requested by the TMS to terminate the session with this train.

Rationale:

This is to avoid the need for creating an Unknown Track Status Area from the last CRE to the border when a train fails to confirm integrity after having left the L3 Area. This could occur during a Level Transition out of the L3 Area or a Handover when the train reports a position from an unknown LRBG but the CRE is still inside the L3 area or the Handing Over L3 Trackside area.

Guidance:

Having enough Balise Groups known by L3 Trackside in these areas could mitigate the issue. Furthermore, the presence of TTD at the L3 Area boundary could be used as a mitigation. If the problem persists, each specific application has to decide when it is considered safe to disconnect the train taking into account the possible Unknown Track Status Area that has to be created.

This Requirement is about when to terminate the communication session with a train leaving the L3 Area. If a train is reporting a position with an LRBG which is not known to the L3 Trackside, then the CRE of this train will not be updated. If the CRE is still within the L3 Area, then some other mechanism is required to determine when to terminate the communication session.

Operational Rules: None

Engineering Rules: None

3.19 Trackside Initialisation

3.19.1 Introduction

This section includes requirements associated with starting or restarting the L3 Trackside system.

In order to provide a safe initialisation, the L3 Trackside has to start in the most restrictive state.

This means that there must be a process in which the L3 Trackside can identify those parts of the area that can be considered Clear. For that purpose, in an ETCS Level 3 Moving Block system without TTD, it will be advantageous for the L3 Trackside to effectively manage stored information to accelerate the initialisation and capture the state of the railway. Without such methods, the L3 Trackside would have to resort to sweeping the entire Area of Control.

When a Trackside initialisation is needed, it is likely that some subsystems also need to be restarted.

This section details the functionality when an entire Area of Control is initialised due to the L3 Trackside being restarted. To take individual areas out of action (such as a section of line between two stations) the dispatcher can utilise the functionality in section 3.2 Track Status to create an Unknown Track Status Area, and utilise existing L2 functionality such as Track Possession Reminders where necessary.

3.19.2 Requirements

REQ-TrackInit-1 [X2R1 D5.1: REQ-TrackInit-1]

The L3 Trackside shall consider the entire L3 Area of Control to be in Track Status Unknown when the L3 Trackside initialisation starts.

Rationale:

This is to start with the most restrictive state.

Guidance:

None.

Operational Rules: None

Engineering Rules: None

REQ-TrackInit-2 [X2R1 D5.1: REQ-TrackInit-2]

The L3 Trackside shall utilise valid Stored Information to enable faster initialisation.

Rationale:

Historic information on the state of the railway from before the L3 Trackside was restarted can enhance the Initialisation process.

Guidance:

The location of all trains in communication prior to the restart, along with the extent of any MAs issued will be valuable information to be utilised.

The validity of the information used must be carefully considered, as if the L3 Trackside has been offline for some time the State of the Railway is likely to have changed.

Criteria for considering Stored information as valid are project dependent e.g. during Trackside Initialisation, if the time passed is smaller than a configured value.

Operational Rules: None

Engineering Rules: ENG-TrackInit-1

REQ-TrackInit-3 [X2R1 D5.1: REQ-TrackInit-3]

The L3 Trackside, if configured, shall provide a means for the person responsible for the Trackside Initialisation to confirm that the procedure is completed.

Rationale:

If Stored Information is not valid, the person in charge of initialising the L3 Trackside has to confirm when the procedure is completed. They have the authority to confirm that all the obstacles on the railway are known to the L3 Trackside.

Guidance:

If Stored information is used to initialise the L3 Trackside, this confirmation is not needed and it is project specific to implement it.

Operational Rules: OPE-TrackInit-3, OPE-TrackInit-5

Engineering Rules: None

REQ-TrackInit-4 [X2R1 D5.1: REQ-TrackInit-4]

The L3 Trackside shall clear the remaining Unknown Track Status Areas created at the start of the Trackside Initialisation procedure and consider the Trackside Initialisation process as completed either:

- upon receiving confirmation of completion of the Initialisation procedure from the responsible person
- after Stored Information has been used and confirmation from the responsible person is not required.

Rationale:

During Initialisation, the L3 Trackside will create Occupied areas for trains in communication, create Unknown areas based on stored data, and accept any additional Unknown areas created at the request of the TMS. Once the procedure is completed, the remaining track can be considered clear.

Guidance:

This step in the Trackside Initialisation process results in the removal of the initial Unknown area created at the start of the process. How this is done is project specific.

Operational Rules: None

Engineering Rules: None

REQ-TrackInit-5	[X2R1 D5.1: REQ-TrackInit-5]

The L3 Trackside shall send Authorisations to trains in the Area of Control only after the Trackside Initialisation procedure has been completed.

Rationale:

This is to prevent the L3 Trackside sending authorities to move during the Initialisation procedure which could be hazardous when trying to identify the state of the track.

Guidance:

None.

Operational Rules: None

Engineering Rules: None

3.20 Handover

3.20.1 Introduction

The Handover procedure is the same as in L2 except for termination of the communication session with the Handing Over L3 Trackside, as introduced by the solution to Change Request 940 [CR940].

3.20.2 Requirements

REQ-HO-1	[X2R1 D5.1: REQ-HO-1]

When acting as an Accepting L3 Trackside, the L3 Trackside shall consider the area sent as part of a Route Related Information message to an adjacent L3 Trackside as a Reserved Status Area.

Rationale:

This is because the adjacent L3 Trackside could have already sent an MA covering this area or be about to do it.

Guidance:

There may need to be a mechanism to remove the Reserved Status Area if the train does not arrive in the Accepting L3 Trackside.

Operational Rules: None

Engineering Rules: None

REQ-HO-2	[X2R1 D5.1: REQ-HO-3]

When the Handing Over L3 Trackside receives a position report and detects that the Confirmed Rear End of the train has crossed the border, it shall send a session termination order to the ETCS On-Board equipment.

Rationale:

This is to allow the Handing Over L3 Trackside to consider the track clear in the area in rear of the border.

Guidance:

In implementing this requirement, consideration needs to be taken of the location of the reported rear end of the train and any additional margins. In the current specifications [BL3 R2], trains can only be requested to report their position when their Min Safe Rear End or Max Safe Front End is at a certain location. See “Proposed Changes” section in D4.3 [X2R3-D4.3] for details of a proposed change that would enable the ETCS On-board to report its position when its CRE is at a certain location.

Operational Rules: None

Engineering Rules: ENG-HO-1

REQ-HO-3	[New Requirement]

If the L3 Trackside considers communication session is terminated with a train approaching the L3 Area, then the L3 Trackside shall set the Track Status to Unknown for any area that is Reserved for this train, unless this area is already Unknown.

Rationale:

If a train is approaching a L3 area and the communication session is considered terminated, the L3 Trackside will no longer know its location nor will be able to determine whether the train will stop before the border location or into its Area of Control. As such, the area that is Reserved for this train needs to change to Unknown to protect the train.

Guidance:

This requirement covers both entry into an L3 area at a Transition border and Handover between two L3 Tracksides.

For Handovers, if there is not loss of communication between L3 Tracksides, projects may implement different solutions, i.e. may cancel the on-going Handover or decide to remove the Unknown area and create a new Reserved Status Area when a new message indicating that the Handover is still ongoing is received by the Accepting L3 Trackside.

When there is no communication between the L3 Tracksides or in a Level Transition, the Accepting L3 Trackside has to create a new Unknown area to ensure that the previously Reserved Status Area is not used by another train.

For a train with its ETCS On-board reporting FS, the Unknown area is needed as the Accepting L3 Trackside cannot be sure where this train will stop before the border.

Criteria for the L3 Trackside to establish whether the train is able to stop before the border are project specific. Similarly, it is left to projects to decide the criteria for when a train is to be considered approaching the L3 area.

Operational Rules: None

Engineering Rules: ENG-HO-1

3.21 Shunting movement

3.21.1 Introduction

A challenge for an ETCS Level 3 Moving Block system without TTD is to manage shunting movement as the trains disconnect while in SH mode. The best way to handle this is to limit

shunting to predefined areas and consider an Active Shunting Area as having Track Status Unknown.

The ETCS Level 3 Moving Block system should be able to manage a possible driver request for shunting anywhere on the line but could decide to reject this and restrict shunting to predefined shunting areas.

Stored information could be useful to provide a quick recovery after SH movements.

Two different types of SH areas are foreseen:

- Permanent SH areas: where there is a predefined area in the track dedicated to shunting
- Temporary SH areas: where there are predefined Shunting Areas which can be activated or deactivated under Traffic Management System control.

A train transitioning to Shunting mode is considered as an End of Mission by the L3 Trackside. As such, the requirements in section 3.16 End of Mission apply to this situation.

3.21.2 Requirements

REQ-SH-1 [X2R1 D5.1: REQ-SH-1]

The L3 Trackside shall be configurable with predefined Permanent and Temporary Shunting Areas.

Rationale:

Areas where it is known that there will be shunting operations can be engineered when the system is designed.

Guidance:

None.

Operational Rules: None

Engineering Rules: ENG-SH-1

REQ-SH-2 [X2R1 D5.1: REQ-SH-2]

On request from the TMS, the L3 Trackside shall be able to activate and deactivate a Temporary Shunting Area.

Rationale:

Temporary Shunting Areas need to be activated and deactivated.

Guidance:

None.

Operational Rules: OPE-SH-1; OPE-SH-2

Engineering Rules: None

REQ-SH-3 [X2R1 D5.1: REQ-SH-3]

The L3 Trackside shall consider the Track Status of an Active Shunting Area to be Unknown and Non-Sweepable.

Rationale:

While shunting the L3 On-board is not connected to the L3 Trackside and therefore any train movements in SH mode are unknown to the L3 Trackside. The Unknown is flagged Non-Sweepable so that it is not removed by a sweeping train.

Guidance:

This applies to Permanent and Temporary Shunting areas.

Operational Rules: None

Engineering Rules: None

REQ-SH-4 [New Requirement]

The L3 Trackside shall perform specific checks before activating a Temporary Shunting Area.

Rationale:

This is to ensure a Temporary Shunting Area is only activated when it is safe to do so.

Guidance:

Possible checks (project specific) may include:

• Trains intended to perform shunting are stationary and their location is fully inside the inactive Temporary Shunting Area

• Trains not intended to perform shunting but are authorised to pass through the area are clear of the inactive Temporary Shunting Area before it is activated

In addition, for a train whose location is not fully inside the inactive Temporary Shunting Area, the L3 Trackside could still activate the Temporary Shunting Area and manage overlapping Unknown areas. Alternatively, projects may decide to extend the Temporary Shunting Area to fully include the location of this train.

Operational Rules: OPE-SH-1

Engineering Rules: None

3.22 Joining

3.22.1 Introduction

Joining procedure in L3 is similar to the procedure in L2, but there are some additional requirements.

The terminology used is as defined in ETCS Specification [BL3 R2]:

- Train to be joined The stationary train waiting to be joined
- Joining Train The train which moves towards the train to be joined.

In addition, the following term is used:

- Joined Train The train after joining.

This section covers the situation where the train to be joined does not perform End of Mission.

The joining train will perform End of Mission.

There are no separate requirements for the derivation of the Train Location and Occupied Track Status Area for the joined train. This is covered in sections 3.1 and 3.2.

3.22.2 Requirements

REQ-Join-1 [X2R1 D5.1: REQ-Join-1]

When there is Joining without End of Mission, the L3 Trackside shall remove the Unknown Track Status Area corresponding to the Train to be Joined and the Joining Train if the Joined Train meets the following conditions:

a) The Joined Train has a new L_TRAIN which is equal to the sum of the L_TRAIN for the Train to be Joined and the L_TRAIN for the Joining Train, plus or minus a tolerance
b) The Joined Train has confirmed Train Integrity.

Rationale:

The Unknown Track Status Areas corresponding to the Train to be Joined and the Joining Train can be removed if the new Joined Train accounts for all the rail vehicles in the Train to be Joined and the Joining Train.

Guidance:

The tolerance is the same as that defined for the configurable minimum length of Unknown Track Status Areas, as defined in section 3.2.

When a train reports new train data, it is considered to have Lost Integrity (REQ-LossTI-10). As such, the Train to be Joined will be located in an Unknown Track Status Area.

Operational Rules: None

Engineering Rules: None

REQ-Join-2 [X2R1 D5.1: REQ-Join-2]

If the Joined Train leaves the Unknown Track Status Area, and the Joined Train has L_TRAIN less than the sum of the L_TRAIN of the Train to be Joined and the L_TRAIN of the Joining Train, then the L3 Trackside shall reduce the length of the Unknown Track Status Area by L_TRAIN of the Joined Train.

Rationale:

The Unknown Track Status Areas corresponding to the Train to be Joined and the Joining Train cannot be fully removed if the new Joined Train does not account for all the rail vehicles in the Train to be Joined and the Joining Train.

Guidance:

Figure 65 shows the Joined Train leaving, and the reduction in the area of Unknown remaining:

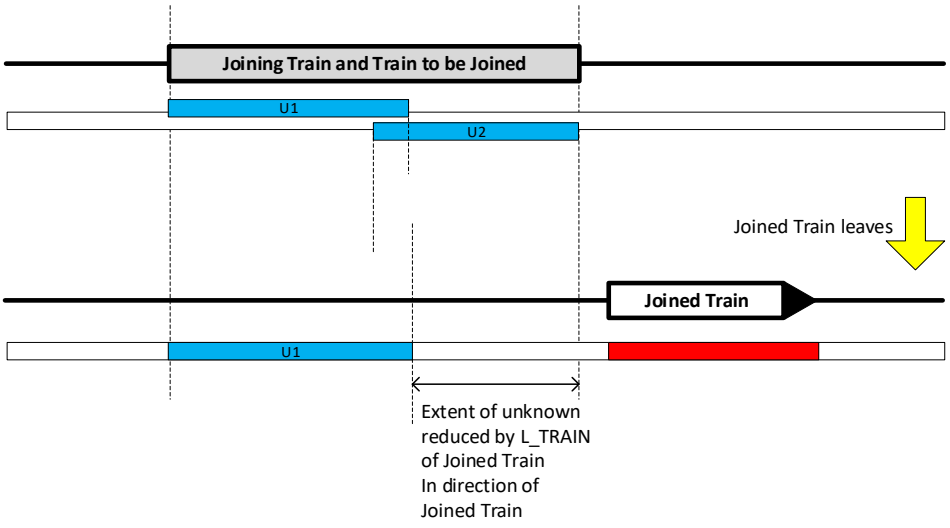

Figure 65: Joining – Shorter Joined Train leaves: update of extent of Unknown Track Status Area

Operational Rules: None

Engineering Rules: None

REQ-Join-3 [X2R1 D5.1: REQ-Join-3]

If the Joined Train leaves the Unknown Track Status Area, and the Joined Train has L_TRAIN less than the sum of the L_TRAIN of the Train to be Joined and the L_TRAIN of the Joining Train, then the L3 Trackside shall subtract the Length of the Joined Train from the length stored for the remaining Unknown Track Status Area.

Rationale:

As the new Joined Train does not account for all the rail vehicles in the Train to be Joined and the Joining Train, an Unknown Track Status Area remains. The Stored Train length associated with the remaining Unknown Track Status Area must be updated to account for the departure of the Joined Train.

Guidance:

Figure 66 shows the Joined Train leaving, and the reduction in the stored train length for the remaining area of Unknown:

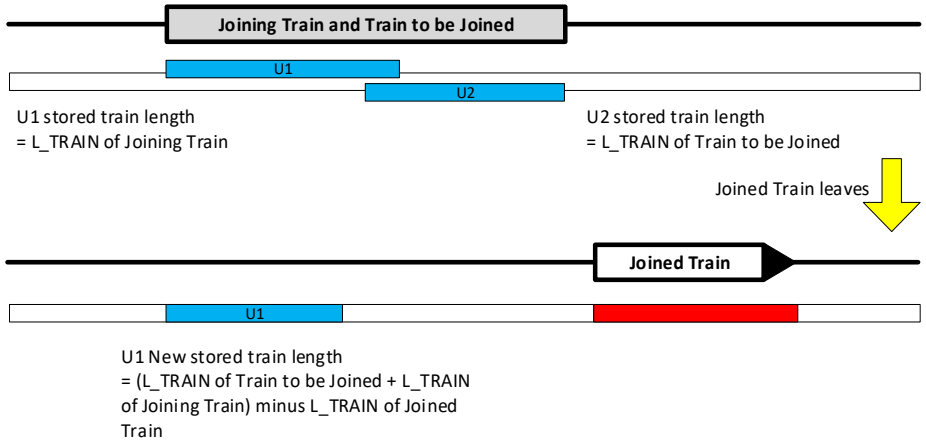

Figure 66: Joining – Shorter Joined Train leaves: update of stored train length

Operational Rules: None

Engineering Rules: None

3.23 Splitting

3.23.1 Introduction

Splitting procedure in L3 is similar to the procedure in L2, but there are some additional requirements.

The terminology used is as defined in ETCS Specifications [BL3 R2]:

- Train to be split The train before splitting
- Front train after splitting The front part of the train after splitting
- New train after splitting The other part of the train after splitting.

This section covers the situation where the Train to be split does not perform End of Mission.

There are no separate requirements for the derivation of the Train Location and Occupied Track Status Areas for the Front train after splitting and the New train after splitting. This is covered in sections 3.1 and 3.2.

There is a specific hazard associated with Splitting. If the Front train after splitting reports a new train length (L_TRAIN) greater or equal to the train length of the Train to be split, the Unknown Track Status Area resulting from the splitting is removed, and the New train after splitting becomes a Ghost Train. See assumption about Train Length in Part 2 System Definition.

3.23.2 Requirements

REQ-Split-1 [X2R1 D5.1: REQ-Split-1]

The L3 Trackside shall be able to reduce the length of the Unknown Track Status Area due to loss of Train Integrity or reception of new Validated Train Data when a train confirms integrity reporting within the Unknown Track Status Area.

Rationale:

This represents the reduction in the Unknown Track Status Area after one of the trains after splitting has confirmed Train Integrity.

Guidance:

The train which leaves the area can leave in either direction. The extent of the Unknown Track Status Area is reduced depending on the direction in which the train has left.

The length of the train which has left (L_TRAIN) is used to reduce both the length of the Unknown Track Status Area, and the train length stored for the Unknown Track Status Area.

Figure 67 shows Front Train After Splitting, train 1 in the figure, leaving in one direction:

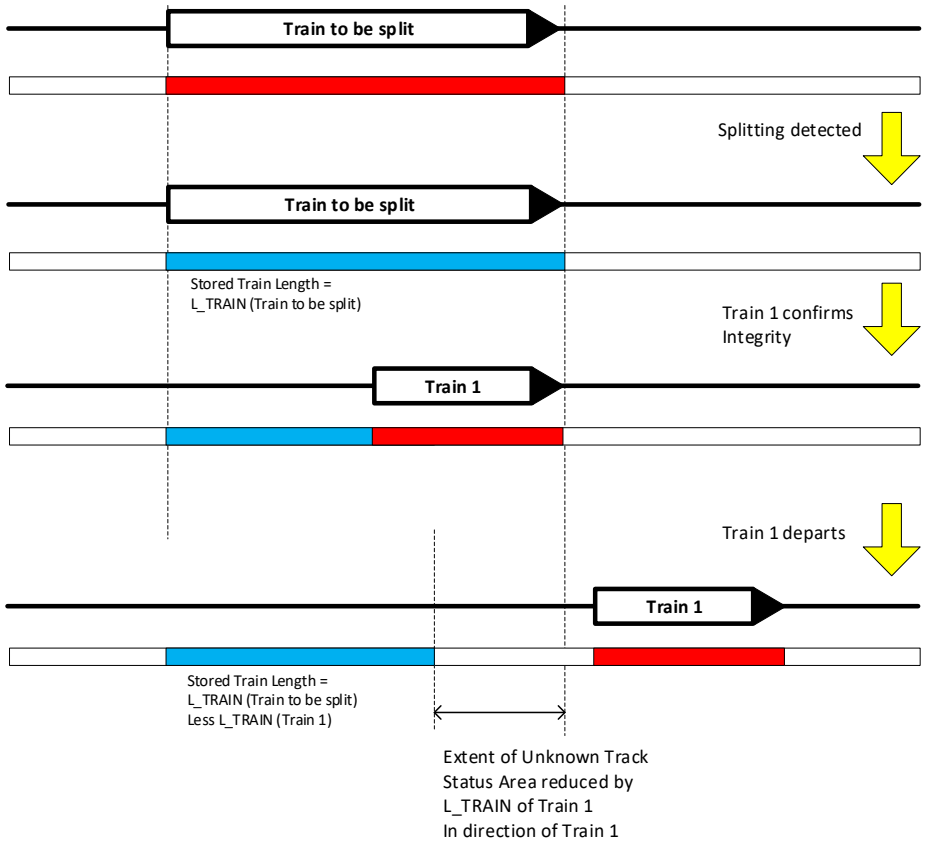

Figure 67: Splitting – Front Train after Splitting leaves Unknown Track Status Area

The process above is repeated if a second train leaves the Unknown Track Status Area.

If the total length for the Train to be Split is accounted for by the reduction in stored train length, then the Unknown Track Status Area is completely removed.

There is an allowed tolerance, which is the same as that defined for the configurable minimum length of Unknown Track Status Areas, as defined in section 3.2.

Operational Rules: None

Engineering Rules: None

3.24 Traffic Management System interface

3.24.1 Introduction

There are several sections in this specification where there are requirements for output of information to the Traffic Management System (TMS), and for interaction between the L3 Trackside and the TMS.

The exported requirements for the TMS are included below. The following tables summarise the interactions between the TMS and L3 Trackside and the associated requirements. Section 0 details a single exported requirement for the interface between the Dispatcher and the TMS.

L3 Trackside → TMS	
Interaction	**Requirement ID**
The L3 Trackside shall report the location and status for all trains in L3 Area	REQ-TrainLoc-2
The L3 Trackside shall report the Track Status of the entire L3 Area	REQ-TrackStatus-13
The L3 Trackside shall report the Reserved Status of the entire L3 Area	REQ-Reserved-3
The L3 Trackside shall send all Movement Authorities issued to trains to the TMS	REQ-MA-10
Alarm	**Requirement ID**
The L3 Trackside shall alert the TMS to a train that is reporting an invalid or unknown position	REQ-StartTrain-2
The L3 Trackside shall notify TMS of a train that has not emerged from a Radio Hole	REQ-RadioHole-7

TMS → L3 Trackside	
Interaction	**Requirement ID**
The TMS shall be able to create Unknown Track Status Areas	REQ-TrackStatus-6
The TMS shall be able to clear Unknown Track Status Areas	REQ-TrackStatus-10
The TMS shall be able to move points within an Unknown Track Status Area by emergency procedure	REQ-PTS-3

TMS → L3 Trackside	
The TMS can provide an estimated location for a train to the L3 Trackside	REQ-StartTrain-3
The TMS must authorise Sweeping of Unknown Track Status Areas before the L3 Trackside issues MA (if configured)	REQ-MA-12
The TMS can activate and deactivate dynamic Radio Holes	REQ-RadioHole-1
The TMS can enable and disable Temporary Shunting Areas	REQ-SH-2

Table 10: TMS associated requirements

3.24.2 Requirements

REQ-TMS-1 [X2R1 D5.1: REQ-TMS-1]

The TMS shall provide means for the Dispatcher to assign a position to a train that is reporting unknown or invalid position.

Rationale:

This is to allow the Dispatcher to locate the train on the track after a specific operational procedure. Whilst this functionality is available at L2, it is different at L3 with Moving Block as the train can be located anywhere in the L3 Area and not in a specific block.

Guidance:

The Dispatcher needs to contact the Driver and determine an estimated location for the train.

Operational Rules: OPE-StartTrain-4; OPE-StartTrain-5

Engineering Rules: None