X2Rail-5

Project Title:	Completion of activities for Adaptable Communication, Moving Block, Fail Safe Train Localisation (including satellite), Zero on site Testing, Formal Methods and Cyber Security
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Deliverable D4.1

Moving Block Specification

Part 2 – System Definition

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Version Management

The Version history below refers to Part 2 of Deliverable D4.1.

Version Management		
Version Number	**Modification Date**	**Description / Modification**
01	26-Feb-21	Import from X2Rail-3 D4.2, no changes
02	02-Sep-22	Updated for “Simple” X2R5 Open Points
03	31-Oct-22	Updated for remaining X2R5 Open Points
04	18-Nov-22	Updated after WP4 first review
05	25-Nov-22	Updated for TMT/SC review
06	25-Nov-22	Clean version for TMT/SC review
07	20-Dec-22	Updated after TMT/SC review and further WP4 review
08	21-Dec-22	Clean version of 07
09	21-Dec-22	PDF version of 08

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1 Background

This document is Part 2 of Deliverable D4.1 "Moving Block Specifications" from the Project titled "Completion of activities for Adaptable Communication, Moving Block, Fail Safe Train Localisation (including satellite), Zero on site Testing, Formal Methods and Cyber Security" (Project Acronym: X2Rail-5; Grant Agreement No 101014250).

Deliverable D4.1 is made up of several different parts. This is Part 2 – System Definition. See Part 1 – Introduction for a list of the different Parts of this Deliverable.

All terms and abbreviations, and all references for all parts of D4.1 are located in Part 1 – Introduction.

2 Introduction

Part 2 of D4.1 has been developed to define the technical scope of D4.1, including the assumptions.

Additionally, this part was used as an input for risk evaluation and assessment, according to the CSM process.

According to the Common Safety Method for risk evaluation and assessment (see [CSM-RA] and [DEU-RS]) this system definition addresses the following issues:

- system objective
- system functions and elements
- system boundaries
- physical and functional interfaces
- system environment
- assumptions that determine the limits for the risk assessment

All new L3 concepts, such as the acquisition of train integrity information and the possibility to manage the track status based on the reported location of trains, have been analysed to identify possible safety issues.

The Deliverable defines an ETCS Level 3 system which can be applied to different railway types:

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

Mixed Traffic Lines for example may include passenger and freight trains.

It is the intent that these can all be handled by the same system definition. However, there will be differences in the way the system is applied to different types of railways.

3 System Objectives

In accordance with [CSM-RA], this section defines the ETCS L3 Moving Block system objectives.

As defined in the X2Rail-5 Grant Agreement [X2R5GA], the overall objective of the Moving Block Technical Demonstrator is to continue the work of defining a high capacity, low cost, high reliability signalling system, based on Moving Block principles, which is applicable across all railway market segments. High Capacity is based on the use of Moving Block principles, which permits decoupling of the infrastructure from train performance parameters. Low Cost is achieved by the reduction in the use of trackside train detection and line-side signals. High Reliability is achieved as a consequence of the reduction in trackside equipment associated with trackside train detection and line-side signals.

ETCS L3 principles developed from X2Rail-1 WP5 and X2Rail-3 WP4 and X2Rail-5 WP4 allow for an ETCS L3 design able to achieve the following advantages:

- improvement of line capacity and train running performance
- reduction of trackside elements and thereby enhanced reliability and reduced costs of maintenance

4 System functions & elements

ETCS Level 3 may be implemented using the following two different Moving Block concepts:

- Full moving block
- Fixed virtual block

For each of the above concepts, two variants have been considered:

- Without TTD
- With TTD

Note that it is possible to mix areas with and without TTD in the same L3 Trackside project.

4.1 Moving Block concepts

This section describes the differences between the Moving Block concepts:

- **Full Moving Block (FMB)**: The system can issue Movement Authorities based on the reported location of the rear of the preceding train. End of Authority can therefore be at an arbitrary location in the railway.
- **Fixed Virtual Block (FVB)**: The system determines occupancy of the Fixed Virtual Blocks based on reported train locations. In this system the end of a Movement Authority is only expected to be at discrete locations predefined during system design.

These concepts bring different benefits and challenges in their implementation. Their deployment may depend on the type of railway being considered. A summary of these points is presented in Table 1 below:

Topic	Full Moving Block	Fixed Virtual Blocks
Integration with other legacy system components	May be harder, as a full moving block system may require changes to concepts in other system components	May be easier, as other system components are also likely to be adapted to block based signalling
Capacity	Full Moving Block makes maximum use of available capacity	Lower theoretical capacity than Full Moving Block, depending on the length of the Fixed Virtual Blocks
Site Engineering	Less engineering is required, as it is not necessary to define Fixed Virtual Blocks	More engineering is required as the Fixed Virtual Blocks must be defined and validated.

Topic	Full Moving Block	Fixed Virtual Blocks
System Engineering	A Full Moving Block system is a larger change from existing signalling systems, and therefore has a larger impact on other system components	A system with Fixed Virtual Blocks is an evolutionary step from existing signalling systems, and therefore has a smaller impact on other system components
Location of trains in degraded situations	Movement Authorities are to arbitrary locations, which may make it harder to locate trains in degraded situations	Movement Authorities are to fixed pre-defined stopping points, which may make it easier to locate trains in degraded situations, depending on the length of the Fixed Virtual Blocks
Impact of Unknown Track Status Areas	Impact of Unknown Track Status Areas on operations is minimised, as such areas are not extended further than necessary	The impact of Unknown Track Status Areas on operations could be larger, as the Unknown areas are never smaller than their associated FVB section(s)

Table 1 – Comparison between Fixed Virtual Blocks and Full Moving Block

4.2 Trackside Train Detection

This section describes the differences between system types with and without Trackside Train Detection.

- **System Type with Partial or no Trackside Train Detection**:
  The system primarily uses Train Position Reports and Train Integrity status in order to determine the Track Status.
- **System Type with Complete Trackside Train Detection**:
  A system with Trackside Train Detection (TTD) can use the TTD to provide additional information about the Track Status. This may be particularly important when recovering from degraded modes of operation.

The presence of TTD may depend on the type of railway being considered.

A summary of advantages and disadvantages of systems with partial or no TTD coverage, or complete TTD coverage, is presented in Table 2 below:

Topic	Partial or No TTD Coverage	Complete TTD Coverage
Equipment Count	Less equipment, which should increase reliability	More equipment, which may decrease reliability
Operational Flexibility	Greater operational flexibility to run trains with different characteristics, even if there is partial TTD, because the train characteristics are not embedded into the infrastructure	TTD layout is embedded into the infrastructure, reducing operational flexibility
Releasing Infrastructure such as points and crossings	Release of infrastructure could be slower, as it is dependent on Train Position Reports. Could be improved by more frequent Train Position Reports	Release of infrastructure could be faster with TTD, as TTD may react before Train Position Report is received, depending on the latency and frequency of Train Position Reports.
Detection of non-communicating rail vehicles	In areas without TTD, it is not possible to detect non-communicating rail vehicles if they are moved, intentionally or unintentionally	TTD will detect non-communicating rail vehicles
Recovery after perturbation	In areas without TTD, “Sweeping” may be required in order to recover to normal operation, unless stored information can be used	TTD will assist in determining which parts of the railway are clear of rail vehicles, removing the need for “Sweeping”, thus recovering to normal operation faster.

Table 2 – Comparison between systems with and without 100% TTD

4.3 System types

This section describes system types for an ETCS Level 3 system obtained as a result of the combination of Moving Block concepts (FMB and FVB) and the presence of Trackside Train Detection (with or without TTD) described in sections 4.1 and 4.2.

Four different system types have been identified for Level 3 systems implementation. These are not mutually exclusive – a Level 3 System could be implemented using a mix of these system types, with adjacent parts of the L3 Area utilising a different option.

These are the Moving Block system types:

1) **Full Moving Block, without Trackside Train Detection**

   The system can issue Movement Authorities based on the rear of the preceding train. End of Authority can therefore be at an arbitrary location on the railway.

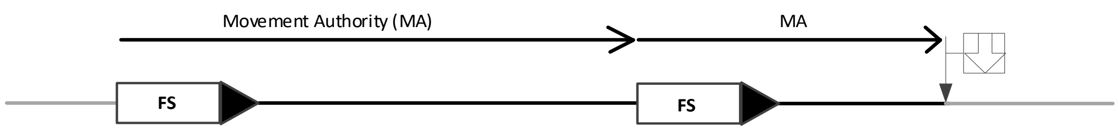

Figure 1 –System Type Full Moving Block without Trackside Train Detection

2) **Full Moving Block, with Trackside Train Detection**

   The system can issue Movement Authorities based on the rear of the preceding train. End of Authority can therefore be at an arbitrary location on the railway.

   Trackside Train Detection can be used to detect train movements, and to improve recovery from degraded situations.

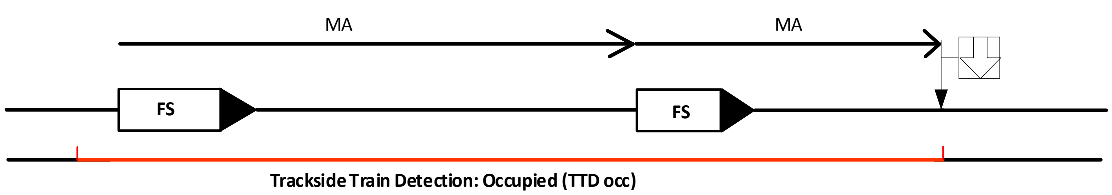

Figure 2 –System Type Full Moving Block with Trackside Train Detection

3) **Fixed Virtual Blocks, without Trackside Train Detection**

   The system can issue Movement Authorities based on the status of Fixed Virtual Blocks determined for the preceding train. The End of Authority can therefore only be to predefined locations on the railway.

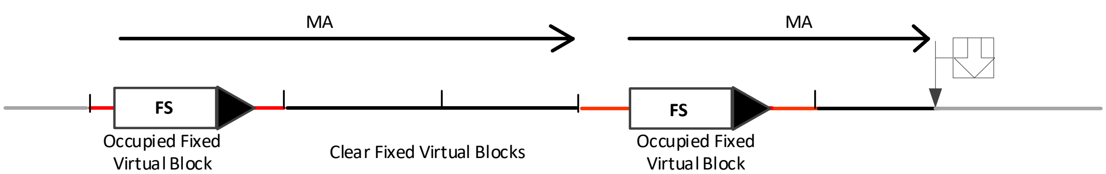

Figure 3 –System Type Fixed Virtual Blocks without Trackside Train Detection

4) Fixed Virtual Blocks, with Trackside Train Detection

The system can issue Movement Authorities based on the status of Fixed Virtual Blocks determined for the preceding train. The End of Authority can therefore only be to predefined locations on the railway.

Trackside Train Detection can be used to detect train movements, and to improve recovery from degraded situations.

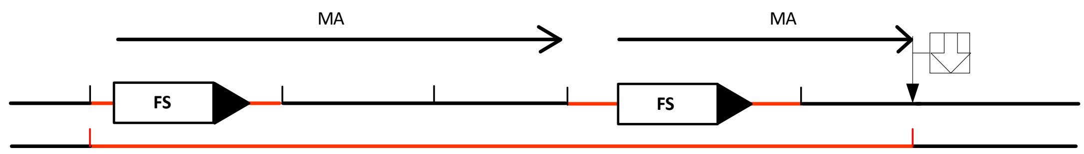

Figure 4 –System Type Fixed Virtual Blocks with Trackside Train Detection

4.4 Protection against Ghost Trains

A Level 3 signalling system is dependent on trains reporting their position, in order to achieve the safe separation of trains. A non-communicating train or other railway vehicle can become a "Ghost Train", which is not known to the L3 Trackside. A Ghost Train is a potential hazard to railway operations.

The L3 Trackside keeps an internal record of the locations of all trains, including trains which have stopped communicating with the L3 Trackside. However, this internal record of the location of all trains can become inaccurate:

1) After initialisation of the L3 Trackside, if there is a rail vehicle which is present on the track, but not known to the L3 Trackside.
2) After movement of a non-communicating rail vehicle, without any interaction between the Dispatcher and the L3 Trackside.

The use of Trackside Train Detection (TTD) provides some mitigation against the presence of a Ghost Train within the L3 Area of Control. However, a Moving Block signalling system will be designed to permit more than one train to enter a single TTD section unless this is equal to a FVB section, and therefore the use of TTD does not provide full mitigation. The following subsections provide some more information.

4.4.1 Systems with Full TTD coverage

In these systems, there is TTD covering all the track within the L3 Trackside Area of Control.

In these systems, the TTD provide significant, but not full mitigation for the presence of Ghost Trains.

The following mitigation is provided:

- The L3 Trackside will detect unexpected TTD occupation, and react by creating an Unknown Track Status Area, to provide protection.

The system can be engineered to provide the following mitigations:

- Detection of a Ghost Train entering at the boundary of the Area of Control, by use of short TTD sections at boundaries, which can only be occupied by a single train.
- Detection of a TTD section which remains occupied longer than expected, when a communicating train leaves the TTD section, by using a timer.

The following mitigation may also be possible:

- Axle Counter technology could be used to detect unexpected entry or departure from TTD sections.

4.4.2 Systems with Partial TTD Coverage

In these systems, TTD is selectively applied within the L3 Trackside Area of Control to manage specific hazards or for performance reasons, for example at boundaries of the Area of Control, over Points, in Shunting Areas, or in stations.

In these systems, the TTD provides some, but not full mitigation for the presence of Ghost Trains, but only in the areas where TTD is present.

The system can be engineered to provide the following mitigations:

- Detection of a Ghost Train entering at the boundary of the Area of Control, by use of short TTD sections at boundaries, which can only be occupied by a single train
- Detection of a Ghost Train after Splitting, by use of TTD sections in locations where Splitting and Joining is part of normal operation.
- Detection of a Ghost Train after Shunting, by use of TTD sections in or adjacent to permanent or temporary Shunting Areas.

The following mitigation may also be possible:

- Axle Counter technology could be used to detect unexpected entry or departure from TTD sections.

4.4.3 Systems with no or minimal TTD coverage

In these systems, there are large parts of the L3 Trackside Area of Control without any TTD. In these systems, the TTD provide little or no mitigation for the presence of Ghost Trains.

The system can be engineered to provide the following mitigations:

- Detection of a Ghost Train entering at the boundary of the Area of Control, by use of short TTD sections at boundaries, which can only be occupied by a single train.
- Detection of a Ghost Train after Splitting, by use of TTD sections in locations where Splitting and Joining is part of normal operation.
- Detection of a Ghost Train after Shunting, by use of TTD sections in permanent or temporary Shunting Areas.

The following mitigation may also be possible:

- Axle Counter technology could be used to detect unexpected entry or departure from TTD sections.

4.4.4 Operational Rules for all systems, whatever the level of TTD coverage

Despite the mitigations above, the L3 Trackside will not be able to detect non-communicating trains in areas where there is no TTD present, and will not be able to discriminate between a communicating train and a non-communicating train which are in the same TTD section.

Therefore, the following are required for all systems whatever the level of TTD coverage:

- Operational rules regarding the initialisation of the L3 Trackside.
- Operational rules regarding the movement of non-communicating rail vehicles.
- Operational rules regarding joining and splitting processes

4.5 List of Level 3 Trackside Functions

Table 3 below provides a list of functions within a L3 Trackside, where the L3 Trackside comprises what would be traditionally Interlocking and RBC functions, in an ETCS Level 2 system.

In Table 3 the following headings are used:

Function	Function within L3 Trackside
Short Description	Short Description of the function within the L3 Trackside
Example Operations	High level view of the operations of the function within the L3 Trackside
Comparison with L2	Indicates whether this function is different from ETCS L2, or the same
Comments	Any additional information, for example operational context or additional details

Table 3 includes all headline functions of the L3 Trackside, in order to enable an assessment of which functions are specific to L3, and which are similar or the same as in L2.

Function	Short description	Example Operations	Comparison with L2	Comments
Communications Management	Manage communication sessions between L3 Trackside and Trains	• Open Session • Terminate Session • Timeout	Same as L2	• Opened at SoM, Transition, Handover • Terminated at EoM, Transition, Handover

Function	Short description	Example Operations	Comparison with L2	Comments
Trains Management	Manage train details, including Train Location	• Create Train Location • Remove Train Location • Update Train Location	Similar to L2 (same function but using Train Integrity information)	• Created at SoM, Transition, Handover • Removed at EoM, Transition, Handover • Train Location is from MSFE to CRE
Track Status Management	Manage areas of Track Status	• Create Track Status Area • Remove Track Status Area • Update Track Status Area • Determine overall Track Status	L3 Specific	• Includes function to manage TMS interface for Dispatcher to manage Unknown Track Status Areas. • Includes interface to TTDs where these are used.
Movement Authority Management	Manage Movement Authorities including associated profile data for e.g. speed, gradient, etc.	• Create MA • Extend MA • Reduce MA • Revoke MA	Similar to L2. In L3, managed via Reserved Status Areas In Full Moving Block systems, the EoA can be located at an arbitrary location on the railway.	• Send an MA to the rear of the train ahead, or to the rear of an occupied FVB if FVB are used • Reduce, extend or update an MA. • Send an MA in OS Mode Profile for Unknown and Occupied areas
Manage Temporary Speed Restrictions	Manage Temporary Speed Restrictions	• Create TSR • Revoke TSR • Modify TSR	Same as L2	• Includes function to manage TMS interface
Manage Low Adhesion Areas (LAA)	Manage Low Adhesion Areas	• Create LAA • Delete LAA • Modify LAA	Same as L2	• Includes function to manage TMS interface

Function	Short description	Example Operations	Comparison with L2	Comments
Route Management	Manage Setting, Releasing and Cancelling of Paths	• Set Path • Cancel Path	Similar to L2, but called "Paths"	• May be multiple trains in the path. • Exchange with Trains for Release
Points Management	Manage control of Point as directed by TMS, or as required by Routes	• Control straight position • Control diverging position	Same as L2	• Interface to Points via Object Controller • Interface to TMS for Point Keys • Interface to Routes for point calling by Routes
Trackside Train Detection Management	Manage status of TTDs		Same as L2	• Only if TTD present • Interface to TTDs via Object Controller • Reset for Axle Counters
Reserved Status Management	Manage areas of Reserved Status	• Create Reserved Status Area • Remove Reserved Status Area • Update Reserved Status Area • Determine overall Reserved Status	L3 Specific	• Includes interface to TTDs where these are used.

Table 3 – L3 Trackside Functions

As a conclusion only Train Location, Track Status and Reserved Status functions require a specific description within the L3 Trackside for a Moving Block Signalling System.

The L3 specific functions for Track Status and Reserved Status and the functions which are similar, but not the same as L2, Movement Authority Management and Train Location, are included in the safety analysis in Part 6.

5 System Boundaries

Figure 5 below shows the ETCS Level 3 System Boundaries. Only the parts of this system within the ETCS L3 System are within the scope of the [CSM-RA] process.

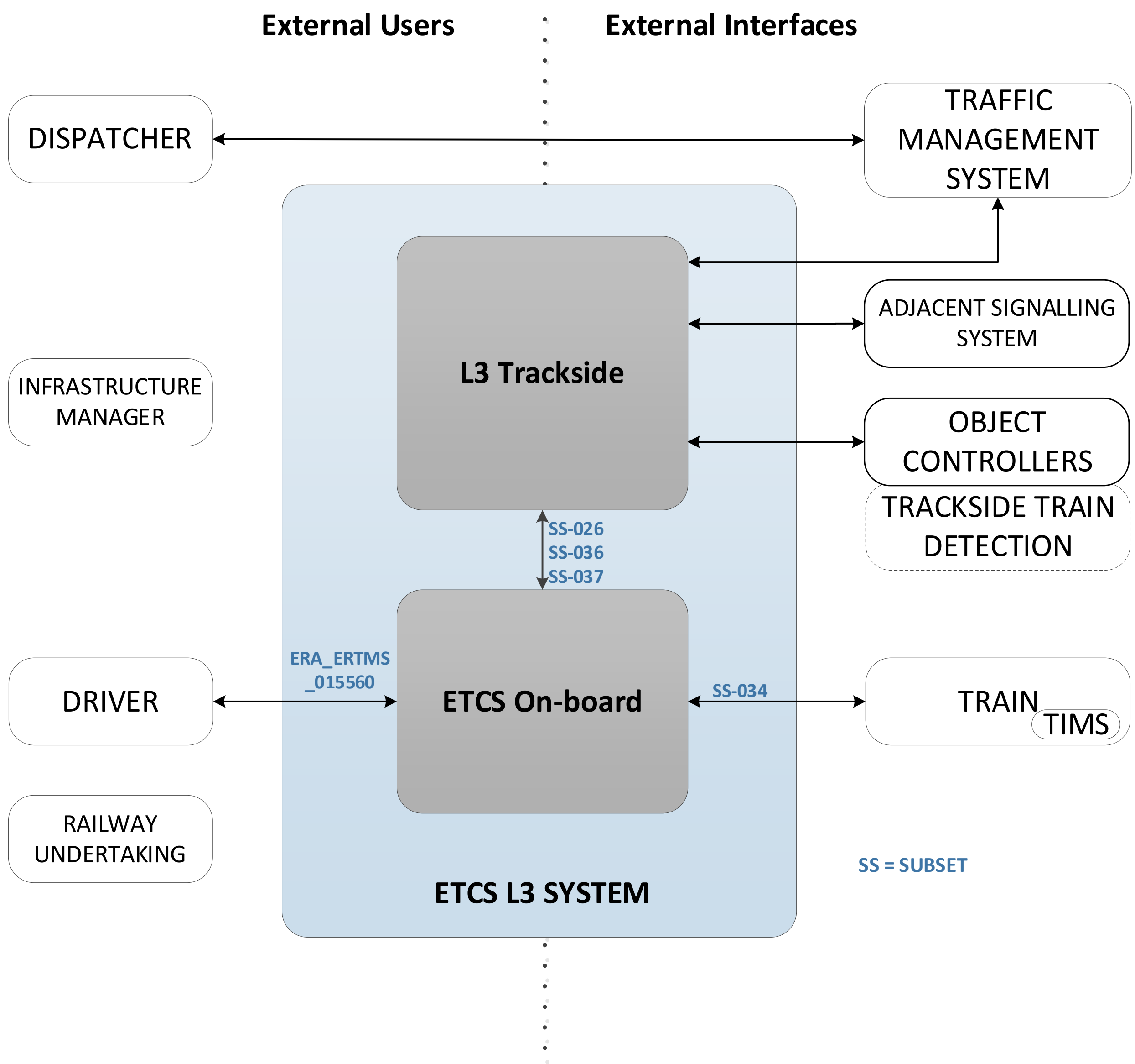

Figure 5 – ETCS Level 3 System Boundaries

Safety hazards outside the scope of this System Definition shall be mitigated by other systems or by operational procedures.

L3 Trackside includes functionality traditionally considered part of the interlocking as well as the RBC. The System Architecture in the ETCS Specifications [BL3 R2] does not consider the interlocking as part of the ETCS system. In an ETCS Level 2 system, although there is no standardised interface between RBC and Interlocking, the separation of functions is clearer. In Level 3:

- Track Status is derived primarily from Train Position Reports, rather than TTD
- Reserved Status is specific to L3, and related to Track Status

Therefore, the Track Status and Reserved Status functions are required to be in scope of the ETCS Level 3 system. This is shown in Figure 6. Throughout this document, the term "L3 Trackside" is used, which encompasses the Track Status and Reserved status functions.

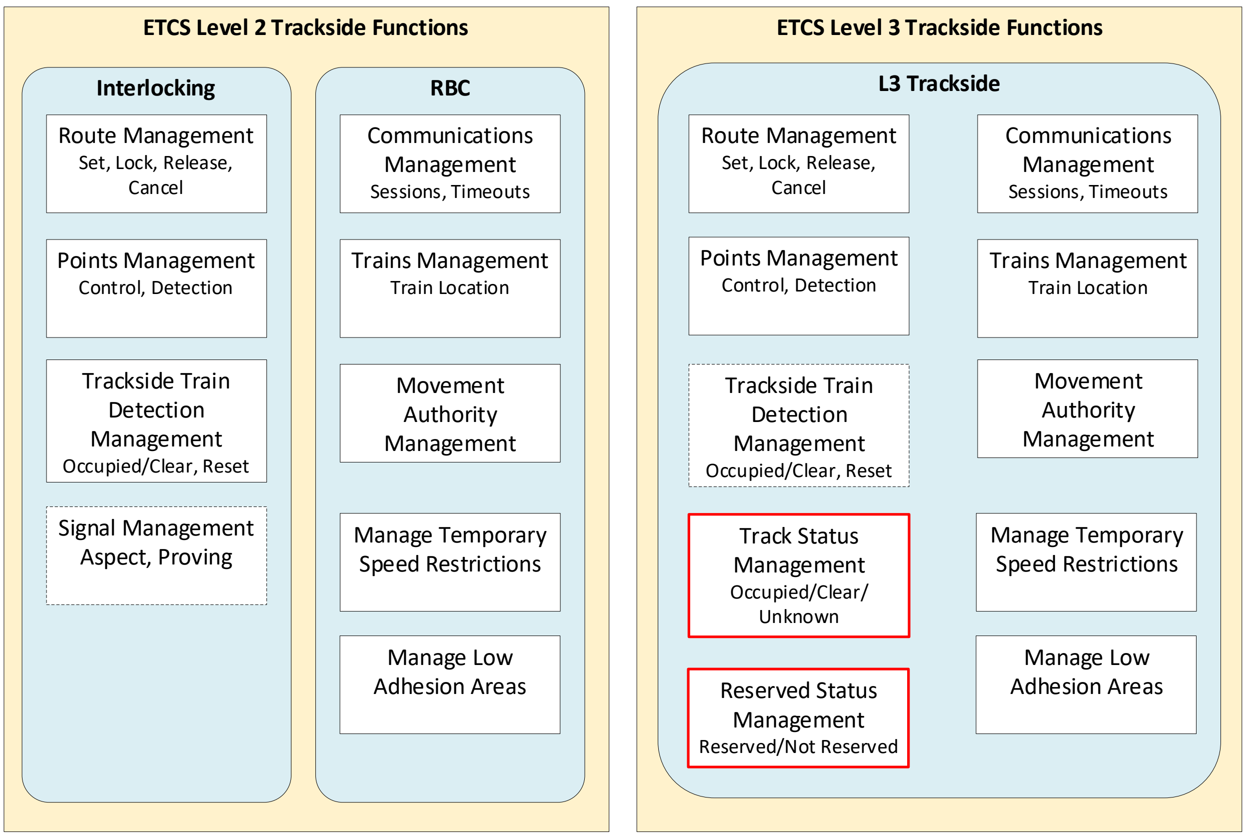

Figure 6 – Trackside Functions for ETCS Level 3 compared with Level 2

Notes for Figure 6:

- Signal Management may or may not be present in Level 2, and so is shown with a dotted line, indicating it being Optional. Signal Management is not expected in Level 3, but may be used in some circumstances.
- Trackside Train Detection Management is shown in Level 2. Trackside Train Detection Management may or may not be present in Level 3, depending on the System Type, and so is shown with a dotted line, indicating it being Optional.
- The functions specific to Level 3 are shown with a red line.

6 Physical and Functional Interfaces

As this is a generic System Definition, this section only covers Functional Interfaces. Physical Interfaces will need to be covered in specific projects.

According to the defined ETCS Level 3 System Boundaries in Figure 5, the External Users for the system are:

- **Dispatcher:** the operator of the Traffic Management System
- **Infrastructure Manager:** the body responsible for the operation and maintenance of the railway infrastructure
- **Driver:** the operator of the train
- **Railway Undertaking:** Responsible for train operation and maintenance

According to the defined ETCS Level 3 System Boundaries in Figure 5, the External Interfaces of the Moving Block system are:

- **Traffic Management System:** any control system from simple route requests to an automated Traffic Management System (TMS)
- **Trackside Train Detection:** physical device installed in the track for train detection (this interface has been considered as optional)
- **Train:** Rolling stock
- **TIMS:** Train Integrity Management System (as TIMS specification is still in progress some assumptions regarding the information to be provided by TIMS are defined in Section 8.)
- **Adjacent Signalling System:** May be another instance of L3 Trackside, or a different type of Signalling System

7 System Environment

System environmental conditions for Railways applications are defined by EN50125 standards. The scope of these standards covers the definitions and ranges of the following parameters: altitude, temperature, humidity, air movement, rain, snow and hail, ice, solar radiation, lightning and pollution for:

- Rolling stock and on-board equipment [EN50125-1]
- Equipment for signalling and telecommunication [EN50125-3]
- Fixed electrical installations [EN50125-2]

The EN50121 standards provide information about the EMC management and describes the characteristics of the railway system which affect electromagnetic compatibility (EMC) behaviour:

- General Electromagnetic compatibility [EN50121-1]
- Emission of the whole railway system to the outside world [EN50121-2]
- Train and complete vehicle [EN50121-3-1]
- Rolling stock. Apparatus [EN50121-3-2]
- Emission and immunity of the signalling and telecommunications apparatus [EN50121-4]
- Emission and immunity of fixed power supply installations and apparatus [EN50121-5]

8 Assumptions

The following sections describe assumptions about topics which are covered elsewhere within the X2Rail projects.

The co-ordination between the different work packages is being addressed by WP2, which is present in all X2Rail projects.

8.1 Train Integrity

Train Integrity was addressed by Shift2Rail TD2.5 in X2Rail-2 and X2Rail-4.

Assumptions:

> **ASM-Integrity-1**: Train Integrity is an input to the ETCS On-board from a TIMS device external to the ETCS On-board, with an interface consistent with Change Request 940 [CR940]
>
> **ASM-Integrity-2**: Train Integrity information is processed by the ETCS On-board in accordance with the behaviour specified in the solution to Change Request 940 [CR940].
>
> **ASM-Integrity-3**: When two trains are joined, this will cause the external TIMS devices in each train to report loss of train integrity.

For Train Integrity, additional assumptions are made for the short term. Here "short term" means systems based on the ETCS Baseline 3 Release 2 [BL3 R2] and Change Request 940 [CR940].

Additional Short-Term Assumptions:

> **ASM-Integrity-4:** The status of the TIMS will be visible to the Driver.
> *This is the status of the TIMS equipment itself, regardless of the state of Train Integrity. This could be directly from the TIMS equipment, or via the Technical and Diagnostic display within the train. This is the maintenance status (Ok/faulty). For example, this permits the Driver to determine whether the TIMS is operational at Start of Mission. Information should only be visible to the Driver when it is relevant.*
>
> **ASM-Integrity-5:** The Driver is able to reset or restart the TIMS if it has failed.
> *For example, the Driver can request the TIMS to be restarted if it is detected as failed at Start of Mission. This could be by operating a power switch.*
>
> **ASM-Integrity-6:** The status of Train Integrity determined by the TIMS will be visible to the Driver.
> *This is the status of the Train Integrity, assuming that the status of the TIMS equipment is OK. This could be directly from the TIMS equipment, or via the Technical and Diagnostic display within the train. For example, this permits the Driver to determine whether or not train integrity is confirmed at Start of Mission.*
> *Information should only be visible to the Driver when it is relevant.*

ASM-Integrity-7: The frequency of reporting of train integrity confirmed or lost by the TIMS is sufficiently high that it reduces the time at risk to an acceptable level in the event that a train divides whilst the train is moving.
For example, an acceptable reporting period is deemed to be at least every 5 seconds. The frequency of reporting of train integrity influences the performance of the railway, by determining how often the rear train position is updated in the L3 Trackside. The time to detect a train which divides whilst the train is moving determines the time at risk.

ASM-Integrity-8: The frequency of reporting of train integrity confirmed or lost by the TIMS is sufficiently high that it is not necessary for a Driver to wait before closing the desk at End of Mission.

It could occur that at the time when the Driver performs End of Mission, the CRE of the train is far behind its Rear End (if Train Integrity has not been confirmed recently). In a station area this could result in alternative routes and infrastructure in rear of the train remaining locked due to the Track Status Area that remains after End of Mission. An alternative to a frequent confirmation of integrity would be for the driver to wait until a position report is sent in which Train Integrity is confirmed. However this is considered as not feasible. For example, an acceptable reporting period is deemed to be at least every 5 seconds, as in ASM-Integrity-7 above.

In the medium or long term, it is expected that there will be changes to the interface between the Train Interface and TIMS, to enable some TIMS devices to provide train length data. In addition, it is expected that TIMS will be able to detect Loss of Integrity of a stationary train.

8.2 Traffic Management

Traffic Management System is being addressed by Shift2Rail TD2.9 in X2Rail-2 and X2Rail-4.

Assumptions:

ASM-TMS-1: There will be an interface between the L3 Trackside and the Traffic Management System.

ASM-TMS-2: The TMS will require information about all communicating trains.

ASM-TMS-3: It is acceptable to request inputs from the Traffic Management System to the L3 Trackside.
ASM-TMS-4: It is acceptable to define outputs from the L3 Trackside to the Traffic Management System.

8.3 Train positioning

Train Positioning is being addressed by Shift2Rail TD2.4 in X2Rail-2 and X2Rail-5.

Assumptions:

ASM-Position-1: Any change to the Train Positioning technology will not have a negative impact on the operation of the L3 Trackside, or the ETCS On-board.

8.4 ATO over ETCS

ATO over ETCS is being addressed by Shift2Rail TD2.2 in X2Rail-1 and X2Rail-4.

The ETCS architecture shown in Figure 5 includes a Driver. This system definition has assumed that there will be a driver present. Therefore, this system is specified to be able to support Grades of Automation up to GoA2.

Assumptions:

> **ASM-ATO-1:** Use of ATO at Grade of Automation 2 (GoA2) will not have an impact on the operation of the L3 Trackside, or the ETCS On-board.

Use of ATO at GoA levels above GoA2 will have an impact on the L3 Moving Block System (for example, impact on use of SR mode).

8.5 Communications

Communications is being addressed by Shift2Rail TD2.1 in X2Rail-1 and X2Rail-3, X2Rail-5.

Assumptions:

> **ASM-Comms-1:** Changes to the communication technology will not affect the content of the messages defined in the ETCS Definitions.

> **ASM-Comms-2:** Changes to the communication technology will not increase the transit time of the messages between L3 Trackside and On-Board.

8.6 Train Length (L_TRAIN)

Train Length was also addressed by Shift2Rail TD2.5 in X2Rail-2 and X2Rail-4.

Assumptions:

> **ASM-Length-1:** The Train Length reported by the train is correct.
> *This means that the Train Length can be used by the L3 Trackside to release track behind the train, and for length calculations during splitting and joining.*

> **ASM-Length-2**: The Train Length reported by the train represents the maximal length of the train.
> *This means the length of the train at maximum extension, if the train can stretch and contract. This means without any additional Margin, as this is added by the L3 Trackside. This means that the Train Length can be used by the L3 Trackside to release track behind the train, and for length calculations during splitting and joining.*