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## Introduction to Moving Block Specification

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#### Short bio

Dipl.-Ing. **Stefanie Schöne** finished her studies of transport engineering at the Technical University of Dresden, Germany with a diploma in 2012. Since then she has been working at the Institute of Transportation Systems of the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt, DLR), mainly in the fields of railway operations and railway signalling systems.

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### Introduction

This contribution introduces the Moving Block Specification developed in the X2Rail projects and finalized in X2Rail-5. It shows examples of new concepts that are introduced in order to deal with the new constraints Moving Block Systems will face.

### Structure and contents of the X2Rail-5 Moving Block System specification

One goal of Shift2Rail is to provide demonstrators that implement European Train Control System (ETCS) Level 3 Moving Block systems. These systems shall conform to the existing ETCS specifications. However as the specifications apply to all levels of ETCS, some of these requirements have to be stated more precisely for Level 3 to reach the level of detail needed to develop individual, interoperable ETCS systems. To aim for the different needs of the market, the system specification fits all different railway

operation systems (High speed, urban, freight and overlay systems) as well as the four railway types:

- Full Moving Block with Trackside Train Detection (TTD),
- Full Moving Block without TTD,
- Fixed Virtual Block with TTD and
- Fixed Virtual Blocks without TTD

The Moving Block Specification is carried out in the dedicated Work Package 4 “Moving Block” of X2Rail-5. The Deliverable 4.1 [1] contains the system specification in six different parts:

- Part 1 Introduction – including used terms, abbreviations and references for all six parts,
- Part 2 System Definition – defining the system and stating assumptions,
- Part 3 System Specification – containing requirements for the Moving Block System,
- Part 4 Operational Rules – for operator interactions needed in the system,
- Part 5 Engineering Rules – for cases in which additional rules or configurations are required, and
- Part 6 Safety Analysis – containing a generic Hazard Analysis, while a full Safety Analysis has to always be executed for a specific system implementation

## **Basic principles of the Moving Block system**

### **Approach and Constraints**

The Moving Block System specification is implementation and technology independent. This means it shall cover all critical safety concerns, basic principles of system design and implementation of interfaces, all the while leaving operators and system manufacturers enough room for their specific implementations and to follow national peculiarities. For example, the development of a safe Moving Block System is possible that works completely without physical trackside signals or TTD. However, there are engineering rules that give a guidance to where additional TTD could improve possible safety or line capacity issues.

The specification aims to be compatible with the existing ETCS specification, specifically Baseline 3 Release 2 [2], already assuming Change Request 940 [3] as included. The Moving Block Specification only describes the rules and requirements that go beyond these already existing for a Level 2 system and therefore does not contain the specification for a whole ETCS system. For the functionalities of Level 2 systems the already existing ETCS specification has to be consulted. This is also the reason why most of the stated requirements in the Moving Block Specification are for the Trackside part of the system as this contains the most differences between Level 2 and Level 3 systems.

What parts of the railway system the specification covers is shown as the indicated “ETCS L3 System” in Figure 1.

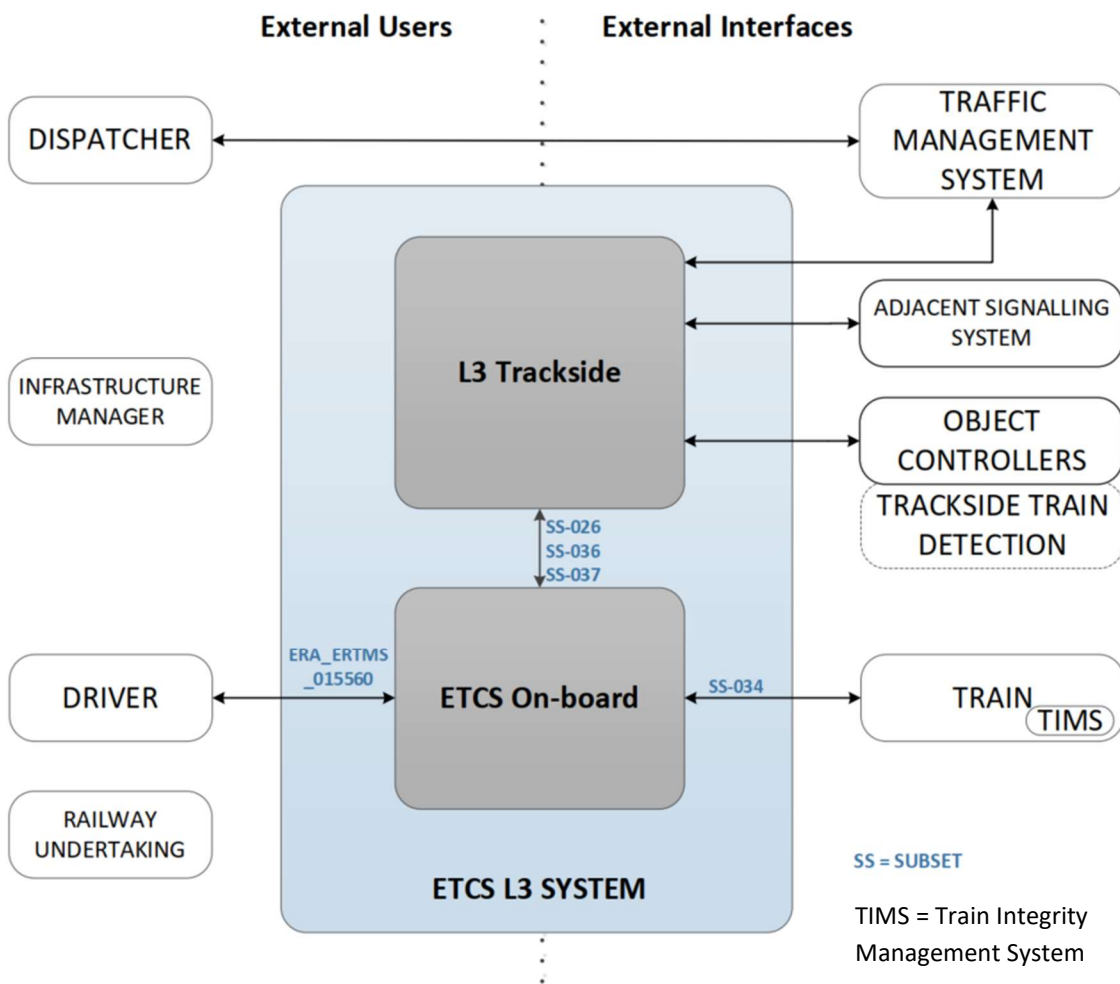


Figure 1: Moving Block System Boundaries, from [1]

The following sections show two examples of new concepts that were introduced to deal with the constraints for Moving Block systems.

### Track State Management

A crucial part of ETCS Level 3 is the fact that the Trackside has to have a clear picture of the track occupation status in their area in order to issue safe Movement Authorities, based only on Train Position Reports. To represent the Track, each section of the track can have the Track Status “Occupied”, “Clear”, or “Unknown”. “Occupied” and “Clear” representing a clear information about the presence of a known obstacle on the track. “Unknown” is issued if it is not clear if there is an obstruction or if the system is sure that there is a train in a certain area, but not sure where exactly. There could be various reasons for a Track Status Area to be “Unknown”, including:

- Trains without confirmed Train Integrity
- Trains not communicating
- Areas created by the dispatcher, in order to secure areas, for example construction sites

The full list is part of [1]. “Unknown” Areas can be cleared by various means, for example by sweeping with train movements. On the other hand, there are also non sweepable “Unknown” Areas, to remain “Unknown” after a train has passed.

Additional to the Track Status, the Track State Management introduces the concept of a Reserved Status. Reserved meaning to be dedicated for the movement of one assigned train in a specific direction. This enables the Trackside to issue Movement Authorities of

any length at any convenient timing, as long as they are issued within the Reserved Area for that train. This concept also provides the safety layer, as a train can generally not enter in a Reserved Area for a different train.

The Track Status is determined from a variety of information sources available to the Trackside, usually including TTD, TIMS and other sources that may be available to the TMS, as the dispatcher. How the logic of Track State Management can be applied to the different railway system types, is shown in Part 3 of [1].

### L3 Margin

Part of the works in the Moving Block Workstream of the X2Rail projects was to analyze possible risks introduced by the new conditions when operating in Moving Block, and to introduce requirements in the specification to mitigate these risks. One of the issues was the risk that a train overpasses its issued Movement Authorities. This risk is higher than in Level 2, because the Movement Authority can be set up to the very rear of the preceding train, as indicated in Figure 2. Additionally, in certain implementations without TTD, it could be that a train is unintentionally rolling back into the Reserved Area of the following train.



**Figure 2:** One train following another in Moving Block, from [1]. Green indicating the Reserved Area for Train 2, Red indicating the Occupied Track Status Areas

In the safety analysis, it is concluded that it is unlikely that both situations described above will occur and pose a risk at the same time. The Moving Block Specification requires the use of a so called “L3 Margin”, that is set between the rear of a train and the end of any Movement Authority for a train following it. However, how large this Margin may be, and if it might have different values set for different circumstances, is up to the specific implementations, national rules and specific risk evaluations in every case.

### Sources

[1] X2Rail-5 Deliverable 5.1: Moving Block Specification, available under [https://projects.shift2rail.org/s2r\\_ip2\\_n.aspx?p=X2RAIL-5](https://projects.shift2rail.org/s2r_ip2_n.aspx?p=X2RAIL-5)

[2] Set of specifications # 3 (ETCS Baseline 3 Release 2 and GSM-R Baseline 1) according to Annex A of Commission Implementing Regulation (EU) 2019/776 of 16 May 2019. It is publicly available: <https://www.era.europa.eu/era-folder/set-specifications-3-etcs-b3-r2-gsm-r-b1>

[3] The Change Request is held within the ERA Change Request database, together with the proposed solution.

The solution is publicly available within Opinion ERA/OPI/2020-2:

<https://www.era.europa.eu/library/documents-regulations/opinions-and-technical-advice>

The description of CR940 is available in Annex 3 of the above.

The solution has subsequently been updated in the ETCS CCM process, but without impact on the Moving Block Specification.