Rail to Digital automated up to autonomous train operation

D13.1 – Moving Block Specifications applying a train-centric approach

Part 1 – System Definition

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Disclaimer

EXECUTIVE SUMMARY

This document contains the System Definition for a train-centric signalling system that aims to provide high capacity with low cost and high reliability and enables moving block operation.

This document is part of the Moving Block System specification deliverable.

This document defines the signalling system, called Moving Block System, in particular the system objectives, capabilities, boundaries, functions, operational requirements and assumptions in order to cooperate with the Moving Block concept.

ABBREVIATIONS AND ACRONYMS

For abbreviations and acronyms used in the ERTMS/ETCS specifications, please refer to Subset-023, [1].

AoC	Area of Control
CR	Change Request
CCS	Control, Command and Signalling
DR	Digital Register
ERJU	Europe’s Rail Joint Undertaking
L2	ETCS Level 2
IXL	Interlocking
MBS	Moving Block System
OC	Object Controller
OP	Operator Panel
OPE	Operation and Traffic Management
PE	Plan Execution
R2DATO	Rail to Digital automated up to autonomous train operation
RCA	Reference CCS Architecture
S2R	Shift2Rail
TA	Trackside Asset
TACS	Trackside Asset Control and Supervision
TIMS	Train Integrity Monitoring System
TMS	Traffic Management System
TSI	Technical Specifications for Interoperability
TTD	Trackside Train Detection

WORK PACKAGE GLOSSARY

Note: Some of those terms are currently also defined in the Glossary of other documents (e.g., System Specification, Safety Analysis) of D13.1. Therefore, as long as there is no separate Glossary document available, care must be taken to keep the definitions synchronised.

Term	Definition
Area of Control	The *Area of Control* is the topologically limited extent and the infrastructural *Trackside Assets* in this geographical extent. The term is used here for defining the technical and operational responsibility of one MBS.
Domain Data	The Domain Data refers to use case specific configuration data for the MBS to define the specific application. These can be broadly classified as Map Data, Segment Profiles, and Parameter Data. As a part of configuration process, the MBS needs Domain Data. Potential updates of Domain Data will be realised by a centralised provisioning process incl. synchronous activation of the new data version.
Operational Plan	The *Operational Plan* is the result of the planning process performed by the planning system (TMS). It describes either a planned Operational Movement, Operational Restriction or Operational Warning Measure through a temporal sequence of Operational Events to be implemented by underlying subsystems in the *Area of Control*.
Operational State	The *Operational State* consists of train-related information (e.g., permissions, authorisations or train position) and track-related information (e.g., state of *Trackside Asset*s).
System Capability	A *System Capability* is a service an actor requires from the system to fulfil its business goals. *System capabilities* are realised by exploiting one or multiple functions, usually in a chain of functions. Syst*em capabilities* in terms of this document are very similar to use cases and the theory behind it.
Train-centric	A train-centric approach from a trackside point of view focuses on the train as the true business object. A train object is derived by a train-centric signalling system using the currently available sensor information from the train and the trackside. This allows the safety logic of train-centric signalling system to operate on the train objects instead on the auxiliary information 'occupancy' only as today in conventional block-centric signalling systems.
Trackside Asset	*Trackside Asset*s are elements on or near the track which are used to monitor (using sensors) and/or control (using actuators) the movement of vehicles through the railway network. to provide a safe route through the railway network. They can be switchable or non-switchable and are controlled by the actors Trackside Asset Control and Supervision.

Usage Restriction Area	A *Usage Restriction Area* (URA) limits or constraints operation on a part within the *Area of Control*. URAs can be created according to an *Operational Plan* (e.g. for enabling construction works) or in response to an incident (e.g. as a mitigation measure). There are various limitations possible for a URA, e.g. speed restriction, full track closure or deactivate automatic operation.

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1 INTRODUCTION

The part 1 of D13.1 Moving Block ETCS Level 3 – Specification within the project FP2 - R2DATO has been developed to define the System Definition of the Moving Block System, including the assumptions.

According to EN50126 this System Definition addresses the following issues:

- System objectives
- System capabilities
- System boundaries including functional interfaces
- System functions and elements
- Scope of operational requirements influencing the system
- Assumptions and existing safety measures

This document contributes as input to the following documents, respectively work packages

- D13.1 Part 2 – System Specification
- D13.1 Part 3 – Safety Analysis
- WP14: Moving Block ETCS Level 3 – Prototype development & Analysis
- WP44: Moving Block ETCS L3 Demonstrator – Specification

2 SYSTEM OBJECTIVE

2.1 DESCRIPTION OF THE SYSTEM UNDER CONSIDERATION

The Moving Block System (MBS) is based on a train-centric approach using Full Moving block principles with the overall objective to engineer high capacity, low cost, high reliability signalling systems. The MBS is defined as a single system, without enforcing the conventional separation of Radio Block Centre (RBC) and interlocking (IXL). The MBS is based on ETCS cab signalling without lineside signals. It uses a more generic and simplified safety logic by abandoning the traditional block concept mainly relying on signals. By emphasising the safety logic, the dependency on country specific operational processes is reduced.

The Moving Block System builds on the Functional Railway System Architecture defined by the System Pillar and the Moving Block specification defined in Shift2Rail [4] and RCA initiative [3]. Depending on the requirements and needs, the MBS can operate within an environment where TTD equipment is installed but also within an environment where TTD equipment is not installed. The rationale for considering TTD is to support migration, recovery from degraded situations, and to facilitate sensor fusion principles to foster different localisation inputs.

2.1.1 System capabilities

The fundamental objectives of the MBS are to ensure safe train movement and prevent railway accidents. They can be split into the following system capabilities:

- MBS manages communication sessions with *Trackside Asset*s (TA) via specified interfaces within its *Area of Control* (AoC).
- MBS manages communication sessions with trains via specified interfaces within its AoC and adjacent areas where trains are supposed to establish or terminate a communication session.
- MBS controls all TAs within its AoC.
- MBS manages the current trackside state and determines the state of the track from information given during runtime by trains and TAs within its AoC.
- MBS manages all track path allocations for all trains and vehicles within its AoC. This contains an adequate and risk-based protection of requested pieces of track for an intentional train movement.
- MBS issues authorisations for train movements based on requested and accepted track path allocations.
- MBS supervises trains and TAs to prevent railway accidents. This includes especially any collision, derailment or over-speeding.
- MBS stores an up-to-date, reliable and consistent current *Operational State* and provides this Operational State to systems connected to MBS.
- MBS manages *Domain Data* changes e.g., by introducing new parts of the track.

- MBS manages Usage Restriction Areas (URA) and ensures that any URA limitations or constraints are considered for operation .
- MBS handles a safe transition of train movement from and to adjacent systems.

The system is providing Moving Block operation but it needs to be understood that its application is more generic. As it authorises a movement to an arbitrary (operationally sensible) location which might or might not be the rear end of the preceding train, it is in its core moving block agnostic, as the on-board unit is. Thus, the MBS is capable of supporting fixed block, virtual fixed block and moving block operation. It depends on the requesting Plan Execution (PE) system which operation is actually performed.

2.2 LONG TERM OPERATING STRATEGY AND CONDITIONS

MBS shall offer increased operational flexibility (e.g., by enabling train movements from anywhere to anywhere, not using pre-defined paths) allowing for both the minimisation of manual operation by the dispatcher/operator and enabling faster recovery from degraded and emergency situations.

The long-term operating strategy of the MBS in combination with the interfacing systems revolves around a high grade of operational automation. In the case of deviations from normal operation, the higher level of automation facilitates the choice of flexible, operational alternatives as well as the reduction of risks associated with human errors by providing improved technical assistance (e.g., for construction workers, maintenance staff, operators).

All in all, MBS should contribute to the increase in capacity by utilising shorter headways enabled by the more efficient use of the infrastructure, the use of information of the running trains and the more precise occupancy information through the combination of information sources (e.g., axle counters, track circuits, Train Position Reports).

2.3 SYSTEM LIFE-TIME CONSIDERATIONS

System life-time is understood as system life-cycle within this system definition. MBS is foreseen with a modular functional approach. Regarding this approach several life-cycle considerations have to be considered:

MBS life-cycle is independent from life-cycles of surrounding systems. Any changes in PE, Digital Register (DR) or Trackside Asset Control and Supervision (TACS) do not affect MBS as long as interfaces used are unchanged. Due to generic safety logic, MBS life-cycle is independent from life-cycle of *Domain Data* provided by DR. Changes in infrastructure and TAs only affects the Domain Data of the MBS without change the software of the MBS. MBS requirements lifecycle is envisioned independent from hardware components and their operating systems.

The only dependency is given by the MBS functional lifecycle itself.

2.4 LOGISTIC CONSIDERATIONS

The MBS as described within this system definition is not a physical product. At this stage of development, logistic considerations are not necessary.

3 SYSTEM BOUNDARIES

This section defines the environment and boundaries of the Moving Block System (MBS) by defining the interfaces and interactions with other technological systems, the environment, humans and other railway duty holders.

As there is no target CCS reference architecture available yet, this chapter is based on the assumptions consolidated in WP13. It is expected that the interfaces or details of the interface is subject to change based on the evolvement of the target CCS reference architecture.

An overview is shown in the following figure with the mentioned technological systems, environment, humans and other railway duty holders further described in the following subchapters.

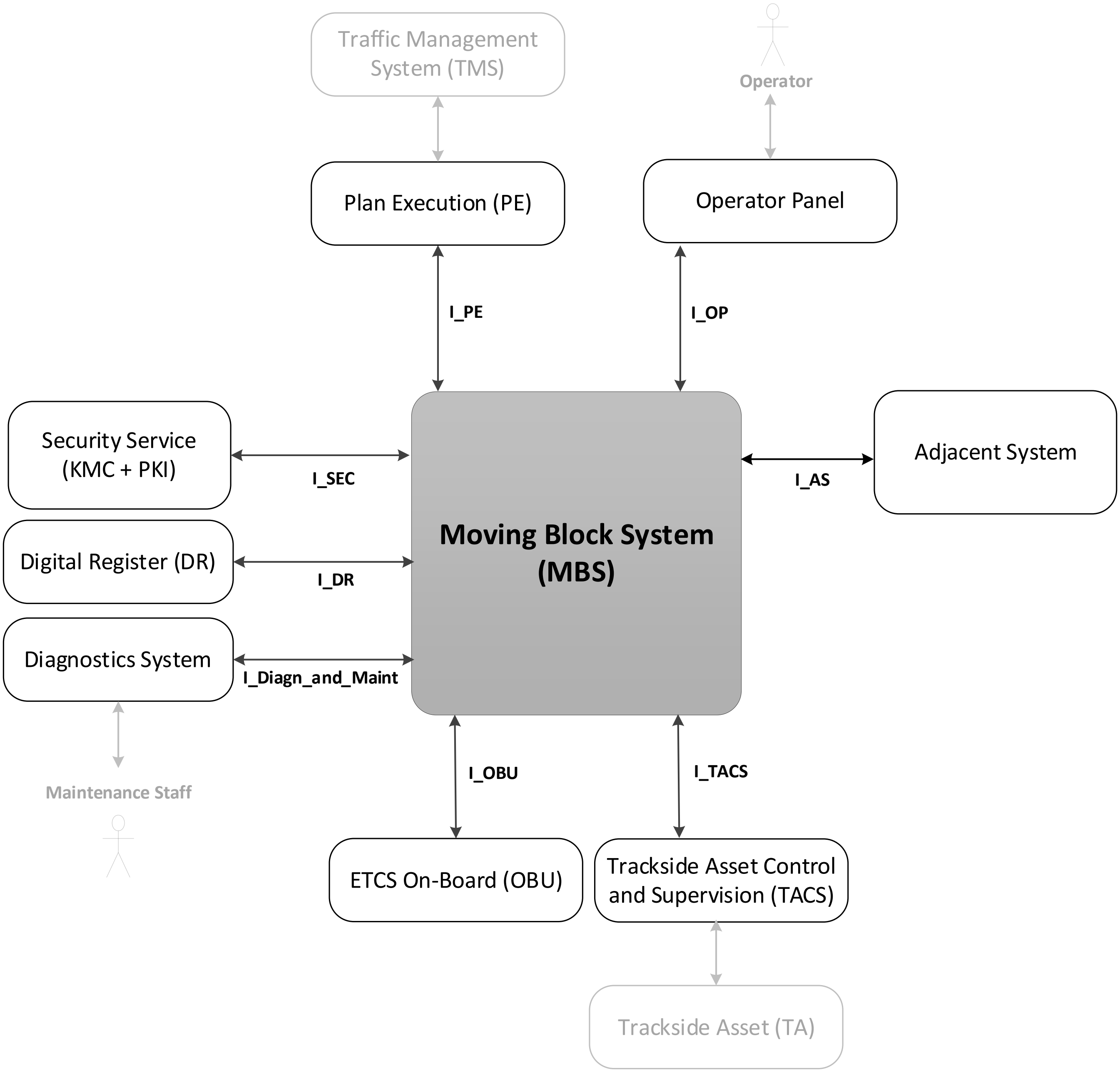

Figure 1: System Boundaries

3.1 INTERFACES AND INTERACTIONS WITH OTHER TECHNOLOGICAL SYSTEM

This chapter defines the interfaces and interactions between the MBS and other technological systems. For each technological system a description, the cardinality (from one MBS instance) and the applicable standard (if any) to be used for the corresponding interface is provided.

3.1.1 Adjacent System

Attribute	Content
Name	Adjacent System
Description	An Adjacent System can be either radio-based ETCS related neighbouring system or a neighbouring system not related to radio-based ETCS. A radio-based ETCS related neighbouring system can be either another MBS or a neighbouring Radio Block Centre (RBC) and an IXL. The interface to such a neighbouring system allows trains to pass the border to/from a neighbouring Level 2 area without changing the driver responsibility and the cab-signalling. A neighbouring system not related to radio based ETCS is an IXL. The interface to such a neighbouring system allows trains to pass the border to/from an area not equipped with Level 2. The cab-signalling is replaced by optical signals.
Cardinality	n
Interface	The interface to a radio-based ETCS related neighbouring system is based on the existing ETCS specifications [1], namely Subset-039 and Subset-098. For the interface to a neighbouring IXL system it is recommended, but not mandatory, to use the SCI-ILS interface as published in EULYNX [2]. Notes: - Interfaces to neighbouring IXL systems depend on the supported interface capabilities of the IXL and have to be adapted, e.g., by using adapter solutions. - An interface to an adjacent MBS may also require enhancements to the existing ETCS specifications.

3.1.2 Diagnostics System

Attribute	Content
Name	Diagnostics System
Description	Diagnostics is, as in any system, a fundamental feature. .

Cardinality	1
Interface	For the target architecture this interface may base on the SDI interface specification published in EULYNX [2]. This will be finally defined by the System Pillar.

3.1.3 Digital Register

Attribute	Content
Name	Digital Register
Description	The Digital Register (DR) provides reliable (meaning complete, accurate, current, and consistent, verified and validated), interoperable and accessible infrastructure information as a critical enabler for safety-related and non-safety-related functions. The Digital Register includes static infrastructure information (static speed profile, gradients, cant, etc.) and configuration data, which are approved after engineering process. The interface between the DR and the MBS is used to update the data in the MBS.
Cardinality	1
Interface	The interface between the DR and the MBS is not standardised yet. It will be defined in coordination with WP27 considering both the data model and the handling of parameter/configuration data as defined by System Pillar Domain TCCS (SD1, SD3).

3.1.4 ETCS on-board

Attribute	Content
Name	ETCS on-board
Description	The ERTMS/ETCS on-board (OBU) equipment is a computer-based system that supervises the movement of the train to which it belongs, on basis of information exchanged with the MBS.
Cardinality	n
Interface	The interface to the OBU is based on existing ETCS specifications [1], namely Subset-026, Subset-037.

3.1.5 Operator Panel

Attribute	Content

Name	Operator Panel
Description	The Operator Panel is used to perform manual interaction with MBS.
Cardinality	1
Interface	The interface between the Operator Panel and the MBS is not standardised yet. It will be defined considering the principles described in RCA and the work of X2Rail-5 Moving Block WP.

3.1.6 Plan Execution

Attribute	Content
Name	Plan Execution
Description	The Plan Execution (PE) requests the setting of field elements and the submission of authorisation for train movements e.g., according to *Operational Plan* from TMS (TMS is out of scope). The MBS provides the *Operational State* to the PE.
Cardinality	1
Interface	The interface between the PE and the MBS is not standardised yet. It will be defined considering the principles described in RCA and the work of X2Rail-5 Moving Block WP.

3.1.7 Security Service

Attribute	Content
Name	Security Service
Description	The Security Service summarises all technological systems that are necessary to manage and provide the cryptographic artefacts (e.g., keys or certificates) to ensure the confidentiality, authenticity and integrity (Information Security Triad) of the communication between - the MBS and the OBUs and - the MBS and an Adjacent System either being a neighbouring RBC/IXL or another MBS and - The MBS and the Trackside Assets.

	Notes: - This list is not exhaustive. In future there may be other interfaces which require securing the communication using cryptographic artefacts from the Security Service. - For some interfaces only, a subset of the Information Security Triad is applied, e.g., for the communication between MBS and the OBUs it is only necessary to ensure the authenticity and integrity.
Cardinality	1
Interface	For managing the authentication keys between MBS and OBUs, neighbouring RBC or another MBS, the interface to the Security Service is based on the existing ETCS specifications [1], namely Subset-114, Subset-137 and Subset-146. For managing the cryptographic artefacts between MBS and the Trackside Assets, the SSI interface specification as published in EULYNX [2] may be used. This will be finally defined by the System Pillar.

3.1.8 Trackside Asset Control and Supervision

Attribute	Content
Name	Trackside Asset Control and Supervision
Description	The Trackside Asset Control and Supervision (TACS) reports the state of the *Trackside Asset*s (TAs). The MBS mainly uses this interface to trigger setting the state of a TA, e.g., moving a point, and to receive status information from TAs (e.g., occupancy information from TTD) The interface also includes safety relevant maintenance issues, e.g., resetting an axle counter.
Cardinality	n
Interface	For the target architecture this interface bases on the specification published in EULYNX [2]. For migration phase other interfaces, even proprietary ones, are possible.

3.2 Interfaces and Interactions with Physical Environment

The MBS as described within this system definition is not a physical product. Therefore, at this stage of development, no interfaces and interactions with physical environment are necessary.

The MBS has to be used in a common railways' environment and therefore the system environmental conditions for railways applications as defined by EN50125 and EN50121 have to be considered whereas:

- the scope of the standards EN50125 covers the definitions and ranges of the following parameters: Altitude, temperature, humidity, air movement, rain, snow and hail, ice, solar radiation, lightning and pollution and
- the standard EN50121 describes the characteristics of the railway system which affect electromagnetic compatibility (EMC) behaviour.

3.3 INTERFACES AND INTERACTIONS WITH HUMANS

The MBS as described within this system definition is not a physical product. Therefore, at this stage of development, no interfaces and interactions with humans are necessary and foreseen.

When using the MBS in a common railways' environment in future, an interface to a Maintenance Staff via Diagnostic System may be necessary.

For test purposes additional interactions with humans may be necessary as required by testing staff, e.g., test interfaces, additional data capture needs, etc.

3.4 INTERFACES AND INTERACTIONS WITH OTHER RAILWAY DUTY HOLDERS

The MBS as described within this system definition is not a physical product. Therefore, at this stage of development, no interfaces and interactions with other railway duty holders are necessary and foreseen. If there are requirements of other duty holders (e.g., railway undertakings), they will be fulfilled using the existing interfaces to the actors as described above.

When using the MBS in a common railways' environment in future, an interface to other railway duty holders may be necessary. This needs to be covered in specific projects.

4 SYSTEM FUNCTIONS AND ELEMENTS

The system functions, derived from the system capabilities in chapter 2.1.1 are outlined in the System Specification [6] whereas the System Specification comprehensively defines and elaborates on each system function by detailing its purpose, behaviour, inputs, outputs, and any dependencies and constraints.

1

5 SCOPE OF OPERATIONAL REQUIREMENTS INFLUENCING THE SYSTEM

5.1 CONSTRAINTS IMPOSED BY EXISTING INFRASTRUCTURE

The existing infrastructure today has the following characteristics that can impose constraints to the system:

- Wide range of application of baselines and system versions
- Different application of L1, L1 with infill, L1 with loops, L2 with light signals, L2 only, etc.
- Highly specialised to fit to "traditional" country-specific rules
- Implement national laws that are sometimes indirectly related to rail traffic, e.g., laws for public roads that affect the use of level crossings

In conclusion, to avoid Moving Block System (MBS) dialects (e.g., in ETCS today), operational harmonisation is necessary. This would drastically minimise the need for adjustments to MBS on a national level.

Nevertheless, considering that the MBS will be integrated into existing railway infrastructure, MBS shall be able to receive necessary information from these legacy systems to be able to ensure safe movements inside its *Area of Control* (AoC). A major interface that needs to be established is the interfaces for adjacent interlockings and RBCs to ensure a safe handover. The integration of legacy Traffic Management Systems (TMS), control systems and object controllers have to be analysed as well for migration purposes. Therefore, requirements have to be identified and exported to these systems so that adapter solutions can be developed to connect them to MBS. MBS itself shall ideally only communicate to another MBS and the systems specified in the target Traffic CS architecture defined by the System Pillar. Legacy systems have to be adapted in order to communicate with MBS.

Note: The interface for handover to and from a legacy system (see also chapter 3.1.1) is out of scope for R2DATO Phase 1 and will thus be excluded in the following subchapters. The scope of R2DATO Phase 2 is not yet specified.

5.2 SYSTEM OPERATING CONDITIONS AND CONSTRAINTS

The following operating constrains apply to MBS:

- Operation with national ATP is not possible
- No light signalling is supported (with the potential exception of transition areas).

There are several operating conditions that apply to MBS:

- MBS supports ETCS Level 2. Flexible migration of fleets concerning the ETCS equipment have to be considered, e.g., handling of different ETCS versions, functions and non-equipped trains.
- Trains that deliver their train integrity and safe train length information to MBS as well as trains that do not send this information have to be supported.
- The aim is a minimum or no manual interaction between driver and signaller.

- All movements inside the AoC of MBS are supervised. Furthermore, the logical handling of all movements is the same, meaning that there is no distinction between shunting routes and train routes anymore. The setting and protection of any kind of train/vehicle movement (scheduled or not) is executed with the same set of functions that only change parameters according to the intended movement on the track. However, this does not mean, that the operational process of shunting (e.g., in the mode SH or SM) will not be necessary or is planned to be eliminated. Only the technical implementation in MBS is referred to in this operational condition.
- MBS is applicable for different types of railways lines (regional, low density, urban, main line, high speed).
- The loading and activation of *Domain Data* to MBS is possible during MBS' runtime. Thus, MBS shall be independent from *Domain Data* update and change lifecycles.

5.3 System maintenance conditions

The maintenance strategy provides the use of IT deployment strategies like continuous integration based on reliable automatic configuration and test procedures. This enables a faster adaptation of the infrastructure to operational needs than today. This includes the update of infrastructure data, e.g., topology data update without restarting MBS, as well as other configuration data. MBS should support the development of easily maintainable solutions e.g., with a feasible degree of modularity, thus reducing the maintenance effort for the staff e.g., changing the configuration of the system, installing updates, etc.

Note: The physical aspects of maintenance are out of scope for now, thus e.g., changing of hardware, cabling etc. is not considered.

Regarding the interface with actor Maintenance Staff, the necessity of an HMI has to be analysed further during system specification. This interface will exclude some maintenance functionalities like the activation of *Domain Data* as this is coordinated by the interfacing system Digital Register.

5.4 Logistic support considerations

Physical architecture of the system is out of scope. Thus, no considerations about logistic support.

5.5 Review of past experience data for similar systems

The general experience with a substantial subset of today's interlockings (IXL) is that there is no standardised interface to it which causes a lot of project engineering and development effort in interfacing systems. Oftentimes, the interfacing systems, like for example the control system, needs detailed knowledge about the behaviour of the IXL to properly command it. Every change of the IXL's baseline leads to changes of all interfacing systems as they have to support new/changed functionalities. High coordination effort to align the rollout and migration of all the affected railway systems, e.g., control system, Radio Block Centre (RBC), TMS and track worker safety systems, is needed. This is not only costly and prone to compatibility issues, but also significantly prolongs project durations.

A more specific example is the operation with ETCS. Due to the fact that the OPE TSI has a lot of non-harmonised rules, major differences remain in the implementation of the same operational processes in different countries. This is due to the freedom of choice and application of the trackside (e.g., whether or not to "stop if in SR" balise, whether or not to apply packet 88, whether or not to apply reference balises, the start of mission procedure used). Additionally, differences arise from the use of different class B systems. But even if the application of the TSI is chosen (i.e., ETCS), there appear to be differences in the implementation and rules of operational processes. Also, this "loophole" to use NTC/STM when implementing ETCS ultimately delays the rollout and operation with ETCS. An example for this can be seen in the complex integration projects, e.g., for Abellio with 3 national ATPs and ETCS integrated on-board.

The integration of ETCS also depends on the used interlocking. For example, when entering an occupied track. Today, this is sometimes done in mode OS, sometimes done in SR or even in SH. In most cases, the difference is due to differences in the functionality of the interlocking which is used. Also, with relatively modern interlockings, which can support OS, SR or SH is implemented nonetheless.

Note: EULYNX [2] is excluded from consideration here because there are no implementations of this standard yet in operation.

5.6 INFLUENCE ON OPERATIONAL AND MAINTENANCE PERSONNEL, PASSENGERS AND PUBLIC

There is no influence on passengers and public expected besides safety by design.

As the new system MBS needs to be maintained throughout its lifecycle, new maintenance procedures and protocols are to be expected. From a hardware perspective, MBS components shall be able to run on a new safe computing platform (standardised by the System Pillar). The deployment on existing legacy hardware through e.g., emulation, can be analysed in a later specification level.

The MBS is expected to influence the operational procedures and conditions at least regarding the available automated assistance for operational personnel, new procedures for Level 2 operation in compliance with the ETCS Specifications [1] and for entering an occupied track. Therefore, it has to be specified how MBS is supporting and managing operation and what is needed on the operational side of things. The operational procedures to handle MBS shall not include business "logic" but be based on necessary issues, not on national particularities/sensitivities.

Note: The definition of the exact operational procedures is out of scope, because this is within the scope of operational harmonisation in the System Pillar.

In order to use the MBS, training as well as operating manuals have to be provided to the railway staff.

5.7 DESCRIPTION OF OPERATING PROCEDURES

The operation of MBS requires operating procedures as well as maintenance procedures. Similar to EULYNX, there is an "operating mode" and "maintenance mode" of the system envisioned. If the system enters "maintenance mode", procedures for system installation, loading of new software data and configurations can proceed. The maintenance mode as well the start of the procedures can be activated either manually by e.g., actor Maintenance Staff, or automatically by an external actor e.g., Plan Execution (PE) for planned maintenance. The transition to the "operating mode" of the system is only possible after a successful system test activating the changes made to the system during maintenance. Either MBS does the system test autonomously or/and in interaction with local staff that ensures that no one is endangered by the system activation e.g., by checking and confirming that no obstacles are in the area affected by the system update.

5.8 MODES OF OPERATION

Modes of operation in the following three major categories according to the TSI OPE [5] are covered by the system:

- Normal operation
- Degraded operation
- Handling of emergency situations

Several use cases that are part of the listed modes of operation have to be handled by the MBS.

Firstly, the downgrade from normal situations to degraded situations have to be covered by MBS. For this consideration, degraded situations can be defined as "the system with limited functionality". Then, the recovery procedure to normal operation needs to be handled by MBS, with or without interaction with interfacing systems.

Furthermore, the recovery from emergency situations to operation in degraded situations has to be handled by MBS. For example, the loss of train integrity monitoring on-board might trigger an emergency reaction first. After the train integrity is assessed once more, the train can continue in degraded situations with localisation by Trackside Train Detection (TTD).

As a general principle, the handling of degraded situation shall be automated as much as possible. This means that the operator shall intervene when a degraded situation can't be handled by rules (interplay between PE and MBS). In order to ensure safety, the human ability to judge and assess a situation is needed either by technical means or through legal obligation.

6 ASSUMPTIONS AND EXISTING SAFETY MEASURES

6.1 Assumptions

This chapter contains assumptions related to external systems or actors interacting with the Moving Block System (MBS) or related to input from external systems that are not covered somewhere else yet (e.g., in the corresponding standard).

Identifier	Allocation	Assumption
G1	**General**	Virtual Coupling is out of scope. Justification: Virtual Coupling is not part of the Grant Agreement of WP13.
T1	**Train**	If a train is equipped with a TIMS and this trains confirms its train integrity, then the MBS can trust the train for: - Train Length – Received in Validated Train Data as L_TRAIN, which is the maximum length of the train in rear of the engine, counted from the front end of the engine considering the active cab, and considering the coupling play and/or any other uncertainties in the length information. - Train Position Reports – including Q_LENGTH, L_TRAININT This is consistent with the approach in the ETCS Specifications [1]: - On-Board can only confirm Train Integrity to Trackside if the train length can be treated as SIL4. Justification: This means that the train length and information from the train position reports (e.g., train integrity information) can be used by the MBS to release track behind the train, and for length calculations during splitting and joining. Note: This implies that the MBS won't trust the train for the Train Length if the train has never confirmed its train integrity (e.g. because the train is not equipped with a TIMS)
T2	**Train**	In case of joining or splitting of trains, this causes the external Train Integrity Monitoring System (TIMS) devices (in each train) to report loss of train integrity. As long as MBS has not acknowledged the new train data (incl. train length), the train integrity is not confirmed again by the train(s). Justification: The safe train length is not valid anymore when trains physically join or split.

Table 2: Assumptions

6.2 EXISTING SAFETY MEASURES

The MBS is based on ETCS and hence all safety measures required by the ETCS Specifications [1] are applied also for MBS.

7 CONCLUSIONS

The aim of this document is to define the System Definition of the Moving Block System (MBS).

To achieve this, the document has provided the objective of the Moving Block System (MBS). Hereby, the document focuses on the description of the capabilities, the boundaries (incl. a brief description of the interfaces to other technological systems) and the system functions. Additionally, the scope of operational requirements influencing the system have been elaborated. Further on, this document also lists the necessary assumptions for the Moving Block System.

REFERENCES

[1] ETCS Specifications
Annex A for the TSI CCS according
Commission Implementing Regulation (EU) 2023/1695
of 10 August 2023
Set of Specifications(ETCS B4 R1, RMR GSM-R B1 MR1 + FRMCS B0, ATO B1 R1)
System Version 2.1

[2] EuLynx
Baseline Set 4 Release 2
https://rail-research.europa.eu/system_pillar/system-pillar-outputs/trackside-assets-specifications/

[3] RCA
RCA Baseline 1 Release 0
https://public.3.basecamp.com/p/KeehzqFmXv5R2N7tGDjaEokq

[4] S2R
Moving Block Specification Release
https://ec.europa.eu/research/participants/documents/downloadPublic?documentIds=080166e5f58a710a&appId=PPGMS

[5] Operation and Traffic Management TSI
Under regulation 2019/773
https://www.era.europa.eu/domains/technical-specifications-interoperability/operation-and-traffic-management-tsi_en

[6] D13.1 - Moving Block Specifications applying a train-centric approach Part 2 - System Specification