



X2Rail-3

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Executive Summary

This Deliverable contains the results from WP4 Task 4.5 Future Moving Block Architectures. The other work in X2Rail-1 WP5 Moving Block and X2Rail-3 WP4 Moving Block has been based on an assumption of minimum changes from the current ETCS baseline. Specifically, the work has been based on:

ETCS Baseline 3 Release 2 [BL3 R2]

CR940 TIMS [CR940]

This task was defined to investigate items relating to Moving Block beyond this assumed baseline.

There are various other groups who are also looking at this topic, both to define the content of CCS TSI 2022, and to look beyond that. In particular:

- ERA has a team working to determine the content of CCS TSI 2022
- RCA, a joint initiative between EUG and EuLynx, is looking at future architectures

ERA is including the introduction of Level 3 as one of the “Game Changers” for CCS TSI 2022.

Since the start of the X2Rail-3 project, a link has been set up between RCA and other Shift2Rail projects, via the Linx4Rail project. The Linx4Rail project has proposed topics for investigation by TD2.3 Moving Block. These investigations are underway at present, and a summary of progress is provided within this Deliverable. Any impact on the results from X2Rail-3 WP4 Moving Block will be incorporated within X2Rail-5.

In addition, there are also initiatives to examine harmonisation of Operational Rules, with a view to increasing interoperability, thus contributing towards the Single European Railway Area (SERA).

With X2Rail-3 WP4, this task has been in communication with these various groups, to understand the best contribution to make. This Deliverable is structured to summarise the results of these communications:

- Proposed changes to Specifications from X2Rail-3 WP4 D4.2
- Work on ETCS Change Requests
- Work on Linx4Rail Moving Block topics

As indicated above, this Task has included discussion with other industry stakeholders, including within Shift2Rail. To date, this task has not had technical discussions with WP6 Virtual Coupling. The focus has been on interactions with EUG regarding CRs, and with Linx4Rail regarding the Linx4Rail Moving Block topics, mostly relating to items for CCS TSI 2022. It is not thought that Virtual Coupling will be included within CCS TSI 2022.

There is further work to do, much of it dependent on the discussions and decisions elsewhere, for example by ERA, EECT, EUG, UNISIG. This Deliverable is a summary of work in progress, and further work is expected within X2Rail-5.

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Abbreviations and acronyms

Term	Meaning	Notes
APS	Advanced Protection System	Abbreviation used within RCA context [RCA]
CCM	Change Control Management	Used within the context of ERA Change Control Management
CCS	Control Command and Signalling	
CR	Change Request	Specifically used to refer to changes to ETCS raised in the ERA Change Request database
CRE	Confirmed Rear End	Defined within CR940 [CR940]
DMI	Driver Machine Interface	Driver interface located in train cabs
EECT	Extended ETCS Core Team	Group including ERA, EUG, UNISIG, which is part of the ETCS change control process
ERA	European Agency for Railways	
ETCS	European Train Control System	
EUG	ERTMS Users Group	
FVB	Fixed Virtual Blocks	Style of Moving Block system
GoA	Grade of Automation	Used in context of GoA 3 and 4 meaning operation without a Driver present, compared with GoA 1 and 2 meaning operation with a Driver present
HL3	Hybrid Level 3	System as defined in EUG [HL3]
IP	Innovation Programme	Part of the structure of Shift2Rail. All the X2Rail projects are part of IP2
IXL	Interlocking	
Linx4Rail	Shift2Rail project	EU reference: S2R-CFM-IPX-CCA-01-2019
LOC&PAS	Locomotives and Passengers	Used in the context of LOC&PAS TSI: "Rolling Stock – Locomotives and Passengers"
MOB	Movable Object	Within RCA, a Movable Object is a representation of a real world movable object in the Operating State
MOL	Mobile Object Locator	A device control component in the RCA interface architecture [RCA]
RAMS	Reliability Availability Maintainability Safety	
RBC	Radio Block Centre	Part of Trackside for ETCS Levels 2, 3
RCA	Reference CCS Architecture	Initiative on future architectures from railway infrastructure managers. [RCA]
SWOC	Smart Wayside Object Controller	One of the TDs within IP2
TD	Technical Demonstrator	Part of the structure of Shift2Rail within IPs.
TIMS	Train Integrity Monitoring System	Proposed On-Board system for monitoring train integrity.
TMS	Traffic Management System	
TSI	Technical Specification for Interoperability	There are various TSIs published by ERA. Most relevant in this context is the CCS TSI.

Term	Meaning	Notes
TTD	Trackside Train Detection	Typically Track Circuits or Axle Counters
UNIFE	Organisation of suppliers to the rail industry within Europe	
UNISIG	Organisation within UNIFE which deals with ETCS matters	
X2Rail-1	Shift2Rail project within IP2	EU reference: H2020-S2RJU-CFM-2015-01-1
X2Rail-3	Shift2Rail project within IP2	EU reference: H2020-S2RJU-CFM-IP2-01-2018
X2Rail-5	Shift2Rail project within IP2	EU call reference: S2R-CFM-IP2-01-2020

1 Introduction

The present document constitutes the first issue of Deliverable D4.3 “Future Moving Block Architectures” 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). The work is part of the work on Technical Demonstrator TD2.3 Moving Block.

The work in X2Rail-1 WP5 Moving Block, and the other Tasks in X2Rail-3 WP4 Moving Block has assumed a baseline at ETCS Baseline 3 Release 2 [BL3 R2] and CR940 [CR940].

This document has been prepared during X2Rail-3 to provide a report on potential developments for Moving Block in ETCS beyond ETCS Baseline 3 Release 2 [BL3 R2] and CR940 [CR940].

For example, there are discussions on topics relating to:

- Changes to minimise disconnected trains, thus enhancing the information within the L3 Trackside
- Changes to extend protection to cover more types of train movements, aiming to enable the protection of all train movements
- Improved coordination with other related initiatives

This report summarises information in three areas:

1. Proposed changes to [BL3 R2] ETCS Specifications based on work within X2Rail-1 WP5 and X2Rail-3 WP4. These are described here, and referenced from X2Rail-3 D4.2 [X2R3-D4.2].
2. Other proposed changes to ETCS beyond [BL3 R2] plus [CR940] raised within the ERA CCM process.
3. A summary of the status of work within X2Rail-3 WP4 linked to the Linx4Rail project (EU Reference: S2R-CFM-IPX-CCA-01-2019).

The work is on-going, with further work to do in all these areas. This Deliverable provides a summary of the work within X2Rail-3 WP4 Moving Block, Task 4.5 Future Moving Block Architectures. The work is expected to continue within X2Rail-5 WP4 Moving Block.

2 Proposed Changes from X2Rail-3 D4.2

2.1 Introduction

This section provides a summary of proposed changes to ETCS specifications arising from the work reported in X2Rail-3 D4.2 [X2R3-D4.2].

There is also a section providing commentary against the changes originally proposed in X2Rail-1 D5.1 [X2R1-D5.1].

2.2 Proposed Changes described in X2Rail-3 D4.2

The following table summarises the proposed changes defined in X2Rail-3 D4.2 Part 3 [X2R3-D4.2].

Change Title	ERA CR Reference	Change Summary	Potential Benefit	Status
Position Report at Safe Rear End	CR1352	Additional value for Position Report Parameter Q_LGTLOC	Faster release of infrastructure, leading to capacity increase	Raised as ERA CR. May not be required if the frequency of Train Position Reports is increased, based on upgrading of ETCS communications.
National Value for On-Board reaction to Loss of Train Integrity	Not raised	Proposal for a National Value for the reaction to the On-Board to Loss of Train Integrity, in a similar way to M_NVCONTACT for loss of communications	Faster reaction on board if train integrity lost	Discussed, but not raised. Rationale for not raising: It is possible for the reaction to be determined within the Trackside, and transmitted to the train. For example, the Trackside could send Unconditional Emergency Stop.

Change Title	ERA CR Reference	Change Summary	Potential Benefit	Status
Train Integrity status visible in ETCS DMI	Not raised	Proposal that the Train Integrity status as reported from TIMS to On-Board is visible to the Driver in the ETCS DMI	Information for the Driver if there are Operational Rules requiring knowledge of Train Integrity status, e.g. at Start of Mission.	Discussed, but not raised. Rationale for not raising: It is possible for the Train Integrity status to be visible to the Driver elsewhere, without adding information to the DMI.

Table 1 – Proposed Changes from X2Rail-3 D4.2

2.2.1 Position Report at Safe Rear End

2.2.1.1 Related Requirements

This proposed change is related to the following requirements in the following sections of X2Rail-3 D4.2 [X2R3-D4.2]:

Section 3.1 Train Location

Section 3.20 Handover

2.2.1.2 Problem Statement

Text from ERA CR database for CR1352:

In a trackside implementation where the position of the train, together with train integrity status, is used to release infrastructure behind the train (L3), the reporting of train position to the RBC is essential for a good performance. Specially to clear a specific trackside object, e.g. a point or a LX, it is important for the trackside to get as soon as possible the position report which clears this object. Currently the position reports are sent at regular intervals, but there is no functionality to trigger a position when the confirmed safe rear end passes a specific trackside location. This means that there will be an average of half the repetition cycle of the position reports. This would normally only be a few seconds, but on high density implementations, this can have a substantial impact on performance. It would therefore be very beneficial if a position report can be triggered at the right location.

2.2.1.3 Proposed Solution

Text from ERA CR database for CR1352:

It shall be possible for the RBC to send a specific location to the on-board for which the matching on-board requirement is that a position report shall be sent to the RBC as soon as the confirmed safe rear end has passed this location.

This could be achieved by creating an additional possible value for the position report parameter Q_LGTLOC sent from Trackside to Train. Currently this has possible values:

Value of Q_LGTLOC	Meaning
0	Min safe rear end
1	Max safe rear end

Table 2 – Current Possible Values of Q_LGTLOC

An addition value for “Confirmed rear end” would be required.

2.2.1.4 Assessment

This proposed change is about performance. By requesting a Train Position Report when the CRE passes a specific location in the railway, release of infrastructure based on Train Position Reports would be released sooner. For example, points could be released sooner.

There is only a benefit from this proposed change if Train Position Reports are not very frequent. However, changes to ETCS communications may permit more frequent Train Position Reports during normal operation, for example every second. If Train Position Reports are more frequent, then there is no need for this change, nor in fact any further requirement to use the mechanism for the trackside to request Train Position Reports based on location.

2.2.1.5 Alternatives

The following are alternatives to implementation of this proposed change:

- Upgrade of ETCS communications, and as a result configuration of more frequent Train Position Reports, for example every second.
This may not be appropriate for all systems, for example where there is an existing communications system, and there is not a strong case to upgrade it.

2.2.2 National Value for On-Board reaction to Loss of Train Integrity

2.2.2.1 Related Requirements

This proposed change is related to the following requirements in the following sections of X2Rail-3 D4.2 [X2R3-D4.2]:

Section 3.17 Loss of Train Integrity

2.2.2.2 Problem Statement

It is already proposed that the Trackside should have a configurable reaction to a reported loss of train integrity, with options such as:

- Trip the Train
- Create an additional margin behind the train
- The Movement Authority may be shortened/updated

This is included in Section 3.17 within [X2R3-D4.2].

It is also suggested that a faster reaction to the loss of train integrity report could be achieved if a reaction was built into the On-Board. The On-Board reaction could be configurable by the Trackside, in the manner of M_NVCONTACT for loss of communications. The required reaction by the On-Board would be sent from the Trackside in the same way as other National Values, and stored in the On-Board.

The advantages of configuring the On-Board with the reaction for loss of train integrity would be in the response time to implement the reaction, and the removal of dependence on communications with the Trackside to implement the reaction. For example, the reaction could still be applied by the On-Board if the train was in a Radio Hole.

2.2.2.3 Proposed Solution

Provide an additional National Value, to be transmitted from Trackside to On-Board, to define the On-Board reaction in the case of loss of train integrity.

The options proposed could be similar to those for loss of communication, so:

- Apply emergency brake
- Apply service brake
- No reaction

2.2.2.4 Assessment

This proposed change is about reaction time to loss of train integrity. For example, if the reaction is to trip the train, then this would happen sooner if the reaction is instigated within the On-Board.

However, two factors may mitigate against implementation of this change:

- a) There are other requirements within LOC&PAS TSI which require a train to be stopped if a failure of train integrity is detected.

- b) Changes to ETCS communications may permit faster reaction, even if the reaction is instigated within the Trackside and transmitted to the Train.

If the reaction is instigated by the Trackside, and transmitted to the Train, then consideration will need to be given to the scenario where the loss of train integrity occurs when communications are lost, either because of a failure, or during normal operation if the train is within a Radio Hole.

2.2.2.5 Alternatives

The following are alternatives to implementation of this proposed change:

- Requirement in a separate TSI (LOC&PAS) that trains with failed train integrity should stop
- Changes to ETCS communications to enable faster reaction instigated by the Trackside
- Display of the Train Integrity status to the Driver, and clear Operational Rules

2.2.3 Train Integrity status visible in ETCS DMI

2.2.3.1 Related Requirements

This proposed change is related to the following requirements in the following sections of X2Rail-3 D4.2 [X2R3-D4.2]:

Section 3.17 Loss of Train Integrity

2.2.3.2 Problem Statement

As currently defined, if there is a loss of train integrity, the ETCS On-Board will inform the ETCS Trackside via the rules for Train Position Reports within CR940 [CR940]. However, the Driver will not be informed.

Whilst in many cases a real loss of train integrity might be very apparent to the Driver, this may not be the case with freight trains.

There may also be an impact on railway operation, for example at End of Mission, if the Driver is able to check train integrity status before performing End of Mission.

2.2.3.3 Proposed Solution

Modify the DMI, and the ETCS On-Board to DMI interface, so that the train integrity status is visible to the Driver.

Some ergonomic investigation work would need to be performed to determine if the train integrity status should be visible at all times, and change to indicate loss of train integrity, or else appear only if there is loss of train integrity.

2.2.3.4 Assessment

This change has been discussed, and the conclusion of the discussions was that this change was not required, based on:

- a) Failure of train integrity will be detected by other systems, and the Driver will be aware

2.2.3.5 Alternatives

The following are alternatives to implementation of this proposed change:

- Separate TIMS equipment can display the status of Train Integrity to the Driver, without changes to the DMI

2.3 Changes described in X2Rail-1 D5.1

The following table summarises the status of the changes originally listed in X2Rail-1 D5.1 [X2R1-D5.1].

X2R1 D5.1 Section	Summary	Potential Benefit	X2Rail-3 Status
7.1 New train position report when the CRE has passed a specific location	Allow new value for position report parameter, to permit trackside to request train position report based on Confirmed Rear End (CRE) as defined in CR940.	Faster release of infrastructure, leading to capacity increase	Raised as CR1352, and validated. Included above.
7.2 Train Integrity information in the DMI	Proposal that the Train Integrity status is made visible to the Driver on the DMI.	Information for the Driver if there are Operational Rules requiring knowledge of Train Integrity status, e.g. at Start of Mission.	Discussed as CR, and not raised. Included above.
7.3 TIMS status in cab	Proposal that the status of the TIMS equipment is made visible to the Driver on the DMI.	Information for the Driver if there are Operational Rules requiring knowledge of TIMS status, e.g. at Start of Mission.	Discussed as CR, and not raised. This can be achieved without changes to the DMI. Related to richer interface between TIMS and ETCS On-Board.

X2R1 D5.1 Section	Summary	Potential Benefit	X2Rail-3 Status
7.4 Request of Train integrity update	<p>Permit request for TIMS update, for example during End of Mission.</p> <p>Only applies if there is intermittent confirmation of Train Integrity</p>	Potential capacity increase if TIMS can be updated on request.	<p>No longer included.</p> <p>After discussion between stakeholders, agreed to specify TIMS update frequency, which removes the need for this change.</p>
7.5 National Value for loss of train integrity reaction	Propose automated reaction to loss of train integrity within the ETCS On-Board, configurable by a national value.	Faster reaction on board if train integrity lost	<p>Discussed as CR, and not raised.</p> <p>Included above.</p>
7.6 Propagation over an L3 Trackside-L3 Trackside boundary	Allow for propagation of Unknown across Handover boundary.	Possible hazard mitigation.	<p>No longer included.</p> <p>Propagation removed during X2Rail-3 WP4 work.</p>
7.7 Position report parameters in a Level Transition to L1	Perceived as an Error CR.	No requirement to resent Position Report Parameters	<p>No longer included.</p> <p>After discussion with stakeholders, it was agreed that this can be solved by resending Position Report Parameters.</p>

Table 3 – Proposed Changes from X2Rail-1 D5.1

3 Work on ETCS Change Requests

This section describes the work performed within X2Rail-3 WP4 Moving Block regarding specific ETCS Change Requests which have been raised within the ERA CCM process, external to Shift2Rail.

CR Number	CR Title
CR0149	TIMS Data Missing
CR1304	Missing Level 3 Safety Requirements
CR1350	Always connected, always reporting
CR1367	Cab anywhere supervision

Table 4 – Current CRs assessed within X2Rail-3

These are all CRs which have been raised.

3.1 CR0149 TIMS Data Missing

3.1.1 Background

This is an old Change Request, largely superseded by CR940 [CR940].

3.1.2 Work Performed

During X2Rail-3, WP4 has collaborated with X2Rail-2 WP4 TIMS to provide a response to ERA on CR0149 [CR0149Response].

The response confirmed that the changes proposed within CR0149 are almost completely solved within CR940. However, there is one area which is not explicitly covered. The solution to CR940 requires that the system should take account of the latency of TIMS information, but does not specify how this is to be done. After discussion, it was determined that this does not need to be specified to achieve interoperability.

Within the response, two options were proposed:

- 1) Base Option
 - This option proposes that ETCS L3 can be implemented without further changes relating to TIMS, beyond those in CR940.
 - This option includes a very simple three state interface between TIMS and the ETCS On-Board, as proposed in CR940.
- 2) Enhanced Option
 - This option proposes a richer interface between the TIMS and the ETCS On-Board, for example containing information about TIMS equipment status, and latency of the TIMS

information.

This richer interface will be worked on by TD2.4 TIMS, within the context of X2Rail-4.

3.1.3 Assessment

Currently, the options are still being assessed. ERA has passed the options paper to EUG for assessment, with the feedback expected during October 2020.

In order to implement ETCS Level 3 within CCS TSI 2022, it will be necessary to implement the base option. The question remaining is whether or not the enhanced option will be included in CCS TSI 2022. We are not able to answer this within X2Rail-3 WP4.

3.2 CR1304 Missing Level 3 Safety Requirements

3.2.1 Background

This Change Request is to update the safety documents for ETCS Level 3. This is required for the implementation of ETCS Level 3.

3.2.2 Work Performed

X2Rail-3 WP4 has been in discussion with the UNISIG RAMS group on this topic. The UNISIG RAMS group is responsible for the update of the safety documents within the CCS TSI. However, they are expecting certain inputs, in order to perform this work.

X2Rail-3 WP4 has made a proposal for this work, based on these discussions, and presented the proposal to UNISIG. This is shown in Figure 1 below.

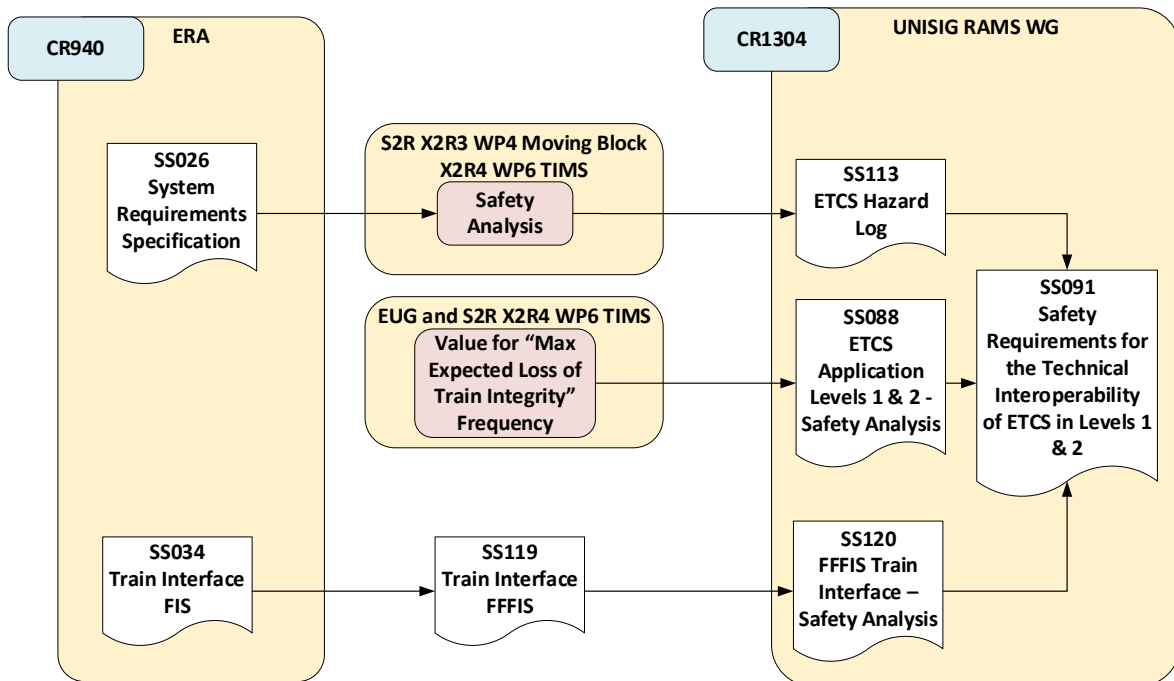


Figure 1: Proposal for update of ETCS Safety Documents

It can be seen from this proposal that the work performed in X2Rail-3 WP4 on the safety analysis will be used as an input to the update of the safety documents by the UNISIG RAMS group. The results of the safety analysis include hazard analysis, and will be published within X2Rail-3 D4.2 [X2R3-D4.2].

3.2.3 Assessment

Work from X2Rail-3 WP4 safety analysis is required to enable the update of the safety documents for ETCS Level 3.

3.3 CR1350 Always Connected, Always Reporting

3.3.1 Background

CR1350 Always Connected, Always Reporting was raised in Aug-19, and has been validated by ERA as one of the CRs related to the Moving Block “Game Changer”.

3.3.2 Work Performed

X2Rail-3 WP4 has held discussions with EUG on this Change Request, and it has been agreed that EUG will focus on the changes to the existing TSI documents, whilst the Shift2Rail team will focus on the impact on the X2Rail-3 deliverables, principally regarding the behaviour of the ETCS Trackside.

There have also been discussions between EUG and ERA, in the context of EECT. Currently, EUG are performing a further assessment of the CR.

3.3.3 Assessment

Intrinsically, from a technical point of view, it is a good idea to ensure that all EVCs on all trains within an ETCS Level 3 area of railway are always reporting their position. There are two main impacts:

- There would be fewer areas with Track Status “Unknown”. For example, following [BL3 R2] principles, a train ceases to communicate at End of Mission. This results in an area of track with Track Status “Unknown”. If trains continue to communicate, even after End of Mission, this area of track can remain with Track Status “Occupied”.
- The risk of a vehicle being in a location not known to the ETCS Trackside is reduced. Following [BL3 R2], the system is dependent on an Operational Rule which forbids the movement of non-communicating trains without explicit protection being provided by the ETCS Trackside.
- If there are multiple EVCs on a train, there is more resilience in the system of train location, as failure of a single EVC on the train does not prevent updates of train location reaching the ETCS Trackside.

Some work is required to understand the full impact of this change on the requirements for the ETCS Trackside. This needs to include understanding the impact of some trains always connected, whilst others, on older baselines, are behaving as in [BL3 R2]. It is now expected that this work will be performed in X2Rail-5.

This change is also relevant to future changes to permit GoA 3 and 4 operation, without a Driver present.

3.4 CR1367 Cab Anywhere Supervision

3.4.1 Background

CR1367 Cab Anywhere Supervision was raised in Nov-19, and has been validated by ERA as one of the CRs related to the Moving Block “Game Changer”.

3.4.2 Work Performed

X2Rail-3 WP4 has held discussions with EUG on this Change Request, and it has been agreed that EUG will focus on the changes to the existing TSI documents, whilst the Shift2Rail team will

focus on the impact on the X2Rail-3 deliverables, principally regarding the behaviour of the ETCS Trackside.

There have also been discussions between EUG and ERA, in the context of EECT. Currently, EUG are performing a further assessment of the CR. This assessment is also linked to a further CR, CR1351 Improvement to manage shunting movements.

3.4.3 Assessment

The key objective of this CR is to remove or reduce the number of movements which are not supervised by ETCS, thus reducing the possibilities for human error.

Presently, there are various movements which cannot be supervised by ETCS, for example if a train is moving backwards, with the Driver remaining in the front cab.

Figure 2 below, taken from CR1367, illustrates different configurations.

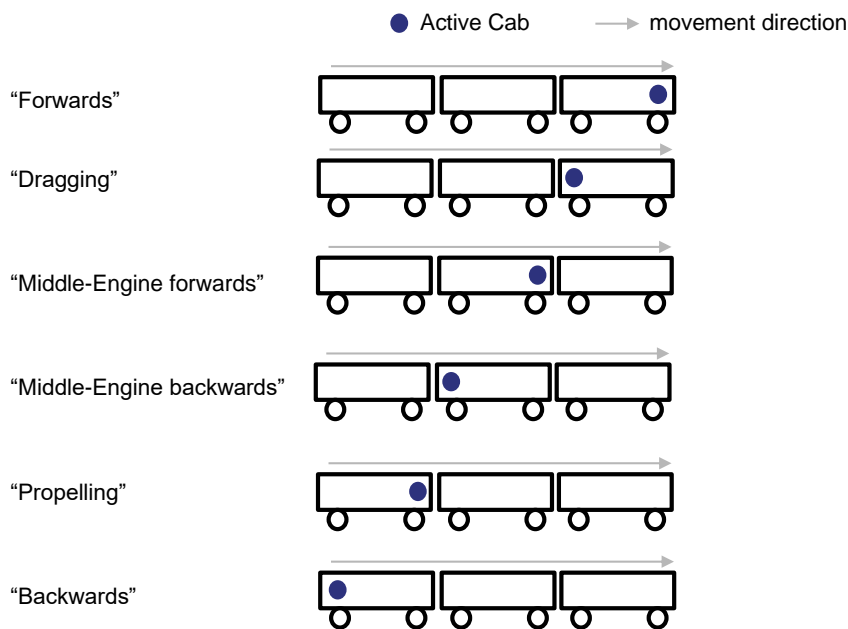


Figure 2: CR1367 Cab Anywhere Supervision configurations

Of these configurations, only "Forwards" is currently able to be fully supervised by ETCS.

Some of these configurations apply to shunting movements. Some of these configurations may more likely apply to yellow fleet maintenance vehicles, or to situations where a failed train is being rescued.

This change is also relevant to future changes to permit shunting and rescue operations without a Driver present, so GoA 3 or 4 operation.

4 Work on Linx4Rail Moving Block topics

This section describes the work performed within X2Rail-3 WP4 Moving Block together with Linx4Rail.

4.1 Background

During the running of X2Rail-3, a new project has been started, Linx4Rail. This project is able to propose topics for investigation by other Shift2Rail projects, within a defined process under the control of the Shift2Rail Executive Director Programme Board.

The Linx4Rail project has proposed two topics for investigation by TD2.3 Moving Block. These are:

- Moving Block – alignment between “Fixed Virtual Block with TTD” and “EUG Hybrid Level 3”
See [L4RTopic-HL3]
- Moving Block Architecture - Gap Analysis
See [L4RTopic-Architecture]
The Gap mentioned is the gap between the architecture assumptions made within X2Rail-1, 3 and the architecture proposed within the Reference CCS Architecture (RCA) [RCA].

Work to investigate these topics has been started during X2Rail-3 WP4 work, but is not yet completed. The work is not expected to be completed within X2Rail-3, so it will be continued within X2Rail-5 WP4 Moving Block. This section provides a summary of the status of these topics, as at the time of preparation of this deliverable.

4.2 Workshop Report

An initial workshop was held in July 2020 to examine both the topics from Linx4Rail. This workshop identified:

- a) Subjects to be investigated for each topic
- b) Scoring the subjects to be investigated by priority and by effort required
- c) Potential impact on the work on X2Rail-3 WP4 deliverables

After the workshop, a process was agreed with the Shift2Rail Programme Board, whereby there will be a second workshop for each topic, which will enable planning, in conjunction with the work to prepare X2Rail-3 WP4 deliverables.

4.3 Comparison with Hybrid Level 3

The subjects identified for the Hybrid Level 3 topic are shown in Table 5 below.

	Topic	Notes	Priority (H/M/L) Size (S/M/L/XL)	Expected Output
1	Examine X2Rail-3 Use Cases using both X2Rail-3 Moving Block Track Status and HL3 algorithm, and compare results.	Can HL3 be considered as an implementation of X2R System Type 4 FVB with TTD? Propagation – included in HL3. In X2R3, decided not to include any details	Priority: High Size: Risk that it is XL. Aim to keep smaller – part of the work is understand how to do that.	Report: 1) Determining if HL3 is an implementation of X2R System Type 4. 2) Recommendation about how to arrive at a “consolidated solution” (as per remit) Expect to mention existence of the Italian “High Density” (HL2).
2	Compare Safety Analyses from X2Rail-3 and HL3	May reveal reasoning for different numbers of Track Status states. Which hazards are mitigated in HL3 by used of Ambiguous? How are those hazards mitigated in X2Rail-3? Are there any hazards identified in X2Rail-3 not covered in HL3, and vice versa?	Priority: High Do this first to assist with limiting scope in Topic 1. Size: Small	Report on: <ul style="list-style-type: none"> • coverage of hazards in X2Rail-3, HL3 • methodology applied in each case

	Topic	Notes	Priority (H/M/L) Size (S/M/L/XL)	Expected Output
3	Examine use of “Reserved” in X2Rail-3, which is not used in HL3		Priority: Low Size: Small	Report
4	Examine use of TMS creating / removing “Unknown” Track Status Areas in X2Rail-3, which is not used in HL3		Priority: Low Size: Small	Report
5	Examine system migration: <ul style="list-style-type: none"> a) migration from ETCS L2 to L3 system with 100% trackside train detection b) beyond 100% trackside train detection, required in HL3, but not required in X2Rail-3 Moving Block 	How to remove TTD? Also consider evolution to Full Moving Block. Check on assumptions regarding trains moving without protection/authorisation from Trackside	Priority: Medium Size: Large	Report on “migratability” of X2Rail-3 and HL3.

	Topic	Notes	Priority (H/M/L) Size (S/M/L/XL)	Expected Output
6	Examine operation of railways with trains fitted with ETCS, but with trains fitted / not fitted with TIMS in X2Rail-3 and HL3.	Don't include trains not fitted with ETCS. Question how this fits with HL3 Specification? Trains without TIMS part of normal operation in HL3.	Priority: Medium Size: Medium	Report on impact of running trains not fitted with TIMS in each case.
7	Compare Operational and Engineering Rules required for implementation of X2R3 System Type 4 (FVB + 100% TTD) and HL3	Operational consideration. Include degraded modes if transitions fail.	Priority: Low Size: Medium	Report on differences in Operational and Engineering Rules required compared with ETCS L2 operation.

Table 5 – Results of first Linx4Rail Workshop: Hybrid Level 3 Topic

4.4 Comparison with RCA Architectures

The subjects identified for the Architecture topic are shown in Table 6 below.

	Topic Title	Notes	Priority (H/M/L) Size (S/M/L/XL)	Expected Output
1	Compare X2Rail-3 Architecture external interfaces with RCA	<p>Expected to detect at least one difference: The “Mobile Object Locator”</p> <p>Consider interfaces – e.g. TMS: In RCA Interface 2 (SCI-CMD) is roughly traditional IXL interface; interface 1 (SCI-OP) is at a different level.</p> <p>Check that X2R3 “L3 Trackside” can be mapped to RCA “APS”.</p> <p>Question about interface 11 in RCA Architecture – is it covered via SWOC?</p>	<p>Priority: High</p> <p>Size: Medium</p>	<p>Report identifying:</p> <ul style="list-style-type: none"> • Mappings/alignments, identifying gaps. • Assessment of criticality of the gaps. • Proposed next steps in X2Rail and RCA.
2	Consider if/how to handle “Mobile Object Locator” (MOL) & “Person Supervisor & Locator” in X2Rail-3 Moving Block	<p>Could be linked to Unknown Track Status</p>	<p>Priority: Low</p> <p>Size: Small</p>	<p>Report identifying:</p> <ul style="list-style-type: none"> • Proposal for extra function(s) linked to protection of people • Assessment of impact.

	Topic Title	Notes	Priority (H/M/L) Size (S/M/L/XL)	Expected Output
3	Examine X2Rail-3 Track Status against RCA Track Occupancy concepts	Both are “train-centric” Keep in mind – may link to HL3	Priority: High Size: Medium / Large	Report comparing X2Rail-3 Track Status with MOB location in RCA
4	Determine if we need to examine internals of functions in RCA Architecture, in particular Geometric Safety Logic	Compare high level functions. Use RCA Architecture Descriptions document: RCA_Concept_Informal_Architectural_Overview.pdf	Priority: High Size: Medium	Report comparing high level concepts within Geometric Safety Logic in RCA and L3 Trackside in X2Rail-3.
5	Potential alignment – Study how we could use X2Rail-3 Moving Block results in RCA. Also consider Vice Versa.	Identify any gaps Look for alignments	Priority: Medium Size: Small	Report summarising which parts of output from X2Rail-3 Moving Block can be used in RCA, and where there may be any gaps. Also if any adaptation is required to RCA to bring X2Rail-3 Moving Block results into RCA.
6	Study impact of “Always On / Always Located” and “Cab Anywhere” proposals from RCA on X2Rail-3 Moving Block results	Related to CR1350 and CR1367	Priority: Medium Size: Medium	Report examining concepts behind these proposals, and the impact on X2Rail-3 Moving Block outputs.

Table 6 – Results of first Linx4Rail Workshop: Architecture Topic

5 Conclusions

This Deliverable contains the results from WP4 Task 4.5 Future Moving Block Architectures.

This Deliverable covers three main areas where work has taken place:

- Proposed changes to Specifications from X2Rail-3 WP4 D4.2
- Work on ETCS Change Requests
- Work on Linx4Rail Moving Block topics

For each of these there is a summary of the current status. There is further work to do, much of it dependent on discussions and decisions elsewhere, for example by ERA, EECT, EUG, UNISIG. This Deliverable is a summary of work in progress, and further work is expected within X2Rail-5.

6 References

- [BL3 R2] 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/content/set-specifications-3-ets-b3-r2-gsm-r-b1>
- [CR940] 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/opinions-and-technical-advice_en
- The description of CR940 is available in Annex 3 of the above.
- [X2R3-D4.2] X2Rail-3 deliverable D4.2 “Moving Block Specifications”
This will be published on the X2Rail-3 web site at a similar time to this deliverable.
- [X2R1-D5.1] X2Rail-1 deliverable D5.1 “Moving Block System Requirements”
Published on the X2Rail-1 web site:
https://projects.shift2rail.org/s2r_ip2_n.aspx?p=X2RAIL-1
- [CR0149Response] Internal Shift2Rail document “Shift2Rail response to ERA re CR0149”
Sent to ERA in July 2020
- [L4RTopic-HL3] Topic definition from Linx4Rail project: “Moving Block – alignment between “Fixed Virtual Block with TTD” and “EUG Hybrid Level 3”
Linx4Rail reference: LNX-S_05-T-DBA-001-01
- [L4RTopic-Architecture] Topic definition from Linx4Rail project: “Moving Block Architecture - Gap Analysis”
Linx4Rail reference: LNX-S_04-T-DBA-001-01
- [RCA] Reference CCS Architecture.
Documents are publicly available on the EUG web site: <https://public.3.basecamp.com/p/x2QOAA9Sd2tLEwXcDKFqHV1>
and the EuLynx web site: <https://public.3.basecamp.com/p/KeehzqFmXv5R2N7tGDjaEokq>
- [HL3] EUG document: “Hybrid ERTMS/ETCS Level 3”
EUG reference: 16E042

Ownership of results

The following Table 7 lists the ownership of results for this deliverable.

Ownership of results			
Company	Percentage	Short Description of share/ of delivered input	Concrete Result (where applicable)
SIE			
STS			
BTSE			
CAF			
TD			
TRV			
AZD			
DB			
MERMEC			

Table 7 - Ownership of results

This deliverable is jointly owned by the companies listed above. The last three columns in the table are intentionally left empty.