FP6-FutuRe
Cost effective regional lines

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DELIVERABLE 3.2
USE CASES AND SCENARIOS FOR ETCS L3 DEMOS ON G1 REGIONAL LINES

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Summary

Executive Summary

Within the global aims of the FutuRe project to ensure the long-term viability of the regional railway by reducing the total cost of ownership (TCO), WP3 and its sub-tasks have the goal of performing some preparatory activities for demonstrators to be used to demonstrate the validity and the relevance of the existing or new interoperable standards and technical solutions on G1 lines and to ensure their long term viability.
The identification and description of the most relevant Use Cases applicable for such demonstrators, with particular focus on ETCS L2 ones, is the scope of Task 3.2.
In this context, to achieve the expected targets, two approaches can be followed: using the solution already available from FP2-R2DATO or adopting a dedicated solution developed for the regional environment. Both approaches are used in this project. How the targets will be achieved in the different contexts will be demonstrated in the continuation of the activities of the FutuRe WP8 project.

Any possible difference compared to other specifications (e.g. FP2-R2DATO or System Pillar) is because of the specific objectives to be achieved in the regional environment. As part of the demonstrators' testing activities, specific evidence to the rationales of each design choice will be provided.

The following operational pillars have been adopted for selecting the relevant UCs:

- Any simplification from the operational point of view is pursued, to get the lowest operational cost of the regional line;
- Any operational scenario must be robust in comparison to the technical or operational degraded conditions;
- Minimizing the manual contribution and activities by signallers (Control Room operators) and train drivers;
- The selected Use Cases should belong to the most realistic (nominal and degraded) operational conditions applicable to a railway line.

The detailed analysis performed by the members of Task 3.2 subgroup led to the identification of N.98 potential Operational Scenarios; 93 out of 98 have been evaluated as relevant and described as a sequence of events according to a predefined template.

Their positive contribution to the achievement of the final and main goals will be analysed in the next future, with the possible integration of additional Use Cases or sub Use Cases for clarifying, as needed, some critical operational aspects.

This document, in its final release, shall be the basis as well for the demonstration activities performed in T8.3 (Development of individual ETCS L3 demonstrators on G1 regional lines). In the same delivery, a cross check with relevant R2DATO Use Cases will be deployed.

List of abbreviations, acronyms and definitions

Abbreviation / Acronym	Definition
ASTP	Absolute Safe Train Positioning
ATO	Automatic Train Operation
BTS	Base Transceiver Station
CCS	Control & Command System
CMD	Cold Movement Detector
CRE	Confirmed Rear End
EoA	End of Authority
EoM	End of Mission
ERTMS	European Railway Traffic Management System
ETCS	European Train Control System
ETCS-OB	European Train Control System – OnBoard
ETCS-TS	European Train Control System - Trackside
EVC	European Vital Computer
FA	Flagship Area
FP	Flagship Project
FS	Full Supervision
GA	Grant Agreement
GSM-R	Global System for Mobile Communications - Railway
HL3	Hybrid Level 3
HTD	Hybrid Train Detection
IXL	Interlocking
ISDN	Integrated Services Digital Network
LRBG	Last Relevant Balise Group
LS	Limited Supervision
LX	Level Crossing
MA	Movement Authority
MB	Moving Block
MBS	Moving Block System
MRSP	Most Restrictive Speed Profile
NP	No Power
OB	Onboard
OS	On Sight
OBU	On Board Unit
OS	On Sight
PCE	Puesto Central ERTMS (Central ERTMS Post)
PR	Position Report
RBC	Radio Block Centre
SB	Stand-By
S&EO	Socio & Economic Objective
SERA	Single European Railway Area
SH	Shunting
SL	Sleeping

Abbreviation / Acronym	Definition
SoM	Start of Mission
SR	Staff Responsible
SvL	Supervised Location
TCO	Total Cost of Ownership
TCP/IP	Transmission Control Protocol / Internet Protocol
TDS	Train Detection System
TMS	Traffic Management System
TS	Trackside
TSA	Track Status Area
TSR	Temporary Speed Restriction
TTD	Trackside Train Detection
UC	Use Case
UES	Unconditional Emergency Stop
VSS	Virtual Sub Section
WAN	Wide Area Network
WP	Work Package

Table 1 - List of abbreviations and acronyms

Definition	Meaning
ETCS trackside subsystem	ETCS trackside control-command and signalling subsystem, including all the concerned components (e.g. RBC, Radio communication network, operator interfaces, etc)
IXL trackside subsystem	Trackside control-command and signalling subsystem, with the concerned equipment, including train detection system, switches, LX etc

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1. Introduction / Background

1.1. General introduction

With the support of EU's key funding program Horizon Europe, the Europe's Rail Joint Undertaking (EU-Rail) aims to deliver a high-capacity integrated European railway network by eliminating barriers to interoperability, providing solutions for full integration, and achieving faster uptake and deployment of innovation.
Having an essential function by providing green transport services and connection with other transport systems, regional railways play a crucial role in the European network acting as feeder lines for both passenger and freight traffic. However, regional lines are gradually disappearing. Current economic, social, and environmental conditions negatively impact their survival throughout Europe to the extent of being abandoned. In response, EU-Rail FP6 Project (FutuRe) is born to revitalize them by exploiting leading-edge technologies which lead to a reduction in the Total Cost of Ownership (TCO), while meeting safety standards and improving reliability and availability of the regional railway system.
The expected outcomes of FutuRe shall form the basis for a common European regional rail development management framework characterized by green, digital, safe, and cost-efficient solutions, which is linked to the technical objective of FutuRe Work Package 3 (WP3):

- Regional rail CCS & operations for Group 1 (G1) regional lines

G1 regional lines are lines or network of lines that are connected to the mainline railway system, forming together the Single European Railway Area (SERA) in accordance with the Directive 2012/34. They are characterized by a regular passenger service operated from/to mainline and/or demonstrated demand for rail freight services. Therefore, G1 lines must be fully compliant with the applicable EU legal framework establishing SERA, primarily with the Directive 2016/797/EU.

In the context of CCS, FutuRe WP3 leads the assessment for the applicability of several solutions covering an integrated control and command system for G1 lines, which shall first be demonstrated in laboratory

conditions in FutuRe Work Package 8 (WP8) targeting the Technology Readiness Level (TRL) 5:

- Automatic Train Operation (ATO), up to GoA4
- ERTMS/ETCS level 2, considering both Fixed Virtual Blocks and Moving Block implementations *(note: these one being the specific scopes of this document)*
- Traffic Management System (TMS)
- Absolute Safe Train Positioning (ASTP)
- Train Integrity and Train Length

FutuRe WP3 builds on specifications, guidelines, and other existing deliverables coming from:

- CCS TSI 2023/1695
- FutuRe Work Package 2 (WP2)
- Flagship Project 1 - Mobility management multimodal environment and digital enablers
- Flagship Project 2 - Rail to Digital automated up to autonomous train operation
- Shift2Rail (S2R) projects

As a result of the work performed in WP3, a comprehensive list of unique use cases/scenarios is provided together with a definition of WP8's demonstrator laboratory set-ups.

Remark: Several references to "L3" are currently present in this document. In most cases, they are due to special acronyms (e.g. HL3) or headlines/texts excerpted from source documents (e.g. "Task 3.2 Preparatory activities for the ETCS L3 demos on G1 regional lines" or Grant Agreement). Despite L3 is no more included in the list of allowed operating levels within the most recent TSI and it has been replaced by L2, it is preferable to keep it as it is in this document, with the explicit assumption that every reference to L3 is supposed to be interpreted as "L2" with special functions related to Hybrid Train Detection or Moving Block.

1.2. Deliverable 3.2 introduction

The present document constitutes the Deliverable D3.2 "Use cases and scenarios for ETCS L3 demos on G1 regional lines" in the framework of the Task 3.2 of the WP3 in FutuRe.

With reference to FutuRe Grant Agreement [REF 1], Task 3.2 is in fact defined as:
Task 3.2 Preparatory activities for the ETCS L3 demos on G1 regional lines (Leader: ATSA; Participants: ADIF, CAF, FS, INDRA, MERMEC, ÖBB-INFRA) (M01-M24).
Based on the specifications, guidelines, and any other deliverables existing and/or coming from WP2, Destination 2 and the System Pillar's Architecture and Shift2Rail projects (i.e. X2Rail-1, X2Rail-3 and X2Rail-5) in regard of ETCS L3 functionalities and interfaces and other transport modes, this task will set the scene to demonstrate the practical use of ETCS L3 applied to regional lines. Thus, the following work will be done: Definition of demonstrator´s setup, of relevant use cases and scenarios applicable and suitable for the different proposed demonstrator locations that will need to be tested. Involved FMs will analyse the inputs to propose the best approach and the work plan to perform tests in respect to target operational environment of regional rail.
Integration of all proposed use cases from partners, finding gaps and overlaps to provide a consolidated and comprehensive list of unique use cases/scenarios, which allow to perform task 8.3 more efficiently.

The Deliverable D3.2 will provide:

• Use Cases and scenarios (as proposed by each company involved in the task);
• Compendium of Use Cases and Scenarios (specific for each demonstrator) – integration of individual inputs, finding gaps and overlaps, to provide a consolidated and complete list of Use Cases/Scenarios, which allow to perform the demonstrators more efficiently.

The Deliverable D3.2 will provide:
• A list of Use Cases (as proposed by each company involved in the task) per each operational context expected to be demonstrated;
• The description of each Use Case.

Beyond the goal of demonstrating the practical use of ETCS L3 applied to regional lines, a full set of operationally relevant scenarios will be defined, in order to set up a potential system configuration that, together with L3 oriented signalling principles, will show the feasibility of operating a regional line. The definition of use cases whose interaction with HTD/moving block functionalities is apparently null will pave the way for having an overall complete vision of how a G1 regional line could ideally be operated.

1.3. Overall considerations on HTD / Moving Block and their contribution to the S&EO

The deployment on a G1 type Regional line of the HTD/HL3 or Moving Block principles would bring benefits to the achievement of the expectations and the objectives stated in the S&EO as defined inside the Grant Agreement.

Strictly correlated to the application of these principles, in fact, there is the opportunity (fully in the scope of all the demonstrators) to reduce significantly the use of specific trackside assets. Such reduction would contribute to the evidence that some of the most relevant KPIs identified as target for the Regional Lines could take benefit.
The technical and more relevant details will be provided, for each one of the four demonstrators, within the dedicated sections of Chapter 4, but here following some generic concepts can be remarked:

- The evidence that even with a reduced number of train detection devices it is possible to set up an operable Regional Line G1 type would allow to demonstrate that it is possible to get advantages in terms of CAPEX and OPEX reduction (S&EO 01, 05 and 08) but also in terms of increased system availability (S&EO 3);
- The reduction of other trackside asset (e.g. balises, LX pedals) - thanks to the adoption of specific technical solutions (out of HTD/Moving Block) - would bring benefit to the achievement of S&EO 01 and 05 as wel.;

2. Objective

WP3 - Regional Rail CCS & Operations for G1 Lines Requirements & Specifications

As an excerpt from the Grant Agreement [REF 1], *"the objective of this WP is to find suitable CCS solutions*

and define preparatory activities for demonstrators using existing and potential interoperable standards applicable across Europe on G1 lines, to ensure long term viability of this lines by decreasing the total cost of ownership while taking into consideration regional lines specificities. Not only CCS solutions but also operational needs adapted to regional lines will be in the scope to enable sustainable operation, efficient functionalities and full connectivity with other transport modes. The goal of an efficient and sustainable operation shall be achieved by automation and asset reduction. Benefit shall be achieved by vehicle owners as well, by the reduction of energy and maintenance costs.
To secure the proper set-up of future fully integrated demonstrators, results of this WP (in particular technical requirements, preparatory work for and results of the demonstrators and validation report) will be transferred to WP7."

Task 3.2 Preparatory activities for the ETCS L3 demos on G1 regional lines
Excerpt from the Grant Agreement [REF 1]
"Based on the specifications, guidelines, and any other deliverables existing and/or coming from WP2, Destination 2 and the System Pillar's Architecture and Shift2Rail projects (i.e. X2Rail-1, X2Rail-3 and X2Rail-5) in regard of ETCS L3 functionalities and interfaces and other transport modes, this task will set the scene to demonstrate the practical use of ETCS L3 applied to regional lines. Thus, the following work will be done:

- *Definition of demonstrator´s setup, of relevant use cases and scenarios applicable and suitable for the different proposed demonstrator locations that will need to be tested. Involved FMs will analyse the inputs to propose the best approach and the work plan to perform tests in respect to target operational environment of regional rail.*
- *Integration of all proposed use cases from partners, finding gaps and overlaps to provide a consolidated and comprehensive list of unique use cases/scenarios, which allow to perform task 8.3 more efficiently."*

When present, any difference compared with specifications and deliverables coming from the above mentioned input sources has been identified for allowing the achievement of the targets fixed in the Grant Agreement of the FutuRe project.

3. Input analysis

The following inputs have been considered for driving the selection and the development of the Use Cases presented in the next chapter 7 of this document:

- Operational Scenarios from [REF 2]

- UNISIG Subset 026 v.3.6.0[2] ([REF 3])
- FP2-R2DATO MBS system specifications [REF 4]

As soon as additional contribution and input will be available, like the ones listed below, they will be considered, triggering possible evolutions and integration of the current set of Use Cases.

- System Pillar – Harmonized Operational Scenarios
- FP2 R2DATO (WP15) Use Cases

It is worth to consider also that the Use Cases (or their derived requirements) defined in this document would be relevant input to the work of System Pillar and FP2 R2DATO.

4. Description of the target operational environment

4.1. HL3 (HTD) operational context (ALSTOM)

4.1.1. Features of the target regional line

The following basic features have been identified for supporting the selection of the regional line to be the target of the demonstrations.

a) Single track line – one single Axle Counter section between 2 adjacent stations;

b) Presence of LX both in station and plain line;

c) Possibly already equipped with an ERTMS L2 system, w/o backup ATP system, to be adapted for the scopes of the demonstration;

d) The line belongs to G1 line;

e) In terms of railway traffic, the target regional lines is characterized by a low density traffic, i.e. not more than 2 trains/hour per direction.

4.1.2. Basic engineering rules for the Demo

The main basic engineering rules listed below will be adopted for equipping the regional line hosting the

[2] The reference to Subset 026 3.6.0 is considered acceptable against version 4.0.0 as the HL3/HTD principles (the Use Cases are based on) do not belong to any version of two and because no functionality added/modified inside 4.0.0 is relevant for the scopes of this document.

demonstration of the operational scenarios. They pursue the goal of supporting the achievement of the expectations and the objectives stated in the S&EO.

1. The line sections of the regional line have a single (physical) axle counter section;

Note: the single axle counter section is deemed necessary only to support the management of degraded operational scenarios.

2. The single line section is divided into several virtual sections, as needed, fulfilling the following basic requirements:
   a. A virtual section inside the plain line should have a maximum dimension (e.g. no longer than 2km);
   b. A dedicated virtual section shall overlap each LX area inside the line;
3. Balises Group dedicated only to recalibration scopes shall be not installed in plain line and their number will be reduced as much as possible in station;

   Note: the reduction of the number of recalibration balise group (actually of all the balise whose telegrams do not contain safety relevant data), associated with an expected improvement of the odometric error management at onboard level, is used for demonstrating that the line is acceptably operable with a reduced number of balises. Any possible concern or consideration on the safety relevance of this engineering rule and any possible inconsistency with existing safety requirements will be evaluated taking care of this assumptions on the onboard performances.

   The reduction of the total amount of balise group installed is assumed possible due to the presence of an ASTP onboard solution that guarantees adequate performances from the odometric error. The ASTP as itself is not in the scope of the demonstrator, but rather the positive impact of this technology to the achievement of the main overall objectives.

4. Inside the station, the presence of physical train detection devices (track circuit) shall be minimized as well; they are usually installed on each switch, but some specific engineering with no TTD will be adopted for executing specific tests of degraded situation (even on switches);
5. No train detection devices overlapping berth tracks and sidings;

   Note: this is a quite challenging design but leading to a big simplification of the track layout design if a good level the operations will be possible.

6. No train detection devices overlapping LX area in plain line and station, unless requested for other reasons (e.g. presence of points);
7. At least one recalibration balise group inside each berth track and each siding;
8. The Balise Groups are composed of 2 redundant balises;

   Note: This is not mandatory and balise groups composed of one balise would be possible; but, so far, most of the infrastructure manager organizations adopted this decision, which is for sure much helpful to support degraded operational scenarios.

9. In case of Level Transition, the area just beyond the entry boundary and upstream the exit boundary is covered by a TTD.

4.1.3. Functional/configuration constraints adopted

1. M_NVCONTACT (reaction to expiration of T_NVCONTACT) shall be SERVICE BRAKE
2. Value of D_SR parameter currently supposed to be set to infinite[3].
3. Release speed usually calculated onboard, except for some specific situation, explicitly defined inside the UCs.
4. Cold Movement Detector available onboard in order to optimize (maximize) the probability of performing SoM procedures with known valid position.
5. Only one ETCS OBU device per train.

Justification/Remark:

The main reason of having one single ETC OBU (double cabin) equipment per train is for getting benefit of a Start of Mission with valid position in case of change of cabin after an EoM. So, the case of having 2 EVCs (single cabin) is supposed to be not used. The case of multiple composition, where each train is equipped with its own EVC, is anyway allowed. In such case the EVC of the secondary unit will be in Sleeping, so still guaranteeing a valid position report in case it become the leading unit.

4.2. HL3 (HTD) operational context (MERMEC)

4.2.1. Features of the target regional line

The following basic features have been identified for supporting the selection of the regional line to be the target of the demonstrations.

1. Single track line – several Axle Counters;
2. Several LXs in station and plain line;
3. Possibly already equipped with an ERTMS L2 system, w/o backup ATP system, to be adapted for the scopes of the demonstration;
4. The line belongs to G1 line.

4.2.2. Basic engineering rules for the Demo

At the engineering level, the basic rules that will be adopted to equip the regional line hosting the demonstration of the operational scenarios are listed.

[3] The proposed value has to be considered just as a default value. Different limited values could be possible, depending where the train with unknown position (see UC_01_2_01_04) is located. Any adaptation will be evaluated during the implementation phase of the demo.

5. The line sections of the regional line have axle counter sections.
6. The line has several Level Crossings
7. The line will be divided in several virtual sections, as needed, fulfilling the following basic requirements:
    a. A virtual section inside the plain line should have a maximum dimension (e.g. no longer than 2km);
    b. A dedicated virtual section shall overlap each LX area inside the line;
8. The Balises Group are already present and will be maintained. The Balise group are compose by 2 redundant balises.
9. Inside the Stations there are track circuits as TTD. The TTD protect every switch.

4.2.3. Functional/configuration constraints adopted

1. Value of D_SR parameter currently supposed to be set to infinite.
2. Cold Movement Detector available onboard in order to optimize (maximize) the probability of performing SoM procedures with known valid position.
3. One ETCS OBU device per train.
4. Additional parameters will be expressed during the test plan configuration

4.3. HL3 (HTD) operational context (INDRA)

4.3.1. Features of the target regional line

The following features have been identified for the selection of the regional line that will be the target of the demonstrations:

a) Single track line with a single block between the stations and a single train detector system in the block
b) Possible presence of LX
c) ERTMS balises already installed in the line
d) The line belongs to G1 line

4.3.2. Basic engineering rules for the Demo

The Indra demonstrator will be built taking into consideration the needs and preferences of ADIF. The following engineering rules shall be adapted and considered for the implementation of the demonstrator:

1. The block between stations will be divided into several VSS in order to improve the performance of the line. Studying the optimal way to do this division of the block into VSS is one of the objectives of the demonstrator.
2. The division of stations tracks into several VSS shall be considered, although since it does not improve the general performance of the line in a significant way, it will not be heavily studied.
3. The demonstrator will try to avoid changing the behaviour of the IXL in order to accommodate for the HL3. This is to try to avoid having to change the IXL of an already existing line when the HL3

functionality is added, as it would increase the cost of the implementation. If any changes are necessary, an attempt to minimize the changes shall be made.

4. The topology of the line (tracks, points, signal, TDS…) will be based on an existing real regional line. This is due to ADIF not expecting the construction of new regional lines and intends to add the HL3 system to already existing lines. Additional balises might be added in order to represent the virtual balises that a train positioning system would add. The train positioning system will not be simulated, since it is beyond the scope of this demonstrator and such tests will be left for integrated demonstrator to be made in the future.

4.3.3. Functional/configuration constraints adopted

The following constraints will be considered:

1. M_NVCONTACT shall be “APPLY SERVICE BRAKE”
2. T_NVCONTACT shall be 20s
3. D_NVSTFF shall be infinite
4. T_CYCLOC shall be 5s
5. Mute timer will be studied in the demonstrator but it will take different values for certain test cases (there are cases that are only possible whether the mute timer is greater than M_NVCONTACT or not)
6. Values for the following timers will be studied in the demonstrator: wait integrity, shadow train, disconnect propagation, ghost train propagation and integrity lost propagation.

It is possible that some of the constrains already defined might be changed if some reason is discovered during the test.

4.4. Moving Block (MB) operational context (CAF)

4.4.1. Features of the target regional line

The following basic features have been identified for supporting the selection of the regional line to be the target of the demonstrations:

a) Regional G1 line
b) ETCS-equipped
c) Low-capacity demand
d) Reduced deployment of Trackside Train Detection systems

4.4.2. Basic engineering rules for the Demo

- The Mute Timer shall be configured with a value lower than the Communication Session Timer

- The Integrity Wait Timer shall be related to the Position Report Parameters and the frequency of reporting integrity confirmation to ETCS-OB
- The National Value T_NVCONTACT shall be less than the Communication Session Timer
- The National Value T_NVCONTACT shall be configured to a value lower than or equal to the Mute Timer
- The National Value M_NVCONTACT shall be configured to “Apply Service Brake”

4.4.3. Functional/configuration constraints adopted

- Train integrity information is provided to ETCS-OB on a regular basis
- ETCS-OB reports integrity according to CR940
- NID_ENGINE is unique for each train. The allowed train composition shall be simple
- End of Mission and Start of Mission procedures are allowed at certain locations
- SR mode is limited by operational procedure

5. Compendium of Use Cases and Scenarios indicating the sponsor and list of involved companies for each UC (a consolidated and complete list of unique use cases/scenarios)

This section contains the use cases coding compliant with the ones adopted inside WP3 deliverables. The list of functions families and their associated codes is also reported; such functions are the main operational functions the Use Cases will be based on.

Each of the demonstrators described in the following section 6 will execute a subset of the identified Use Cases, actually the ones defined as relevant for the specific operational context.
The related testing plan will be produced during the next phase of the project, as part of the deliverables of WP3 – Task 8.3.

5.1. Coding rules

5.1.1. Use Cases coding rules

The following coding rule will be applied for the proper identification of the Use Cases:

UC_<*X*>_<*Y*>_<*W*>_<*Z*>

Where:

- <X> Use Case group ID (FutuRe WP3:01);
- <Y> Use Cases family (FutuRe WP3 T3.2: 02);

- <W>functions family (see below for detail);
- <Z> Use Case counter for each function family.

The Table X lists the identified function families and their associated codes (for parameter W):

Code	Description
HL3/HTD	
01	Start of Mission
02	Train Movement – nominal conditions
03	Completion of the mission
04	Degraded operational scenarios
05	Radio communication issues
06	Level Crossing (LX) management
07	Temporary Speed Restriction
08	Emergency Stop management
09	Joining / Splitting
10	Level transitions/ Handover
11	Degraded technological scenarios / system faults
12	Miscellaneous
Moving Block	
13	Movement Authority Management
14	Train Integrity Loss
15	Communication Loss

Table 3 – Functions and associated codes

5.1.2. Requirements' coding rules

The requirement's tag follows the following rule:

R_*<Use Case>*_*<X>*

Where:

- <Use Case> is numerical identifier of the Use Case
- <X> Requirement's counter for each Use Case.

Example:

R_01_02_03_07_02 is the requirement “02” of Use Case with ID “01_02_03_07”.

This is for improving the traceability between requirements and the associated Use Cases.

6. Definition of the demonstrator’s setup and test execution plan

6.1. HL3 / HTD - ALSTOM

In order to achieve the goals defined in the Grant Agreement, the proper identification of the line the demonstrator will be based on is quite important.

In fact, this line has to be fully representative of a typical G1 type regional line and it must be coherent with the features and basic engineering rules reported in § 4.1.1 and § 4.1.2.

The real G1 Regional line currently selected to host the demonstrator of Task 8.3 is the Padiglione-Nettuno line depicted in Figure 1. It is in Central Italy inside region Lazio, not so far from Rome.
In line with § 4.1.1, its characteristics are:

1. Single track;
2. One single Axle Counter section between 2 adjacent stations;
3. Each station is partially equipped with physical train detection devices (track circuits in particular);
4. Presence of at least one LX in a station and one in a line section.

An ERTMS L2 system without lateral signals compliant with Set #3 (B3R2 - M_VERSION=“2.1”) is currently being deployed by Alstom in the abovementioned line.

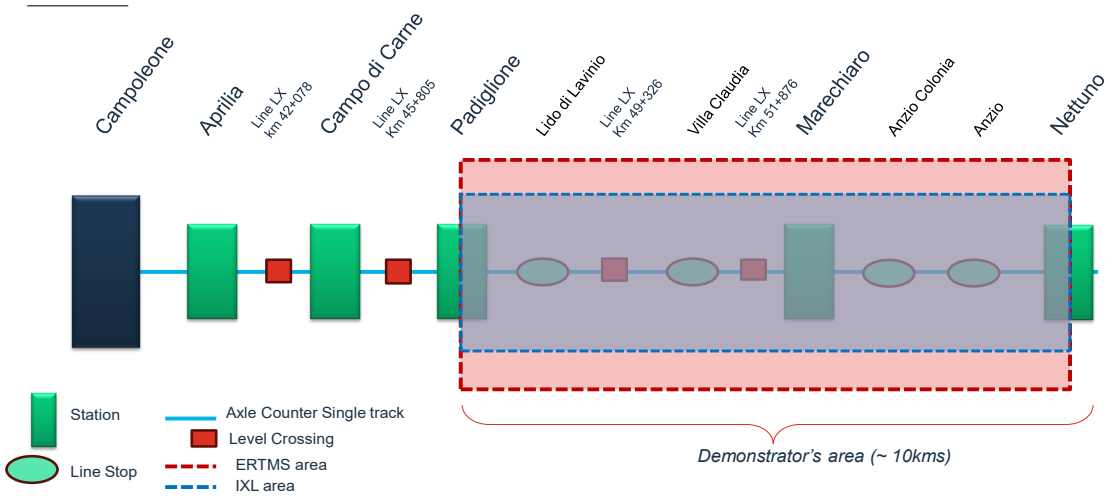


Figure 1: G1 Regional line Campoleone-Nettuno

The demonstrator's test environment will be based on a laboratory architecture that shall be used for performing the scenarios and to provide proper evidence of the validity of the technical solution, selected between others by Alstom, for the G1 regional lines.
Despite the laboratory architecture, as Figure 2 shows, most of the components going to be used are target components containing the exact configuration of the real line. The use of simulators will be limited to the simulation of the track equipment and the simulation of the train movement.

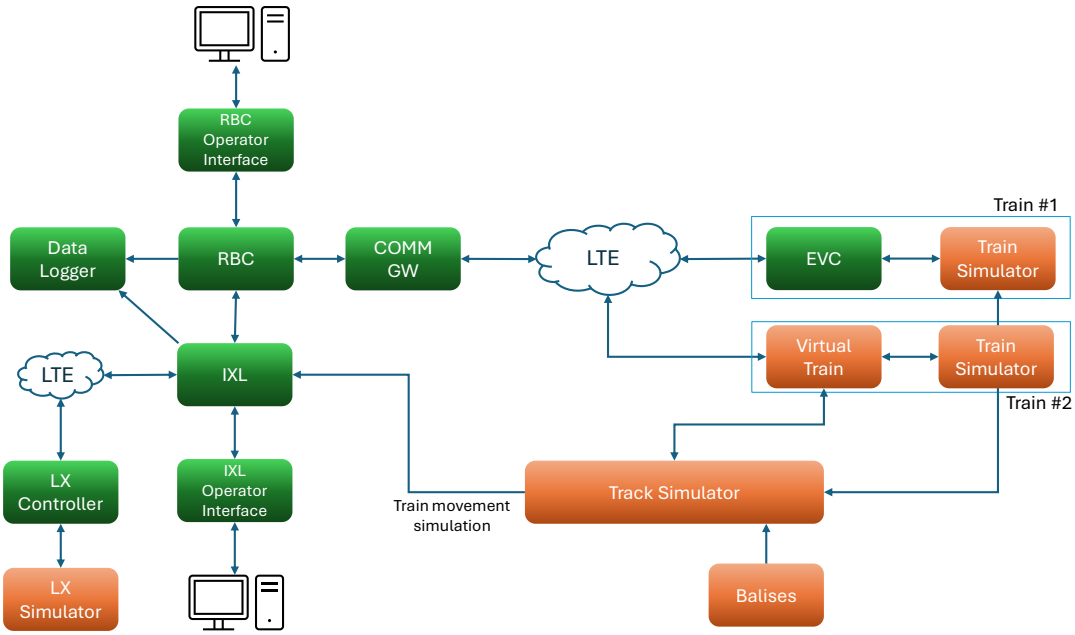


Figure 2: Test Bench schematic architecture

In the picture above, the green boxes represent functional components running on target HW and platform, while the orange boxes are simulated components supporting the execution of the specified Use Cases.

Within these functional blocks architecture it is possible to find:

- an HL3/HTD ETCS Trackside, which is mainly composed of:
  - RBC elaborating the core functionalities of the HL3 principles, including the status of Fixed Virtual Sections, the interface with interlocking subsystem and with its own operator interface;
  - The Communication Gateway in charge of managing the physical direct interface with the telecommunication radio system and, through it, with the onboard subsystems;
  - RBC operator interface, in charge of [1] displaying the track layout and the main ETCS related information (e.g. Trains icons, Movement Authorities, LXs etc) and of [2] executing the ETCS commands (e.g. TSR, Emergency Stop Request etc);
  - Data Logger, responsible for logging the main internal data produced by RBC, including all the messages exchanged with train and the main peripherals.
- An IXL subsystem: composed of:
  - Main computer in charge of the execution of the signalling logic, transmitting the TTD status and line block direction to the RBC;

- IXL operator interface, in charge of [1] displaying the IXL related information (e.g. routes, position of points, etc) and of [2] executing the IXL nominal and degraded commands;
- LX controller, controlling a simulated Level Crossing in plain line, connected to IXL via a radio channel;

- Train: both real and simulated ERTMS/ETCS L2 on-board subsystems, compliant with B3R2 standards transmitting Train Integrity information according to the UNISIG CR940.
- Train simulator, in charge to simulate the several train equipment and the behaviour of a train controlled by the ETCS onboard subsystem;
- Track simulator, in charge of translating the position report reported by the OBU in absolute position along the track and occupying/freeing the track detection device (if any), according this position report.

6.2. HL3 / HTD – MERMEC

This chapter reports MERMEC's general laboratory architecture supporting MERMEC's Demonstrator.

The MERMEC laboratory architecture is composed as in Figure 3 below:

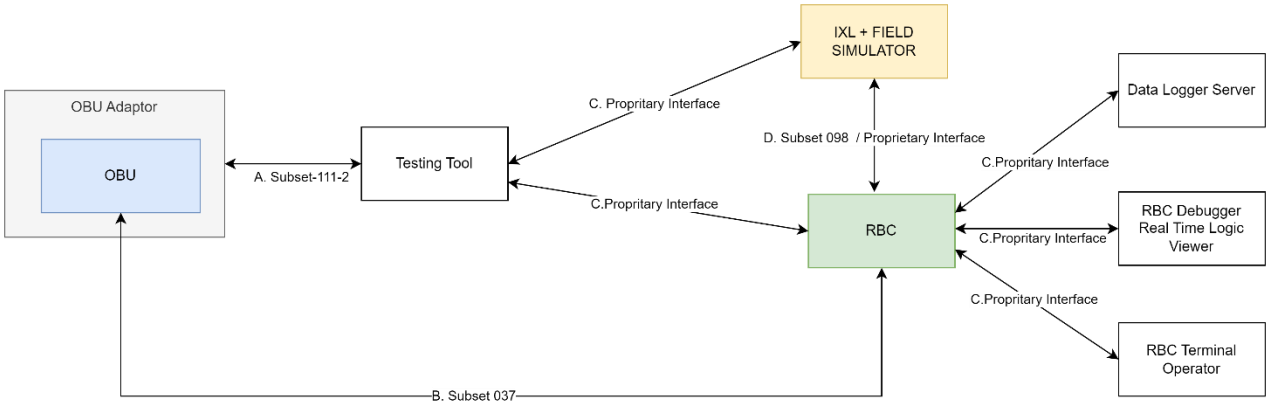


Figure 3: MERMEC laboratory architecture

The main components are:

- OBU / OBU Adaptor

  OBU chosen for the execution of the test. The OBU adaptor unit allows the OBU component to be connected to the test environment as specified in subset 110-111_2.

- Testing Tool

  Proprietary tool for system testing. It supports the 111_2 subset for communication with OBUs and has a scripting environment for test automation. It is able to communicate with IXL simulators and the RBC system.

- IXL and Field Simulator

Is a tool capable of simulating the logic of an interlocking system and all field objects (point machines, signals, etc.) of a railway system. It can interface with RBC using either a standard protocol such as subset 098 or through a proprietary protocol.

- RBC
  RBC chosen for the execution of the test
- Data Logger Server
  It records all the system states and alarms
- RBC Debugger
  It is a system capable of monitoring RBC state machines in real time for inspection and logic validation purposes.
- RBC Terminal Operator
  It acts as the synoptic view of the line and as the interface for sending commands to RBC (e.g. UES, TSR, etc.).

For the HL3/HTD solution MERMEC has the following architecture based on solutions from FA2 WP15/WP16.
The Figure shows the organization of the systems involved in the demonstrator environment. It contains:

1. Communication Network based on Ethernet (WAN)
2. Diagnostic Server, it records all the system states and alarms.
3. Communication Server, equipped with:
   - ISDN Modem, for communication with trains
   - Interface to traffic monitoring systems (TMS)
   - Interface to Interlockings
4. RBC Operator Desk :
   - Command Terminal
   - Synoptic view of the line

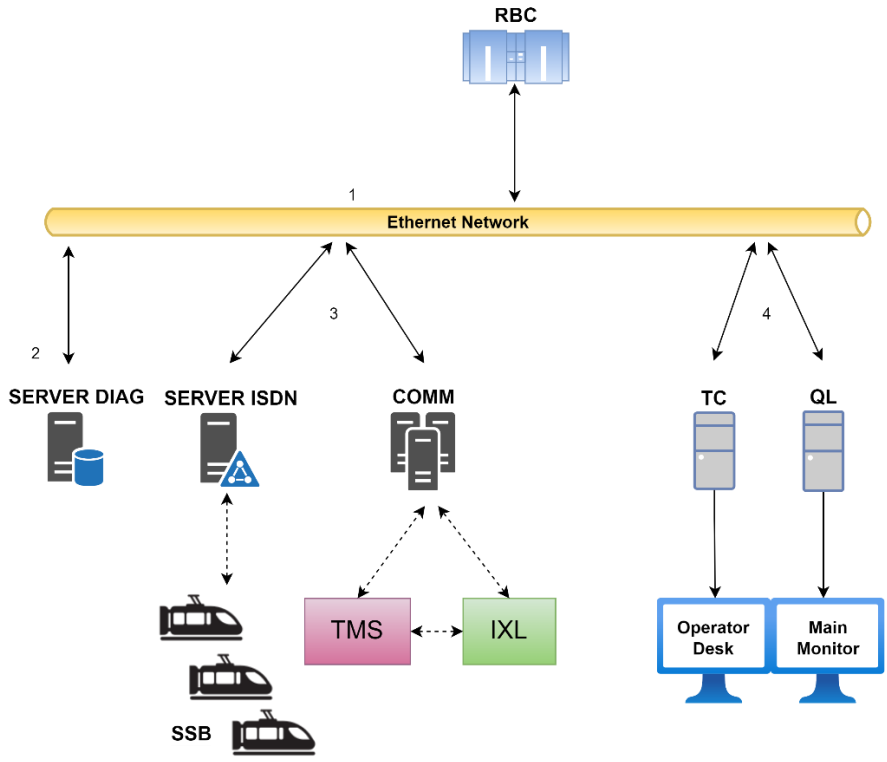


Figure 4: MERMEC HL3/HTD G1 Regional line

6.3. HL3 / HTD - INDRA

This chapter describes the laboratory architecture that will be used to perform the tests for Indra's demonstrator.

The following components will be the real ones:

- RBC with adaptations for HL3
- PCE

A new component will be developed to support the HL3 functionality:

- VSS Manager: this component might be implemented as a separate component or integrated with the RBC

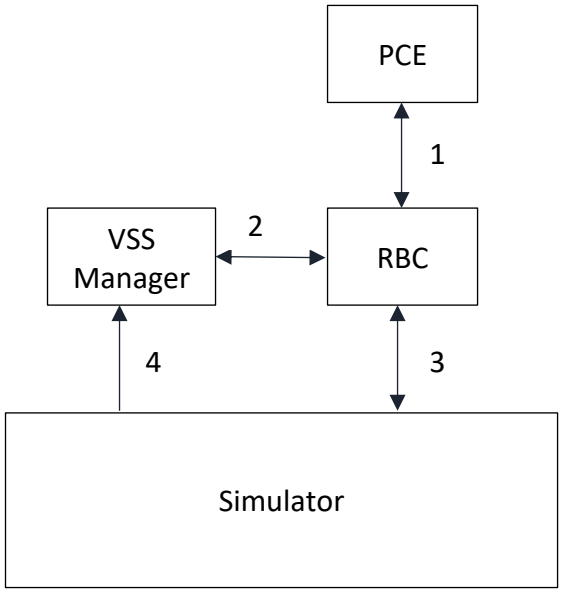
The rest of the components will be simulated:

- EVC with integrity information
- Radio communications
- Track and balises
- IXL

The main information exchanged between the different components are:

1. Commands and status for TSR and emergency stops

2. Train position reports and status of the VSS
3. Euroradio communications and IXL indications
4. Track circuit indications



6.4. Moving Block - CAF

This chapter reports the laboratory architecture that shall be used to perform tests and to analyse the benefits that the Moving Block System (MBS) developed in FP2-R2DATO brings in the context of a Spanish regional G1 line. The Moving Block test campaign, which centres around the use cases reported in chapters 7.17, 7.18 and 7.19, shall be led by CAF Signalling and supported by Centro de Estudios y Experimentación de Obras Públicas (CEDEX).

As illustrated in Figure 5, there shall exist a connection between CAF Signalling's and CEDEX's laboratory. The environment comprises the following components:

- CAF's FP2-R2DATO MBS Prototype developed in FP2-R2DATO WP14
- ETCS-OB
- Wayside assets simulator
- ERTMS train simulator and wayside simulator

The Moving Block operational context shall consider what is stated in chapter 4.4:

- Features of the target regional line
- Basic engineering rules
- Functional/configurations constraints

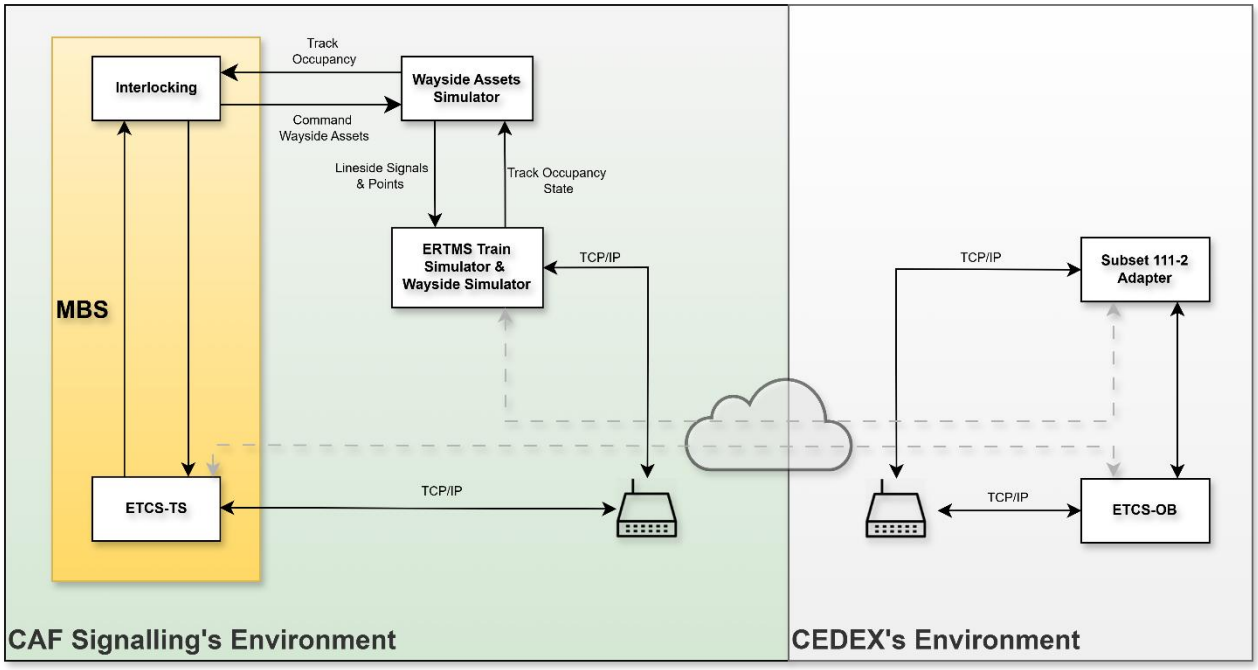


Figure 5: CAF's Moving Block Test Environment

CAF's Moving Block Test Environment shall use a Spanish regional G1 line located in Vasque Country as its context for testing performance. The line in question shall be characterized as the specific application on which all of the moving block use cases referenced to in the present document shall be tested. Specific details on the features of the line shall be provided in FP6-FutuRe WP8 D8.3 deliverable.

7. List of Use Cases

7.1. HL3 / HTD - ALSTOM

UC Code	Rev.	Use Cases title
01_xx		**Start of Mission**
UC_01_2_01_01	A	Positive train data validation
UC_01_2_01_02	A	Negative train data validation
UC_01_2_01_03	A	Start of Mission – Line / Known position
UC_01_2_01_04	A	Start of Mission – Line / Unknown position
UC_01_2_01_05	A	Start of Mission – Station / Known Position
UC_01_2_01_06	A	Start of Mission – Station / Unknown position
UC_01_2_01_07	A	Start of Mission – Management of virtual section status on berth/siding track
UC_01_2_01_10	A	Start of Mission with invalid operating level inside L2 area

UC Code	Rev.	Use Cases title
02_xx		**Train Movement – nominal conditions:**
UC_01_2_02_01	A	Train Position Management
UC_01_2_02_02	A	Sending Virtual Sections status to IXL
UC_01_2_02_03	A	Train with TIMS available onboard
UC_01_2_02_04	A	Train with TIMS not available onboard
UC_01_2_02_05	A	Train integrity loss in plain line reported by TIMS
UC_01_2_02_06	A	Balise Group detection
03_xx		**Completion of the mission:**
UC_01_2_03_01	A	Arrival at buffer stop
UC_01_2_03_02	A	Arrival at berth track occupied by a stationary train – train joining
UC_01_2_03_03	A	Arrival at virtual signal at danger (berth track/siding)
UC_01_2_03_04	A	Arrival at virtual signal at proceed (operational stop)
UC_01_2_03_05	A	End of mission
UC_01_2_03_06	A	Arrival at berth track occupied by a stationary train (train parking)
UC_01_2_03_07	A	Change of train orientation (nominal)
UC_01_2_03_08	A	Change of train orientation (degraded)
04_xx		**Degraded operational scenarios:**
UC_01_2_04_01	A	Entering a station with virtual sections occupied by a stranded train
UC_01_2_04_02	A	Movement on virtual sections in plain line not free
UC_01_2_04_03	*N/R*	*Making free a virtual section not free*
UC_01_2_04_04	A	Overriding a virtual signal set to danger (Staff Responsible with Override)
UC_01_2_04_05	A	Cooperative revocation of MA
UC_01_2_04_06	A	Temporary Train integrity loss in plain line
UC_01_2_04_07	A	Permanent Train integrity loss in plain line
UC_01_2_04_08	A	Entering a station with virtual sections not free
UC_01_2_04_09	A	Train integrity temporarily unavailable in plain line
05_xx		**Radio communication issues:**
UC_01_2_05_01	A	Temporary track-train radio disconnection due to radio fault – T_NVCONTACT not expired
UC_01_2_05_02	A	Temporary track-train radio disconnection due to radio fault – T_NVCONTACT expired
UC_01_2_05_03	A	Permanent track-train radio disconnection due to missing radio coverage (Radio Hole)
UC_01_2_05_04	A	Temporary track-train radio disconnection due to radio fault – T_NVCONTACT not expired, mute timer expired
06_xx		**Level Crossing (LX) management:**

UC Code	Rev.	Use Cases title
UC_01_2_06_01	A	LX activation (barriers closing)
UC_01_2_06_02	A	Train approach to an unprotected LX
UC_01_2_06_03	A	Overpassing an unprotected LX
UC_01_2_06_04	A	LX deactivation after train passage
UC_01_2_06_05	A	LX missing deactivation after train passage
07_xx		**Temporary Speed Restriction:**
UC_01_2_07_01	A	TSR activation by trackside operator
UC_01_2_07_02	A	TSR de-activation by trackside operator
08_xx		**Emergency Stop Request:**
UC_01_2_08_01	A	Emergency Stop Request activated by trackside operator
UC_01_2_08_02	A	Emergency Stop Request revoked by trackside operator
09_xx		**Joining / Splitting:**
UC_01_2_09_01	A	Joining of a train on a berth track
UC_01_2_09_02	A	Splitting of a train on a berth track
10_xx		**Level transitions / Handover:**
UC_01_2_10_01	A	Exit from L2 area to an LNTC area
UC_01_2_10_02	A	Entering a L2 area from an LNTC area - Nominal
11_xx		**Degraded technological scenarios / system faults:**
UC_01_2_11_01	A	Train movement with ETCS not available
UC_01_2_11_02	*N/R*	*Radio network registration and transition*
UC_01_2_11_03	A	Recovery after RBC shut down
UC_01_2_11_04	A	Trackside subsystem initialization (first start-up)
UC_01_2_11_05	A	Working area handover to operation
12xx		**Miscellaneous:**
UC_01_2_12_01	A	Shunting movements
UC_01_2_12_02	*N/R*	*Hot Temperature Alarms on wheels*
UC_01_2_12_03	A	Sweeping Train
UC_01_2_12_04	*N/R*	*Chasing trains*
UC_01_2_12_05	A	Entering a Shunting Yard
UC_01_2_12_06	A	Exiting from a Shunting Yard
UC_01_2_12_07	*N/R*	*Movement in Reversing mode*
UC_01_2_12_08	A	Manual reset of Virtual Sections
UC_01_2_12_09	A	Shunting area handover to operation
UC_01_2_12_10	A	Management of Permitted Braking Distance profile
UC_01_2_12_11	A	Management of Non Stopping Area
UC_01_2_12_12	A	Management of Route Suitabilities – Positive Case

UC Code	Rev.	Use Cases title
UC_01_2_12_13	A	Management of Route Suitabilities – Negative Case

Table 4 – List of FA6 WP3 Task 3.2 Use Cases / HL3 for Alstom's demonstrator

7.2. HL3 / HTD - MERMEC

UC Code	Rev.	Use Cases title
01_xx		**Start of Mission**
UC_01_2_01_08	A	Start of Mission with valid position - Trackside provides a FS MA
UC_01_2_01_09	A	Start of Mission with invalid or unknown position – Departure with SR authorization
04_xx		**Degraded operational scenarios:**
UC_01_2_04_10	A	Loss of Train Integrity during Normal Movement
UC_01_2_04_11	A	EoM after Loss of Train Integrity
UC_01_2_04_12	A	Train does not confirm Integrity – Wait Integrity timer expires
UC_01_2_04_13	A	End of Mission with train integrity confirmed after standstill
UC_01_2_04_14	A	End of Mission without train integrity confirmed after standstill
05_xx		**Radio communication issues:**
UC_01_2_05_05	A	Loss of Communication without re-connection
UC_01_2_05_06	A	Train passes through Radio Hole within expected time
UC_01_2_05_07	A	Train passes through Radio Hole longer than expected time
09_xx		**Joining / Splitting:**
UC_01_2_09_03	A	Train Joint another one
UC_01_2_09_04	A	Splitting of a train with integrity confirmed
UC_01_2_09_05	A	Splitting of a train with integrity confirmed
10_xx		**Level transitions / Handover:**
UC_01_2_10_03	A	Nominal Handover without interface for the communication of the state of the VSSs
UC_01_2_10_04	A	Loss of Connection between Handing Over RBC and Accepting RBC
UC_01_2_10_05	A	Entering HL3/HTD Area
UC_01_2_10_06	A	Exiting HL3/HTD Area

Table 5 – List of FA6 WP3 Task 3.2 Use Cases / HL3 for Mermec's demonstrator

7.3. HL3 / HTD – INDRA

UC Code	Rev.	Use Cases title
01_xx		**Start of Mission**
UC_01_2_01_01	A	Positive train data validation
UC_01_2_01_09	A	Start of Mission with invalid or unknown position – Departure with SR authorization
02_xx		**Train Movement – nominal conditions:**
UC_01_2_02_01	A	Train Position Management
UC_01_2_02_03	A	Train with TIMS available onboard
UC_01_2_02_04	A	Train with TIMS not available onboard
UC_01_2_02_05	A	Train integrity loss in plain line reported by TIMS
UC_01_2_02_06	A	Balise Group detection
03_xx		**Completion of the mission:**
UC_01_2_03_05	A	End of mission
04_xx		**Degraded operational scenarios:**
UC_01_2_04_11	A	EoM after Loss of Train Integrity
UC_01_2_04_13	A	End of Mission with train integrity confirmed after standstill
UC_01_2_04_14	A	End of Mission without train integrity confirmed after standstill
05_xx		**Radio communication issues:**
UC_01_2_05_01	A	Temporary track-train radio disconnection due to radio fault – T_NVCONTACT not expired
UC_01_2_05_02	A	Temporary track-train radio disconnection due to radio fault – T_NVCONTACT expired
UC_01_2_05_03	A	Permanent track-train radio disconnection due to missing radio coverage (Radio Hole)
UC_01_2_05_04	A	Temporary track-train radio disconnection due to radio fault – T_NVCONTACT not expired, mute timer expired
07_xx		**Temporary Speed Restriction:**
UC_01_2_07_01	A	TSR activation by trackside operator
UC_01_2_07_02	A	TSR de-activation by trackside operator
08_xx		**Emergency Stop Request:**
UC_01_2_08_01	A	Emergency Stop Request activated by trackside operator
UC_01_2_08_02	A	Emergency Stop Request revoked by trackside operator
11_xx		**Degraded technological scenarios / system faults:**
UC_01_2_11_01	A	Train movement with ETCS not available
UC_01_2_11_04	A	Trackside subsystem initialization (first start-up)
12xx		**Miscellaneous:**

UC Code	Rev.	Use Cases title
UC_01_2_12_03	A	Sweeping Train
UC_01_2_12_08	A	Manual reset of Virtual Sections

Table 6 – List of FA6 WP3 Task 3.2 Use Cases / HL3 for INDRA's demonstrator

7.4. Moving Block - CAF

UC Code	Rev.	Use Cases title
13_xx		**Movement Authority Management:**
UC_01_02_13_01	A	Movement Authority management process when train integrity is confirmed
UC_01_02_13_02	A	Movement Authority management process when train integrity is not confirmed
14_xx		**Train Integrity Loss:**
UC_01_02_14_01	A	Train Integrity is confirmed after Train Integrity information is not available
UC_01_02_14_02	A	Train Integrity is confirmed after Train Integrity loss is reported
UC_01_02_14_03	A	Train Integrity is confirmed after the Integrity Wait Timer expires
UC_01_02_14_04	A	End of Mission is performed after Train Integrity is lost
UC_01_02_14_05	A	Train integrity is not confirmed when entering an Area of Control
15_xx		**Communication Loss:**
UC_01_02_15_01	A	Nominal Communication Scenario
UC_01_02_15_02	A	Communication Loss Scenario (1)
UC_01_02_15_03	A	Communication Loss Scenario (2)
UC_01_02_15_04	A	Communication Loss Scenario (3)
UC_01_02_15_05	A	Communication Loss Scenario (4)
UC_01_02_15_06	A	Communication Loss Scenario (5)
UC_01_02_15_07	A	Communication Loss Scenario (6)

Table 7 – List of FA6 WP3 Task 3.2 Use Cases / MB for CAF's demonstrator

Note:
In the following tables detailed there will be a frequent usage of terms like "ETCS trackside subsystem" or "IXL subsystem". These terms have to be meant as being part of the more generic "trackside control-command and signalling subsystem". The detail reported with the reference to ETCS or IXL specific subsystems as owner of a specific event of action is meant to better clarify the interaction of the most impacted subsystem inside the CCS.

This will avoid also verbose and repeated reference to a long item like the one above.

7.5. Start of Mission

7.5.1. UC_01_02_01_01 - Positive train data validation

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	01 (Start of Mission)
UC ID	**UC_01_02_01_01**
Use Case	**Positive train data validation**
Main actor	Train driver
Other actors	GSM-R network
Main goal	Description of the Train Data acceptance process.
Assumptions	• OBU active in nominal conditions; • ETCS trackside subsystem active and in nominal conditions;
Precondition	• OBU in SB/NP operating mode; • Train registered to the radio network;
Flow of events	1. Train driver performs the Start of Mission Procedure, inserting all the train data as needed; *Note: at least some of the train data set could be preconfigured onboard;* 2. OBU initiates the radio communication with RBC and communicates its Train Data; 3. RBC checks with success these data versus the track characteristics and accepts the train, allowing the completion of SoM procedure.
Postcondition	Train with active communication with RBC and ready for completing the SoM procedure.
Safety relation	This use case is safety relevant.
Open topics / consideration	High Level Requirements: R_01_02_01_01_01 The system shall check the validity of the Train Data versus the track characteristics and shall accept the train only in case of positive check. *Note: Possible data to be checked:* • *Type of traction;*

	• *Loading gauge;* • *Axle Load profile;* • *Train length.*

7.5.2. UC_01_02_01_02 - Negative train data validation

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	01 (Start of Mission)
UC ID	**UC_01_02_01_02**
Use Case	**Negative train data validation**
Main actor	Train driver
Other actors	GSM-R network
Main goal	Description of the Train Data refusal process;
Assumptions	• OBU active in nominal conditions; • ETCS trackside subsystem active and in nominal conditions;
Precondition	• OBU in SB/NP operating mode; • Train registered to the radio network;
Flow of events	1. Train driver performs the Start of Mission Procedure, inserting all the train data as needed; *Note: at least some of the train data set could be preconfigured onboard;* 2. OBU initiates the radio communication with RBC and communicates its Train Data; 3. RBC verifies that at least one of the train data is not compatible with the track characteristics; 4. RBC sends a text message to the driver to inform about the negative check; 5. RBC rejects the train, ordering the radio disconnection.
Postcondition	Train with no communication with RBC, SoM procedure, leading to an MA transmission, is aborted.
Safety relation	This use case is safety relevant.
Open topics / consideration	High Level Requirements: R_01_02_01_02_01 The system shall inform the train driver through a text message about the train data which is detected as not compatible with the trackside. R_01_02_01_02_02 The system shall order the radio disconnection of a train whose characteristics reported during the SoM procedure are not

	compatible with the track characteristics. *Note: Possible data to be checked:* • *Type of traction;* • *Loading Gauge;* • *Axle Load Profile;* • *Train length.*

7.5.3. UC_01_02_01_03 - Start of Mission – Line / Known position

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	01 (Start of Mission)
UC ID	**UC_01_02_01_03**
Use Case	**Start of Mission – Line / Known position**
Main actor	Train driver
Other actors	GSM-R network Single Track line
Main goal	Description of the Start of Mission procedure in plain line by a train with a valid known position, aiming at the transmission of the first MA.
Assumptions	• OBU active in nominal conditions; • ETCS and IXL trackside subsystems active and in nominal conditions;
Precondition	• Rolling stock located in plain line, in SB operating mode if no CMD (Cold Movement Detector) available; mode can be NP only if CMD information is available; • Virtual section occupied by the train in a status not available for supervised manouvres by other trains; • Valid position known by the OBU; • Inputs received from IXL good for MA transmission (e.g. line block properly oriented, physical or virtual sections free [1] in front of the train); • Train registered to the radio network;
Flow of events	1. Train driver has to perform a Start of Mission, for whatever reason (e.g. drivers attempts to recover the radio communication after a radio outage or after a train temporarily parked on a line stop and switched off); 2. Train driver initiates the Start of Mission Procedure, inserting all the train data as needed; 3. OBU initiates the radio communication with RBC, as part of the SoM procedure; *Refer also to UC_01_02_01_01 - Positive train data validation* 4. Train driver pushes “Start” button; 5. RBC checks with success the right conditions to issue an MA;

	6. RBC issues an OS MA [2] covering the first virtual section where the train is located and an FS MA on any free virtual section beyond the first, as long as possible based on the line condition and engineering rules adopted; 7. Train leaves the Virtual Section where it performed the SoM, reporting a position report with confirmed train integrity; 8. The Virtual Section is ready to accept a following train.
Postcondition	Train in FS outside the virtual section.
Safety relation	This use case is safety relevant.
Open topics / consideration	High Level Requirements: R_01_02_01_03_01 The system shall be able to accept a train performing the Start of Mission in plain line, assuming that the train data are compatible with the line itself. R_01_02_01_03_02 When the signalling conditions for issuing the first MA after a SoM are met, the system shall transmit an MA in OS covering at least the section occupied by the train. *Remarks:* *[1] One or more virtual sections between the train front and the first marker board could be possibly "not free". The choice to consider them as free is because this UC is supposed to be quite nominal, with no degrades. Anyway, even in case of virtual sections "not free", the transmission of an OS MA after the conclusion of SoM procedure could be still applicable.* *[2] The very first MA issued by RBC after a Start of Mission procedure is, at least for the Italian signalling principles, covered by an OS mode profile at least from the train front up to the end of the first virtual section. In fact, with the application of ATAF concepts, there is no need to set any constraint on the maximum distance between the train and the end of the section that should be otherwise mandatory in case an FS MA would be expected.*

7.5.4. UC_01_02_01_04 - Start of Mission – Line / Unknown position

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	01 (Start of Mission)
UC ID	**UC_01_02_01_04**
Use Case	**Start of Mission – Line / Unknown position**
Main actor	Train driver
Other actors	GSM-R network Single Track line
Main goal	Description of the Start of Mission procedure in plain line by a train having an invalid/unknown position, aiming at the transmission of the first MA.

Assumptions	• OBU active in nominal conditions; • ETCS and IXL trackside subsystems active and in nominal conditions;
Precondition	• Rolling stock physically located in plain line; • OBU in NP operating mode; • no CMD (Cold Movement Detector) available or CMD with detected movement => no valid position known by the OBU; • input received from IXL good for MA transmission (e.g. line block properly oriented, physical or virtual sections free [1] in front of the train); • Train registered to the radio network; • Satellite positioning system available and working on-board;
Flow of events	1. Train driver has to perform a Start of Mission; 2. Train driver performs the Start of Mission Procedure, inserting all the train data as needed; 3. OBU initiates the radio communication with RBC; *Refer also to UC_01_02_01_01 - Positive train data validation* 4. Train driver pushes “Start” button; 5. RBC checks with no success the right conditions to issue an MA as the train position is not known; 6. RBC issues a SR Authorization with infinite distance allowed and a list of balises that can be passed up to the end of the plain line [2]; 7. Train driver moves the train supervising the speed imposed by SR mode, the distance and the list of allowed balises; 8. OBU, using the contribution of satellite positioning system, is able to establish its position in an unambiguous way with a given confidence interval, referred to an LRBG and reports this position to RBC; 9. RBC issues an OS MA covering the first virtual section where the train is located and an FS MA on any free virtual section beyond the first, as long as possible based on the line condition and engineering rules adopted; 10. Train leaves the Virtual Section where it performed the SoM, with its safe rear end; 11. The Virtual Section is ready to accept a following train.
Postcondition	Train in FS outside the virtual section.
Safety relation	This use case is safety relevant.
Open topics / consideration	High Level Requirements: R_01_02_01_04_01 The system shall accept a train performing the Start of Mission also when its position is invalid or unknown. R_01_02_01_04_02 The system shall be able to localize the train on the right track in plain line, in case of single track line, taking in account the contribution of satellite positioning system. *Remarks:* *[1] One or more virtual sections between the train front and the first marker board could be possibly “not free”. The choice to consider them as free is because this UC is supposed to be quite nominal, with no degrades. Anyway,*

	even in case of virtual sections "not free", the transmission of an OS MA after the conclusion of SoM procedure could be still applicable. *[2] The allowed distance in SR mode is something potentially critical. First, because the train location is not known, it is not possible to grant a calculated distance up to the marker board supposed to be the final destination of the train. So, a fixed value can be only used. On one side, an infinite distance could allow the driver to move the train as much as needed, but with the risk to move the train possibly beyond the marker board. On the other side, a short "safe" distance would have relevant operational impacts; the driver should be obliged to ask for updated SR authorizations if the train hasn't completed yet its movement. The design choice, so far, is to use an infinite distance and to protect undue movements with the list of allowed balises and "Stop if in SR" packet inside the BG at the marker board. This design choice is done under the assumption that there is a method for the RBC to decide where the train could likely be located, even if not communicated through a PR.*

7.5.5. UC_01_02_01_05 – Start of Mission – Station / Known Position

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	01 (Start of Mission)
UC ID	**UC_01_02_01_05**
Use Case	**Start of Mission – Station / Known position**
Main actor	Train driver
Other actors	GSM-R network
Main goal	Description of the Start of Mission procedure by a train in a station with a valid known position, aiming at the transmission of the first MA.
Assumptions	• OBU active in nominal conditions; • ETCS and IXL trackside subsystems active and properly working;
Precondition	• Rolling stock located in station (sidings or berth track), in SB mode if no CMD available; mode in NP only if CMD available; • Valid position known by the OBU; • Input received from IXL good for MA transmission (e.g. exit route set&locked); • Train registered to the radio network;
Flow of events	1. Train has to perform a Start of Mission; 2. Train driver performs the Start of Mission Procedure, inserting all the train data as needed;

	Refer also to UC_01_02_01_01 - Positive train data validation 3. OBU initiates the radio communication with RBC; 4. Train driver pushes “Start” button; 5. RBC checks with success the right conditions to issue an MA; 6. RBC issues an OS MA covering the first virtual section where the train is and an FS MA on any free virtual section, as long as possible based on the line condition and engineering rules adopted; 7. Train leaves the virtual section where it performed the SoM, with its safe rear end; 8. The virtual section is ready to accept a following train, after a new route set&locked.
Postcondition	Train in FS outside the virtual section.
Safety relation	This use case is safety relevant.
Open topics / consideration	High Level Requirements Here R_01_02_01_03_02 is also applicable.

7.5.6. UC_01_02_01_06 - Start of Mission – Station / Unknown position

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	01 (Start of Mission)
UC ID	**UC_01_02_01_06**
Use Case	**Start of Mission – Station / Unknown position**
Main actor	Train driver
Other actors	GSM-R network
Main goal	Description of the Start of Mission procedure by a train in a station with a invalid/unknown position, aiming at the transmission of the first MA.
Assumptions	• OBU active in nominal conditions; • ETCS and IXL trackside subsystems active and properly working; • Physical balise group installed on berth tracks and siding, close to each Virtual signal protecting the exit route;
Precondition	• Rolling stock located in station (sidings or berth track); • OBU in NP operating mode; • no CMD (Cold Movement Detector) available or CMD with detected movement => no valid position known by the OBU; • Input received from IXL good for MA transmission (e.g. exit route set&locked); • Train registered to the radio network;
Flow of events	1. Train has to perform a Start of Mission in the station; 2. Train driver performs the Start of Mission Procedure, inserting all the train

	data as needed; *Refer also to UC_01_02_01_01 - Positive train data validation* 3. OBU initiates the radio communication with RBC; 4. Train driver pushes “Start” button; 5. RBC checks unsuccessfully the right conditions to issue an MA as the train position is not known; 6. RBC issue a SR Authorization, with infinite distance allowed and a list of balises that can be passed to the end of the allowed distance; 7. Train driver moves the train supervising the speed imposed by SR mode, the distance and the list of allowed balises; 8. OBU reads one BG installed on the track and reports its known position to RBC; 9. RBC checks with success the right conditions to issue an MA; 10. RBC issues an OS MA covering the first virtual section where the train is and an FS MA on any free virtual section, as long as possible based on the line condition and engineering rules adopted; 11. Train leaves the virtual section where it performed the SoM, with its safe rear end; 12. The virtual section is ready to accept a following train, after a new route set&locked.
Postcondition	Train in FS outside the virtual section.
Safety relation	This use case is safety relevant.
Open topics / consideration	High Level Requirements R_01_02_01_06_01 In case the train position is not known, the system shall send an SR_Authorization to the train when OBU requests for an MA after driver’s selection on START button. Here R_01_02_01_03_01 is also applicable. *Remarks:* *[1] One or more virtual sections between the train front and the first marker board could be possibly "not free". The choice to consider them as free is because this UC is supposed to be quite nominal, with no degraded. Anyway, even in case of virtual sections "not free", the transmission of an OS MA after the conclusion of SoM procedure could be still applicable.* [*2] The allowed distance in SR mode is something potentially critical. First, because the train location is not known, it is not possible to grant a calculated distance up to the marker board supposed to be the final destination of the train. So, a fixed value can be only used. On one side, an infinite distance could allow the driver to move the train as much as needed, but with the risk to move the train possibly beyond the marker board. On the other side, a short "safe" distance would have relevant operational impacts; the driver should be obliged to ask for updated SR authorizations if the train hasn't completed yet its movement. The design choice, so far, is to use an infinite distance and to protect undue movements with the list of allowed balises and "Stop if in SR" packet inside the

	BG at the marker board. This design choice is done under the assumption that there is a method for the RBC to decide where the train could likely be located, even if not communicated through a PR.

7.5.7. UC_01_02_01_07 - Start of Mission – Management of virtual section status on berth/siding track

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	01 (Start of Mission)
UC ID	**UC_01_02_01_07**
Use Case	**Management of virtual section on berth/siding track**
Main actor	Train driver
Other actors	GSM-R network
Main goal	Description about how the virtual section within a berth track shall be managed.
Assumptions	• OBU active in nominal conditions; • ETCS and IXL trackside subsystems active and properly working; • Physical balise group installed on berth tracks and siding, close to each Virtual signal protecting the exit route; • Berth/siding track supposed to host nominal EoM/SoM scenarios are excluded from managing joining/splitting procedures or multiple trains parking;
Precondition	• Rolling stock located in station (sidings or berth track); • OBU in NP operating mode; • Input received from IXL good for MA transmission (e.g. exit route set&locked); • Valid position known by the OBU; • Train registered to the radio network; • Virtual section where the rolling stock is parked being in OCCUPIED status; • Train integrity available onboard;
Flow of events	1. Train driver performs the Start of Mission Procedure, inserting all the train data as needed; *Refer also to UC_01_02_01_01 - Positive train data validation* 2. OBU initiates the radio communication with RBC; 3. Train driver pushes “Start” button; 4. OBU provides a Position Report locating the train in a virtual section; 5. The status of virtual section remains OCCUPIED; 6. RBC checks with success the right conditions to issue an MA; 7. RBC issues an OS MA covering the first virtual section where the train is and

	an FS MA on any free virtual section, as long as possible based on the line condition and engineering rules adopted; 8. The driver moves the train supervising the MA; 9. The train leaves the berth/siding track reporting the train integrity confirmed; 10. The status of the virtual section covering the berth/siding track goes to FREE.
Postcondition	Train in supervised mode outside the berth/siding track.
Safety relation	This use case is safety relevant.
Open topics / consideration	*Remark:* *Given the assumptions listed in the relative section, an immediate FS MA would be technically possible. In fact, it is operationally supposed that no other vehicle can enter the virtual section where the train is. OS MA is anyway maintained for supporting the same operational management of the SoM procedure by the driver.* High Level Requirements R_01_02_01_07_01 The system shall mark as OCCUPIED a virtual section within a berth/siding track as soon as a train is localized inside it, assuming that it shall be operationally excluded that more than one rolling stock will be placed on such tracks apart from some predefined sections configured to allow joining/splitting. R_01_02_01_07_02 The system shall mark as FREE a virtual section within a berth/siding track as soon as a train reports to have safely left it with its confirmed rear end.

7.5.8. UC_01_02_01_08 - Start of Mission with valid position - Trackside provides a FS MA

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	01 (Start of Mission)
UC ID	**UC_01_02_01_08**
Use Case	**Start of Mission with valid position - Trackside provides a FS MA**
Main actor	ETCS On-board
Other actors	HL3/HTD Trackside Driver OTI-I OTI-L
Main goal	Describes the Start of Mission procedure when the position of the train is valid and the HL3/HTD Trackside is able to recover the Unknown area created at End of Mission and assign a FS MA to the ETCS on-board

Assumptions	The HL3/HTD Trackside can trust the information received from the On-board about the train integrity status (Q_INTEGRITY) and the confirming train length (L_TRAININT). There are no other trains in the VSS where the Train performs EoM and SoM. There are no expiring timers of other trains affecting the states of VSS where the considered train is located. The train is without confirmed train length. In this Use Case the assumption is that the Train Length validated by the Driver is SIL4.
Precondition	There is a train parked in a station with all desks closed. The ETCS On-board is in SB mode with no communication session but registered to a radio network. There is a part of track in the station with VSS status “Unknown” corresponding to the location where the train performed End of Mission. Train integrity available onboard. A desk is opened.
Flow of events	1. ETCS On-board initiates the Start of Mission procedure; the stored position and level are still valid. The Driver is requested to revalidate or change the Driver ID and is offered to revalidate or change Train Running Number. 2. ETCS On-board opens a communication session with the HL3/HTD Trackside and reports a valid position (with no train integrity information) in SB mode. 3. HL3/HTD Trackside receives the Start of Mission Position Report, accepts the train, evaluates the reported position. As no updated train length info is received, HL3/HTD Trackside does not update states of VSS, which will remain unknown. 4. Driver enters or (re-) validates the Train Data, including the Train Length. 5. ETCS On-board sends the Validated Train Data to the HL3/HTD Trackside, including a position report with no train integrity information. 6. L3 Trackside acknowledges the Validated Train Data. HL3/HTD Trackside uses received Train Length info to update state of VSS, checks that the train is located in the same area previously set as “unknown” and updates VSS to state “Ambiguous”. 7. ETCS On-board sends a position report with train integrity confirmed by external device (OTI-I). 8. HL3/HTD Trackside determines the Confirmed Rear End and updates the VSS state corresponding to the Train Location from “Ambiguous” to “Occupied” and set to “Free” the VSSs in rear of the train which became unknown due to the disconnect propagation timer (assuming that trackside is sure that the disconnect propagation timer was the only reason for Unknown). 9. Train sends an MA Request. 10. Trackside provides an FS MA to the train as there are some free VSSs in front of the train location.

	11. Train receives FS MA, starts moving and regularly reports its new position with integrity confirmed. 12. Train moves and when the TTD of the ambiguous VSS is free it set to “Free” this VSS where the SoM was performed. 13. Trackside regularly receives TPR with integrity confirmed. Trackside computes the new train location and changes the VSS in front of the train to from “Free” to “Occupied”, and the VSS of the old train location which are no longer part of the new train location from “Occupied” to “Free”.
Postcondition	Train is moving in FS after SoM and the status of the location where EoM was performed is now Free.
Safety relation	This use case is safety relevant
Open topics / consideration	

7.5.9. UC_01_02_01_09 - Start of Mission with invalid or unknown position – Departure with SR authorization

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	01 (Start of Mission)
UC ID	**UC_01_02_01_09**
Use Case	**Start of Mission with invalid or unknown position – Departure with SR authorization**
Main actor	ETCS On-board
Other actors	Driver HL3/HTD Trackside
Main goal	Describes the changes to the track status during the Start of Mission procedure when the position of the train is invalid or unknown
Assumptions	The L3 Trackside can trust the information received from the On-board about the train integrity status (Q_INTEGRITY) and the confirmed train length (L_TRAININT).
Precondition	There is a train parked in a station with all desks closed. The ETCS On-board is in SB mode with no communication session but registered to a radio network. There is a part of track in the station with VSS status Unknown corresponding to the location of the train after it performed End of Mission. Train integrity available onboard. A desk is opened.
Flow of events	1. ETCS On-board initiates the Start of Mission procedure; the stored position and level are invalid/unknown. The Driver is requested to revalidate or change the Driver ID and is offered to revalidate or change Train Running Number.

	2. ETCS On-board opens a communication session with the HL3/HTD Trackside and does not report a valid position (with no train integrity information) in SB mode. 3. HL3/HTD Trackside receives the Start of Mission Position Report, accepts the train, evaluates the reported position. There is no change to VSS states. 4. Driver enters or (re-) validates the Train Data, including the Train Length. 5. ETCS On-board sends the Validated Train Data to the HL3/HTD Trackside, including a position report with no train integrity information. 6. HL3/HTD Trackside acknowledges the Validated Train Data. The reported position is not yet valid. 7. ETCS On-board enables the START button on the DMI. 8. The ETCS On-board is in SB mode and communicating with the HL3/HTD Trackside; the VSS states remains Unknown after Start of Mission. From here, the train can be given an SR authorisation.
Postcondition	Train is ready to depart in SR when authorized to do so.
Safety relation	This use case is safety relevant
Open topics / consideration	

7.5.10. UC_01_02_01_10 - Start of Mission with invalid operating level inside L2 area

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	01 (Start of Mission)
UC ID	**UC_01_02_01_10**
Use Case	**Start of Mission with invalid operating level inside L2 area**
Main actor	ETCS On-board
Other actors	Driver HL3/HTD Trackside
Main goal	Description of the system behaviour in case a train executes a SoM with an operating level lower than L2.
Assumptions	• Train fitted with ETCS onboard unit; • OBU active in nominal conditions; • ETCS and IXL trackside subsystems active and in nominal conditions; • Balise group containing the packet “41: Level Transition Order” is installed at the border of the sidings/berth tracks, requesting an immediate transition to Level 2;
Precondition	• Rolling stock located in station (sidings or berth track), in SB mode if no CMD available; mode in NP only if CMD available;

	• Input received from IXL good for MA transmission (e.g. exit route set&locked); • Train registered to the radio network;
Flow of events	1. ETCS On-board initiates the Start of Mission procedure. The Driver for any reason changes the operating level to LNTC and performs a SoM in LNTC; 2. At the end of the SoM procedure, the driver selects “Start” button; 3. SN operating mode is proposed to the driver and it acknowledges the transition to SN; 4. The train starts moving in SN operating mode; 5. The train reads the balise containing the packet 41 and goes to Level 2; as it does not have any valid Movement Authority, it moves immediately to TR mode; 6. The train arrives to standstill and the driver acks the trip; 7. ETCS on-board goes to PT mode after driver’s acknowledgement.
Postcondition	Train is stopped.
Safety relation	This use case is safety relevant
Open topics / consideration	High Level Requirements R_01_02_01_10_01 The system shall stop the train in case of wrong selection of the operating level during a Start of Mission procedure executes inside the Level 2 area. *Remarks:* *The main goal of this scenario is to state that the signalling system must be robust against mistakes, likely performed by the driver, during the execution of Start of Mission inside the Level 2 area. The wrong selection of the operating mode is supposed to be one of the most probable events.*

7.6. Train Movement – nominal conditions

7.6.1. UC_01_02_02_01 - Train Position Management

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	02 (Train Movement – nominal conditions)
UC ID	**UC_01_02_02_01**
Use Case	**Train Position Management**
Main actor	Rolling stock
Other actors	Train Driver GSM-R network

Main goal	Description of the nominal management of the train position through Position Reports.
Assumptions	• OBU active in nominal conditions; • ETCS trackside subsystem active and properly working;
Precondition	• Train running along the track, following the MA available onboard; • OBU in a supervised operating mode (FS/OS); • Train integrity device active onboard; • Track-train radio link active;
Flow of events	1. OBU is configured for providing its position on a periodical base; 2. While running along the line, OBU provides to the ETCS trackside subsystem its position, calculated according its own internal algorithms and functionalities; 3. As soon as ETCS trackside receives the train position, it uses it for locating unambiguously the train on the track and for updating the related functionalities; 4. Among such functionalities, the updating of the status of the fixed virtual sections are included;
Postcondition	Same as the preconditions
Safety relation	This use case is safety relevant.
Open topics / consideration	High Level Requirements R_01_02_02_01_01 The system shall be able to locate unambiguously the train through the periodical position reported by the train. R_01_02_02_01_02 The system shall update the train front end and the train rear end when an updated position is received from the train.

7.6.2. UC_01_02_02_02 - Sending Virtual Sections status to IXL

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	02 (Train Movement – nominal conditions)
UC ID	**UC_01_02_02_02**
Use Case	**Sending Virtual Sections status to IXL**
Main actor	Rolling stock
Other actors	GSM-R network
Main goal	Description of the nominal management of the Virtual Sections status forwarded to IXL.
Assumptions	• OBU active in nominal conditions; • ETCS trackside subsystem active and properly working;

Precondition	• Train performing normal operations during its mission; • OBU in a normal active operating mode; • Train integrity device active onboard; • Track-train radio link active;
Flow of events	1. OBU, configured for providing its position on a periodical base, issues a periodical position report (first default frequency supposed to be every 5s); 2. Each position report includes the train integrity information, as calculated by TIMS and provided to ETCS onboard subsystem; 3. ETCS trackside subsystem elaborates the status of configured virtual section according to the position reports, the values of train integrity and the status of physical train detection devices, when present; 4. ETCS trackside subsystem forwards this information to IXL, which uses it for executing its functionalities;
Postcondition	Same as the preconditions.
Safety relation	This use case is safety relevant.
Open topics / consideration	High Level Requirements R_01_02_02_02_01 The ETCS subsystem shall forward the status of all virtual sections to IXL. R_01_02_02_02_02 The IXL subsystem shall use the status of virtual sections for implementing its functionalities requiring the knowledge of the freedom of the track.

7.6.3. UC_01_02_02_03 - Train with TIMS available onboard

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	02 (Train Movement – nominal conditions)
UC ID	**UC_01_02_02_03**
Use Case	**Train with TIMS available onboard**
Main actor	Rolling stock
Other actors	GSM-R network
Main goal	Description of the nominal behaviour of a train reporting train integrity confirmed.
Assumptions	• OBU active in nominal conditions; • TIMS active in nominal conditions, with train integrity updating frequency higher than Position Reports; • Radio communication system active in nominal conditions; • ETCS trackside subsystem active and properly working;
Precondition	• OBU in a supervised operating mode (FS/OS);

	• Train standstill on a berth track in a station, in front of a route set&locked (Marker board set to proceed); • OBU configured for providing its position periodically;
Flow of events	1. Train is allowed to move supervising the MA received from RBC; 2. While running along the route and later on the plain line, OBU provides to the ETCS trackside subsystem its position, calculated according its own internal algorithms and functionalities; this position report always includes train integrity confirmed; 3. As soon as ETCS subsystem receives the train position, it uses it for locating unambiguously the train on the track and for updating the related functionalities; 4. All the Virtual Sections, both in station and in plain line, on which the train run are declared first OCCUPIED when the max safe front end is detected within the VSS and later on FREE; 5. The train enters the next station, stopping itself on the berth track;
Postcondition	Same as the preconditions; All the Virtual Sections crossed by the train are calculated as FREE, except for the ones occupied by the train.
Safety relation	This use case is safety relevant.
Open topics / consideration	High Level Requirements R_01_02_02_03_01 The system shall be able to calculate the status of the virtual sections through the periodical position reported by the train and using the train integrity information contained within the position report.

7.6.4. UC_01_02_02_04 - Train with TIMS not available onboard

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	02 (Train Movement – nominal conditions)
UC ID	**UC_01_02_02_04**
Use Case	**Train with TIMS not available onboard**
Main actor	Rolling stock
Other actors	GSM-R network
Main goal	Description of the system behaviour in case of a train without TIMS or TIMS not active in plain line.
Assumptions	• OBU active in nominal conditions; • Radio communication system active in nominal conditions; • ETCS trackside subsystem active and properly working; • TIMS not available onboard; • Single line section marked by AxCo;

Precondition	• OBU in a supervised operating mode (FS/OS); • Train standstill on a berth track in a station, in front of a route set&locked (Marker board set to proceed); • OBU configured for providing its position periodically;
Flow of events	1. Train is allowed to move supervising the MA received from RBC; 2. While running along the route and later on the plain line, OBU provides to the ETCS trackside subsystem its position, calculated according its own internal algorithms and functionalities; all the position reports include train integrity not available information; 3. The ETCS subsystem marks the virtual section/s occupied by the train as not available; 4. The train enters the next station; 5. The axle counter section is detected as free; 6. All the Virtual Sections in plain line are marked as FREE, so ready to be occupied by a following train;
Postcondition	Same as the preconditions; All the Virtual Sections formerly crossed by the train in plain line are FREE.
Safety relation	This use case is safety relevant.
Open topics / consideration	Note: High Level Requirements R_01_02_02_04_01 The system shall be able to calculate the status of the virtual sections through the status of the physical train detection device, when available.

7.6.5. UC_01_02_02_05 - Train integrity loss in plain line reported by TIMS

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	02 (Train Movement – nominal conditions)
UC ID	**UC_01_02_02_05**
Use Case	**Train integrity loss in plain line**
Main actor	Rolling stock
Other actors	GSM-R network Train driver
Main goal	Description of the system behaviour in case a TIMS reports integrity lost information in plain line through Position Reports.
Assumptions	• OBU active in nominal conditions; • Radio communication system active in nominal conditions; • ETCS trackside subsystem active and properly working; • Train Integrity Management System (TIMS) active, configured for providing train integrity information on a periodical base to ETCS OB;

	• Period of Train integrity updating on TIMS lower than Position Reports period; • Single line section marked by AxCo;
Precondition	• OBU in a supervised operating mode (FS/OS); • Train standstill on a berth track in a station, in front of a route set&locked (Marker board set to proceed); • OBU configured for providing its position periodically; • TIMS active in degraded conditions;
Flow of events	1. Train is allowed to move supervising the MA received from RBC; 2. While running along the route and later on the plain line, OBU provides to the ETCS trackside subsystem its position, calculated according its own internal algorithms and functionalities; at least one of the position reports includes train integrity lost information; this could likely be due to TIMS faults; 3. The ETCS trackside subsystem uses the received position report for calculating the Max Safe Front End of the train, without updating the Confirmed Read End (CRE) which remains with the former value; 4. The ETCS trackside subsystem marks the virtual section/s occupied by the train as not available for following trains; 5. The train enters the next station; 6. The axle counter section is detected as free; 7. All the Virtual Sections in plain line are marked as FREE, so ready to by occupied by a following train;
Postcondition	Same as the preconditions; All the Virtual Sections formerly crossed by the train in plain line are FREE.
Safety relation	This use case is safety relevant.
Open topics / consideration	Note: High Level Requirements Same as scenario UC_01_02_02_04 - Train with TIMS not available.

7.6.6. UC_01_02_02_06 - Balise Group detection

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	02 (Train Movement – nominal conditions)
UC ID	**UC_01_02_02_06**
Use Case	**Balise Group detection**
Main actor	Rolling stock
Other actors	GSM-R network

Main goal	Description of the nominal management of the train position through Position Reports in case of balise group detection.
Assumptions	• OBU active in nominal conditions; • ETCS trackside subsystem active and properly working; • Balise group composed of 2 redundant balises;
Precondition	• Train running along the track, either in supervised or not supervised movement (not relevant for the validity of the scenario); • Train integrity device (TIMS) active onboard; • Track-train radio link active; • Train configured through a Position Report Parameters packet to report Position Reports on a periodical base;
Flow of events	1. While running along the line, a relocation balise group is correctly detected by the OBU; 2. OBU elaborates its position referred to such BG, together with the train integrity information received from the TIMS; 3. OBU provides to the ETCS trackside subsystem its position through the position report having the train integrity information confirmed by device; 4. As soon as ETCS subsystem receives the train position, it uses it for locating unambiguously the train on the track and for updating the related functionalities; 5. Among such functionalities, the updating of the status of the fixed virtual sections are included, based on the value of the train integrity;
Postcondition	Same as the preconditions
Safety relation	This use case is safety relevant.
Open topics / consideration	R_01_02_02_06_01 The system shall be able to locate the train using the relative distance from the LRBG (Last Relevant Balise Group).

7.7. Completion of the mission

7.7.1. UC_01_02_03_01 - Arrival at buffer stop

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	03 (Completion of the mission)
UC ID	**UC_01_02_03_01**
Use Case	**Arrival at buffer stop**
Main actor	Train Driver
Other actors	GSM-R network
Main goal	Description of the nominal approach of the train to a buffer stop in the station.

Assumptions	• OBU active in nominal conditions; • ETCS trackside subsystem active and properly working;
Precondition	• Train running along the track, supervising the MA available onboard; • MA having EoA at the Marker Board close to the buffer stop, with fixed release speed; SvL being at the buffer stop location; • OBU in a supervised operating mode (FS/OS); • Track-train radio link active;
Flow of events	1. Train enters the route ending on the buffer stop; 2. When the train front is approaching the buffer stop, the driver shall drive the train supervising the ceiling speed done by the fixed release speed included in the MA; 3. The train driver stops the train when the train front is aligned to the Marker Board at the buffer stop location.
Postcondition	Train stopped with the front aligned with the Marker Board at the buffer stop.
Safety relation	This use case is safety relevant.
Open topics / consideration	This Use Case is relevant for emphasizing the need to support, through a proper configuration of trackside subsystems, the approach of a train to a buffer stop in order to improve the performances and to minimize the risk of weak route release process. High Level Requirements R_01_02_03_01_01 The system shall issue MA ending on a buffer stop (including terminal stations) so that the train is allowed to stop close to the Marker Board at the buffer stop. *Note: It will likely require the adoption of a fixed release speed.*

7.7.2. UC_01_02_03_02 - Arrival at berth track occupied by a stationary train

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	03 (Completion of the mission)
UC ID	**UC_01_02_03_02**
Use Case	**Arrival at berth track occupied by a stationary train – train joining**
Main actor	Train Driver
Other actors	GSM-R network
Main goal	Description of the approach of the train to berth track occupied by a stationary train.
Assumptions	• OBU of the train entering the station active in nominal conditions; • ETCS trackside subsystem active and properly working;

	• Berth track composed (at least) of 2 virtual sections, one of them being occupied by the stationary train; • The berth track is long enough for hosting 2 trains;
Precondition	• Stationary train located inside a berth track; • Second train in a supervised operating mode (FS/OS), running along the track, approaching the station; • Track-train radio link of both trains active;
Flow of events	1. Trackside operator set the special entry route; 2. The system extends the FS MA covering the entire route except for the virtual section occupied by the stationary train, which is occupied; 3. No MA is extended on the occupied virtual section; 4. Train driver is authorized by the signaller to enter the virtual section; 5. Train moves to SR after Override EoA and enters the route, proceeding in SR mode, approaching the stationary train; 6. The train stops upstream the stationary train;
Postcondition	Two trains stopped within one virtual section.
Safety relation	This use case is safety relevant.
Open topics / consideration	This Use Case is relevant for showing that the procedure for approaching a stationary train by another train can be managed also if no train detection device is present on a berth track. R_01_02_03_02_01 The system shall be able to set a route even if it ends on the berth track occupied by a stationary train. R_01_02_03_02_02 In case of a route ending on a occupied berth track, the system shall be able to issue an MA in FS up to occupied virtual section, if all other signalling conditions are verified. Same as scenario UC_01_02_09_01 - Joining of a train on a berth track

7.7.3. UC_01_02_03_03 - Arrival at virtual signal at danger (berth track/siding)

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	03 (Completion of the mission)
UC ID	**UC_01_02_03_03**
Use Case	**Arrival at virtual signal at danger (berth track/siding)**
Main actor	Train Driver
Other actors	GSM-R network

Main goal	Description of the nominal approach of the train to a virtual signal at danger in station.
Assumptions	• OBU active in nominal conditions; • ETCS trackside subsystem active and properly working;
Precondition	• Train running along the track, supervising the MA available onboard; • MA having EoA at the Marker Board at the end of an entry route which is set to danger (e.g. because no departing route is set&locked); • Virtual Section beyond the entry route detected as FREE; • MA including an Overlap covering the Virtual Section with release speed calculated onboard; • OBU in a supervised operating mode (FS/OS); • Track-train radio link active;
Flow of events	1. Train enters the route; 2. When the train front is approaching the EoA, the driver shall drive the train supervising the braking curve and the ceiling speed calculated by onboard subsystem based on overlap dimension; 3. The release speed allows the driver to approach at max the Marker Board; 4. The train driver stops the train when the train front is aligned to the Marker Board at the end of the route.
Postcondition	Train stopped with the front aligned with the Marker Board at the end of the route.
Safety relation	This use case is safety relevant.
Open topics / consideration	This Use Case is relevant for emphasizing the need to support, through a proper configuration of trackside subsystems, the approach of a train to an EoA on a berth track or siding, in order to improve the performances and to minimize the risk of weak route release process. High Level Requirements R_01_02_03_03_01 The system shall issue MA ending on a Marker Board at the end of an entry route so that the train is allowed to stop close to this Marker Board. *Note: It will likely require the adoption of a release speed linked to an overlap included inside the MA.*

7.7.4. UC_01_02_03_04 - Arrival at virtual signal at proceed (operational stop)

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)

Use Case function	03 (Completion of the mission)
UC ID	**UC_01_02_03_04**
Use Case	**Arrival at virtual signal at proceed (operational stop)**
Main actor	Train Driver
Other actors	GSM-R network
Main goal	Description of the nominal approach of the train to a virtual signal at proceed in plain line.
Assumptions	• OBU active in nominal conditions; • ETCS trackside subsystem active and properly working;
Precondition	• Train running along the track, exiting from a station and supervising the MA available onboard; • OBU in a supervised operating mode (FS/OS); • Track-train radio link active;
Flow of events	1. Train enters the plain line; 2. Train supervises the MA having the EoA at the marker board placed in plain line for marking the train stop; 3. Train stops at the platform for the dwell time; 4. The MA is extended automatically beyond the marker board according to the IXL conditions as soon as the train is detected as standstill close to the platform; 5. Train resumes the movement towards the next station.
Postcondition	Train running toward the entry signal of the following station.
Safety relation	This use case is safety relevant.
Open topics / consideration	High Level Requirements R_01_02_03_04_01 The system shall be able to manage the train stopping in plain line, due to operational needs, even if the marker board is set to proceed. *Remark:* *The scope of this UC is to make a focus on one typical operational need of a passenger service in a Regional Line, that is to perform a train stop/start on a passengers stop, but configured inside the plain line (so not managed by entry/exit route like in a station). In such operational scenario, the Marker Board installed at the end of the platform has just ergonomic scope for supporting the driver in his approach towards the final correct stopping place. The analysis of this scenario will help in clarifying is additional operational rules or signalling functions will be deemed necessary for the best management.*

7.7.5. UC_01_02_03_05 – End of Mission

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	03 (Completion of the mission)
UC ID	**UC_01_02_03_05**
Use Case	**End of Mission**
Main actor	Train Driver
Other actors	GSM-R network
Main goal	Description of the nominal EoM procedure and its impact on virtual section status.
Assumptions	• OBU active in nominal conditions; • ETCS trackside subsystem active and properly working;
Precondition	• Train standstill on a berth track/siding inside a station; • OBU in a supervised operating mode (FS/OS); • MA having EoA at the Marker Board at the end of the entry route; • Track-train radio link active;
Flow of events	1. Train driver performs EoM procedure (disabling the leading cabin); 2. OBU is disconnected from ETCS subsystem; 3. As soon as ETCS subsystem detects the radio disconnection, it updates the status of the virtual section where the train was localized in order not to be available for a following train moving on the virtual section in a full supervised mode;
Postcondition	Train located on the berth track/siding, not connected with ETCS trackside subsystem.
Safety relation	This use case is safety relevant.
Open topics / consideration	High Level Requirements R_01_02_03_05_01 The system shall consider as not available for a full supervised movement any virtual section where a train performs an EoM.

7.7.6. UC_01_02_03_06 - Arrival at berth track occupied by a stationary train – train parking

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	03 (Completion of the mission)
UC ID	**UC_01_02_03_06**
Use Case	**Arrival at berth track occupied by a stationary train – train parking**
Main actor	Train Driver
Other actors	GSM-R network

Main goal	Description of the approach of the train to berth track occupied by a stationary train.
Assumptions	• OBU of the train entering the station active in nominal conditions; • ETCS trackside subsystem active and properly working;
Precondition	• Stationary train located inside a berth track; • Berth track composed (at least) of 2 virtual sections, one of them being occupied by the stationary train; • Second train in a supervised operating mode (FS/OS), running along the track, approaching the station; • Track-train radio link active (surely the second train);
Flow of events	1. Trackside operator set the special entry route; 2. The system extends the FS MA covering the entire route except for the virtual section occupied by the stationary train, which is occupied; no MA issued to the second train covers this virtual section; 3. Train enters the route, proceeding in FS mode; 4. Train enters the virtual section upstream the one occupied by the stationary train; 5. Driver of the second train stops the train at a marker board in rear of the beginning of the occupied virtual section, being the train still in FS; 6. Driver performs EoM;
Postcondition	Two trains stopped inside two adjacent virtual sections.
Safety relation	This use case is safety relevant.
Open topics / consideration	This Use Case is relevant for showing that the procedure for parking a second train inside a berth track already occupied by a stationary train can be managed also if no train detection device is present on a berth track.

7.7.7. UC_01_02_03_07 - Change of train orientation (nominal)

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	03 (Completion of the mission)
UC ID	**UC_01_02_03_07**
Use Case	**Change of train orientation (nominal)**
Main actor	Train Driver
Other actors	GSM-R network
Main goal	Description of the operation of change of cabin of a regional train for supporting its movement in the opposite direction of travel. Case of nominal and optimized behaviour.
Assumptions	• One EVC installed on a Regional Train, with two cabins per train; • OBU of the train active in nominal conditions; • ETCS trackside subsystem active and properly working;

Precondition	• Track-train radio link active; • Cabin #A supposed to be the leading cabin when train enters the station;
Flow of events	1. Train enters the station and goes to standstill on the berth track, being in FS mode; 2. The Driver performs End of Mission on Cabin #A; 3. OBU terminates the radio communication with RBC and goes to SB operating mode; 4. Due to the EoM, ETCS trackside subsystem activates a mechanism for checking that the berth track is not violated, for a given period of time; 5. The Signaller set an exit route from the berth track; the marker board protecting this route goes to proceed; 6. The Driver moves to the opposite cabin of the train; 7. The Drivers performs a Start of Mission procedure; 8. The OBU establishes a new radio communication with RBC, reporting a valid known position; 9. The Driver presses the START button for requesting a new MA; 10. ETCS trackside subsystem issues an FS MA under the condition that the berth track is detected as not violated yet and the timer is not expired yet; 11. The train starts moving supervising the MA received;
Postcondition	Train in FS operating mode moving along the exit route.
Safety relation	This use case is safety relevant.
Open topics / consideration	This Use Case has been described considering a single train with one EVC. It is indeed relevant and applicable also for trains in double composition, under the assumption that the EVC of the rear train is in SL operating mode. R_01_02_03_07_01 The system shall be able to detect a possible violation of the virtual section of the berth track after a train performs an EoM in FS on it. R_01_02_03_07_02 The system shall be able to grant again an MA in FS for a train performing a SoM on a berth track within a predefined timer from the EoM in FS, if the berth track has not been detected as violated in the meantime.

7.7.8. UC_01_02_03_08 - Change of train orientation (degraded)

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	03 (Completion of the mission)
UC ID	**UC_01_02_03_08**
Use Case	**Change of train orientation (degraded)**
Main actor	Train Driver
Other actors	GSM-R network

Main goal	Description of the operation of change of cabin of a regional train for supporting its movement in the opposite direction of travel. Case of degraded not optimized behaviour.
Assumptions	• One EVC installed on a Regional Train, with two cabins per train; • OBU of the train active in nominal conditions; • ETCS trackside subsystem active and properly working;
Precondition	• Track-train radio link active; • Cabin #A supposed to be the leading cabin when train enters the station;
Flow of events	1. Train enters the station and goes to standstill on the berth track; 2. The Driver performs End of Mission on Cabin #A; 3. OBU terminates the radio communication with RBC and goes to SB operating mode; 4. Due to the EoM, ETCS trackside subsystem activates a mechanism for checking that the berth track is not violated, for a given period of time; 5. The Signaller set an exit route from the berth track; the marker board protecting this route goes to proceed; 6. The ETCS trackside subsystem detects a violation of the berth track; as an example, the transition from FREE to not FREE of the virtual sections adjacent to the berth track is detected; 7. The Driver moves to the opposite cabin of the train; 8. The Drivers performs a Start of Mission procedure; 9. The OBU establishes a new radio communication with RBC, reporting a valid known position; 10. The Driver presses the START button for requesting a new MA; 11. ETCS trackside subsystem issues an OS MA, due to the violation of the berth track protection status [*]; 12. The train starts moving supervising the OS MA received;
Postcondition	Train in OS operating mode moving along the exit route.
Safety relation	This use case is safety relevant.
Open topics / consideration	[*] The expiration of the timer can be considered an equivalent case like the violation of the berth track perimeter. Another equivalent case is when the train performs a SoM procedure with invalid position, for whatever reason. This Use Case has been described considering a single train with one EVC. It is relevant and applicable indeed also for trains in double composition, under the assumption that the EVC of the rear train is in SL operating mode. R_01_02_03_08_01 The system shall issue an MA in OS for a train performing a SoM on a berth track, if the berth track has been detected as violated in the time elapsed between EoM and SoM.

7.8. Train movement – Degraded operational conditions

7.8.1. UC_01_02_04_01 – Entering a station with virtual sections occupied by a stranded train

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	04 (Train movement – Degraded operational conditions)
UC ID	**UC_01_02_04_01**
Use Case	**Entering a station with virtual sections occupied by a stranded train**
Main actor	Train Driver
Other actors	EVC, Signaller
Main goal	The goal of this operational scenario is to describe the expected system behaviour in case of entry route setting containing one or more virtual sections occupied by a stranded train, ideally for recovering this train. In such case no supervised movement shall be possible and only a SR movement can be managed through the use by the driver of the Override function. This UC aims at describing the application of this function in such specific case.
Assumptions	• OBU active in nominal conditions; • ETCS trackside subsystem active and properly working; • The driver is not allowed to use the “Override” procedure unless authorised by trackside personnel (signaller). This authorisation is covered by operational procedures and it is usually performed via written orders;
Precondition	• OBU in a supervised operating mode (e.g. FS); • MA having EoA at the Marker Board protecting the entry route; • EoA is due to the entry route setting and locking not possible because of one or more virtual sections set to OCCUPIED; • Track-train radio link active; • The operational procedure for authorizing the driver to use the Override function can be executed; • All the correct conditions for allowing the driver to select “Override” are correctly verified;
Flow of events	1. The train arrives close to the Marker Board protecting the entry route, reaching the standstill position because of the EoA; 2. Signaller gives the written order to the driver to select “Override”; 3. Train driver selects "override"; 4. OBU enters SR operating mode; 5. The train moves and overpasses its End of Movement Authority; 6. The train moves along the entry route, possibly up to the occupied virtual sections.

Postcondition	Train moving in SR (using National Values about speed and distance) inside the route.
Safety relation	The function of Movement in SR is safety relevant as part of ERTMS/ETCS system running on a degraded situation.
Open topics / consideration	• By using this procedure, the driver is fully responsible for the train driving while in SR mode; • The ERTMS/ETCS on-board equipment supervises a ceiling speed, a SR distance if finite, a maximum time and, if available, a list of balises. • Any operational procedure for recovering the stranded train is out of the scope of this Use Case. R_01_02_04_01_01 The system shall inhibit the setting of a route in station if at least one virtual section required by the signalling condition is set to OCCUPIED. Same as scenario UC_01_02_04_04 – Overriding a virtual signal set to danger.

7.8.2. UC_01_02_04_02 – Movement on virtual sections in plain line not free

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	04 (Train movement – Degraded operational conditions)
UC ID	**UC_01_02_04_02**
Use Case	**Movement on virtual sections in plain line not free**
Main actor	Train Driver
Other actors	EVC
Main goal	The goal of this operational scenario is to describe the system expected behaviour in case of a train entering in a line block section where at least one virtual section has a status different from FREE and OCCUPIED.
Assumptions	• OBU active in nominal conditions; • ETCS trackside subsystem active and properly working; • Train integrity device active and working onboard.
Precondition	• OBU in a supervised operating mode (e.g. FS); • MA having EoA at the Marker Board protecting the line block section with degraded virtual section; • EoA is due to the degraded of at least one virtual section (included inside the line section) being not free; • Track-train radio link active;
Flow of events	1. The train approaches the Marker Board protecting the degraded line section;

	2. When the train is localized close to the marker board, the ETCS trackside subsystem extends the MA on the degraded line section, covering it with an OS mode profile; 3. The transition to OS operating mode is proposed on DMI; 4. Driver acks transition to OS operating mode and OBU enters OS operating mode; 5. The driver moves the train supervising the speed associated to the OS mode profile; 6. As soon as the ETCS trackside subsystem receives the position report locating the train beyond each virtual section in the section (if more than one) with its established rear end, it marks such virtual section as free; 7. The train front exit from the OS mode profile and OBU goes automatically to FS; 8. The train leaves completely all the line block section with its safe rear end; 9. The line section is declared as FREE because all the virtual sections included are set to FREE;
Postcondition	Train in FS mode located entirely on the line section beyond the degraded one.
Safety relation	This use case is safety relevant.
Open topics / consideration	This Use Case has been developed imaging a preliminary approach of the train to the section not free. It is assumed to be acceptable indeed that the train receives the MA extension covering the degraded section even if it is still approaching the marker board, With equivalent operational conditions. R_01_02_04_02_01 The system shall be able to grant an MA in OS on a line virtual section whose state is neither FREE nor OCCUPIED. R_01_02_04_02_02 The system shall be able to upgrade the status of a virtual section in line to FREE once a train, after having crossed it with train integrity confirmed, reports with its safe rear end beyond the virtual section.

7.8.3. UC_01_02_04_03 – Making free a virtual section not free

Note: Use Case non developed because it is considered logically duplicated of UC_01_02_04_03.

7.8.4. UC_01_02_04_04 – Overriding a virtual signal set to danger

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	04 (Train movement – Degraded operational conditions)
UC ID	**UC_01_02_04_04**
Use Case	**Overriding a virtual signal set to danger (Staff Responsible with Override)**

Main actor	Train Driver
Other actors	EVC, Signaller
Main goal	In specific degraded situations (for example in the case of a failed signal, failed track circuit, failed point…), the train is forced to stop in front of the virtual signal protecting the failed section being its End of Authority. The system allows a train to pass the EoA, through the use by the driver of the Override function to enter SR mode. This UC aims at describing the application of this function in a specific case.
Assumptions	• OBU active in nominal conditions; • ETCS trackside subsystem active and properly working; • The driver is not allowed to use the “Override” procedure unless authorised by trackside personnel (signaller). This authorisation is covered by operational procedures and it is usually performed via written orders;
Precondition	• Train standstill on a berth track/siding inside a station; • OBU in a supervised operating mode (FS/OS); • MA having EoA at the Marker Board at the end of the entry route; • EoA is due to a trackside fault beyond the virtual signal protecting the route; • Track-train radio link active; • The operational procedure for authorizing the driver to use the Override function can be executed; • All the correct conditions for allowing the driver to select “Override” are verified (train speed is under or equal to the speed limit for triggering the “override” function (national value), current mode is FS, LS, OS, validated Train Data and Train running number are available);
Flow of events	7. The signaller gives the written order to the driver to select “Override”; 8. Train driver selects "override"; 9. SR mode is entered; 10. The train moves and overpasses its End of Movement Authority;
Postcondition	Train moving in SR (using National Values about speed and distance) inside the route.
Safety relation	The function of Movement in SR is safety relevant as part of ERTMS/ETCS system running on a degraded situation.
Open topics / consideration	By using this procedure, the driver is fully responsible for the train driving while in SR mode; The ERTMS/ETCS on-board equipment supervises a ceiling speed, a SR distance if finite, a maximum time and, if available, a list of balises. R_01_02_04_04_01 The SR authorisation to cross a Marker Board must be authorised by trackside personnel with dedicated operational procedures.

7.8.5. UC_01_02_04_05 – Cooperative revocation of MA

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	04 (Train movement – Degraded operational conditions)
UC ID	**UC_01_02_04_05**
Use Case	**Cooperative revocation of MA**
Main actor	Train Driver
Other actors	EVC, Signaller
Main goal	In specific operational conditions (for example in case of a route release or emergency detection) it is requested to stop the train in a "controlled" way on some specific locations. The scope of this Use Case is to describe such operation and to detect any impact on virtual sectioning functions due to the application of the Cooperative MA shortening command.
Assumptions	• OBU active in nominal conditions; • ETCS trackside subsystem active and properly working;
Precondition	• Train running in plain line; • OBU in a supervised operating mode (FS/OS); • MA having EoA at the Marker Board at the end of the entry route; • Track-train radio link active;
Flow of events	1. The signaller executes the command "Route Release" for the entry route; 2. ETCS trackside subsystem issues a Cooperative MA shortening to the train at the marker board protecting the entry route; 3. ETCS trackside subsystem issues an MA shortening to the train at the marker board protecting the entry route; 4. OBU checks the acceptability of the Cooperative MA shortening and grants it; 5. OBU starts supervising the new EoA, applying the braking if needed; 6. The acceptance of the Cooperative MA shortening is used for allowing the complete route release.
Postcondition	Train stopped in front of the marker board protecting the entry route.
Safety relation	This use case is safety relevant
Open topics / consideration	R_01_02_04_05_01 When the release of a route included in a Movement Authority is commanded, the system shall issue a Cooperative MA shortening request followed by an updated Shortened MA to the train. R_01_02_04_05_02 The grant of the Cooperative MA shortening request shall allow the complete route release.

7.8.6. UC_01_02_04_06 – Temporary Train integrity loss in plain line

Use Case Group	01 (WP3)

Use Case family	02 (Task 3.2)
Use Case function	04 (Train movement – Degraded operational conditions)
UC ID	**UC_01_02_04_06**
Use Case	**Temporary Train integrity loss in plain line**
Main actor	Train Driver
Other actors	EVC, Signaller
Main goal	This UC aims at describing how the system has to recover to the nominal operational conditions after a temporary loss of integrity by a train running in plain line.
Assumptions	• OBU active in nominal conditions; • ETCS trackside subsystem active and properly working; • Train integrity device active onboard;
Precondition	• Train running in plain line with a supervised movement; • OBU in a supervised operating mode (FS/OS); • Track-train radio link active;
Flow of events	1. Train integrity device reports “Train integrity lost to EVC”; 2. EVC reports “train integrity lost” to RBC within the position report; 3. The ETCS trackside system marks the virtual section/s underneath the train as not available for full supervised movement by a following train; 4. After few seconds the train integrity is restored onboard and communicated to the ETCS trackside subsystem (with the same length than before the integrity loss); 5. The ETCS trackside system recovers the status of the virtual section/s to be available for full supervised movements; 6. Train enters the next station, leaving the line section ready for another train.
Postcondition	Train standstill on a berth track inside a station.
Safety relation	This use case is safety relevant.
Open topics / consideration	• The train integrity loss is supposed in this scenario to be temporary, maybe because not really due to a train break but due to a technical issue;

7.8.7. UC_01_02_04_07 – Permanent Train integrity loss in plain line

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	04 (Train movement – Degraded operational conditions)
UC ID	**UC_01_02_04_07**
Use Case	**Permanent Train integrity lost in plain line**
Main actor	Train Driver
Other actors	EVC, Signaller

Main goal	This UC aims at describing how the system has to recover to the nominal operational conditions after a permanent loss of integrity by a train running in plain line.
Assumptions	• OBU active in nominal conditions; • ETCS trackside subsystem active and properly working; • Train integrity device active onboard;
Precondition	• Train running in plain line with a supervised movement; • OBU in a supervised operating mode (FS/OS); • Track-train radio link active;
Flow of events	1. Train integrity device reports “Train integrity lost to EVC”; 2. EVC reports “train integrity lost” to RBC within the position report; 3. The ETCS trackside system marks the virtual section/s underneath the train as not available for full supervised movement by a following train; 4. Due to the loss of integrity, the train starts braking while still moving; 5. Any virtual section occupied by the train while braking is declared as not available for full supervised movements by following trains; 6. Train stops still reporting train integrity lost; 7. A specific procedure is now necessary for recovering the broken train from the plain line and so making it available for full supervised movements;
Postcondition	Train (broken) standstill on in plain line.
Safety relation	This use case is safety relevant.
Open topics / consideration	

7.8.8. UC_01_02_04_08 – Entering a station with virtual sections not free

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	04 (Train movement – Degraded operational conditions)
UC ID	**UC_01_02_04_08**
Use Case	**Entering a station with virtual sections not free**
Main actor	Train Driver
Other actors	EVC, Signaller
Main goal	The goal of this operational scenario is to describe the system expected behaviour in case of a train entering in an entry route containing one or more virtual sections whose status is different from FREE, OCCUPIED and AMBIGUOUS.
Assumptions	• OBU active in nominal conditions; • ETCS trackside subsystem active and properly working; • Train integrity device active and working onboard.
Precondition	• OBU in a supervised operating mode (e.g. FS);

	• MA having EoA at the Marker Board protecting the entry route; • EoA is due to the entry route setting and locking in nominal mode not possible because of one or more virtual sections set being not free; • Track-train radio link active;
Flow of events	1. The train approaches the Marker Board protecting the entry route, reaching the standstill position because of the EoA on such Marker Board; 2. Signaller executes command for enabling the route locking in "call-on" (Degrado 1°L in Italian); 3. ETCS trackside subsystem extends the MA to the train up to the end of the entry route, containing an OS mode profile covering the entire entry route; 4. Driver acks transition to OS operating mode; 5. OBU enters OS operating mode; 6. The train moves along the entry route in OS; 7. As soon as the ETCS trackside subsystem receives the position report locating the train beyond each virtual section (if more than one) with its established rear end, it marks such virtual section as free;
Postcondition	Train standstill in OS mode on the berth track at the end of the entry route.
Safety relation	This use case is safety relevant.
Open topics / consideration	

7.8.9. UC_01_02_04_09 – Train integrity temporarily unavailable in plain line

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	04 (Train movement – Degraded operational conditions)
UC ID	**UC_01_02_04_09**
Use Case	**Train integrity temporarily not available in plain line**
Main actor	Train Driver
Other actors	EVC, Signaller
Main goal	This UC aims at describing how the system has to recover to the nominal operational conditions after a temporary absence of integrity information by a train running in plain line.
Assumptions	• OBU active in nominal conditions; • ETCS trackside subsystem active and properly working; • Train integrity device active onboard;
Precondition	• Train running in plain line with a supervised movement; • OBU in a supervised operating mode (FS/OS); • Track-train radio link active;
Flow of events	1. Train integrity device reports "no train integrity information available" to EVC;

	2. EVC reports “no train integrity information available” to RBC within the position report; 3. The ETCS trackside system marks the virtual section/s underneath the train as not available for full supervised movement by a following train while keeping the former ones occupied, since the position of the tail of the train cannot be updated; 4. After a few seconds, before the expiration of the integrity timer , the train integrity is available onboard without a train length change and communicated to the ETCS trackside subsystem; 5. The ETCS trackside system uses the new position of the tail of the train to update the status of the virtual section/s to be available for full supervised movements; 6. Train enters the next station, leaving the line section ready for another train.
Postcondition	Train standstill on a berth track inside a station.
Safety relation	This use case is safety relevant.
Open topics / consideration	• The train integrity lack of integrity information can be either not available from the train integrity device or due to the train integrity device not being available;

7.8.10. UC_01_02_04_10 – Loss of Train Integrity during Normal Movement

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	04 (Train movement – Degraded operational conditions)
UC ID	**UC_01_02_04_10**
Use Case	**Loss of Train Integrity during Normal Movement**
Main actor	ETCS On-board
Other actors	HL3/HTD Trackside
Main goal	Recovering Normal Movement of train after loss of train Integrity during Normal Movement
Assumptions	The HL3/HTD Trackside can trust the information received from the On-board about the train integrity status (Q_LENGTH) and the confirmed train length (L_TRAININT). It is assumed that HL3/HTD Trackside is configured to keep on sending MAs to the trains having reported the Loss of Train Integrity. The train is not actually broken but the integrity loss is a failure of the OTI.
Precondition	Train running in Normal Movement
Flow of events	1. Train running in Normal Movement. The HL3/HTD Trackside updates the Train Location with position reports.

	2. Train reports loss of integrity (PR with "Train integrity lost"). The HL3/HTD Trackside updates the Front of the Train Location but does not update the CRE and changes the Track Status Area associated with the train to "Unknown" and "Sweepable". 3. Train continues moving. The ETCS On-board continues sending position reports without integrity confirmed. The HL3/HTD Trackside updates the Max Safe Front End and the "Unknown" Track Status Area is updated. 4. Before the wait integrity timer expires, Train reports train integrity confirmed. The ETCS On-board sends a position report with train integrity confirmed. The HL3/HTD Trackside updates the Train Location of the train, updates Track Status, changes Track Status Area from Unknown to Occupied and re-starts the Integrity Wait timer.
Postcondition	Train running in Normal Movement
Safety relation	This use case is safety relevant
Open topics / consideration	Note that if the train reports "No train integrity information" for some time but without the Integrity Wait timer expiring, there is no reaction from the HL3/HTD Trackside.

7.8.11. UC_01_02_04_11 – EoM after Loss of Train Integrity

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	04 (Train movement – Degraded operational conditions)
UC ID	**UC_01_02_04_11**
Use Case	**EoM after Loss of Train Integrity**
Main actor	ETCS On-board
Other actors	HL3/HTD Trackside Driver
Main goal	Manage the EoM of train after loss of Train Integrity
Assumptions	The L3 Trackside can trust the information received from the On-board about the train integrity status (Q_LENGTH) and the confirmed train length (L_TRAININT). It is assumed that HL3/HTD Trackside is configured to keep on sending MAs to the trains.
Precondition	Train running in Normal Movement
Flow of events	1. Train running in Normal Movement. The HL3/HTD Trackside updates the Train Location with position reports. 2. Train reports loss of integrity (PR with "Train integrity lost"). The HL3/HTD Trackside updates the Front of the Train Location but does not update the CRE and changes the Track Status Area associated with the train to Unknown and Sweepable. 3. Train continues moving. The ETCS On-board continues sending position reports without integrity confirmed. The HL3/HTD Trackside updates the Max Safe Front End and the Unknown Track Status Area is updated.

	4. The train continues moving and stops near the EoA. The ETCS On-board sends a position report with train integrity lost. The HL3/HTD Trackside updates the Train Location, updates the Unknown Track Status Area accordingly but keeps the CRE. 5. The train performs EoM. The Driver closes the desk and ETCS On-board terminates the communication session with the HL3/HTD Trackside.
Postcondition	The ETCS On-board is in SB mode and no longer communicates with the HL3/HTD Trackside.
Safety relation	This use case is safety relevant
Open topics / consideration	For system types without TTD, the points area will have to be swept to enable other trains to pass without restrictions. In case the train later on performs a SoM and is able to confirm integrity and accounts for the train length associated with the Unknown Area, then the HL3/HTD Trackside can update that Track Status Area in accordance with the established Train Location and change it to Occupied.

7.8.12. UC_01_02_04_12 – Train does not confirm Integrity – Wait Integrity timer expires

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	04 (Train movement – Degraded operational conditions)
UC ID	**UC_01_02_04_12**
Use Case	**Train does not confirm Integrity – Wait Integrity timer expires**
Main actor	ETCS On-board
Other actors	HL3/HTD Trackside
Main goal	ID of the UC main goal: G_UC_06_03 Manage the expiration of Integrity wait timer without Integrity confirmation from train.
Assumptions	The HL3/HTD Trackside can trust the information received from the On-board about the train integrity status (Q_LENGTH) and the confirmed train length (L_TRAININT). It is assumed that HL3/HTD Trackside is configured to keep on sending MAs to the trains.
Precondition	Train running in Normal Movement
Flow of events	1. Train running in Normal Movement. The HL3/HTD Trackside updates the Train Location with position reports. 2. Train reports “No train integrity information” while moving. The HL3/HTD Trackside updates the front of the Train Location and updates the Unknown Track Status Area. The rear of the train remains at the same location. 3. The train reports “No train integrity information” for longer than the Integrity wait timer. The HL3/HTD Trackside detects that the Integrity wait timer has expired and considers the train integrity as lost. HL3/HTD Trackside

	changes the Track Status Area associated with the train to Unknown and Sweepable 4. The train continues moving and stops near the EoA. The HL3/HTD Trackside updates the Front of the Train Location and updates the Unknown Track Status Area. The rear of the train remains at the same location. 5. The train reports train integrity confirmed. The HL3/HTD Trackside updates the Train Location, updates the Track Status Area changes the Track Status Area associated to the train to Occupied.
Postcondition	Train running in Normal Movement
Safety relation	This use case is safety relevant
Open topics / consideration	

7.8.13. UC_01_02_04_13 – End of Mission with train integrity confirmed after standstill

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	04 (Train movement – Degraded operational conditions)
UC ID	**UC_01_02_04_13**
Use Case	**End of Mission with train integrity confirmed after standstill**
Main actor	ETCS On-board
Other actors	HL3/HTD Trackside Driver
Main goal	Describes what happens to the track status at End of Mission when Train Integrity has been confirmed after the train has reached standstill.
Assumptions	The HL3/HTD Trackside can trust the information received from the On-board about the train integrity status (Q_INTEGRITY) and the confirmed train length (L_TRAININT). The state of all VSSs covered by the train location is Occupied. The state of the VSSs in rear and in front of the train are free.
Precondition	Train stopped in a station (at standstill). The ETCS On-board has reported a position with integrity confirmed after reaching standstill, so the CRE is at the min safe rear end. Driver closes the desk.
Flow of events	1. ETCS on board changes to SB mode and reports EoM with integrity confirmed. 2. The HL3/HTD Trackside orders to terminate the communication session and updates stored location info of train. 3. ETCS on board terminates communication session with HL3/HTD Trackside. 4. The HL3/HTD Trackside updates VSS states previously occupied by train to “Unknown” state and starts a disconnect propagation timer for each VSS of the train location.

	5. On trackside, the disconnect propagation timers expire and the VSS in rear and beyond the train location on the same TTD are changed from “Free” to “Unknown”.
Postcondition	ETCS on board in SB after EoM and no longer communicating with HL3/HTD Trackside.
Safety relation	This use case is safety relevant
Open topics / consideration	

7.8.14. UC_01_02_04_14 – End of Mission without train integrity confirmed after standstill

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	04 (Train movement – Degraded operational conditions)
UC ID	**UC_01_02_04_14**
Use Case	**End of Mission without train integrity confirmed after standstill**
Main actor	ETCS On-board
Other actors	HL3/HTD Trackside Driver
Main goal	Describes what happens to the track status at End of Mission when Train Integrity has NOT been confirmed after the train has reached standstill.
Assumptions	The HL3/HTD Trackside can trust the information received from the On-board about the train integrity status (Q_INTEGRITY) and the safe train length (L_TRAININT).
Precondition	Train stopped in a station (at standstill). The ETCS On-board has not reported a position with integrity confirmed after reaching standstill, so the CRE is at some location in rear of the actual rear end of the train, being further away than if integrity had been confirmed. Driver closes the desk.
Flow of events	1. ETCS on board changes to SB mode and reports EoM with no integrity info in same location. 2. The HL3/HTD Trackside orders to terminate the communication session. 3. ETCS on board terminates communication session with HL3/HTD Trackside. 4. The HL3/HTD Trackside updates all VSS states previously “Occupied” by the train (up the VSS where the CRE is located) to “Unknown” state and starts the disconnect propagation timer.
Postcondition	ETCS on board in SB after EoM and no longer communicating with HL3/HTD Trackside. For VSS located on a free TTD, the status can be set to “Free”.
Safety relation	This use case is safety relevant
Open topics / consideration	

7.9. Radio communication issues

7.9.1. UC_01_02_05_01 - Temporary track-train radio disconnection due to radio fault – T_NVCONTACT not expired

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	05 (Radio communication issues)
UC ID	**UC_01_02_05_01**
Use Case	**Temporary track-train radio disconnection due to radio fault – T_NVCONTACT not expired**
Main actor	Rolling stock
Other actors	GSM-R network
Main goal	Description of the management by the train of temporary radio disconnection.
Assumptions	• OBU active in nominal conditions; • ETCS trackside subsystem active and properly working; • Mute timer greater than T_NVCONTACT;
Precondition	• Train running along the track, following the MA available onboard; • OBU in a supervised operating mode (FS/OS); • Track-train radio link active;
Flow of events	1. While running along the line (likely due to a fault in the GSM-R components) the OBU does not receive anymore messages from the trackside; 2. OBU does not apply any reaction if T_NVCONTACT is not expired; 3. ETCS subsystem does not declare the train as MUTE as the mute timer is not expired; 4. The radio link is re-established before the T_NVCONTACT expiration; 5. As soon as ETCS subsystem receives an updated position report from OBU, it uses it for locating unambiguously the train on the track (both front and safe rear, according with the value of the train integrity information) and for updating the related functionalities; 6. Among such functionalities, the updating of the status of the fixed virtual sections are included;
Postcondition	Same as the preconditions
Safety relation	This use case is safety relevant.
Open topics / consideration	High Level Requirements R_01_02_05_01_01 The system shall be able to manage temporary train-track radio disconnection with no impact on the signalling functionalities.

7.9.2. UC_01_02_05_02 - Temporary track-train radio disconnection due to radio fault – T_NVCONTACT expired

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	05 (Radio communication issues)
UC ID	**UC_01_02_05_02**
Use Case	**Temporary track-train radio disconnection due to radio fault – T_NVCONTACT expired**
Main actor	Rolling stock
Other actors	GSM-R network
Main goal	Description of the management by the train of temporary radio disconnection.
Assumptions	• OBU active in nominal conditions; • ETCS trackside subsystem active and properly working;
Precondition	• Train running along the track, following the MA available onboard; • OBU in a supervised operating mode (FS/OS); • Track-train radio link active;
Flow of events	1. While running along the line the OBU does not receive anymore messages from the trackside (likely due to a fault in the GSM-R components); 2. OBU does not apply any reaction until T_NVCONTACT is expired; 3. As soon as T_NVCONTACT expires, the OBU applies the associated reaction (typically service brakes application) – the train starts braking, in such case; 4. After a preconfigured timeout, train is declared as MUTE by trackside and the status of the virtual sections currently occupied by the train is modified accordingly; 5. Train stops; 6. Radio connection is re-established again; 7. The status of the virtual sections is updated according with the VSS state machine adopted; 8. Train moves and leaves the virtual section in which it was declared MUTE; 9. The VSS becomes available for a supervised movement.
Postcondition	Same as the preconditions
Safety relation	This use case is safety relevant.
Open topics / consideration	High Level Requirements R_01_02_05_02_01 The system shall declare the train as MUTE if it does not receive any message for a preconfigured time. R_01_02_05_02_02 The system shall update the status of the virtual sections occupied by the train as soon as it is declared as MUTE. R_01_02_05_02_03 The system shall update the status of the virtual sections occupied by the train as soon as the radio communication is re-established again after a temporary loss. R_01_02_05_02_04 The system shall consider as not available for a following train a virtual section on which a communication lost with a previous

	train has been recorded; R_01_02_05_02_05 After the radio communication is re-established again after a temporary loss and the train leaves the virtual section with its safe rear end, the virtual section shall be declared as free for a supervised movement.

7.9.3. UC_01_02_05_04 - Temporary track-train radio disconnection due to radio fault – T_NVCONTACT not expired, mute timer expired

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	05 (Radio communication issues)
UC ID	**UC_01_02_05_04**
Use Case	**Temporary track-train radio disconnection due to radio fault – T_NVCONTACT not expired, mute timer expired**
Main actor	Rolling stock
Other actors	GSM-R network
Main goal	Description of the management by the system of temporary radio disconnection that cause the mute timer to expire.
Assumptions	• OBU active in nominal conditions; • ETCS trackside subsystem active and properly working;
Precondition	• Train running along the track, following the MA available onboard; • OBU in a supervised operating mode (FS/OS); • Track-train radio link active;
Flow of events	1. While running along the line (likely due to a fault in the GSM-R components) the OBU does not receive anymore messages from the trackside and the OBU does not send more messages to the trackside; 2. OBU does not apply any reaction as T_NVCONTACT is not expired yet; 3. After a preconfigured timeout, train is declared as MUTE by trackside system and the status of the virtual sections currently occupied by the train is modified accordingly; 4. The radio link is re-established before the T_NVCONTACT expiration; 5. As soon as ETCS subsystem receives an updated position report from OBU, it uses it for locating unambiguously the train on the track (both front and safe rear, according with the value of the train integrity information) and for updating the related functionalities; 6. Among such functionalities, the updating of the status of the fixed virtual sections are included;
Postcondition	Same as the preconditions
Safety relation	This use case is safety relevant.
Open topics / consideration	High Level Requirements

	Here R_01_02_05_01_01 is also applicable.

7.9.4. UC_01_02_05_03 - Permanent track-train radio disconnection due to missing radio coverage (Radio Hole)

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	05 (Radio communication issues)
UC ID	**UC_01_02_05_03**
Use Case	**Permanent track-train radio disconnection due to missing radio coverage (Radio Hole)**
Main actor	Rolling stock
Other actors	GSM-R network
Main goal	Description of the management by the train of a permanent radio hole.
Assumptions	• OBU active in nominal conditions; • ETCS trackside subsystem active and properly working; • Unavailability of one or more adjacent BTSs or GSM-R coverage not uniform;
Precondition	• Train running along the track, following the MA available onboard; • OBU in a supervised operating mode (FS/OS); • Track-train radio link active;
Flow of events	1. While running along the line the trackside system detects an area without radio coverage, for which a Radio Hole has been configured as track condition; 2. Before the rolling stock enters the radio hole, the OBU is informed about the presence of this radio hole; 3. As soon as the train enters the area without radio coverage, OBU suspends any reaction linked to the T_NVCONTACT expiration; 4. After a preconfigured timeout, train is declared as MUTE by trackside system and the status of the virtual sections currently occupied by the train is modified accordingly; 5. Train does not stops and it exits from the radio hole; 6. Radio connection is re-established again; 10. The status of the virtual sections is updated according with the VSS state machine adopted;
Postcondition	Same as the preconditions.
Safety relation	This use case is safety relevant.
Open topics / consideration	High Level Requirements R_01_02_05_03_01 The train shall be able to manage Radio Hole track conditions.

7.9.5. UC_01_02_05_05 - Loss of Communication without re-connection

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	5 (Radio communication issues)
UC ID	**UC_01_02_05_05**
Use Case	**Loss of Communication without re-connection**
Main actor	ETCS On-board
Other actors	HL3/HTD Trackside Dispatcher/Traffic Management System
Main goal	Train is at standstill and located inside the area of the last granted MA. The VSSs of the TTDs where train could be located are set to Unknown to protect the train against movements of other trains in FS (safe situation).
Assumptions	A FS MA is not granted over Unknown VSSs. M_NVCONTACT is configured for Service Brake or Emergency Brake SR movements initiated by the driver are excluded
Precondition	Train is located on VSSs which are Occupied Train has a Movement Authority (FS or OS) over Free VSS in front of the train The mute timer of the train is started The train no longer sends train position reports
Flow of events	1. The mute timer expires. Trackside stores the train location. The VSSs where the train was located at the time of mute timer expiration becomes Unknown (#7A of VSS state machine). Also the VSSs in advance of the memorised train location which are on an occupied TTD and are part of the MA become Unknown (#1B of VSS state machine). The disconnect propagation timer for each VSS of the MA which became Unknown is started. 2. Since the train does not re-connect, when the disconnect propagation timers expires also the adjacent VSSs which are Free, included in the MA area and on the same (occupied) TTD become Unknown due to the propagation (#1C of VSS state machine). 3. After T_NVCONTACT expires, the train starts to brake due to the configured reaction (i.e. service brake or emergency brake) until reaches standstill. 4. After 5 minutes, the communication session is terminated by the train and by trackside.
Postcondition	Train is at standstill and located in the area of the last granted MA. VSSs of the TTDs where train could be located are set to Unknown.
Safety relation	This use case is safety relevant
Open topics / consideration	Correct configuration of the disconnect propagation timer is needed according to the rules of the specific application

7.9.1. UC_01_02_05_06 - Train passes through Radio Hole within expected time

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	5 (Radio communication issues)
UC ID	**UC_01_02_05_06**
Use Case	**Train passes through Radio Hole within expected time**
Main actor	ETCS On-board
Other actors	HL3/HTD Trackside
Main goal	Normal Movement through Radio Hole without an impact on following trains
Assumptions	Radio Hole is pre-defined (Permanent or Temporary) An appropriate Radio Hole timer is set in the HL3/HTD Trackside for the expected duration of travel through the Radio Hole Radio Hole is covered by a single VSS and the borders of the Radio Hole coincide with TTD boundaries Radio Hole timer start location is engineered in rear of the start location of the Radio Hole by a distance depending on the duration of the Mute timer
Precondition	Train running in Normal Movement (in FS or OS mode) The mute timer Wait Integrity timer and ETCS timer for that train are started
Flow of events	1. The HL3/HTD Trackside extends an MA for the train through the whole Radio Hole and sends track condition “radio hole” information to the ETCS On-board. 2. Train reports MaxSFE having passed the start location of the Radio Hole timer. The HL3/HTD Trackside updates the Front of the Train Location and starts the Radio Hole timer, stops supervising the Mute timer, the Wait Integrity timer and the ETCS session timer. 3. First TTD inside the Radio Hole becomes occupied. The status of the VSS inside the Radio Hole is changed to occupied. 4. Train continues moving but the ETCS On-board does not send position reports. 5. Train has passed the end location of the Radio Hole and re-establishes a communication session before the Radio Hole timer expires. 6. The ETCS On-board sends a position report with the train integrity confirmed. The HL3/HTD Trackside updates the Train Location of the train, updates the VSS status, stops the Radio Hole timer and starts supervising the Mute Timer, the Wait Integrity timer and the ETCS session timer.
Postcondition	Train running in Normal Movement. The VSS status inside the Radio Hole is free, unknown or occupied depending on the Train Location.
Safety relation	This use case is safety relevant
Open topics / consideration	Starts the Radio Hole timer with a prolonged value in case the train reports MaxSFE in a window defined by the length of the Mute Timer in rear of the start location of the Radio Hole.

	Preconfigured Temporary Radio Hole could be activated over more than one VSS, but it does not bring any operational benefits as an MA for a following train cannot end inside a Radio Hole (HL3/HTD trackside can only adjust a Train Location based on TTD occupancy).

7.9.1. UC_01_02_05_07 - Train passes through Radio Hole longer than expected time

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	5 (Radio communication issues)
UC ID	**UC_01_02_05_07**
Use Case	**Train passes through Radio Hole longer than expected time**
Main actor	ETCS On-board
Other actors	HL3/HTD Trackside
Main goal	ID of the UC main goal: G_UC_08_02 Radio Hole timer expires and the VSS status is changed accordingly
Assumptions	Radio Hole is pre-defined (Permanent or Temporary) An appropriate Radio Hole timer is set in the HL3/HTD Trackside for the expected duration of travel through the Radio Hole Radio Hole is covered by a single VSS and that the borders of the Radio Hole coincide with TTD boundaries Radio Hole timer start location is engineered in rear of the start location of Radio Hole by a distance depending on the duration of the Mute timer
Precondition	Train running in Normal Movement (in FS or OS mode) The mute timer Wait Integrity timer and ETCS timer for that train are started
Flow of events	1. The HL3/HTD Trackside extends an MA for the train through the whole Radio Hole and sends the track condition “radio hole” information to the ETCS On-board. 2. Train reports MaxSFE having passed the start location of the Radio Hole timer. The HL3/HTD Trackside updates the Front of the Train Location and starts the Radio Hole timer, stops supervising the Mute timer, the Wait Integrity timer and the ETCS session timer. 3. First TTD inside the Radio Hole becomes occupied. The VSS status inside the Radio Hole is changed to occupied (#2A). 4. Train continues moving but the ETCS On-board does not send position reports. 5. Radio Hole timer expires and the HL3/HTD Trackside changes the status of the VSS inside the Radio Hole to “Unknown” up to the end of the last occupied TTD section within the MA and alerts the Dispatcher. 6. The non-communicating train continues moving and occupies next TTD, the HL3/HTD Trackside changes the status of all VSS within the occupied TTD to unknown.

	7. Train has passed the end location of the Radio Hole and re-establishes a communication session. If no communication session with RBC is re-established, the train brakes depending on the configuration, the reaction could lead to train trip or a service brake application, the driver shall be informed that no radio message has been received in due time. In this case step 8 shall not apply. 8. The ETCS On-board sends a position report with the train integrity confirmed. The HL3/HTD Trackside updates the Train Location of the train, updates the VSS status and starts supervising the Mute timer, the Wait Integrity timer and the ETCS session timer.
Postcondition	Train running in Normal Movement. The VSS status inside the Radio Hole is free, unknown or occupied depending on the Train Location.
Safety relation	This use case is safety relevant
Open topics / consideration	Preconfigured Temporary Radio Hole could be activated over more than one VSS, but it does not bring any operational benefits as an MA for a following train cannot end inside a Radio Hole (HL3/HTD trackside can only adjust a Train Location based on TTD occupancy).

7.10. Level Crossing (LX) management

7.10.1. UC_01_02_06_01 - LX activation (barriers closing)

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	06 (Level Crossing (LX) management)
UC ID	**UC_01_02_06_01**
Use Case	**LX activation (barriers closing)**
Main actor	Train Driver
Other actors	GSM-R network LX components
Main goal	Description of the optimized method for activating a LX based on distance and train speed.
Assumptions	• OBU active in nominal conditions; • ETCS and IXL trackside subsystems active and properly working; • LX devices working properly; • LX connected to IXL;
Precondition	• Train approaching an LX in plain line, not activated; • OBU in FS operating mode; • Track-train radio link active; • Virtual Section covering the LX area detected as free due to a previous train passed over with train integrity confirmed;

Flow of events	1. Train is approaching the LX not activated, supervising an MA having EoA at the Marker Board protecting the LX; 2. Based on the position report received from OBU and the data inside (position and actual train speed), the ETCS trackside subsystem calculates the running distance and time to reach the LX; 3. At the right moment before the train movement is impacted by the presence of the not activated LX, the ETCS trackside subsystem request the LX activation to IXL; 4. The IXL subsystem executes the activation command; 5. The LX activates and, after a given time, is detected as protected; 6. The IXL subsystem sends the protected status of LX to the ETCS trackside subsystem; 7. The ETCS trackside subsystem sends a new MA issuing a new packet 88 without any LX speed restriction; 8. The train enters the LX area at line speed.
Postcondition	Train beyond the LX area.
Safety relation	This use case is safety relevant.
Open topics / consideration	High Level Requirements R_01_02_06_01_01 The system shall activate a LX in time to avoid any impact of the train movement due to the LX status. *Note:* *The method or the algorithm for detecting the activation time performed by the ETCS trackside subsystem is out of scope of this Use Case.*

7.10.2. UC_01_02_06_02 - Train approach to an unprotected LX

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	06 (Level Crossing (LX) management)
UC ID	**UC_01_02_06_02**
Use Case	**Train approach to an unprotected LX**
Main actor	Train Driver
Other actors	GSM-R network LX components
Main goal	Description of the approach of the train to a LX which is unprotected (e.g. barriers detected to be not lowered).
Assumptions	• OBU active in nominal conditions; • ETCS and IXL trackside subsystems active and properly working; • LX devices connected to IXL with faults that prevents from getting its protection status;
Precondition	• Train approaching an unprotected LX in plain line;

	• OBU in FS operating mode; • Train integrity device active onboard; • Track-train radio link active; • LX formerly activated and detected in “unprotected” status (not in the scope of this Use Case); • Virtual Section covering the LX area detected as free due to a previous train passed over with train integrity confirmed;
Flow of events	1. Train is approaching the unprotected LX supervising the speed restriction imposed by the trackside; MA is also having EoA at the Marker Board protecting the LX; 2. As the Virtual Section covering the LX area detected as FREE, the MA ending at the Marker Board includes an Overlap covering the Level Crossing area, with release speed calculated onboard; 3. Train Driver shall approach the Marker Board supervising the release speed calculated based on the extension of overlap parameter; 4. The train driver stops the train when the train front is aligned to the Marker Board protecting the LX. 5. Train driver is authorized to push Override EoA button; 6. Onboard subsystem goes to SR operating mode; 7. Train driver moves the train in SR through the level crossing area; 8. As soon as the system detects that the train front has overpassed the LX area, it issues an updated MA respecting the signalling condition beyond the LX.
Postcondition	Train beyond the LX area with an updated MA onboard.
Safety relation	This use case is safety relevant.
Open topics / consideration	High Level Requirements R_01_02_06_02_01 The system shall limit/shorten the MA for a train at the Marker Board protecting a LX detected in unprotected status. R_01_02_06_02_02 If the Virtual Section covering the LX area is detected as free, the system shall include within the MA ending on the Marker Board protecting the LX an overlap covering the Virtual Section and having a release speed calculated onboard based. R_01_02_06_02_03 If the Virtual Section covering the LX area is detected as not free, the system shall not include within the MA ending on the Marker Board protecting the LX any overlap.

7.10.3. UC_01_02_06_03 - Overpassing an unprotected LX

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	06 (Level Crossing (LX) management)
UC ID	**UC_01_02_06_03**
Use Case	**Overpassing an unprotected LX**

Main actor	Train Driver
Other actors	GSM-R network LX components
Main goal	In some specific operational conditions (different from the ones leading to UC_01_02_06_02), an unprotected LX can be overpassed by a train in OS mode, with a speed limitation. This Use Case describes how this operation can be performed.
Assumptions	• OBU active in nominal conditions; • ETCS and IXL trackside subsystems active and properly working; • LX devices connected to IXL with faults that prevents from getting its full protection status;
Precondition	• Train approaching an LX in plain line reported to be unprotected; • OBU in FS operating mode; • Train integrity device active onboard; • Track-train radio link active; • LX formerly activated and detected in “unprotected” status (not in the scope of this Use Case); • Virtual Section covering the LX area detected as free due to a previous train passed over with train integrity confirmed;
Flow of events	1. Train is approaching the unprotected LX supervising the speed restriction imposed by the trackside through the packet 88; 2. As the Virtual Section covering the LX area detected as FREE, the MA ending at the Marker Board includes an Overlap covering the Level Crossing area, with release speed calculated onboard; 3. Train Driver shall approach the Marker Board supervising the release speed calculated based on the extension of overlap parameter; 4. When the train is located within the LX profile window, at the speed of the speed restriction, an OS speed profile covering the LX area is issued by ETCS subsystem; 5. The driver is requested to ack the transition to OS mode and he/she acks it; 6. Onboard subsystem goes to OS operating mode; 7. Train driver moves the train in OS through the level crossing area, at very low speed defined by the LX speed restriction; 8. The train enters the LX area.
Postcondition	Train beyond the LX area with an updated MA onboard.
Safety relation	This use case is safety relevant.
Open topics / consideration	R_01_02_06_03_01 When the system detects a LX as unprotected, but its barriers are detected to be lowered, the system shall transmit to the train the information of the unprotected status with a LX speed restriction and a Movement Authority in OS covering the LX area.

7.10.4. UC_01_02_06_04 - LX deactivation after train passage

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	06 (Level Crossing (LX) management)
UC ID	**UC_01_02_06_04**
Use Case	**LX deactivation after train passage**
Main actor	Rolling stock
Other actors	GSM-R network LX components
Main goal	Description of the automatic deactivation of the LX after the detection of the train passage.
Assumptions	• OBU active in nominal conditions; • ETCS and IXL trackside subsystems active and properly working; • LX devices connected to IXL;
Precondition	• Train approaching a protected LX in plain line; • OBU in FS operating mode; • Train integrity device active onboard; • Track-train radio link active; • LX formerly activated and detected in “protected” status (not in the scope of this Use Case);
Flow of events	1. Train is approaching the protected LX with no speed restriction; 2. As soon as the system is able to detect that the train rear has overpassed the LX area (train rear safely calculated beyond the LX area), the system provides to IXL the consensus to de-activate the LX (e.g. barriers raised).
Postcondition	LX de-activated (barriers up if present)
Safety relation	This use case is safety relevant.
Open topics / consideration	*Remark:* *As the train is supposed to be entirely beyond the LX area, its deactivation does not impact at all the train movement.* High Level Requirements R_01_02_06_04_01 The system shall be able to detect that the safe rear end of a train has overpassed the Level Crossing area. R_01_02_06_04_02 When the system detects that the train has safely overpassed the Level Crossing with its rear end, it shall provide to IXL its consensus to de-activated it.

7.10.5. UC_01_02_06_05 - LX missing deactivation after train passage

Use Case Group	01 (WP3)

Use Case family	02 (Task 3.2)
Use Case function	06 (Level Crossing (LX) management)
UC ID	**UC_01_02_06_05**
Use Case	**LX missing deactivation after train passage**
Main actor	Rolling stock
Other actors	GSM-R network LX components
Main goal	Description of the missing automatic deactivation of the LX after the detection of the train passage.
Assumptions	• OBU active in nominal conditions; • ETCS and IXL trackside subsystems active and properly working; • LX devices connected to IXL;
Precondition	• Train approaching a protected LX in plain line; • OBU in FS operating mode; • Train integrity device not active onboard or not able to provide a “train integer” information; • Track-train radio link active; • LX formerly activated and detected in “protected” status (not in the scope of this Use Case);
Flow of events	1. Train is approaching the protected LX with no speed restriction; 2. ETCS subsystem receives periodical position reports either with “train integrity not available” or “train integrity lost”; 3. The system is not able to detect that the train rear has overpassed the LX area (train rear safely calculated beyond the LX area), so the system does not provide to IXL the consensus to de-activate the LX (barriers raised); 4. Through a specific operational procedure, the trackside operator, taking in account also any contribution from the train driver, execute a manual safe command for de-activating the LX;
Postcondition	LX de-activated (barriers up) Virtual section where the LX is located is occupied
Safety relation	This use case is safety relevant.
Open topics / consideration	High Level Requirements R_01_02_06_05_01 The system shall be able to manage a command by trackside operator for the manual de-activation of a Level Crossing.

7.11. Temporary Speed Restriction

7.11.1. UC_01_02_07_01 - TSR activation by trackside operator

Use Case Group	01 (WP3)

Use Case family	02 (Task 3.2)
Use Case function	07 (Temporary Speed Restriction)
UC ID	**UC_01_02_07_01**
Use Case	**TSR activation by trackside operator**
Main actor	Trackside operator
Other actors	GSM-R network Train driver
Main goal	Management of Temporary Speed Restriction imposed by trackside operator.
Assumptions	• OBU active in nominal conditions; • ETCS trackside subsystem active and properly working, including its operator interface;
Precondition	• Train running along the track; • OBU in a supervised operating mode (FS/OS);
Flow of events	1. Train is running along track according to the MA available onboard and supervising the MRSP calculated onboard; 2. Trackside operator activates a Temporary Speed Restriction in front of the train, at a proper distance in order to avoid an immediate brakes intervention; TSR to be respected with the train rear; 3. Train driver is aware of the new speed limitation and starts decreasing the train speed in order to respect it; 4. OBU updates its own braking curves for controlling the updated MRSP; 5. Train passes through the area covered by the TSR; 6. As soon as the train detects its own (min safe) rear end beyond the TSR area, the speed restriction is no more relevant and the train driver is allowed to accelerates up to the new permitted speed.
Postcondition	Same as the preconditions
Safety relation	This use case is safety relevant.
Open topics / consideration	High Level Requirements R_01_02_07_01_01 The system shall be able to activates Temporary Speed Restriction on the user interface to be reported to the train. *Comment:* *The train positions used by the algorithm (max_safe_front_end and min_safe_read_end) are affected by the confidence interval but not by the safe train length. For such consideration, this Use Case should not be marked as relevant for the scope of the demo.*

7.11.2. UC_01_02_07_02 - TSR de-activation by trackside operator

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	07 (Temporary Speed Restriction)

UC ID	**UC_01_02_07_02**
Main actor	**TSR de-activation by trackside operator**
Other actors	GSM-R network Train driver
Main goal	Management of Temporary Speed Restriction revoked by trackside operator.
Assumptions	• OBU active in nominal conditions; • ETCS trackside subsystem active and properly working, including its operator interface;
Precondition	• Train running along the track; • OBU in a supervised operating mode (FS/OS);
Flow of events	1. Train is running along track according to the MA available onboard and supervising a TSR formerly imposed by the system, to be respected with the train length; 2. Trackside operator de-activates the TSR when the train is within the restricted area; 3. Message with TSR revocation is sent to the onboard subsystem; 4. OBU updates its own braking curves, removing immediately the speed limitation imposed by the TSR, without delay for the train length; 5. Train driver is allowed to increase the train speed up to the new permitted speed.
Postcondition	Train moving at line speed.
Safety relation	This use case is safety relevant.
Open topics / consideration	High Level Requirements R_01_02_07_02_01 The system shall be able to revoke immediately the Temporary Speed Restriction to the train as soon as the operator set the proper commend on the user interface. *Comment:* *The train positions used by the algorithm (max_safe_front_end and min_safe_read_end) are affected by the confidence interval but not by the safe train length. For such consideration, this Use Case should not be marked as relevant for the scope of the demo.*

7.12. Emergency Stop Request

7.12.1. UC_01_02_08_01 - Emergency Stop Request activated by trackside operator

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)

Use Case function	08 (Emergency Stop Request)
UC ID	**UC_01_02_08_01**
Use Case	**Emergency Stop Request activated by trackside operator**
Main actor	Trackside operator
Other actors	GSM-R network Train driver
Main goal	Management of Emergency Stop Request imposed by trackside operator.
Assumptions	• OBU active in nominal conditions; • ETCS trackside subsystem active and properly working, including its operator interface; • Train integrity device active onboard; • Track-train radio link active;
Precondition	• Train running along the track; • OBU in a supervised operating mode (FS/OS);
Flow of events	1. Train is running along track according to the MA available onboard; 2. Trackside operator activates an immediate Emergency Stop Request to the train; 3. The emergency stop request message (UES) is sent to the train; 4. The onboard subsystem goes to TRIP operating mode; 5. The train applies the brakes until the standstill; 6. The transition to TRIP mode does not have any impact on the management of the Virtual Sections overpassed by the train during the braking phase, assuming it is able to report the train integrity information confirmed onboard; 7. The POST_TRIP mode is proposed to the driver; 8. The train driver acknowledges the transition to POST_TRIP according the valid operating rules; 9. The onboard subsystem goes to POST_TRIP operating mode; 10. The transition to POST_TRIP mode does not have any impact on the management of the Virtual Sections underneath the train, assuming it is able to report the train integrity information confirmed onboard; 11. No MA shall be issued to the train until the emergency request remains active.
Postcondition	Train stopped with onboard subsystem in POST_TRIP mode.
Safety relation	This use case is safety relevant.
Open topics / consideration	The actual goal of this Use Case is to highlight that the management of an Emergency Stop Request (with the transition to Trip and Post_Trip operating mode) shall not impact the nominal management of the Virtual Section, under the assumption that the train is able to regularly confirm its train integrity information. High Level Requirements R_01_02_08_01_01 The system shall issue an Emergency Stop Request to the train as soon as the command is set by the trackside operator on the user

	interface.

7.12.2. UC_01_02_08_02 - Emergency Stop Request revoked by trackside operator

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	08 (Emergency Stop Request)
UC ID	**UC_01_02_08_02**
Use Case	**Emergency Stop Request revoked by trackside operator**
Main actor	Trackside operator
Other actors	GSM-R network Train driver
Main goal	Management of Emergency Stop Request revoked by trackside operator.
Assumptions	• OBU active in nominal conditions; • ETCS trackside subsystem active and properly working, including its operator interface;
Precondition	• Train stopped anywhere on the track due to a former Emergency Stop command; • OBU in a POST_TRIP mode; • Train integrity device active onboard; • Track-train radio link active;
Flow of events	1. Train is standstill along the track in POST_TRIP operating mode; 2. Trackside operator revokes the Emergency Stop Request; 3. The Emergency Stop Request revocation message is sent to the train; 4. The onboard subsystem remains in POST_TRIP mode; 5. Following the valid operating rules, the train driver pushes the START button and the MA Request is sent to the trackside subsystem; 6. The trackside subsystem verifies with success the proper conditions to issue an MA; 7. An updated MA is issued to the train; 8. Onboard subsystem goes to OS/FS depending on the characteristics of the MA; 9. The transition to OS/FS mode does not have any impact on the management of the Virtual Sections underneath the train, assuming it is able to report the train integrity information confirmed onboard; 10. The train moves in OS/FS mode.
Postcondition	Train running in OS/FS operating mode.
Safety relation	This use case is safety relevant.
Open topics / consideration	The actual goal of this Use Case is to highlight that the management of an Emergency Stop Request revocation (with the transition from Post_Trip

	operating mode to FS/OS) shall not impact the nominal management of the Virtual Section, assuming that the train will confirm the regular train integrity information. High Level Requirements R_01_02_08_02_01 The system shall issue an Emergency Stop Request revocation to the train as soon as the command is set by the trackside operator on the user interface. R_01_02_08_02_02 The system shall be able to issue an updated Movement Authority after the revocation of an Emergency Stop Request and the reception of an MA Request.

7.13. Joining / Splitting

7.13.1. UC_01_02_09_01 - Joining of a train on a berth track

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	09 (Joining / Splitting)
UC ID	**UC_01_02_09_01**
Use Case	**Joining of a train on a berth track**
Main actor	Train drivers
Other actors	Trackside operator
Main goal	Description of the joining process of two trains (T1 and T2) on a berth track: • T1 is on a berth track • T2 is approaching the rear end of T1
Assumptions	• No TTD covering the berth track • Both trains T1 and T2 have a TIMS onboard
Precondition	• T1 is at a standstill on a berth track, with active communication with RBC; • T2 in SR mode upstream the stationary train T1 (post condition of UC_01_02_03_02);
Flow of events	1. T2 is mechanically coupled with T1; 2. T2 train driver performs End of Mission (closing desk) on his cabin; 3. The communication session between RBC and T2 is terminated; 4. T1 train length is updated by its driver; 5. RBC receives the new train length; 6. T2+T1's integrity is confirmed, a new position report is sent, and the RBC updates the status of the fixed virtual blocks occupied by T2+T1; 7. The signaller set&lock the exit route;

	8. Train T2+T1 receives an updated Movement Authority; 9. Train T2+T1 moves in a supervised mode and exit from the berth track with its confirmed rear end.
Postcondition	Train T2+T1 is ready for normal movement
Safety relation	This use case is safety relevant.
Open topics / consideration	R_01_02_09_01_01 It shall be possible to configure some predefined areas where trains coupling is allowed. R_01_02_09_01_02 In some predefined areas of the station occupied by a stationary train, the system shall be able to manage the joining of a second train. R_01_02_09_01_03 During the joining phase, the system shall transmit to the approaching train a Movement Authority in OS on the virtual section already occupied by a stationary train.

Remarks:
This UC is actually one of the most critical. Here below some concerns about it, which can be applicable also to other UCs.

1. *About standstill train T1, it is important to fix if it remains connected to RBC or not. If not, the virtual section should become "not available" and another train could be no more allowed to enter the virtual section;*
2. *For sure, the train T2 must be in SR mode when allowed to approach T1, whatever is the status of the virtual section;*
3. *In theory, as soon as the train T2 enters the virtual section where T1 is, the VSS should go to a restrictive status;*
4. *Both trains must be assumed to have TIMS onboard;*
5. *After the coupling, the train integrity of each train maybe does not change automatically; both trains could ideally still report train integrity confirmed;*
6. *As soon as the train length is updated by the driver (no automatic updating of the train length), the status of the VSS should change;*
7. *At the end of the procedure, train T2 should perform the EoM because its leading cabin cannot be operational anymore; also cabin of T1, if facing with approaching train T2, should be disabled soon or later;*
8. *When the "new" train moves and leaves the virtual section, it is quite hard to make it free, if no track detection system is present on the berth track; how to achieve this goal?*

7.13.2. UC_01_02_09_02 - Splitting of a train on a berth track

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	09 (Joining / Splitting)
UC ID	**UC_01_02_09_02**
Use Case	**Splitting of a train on a berth track**
Main actor	Train drivers

Other actors	Trackside operator
Main goal	Description of the splitting process of a train on a berth track that has not performed End of Mission
Assumptions	• T0: Train to be split; • T0 comprises T1 (front) and T2 (rear); • Both T1 and T2 are fitted with TIMS; • No End of Mission performed by train T0; • Berth track not covered with TTD
Precondition	• T1 (corresponding to T0) is initially in mode FS; • T2 is initially in mode NL (not connected with ETCS trackside); • The communication session between T0 (T1) and the RBC is open; • There is no open communication session between T2 and the RBC;
Flow of events	1. T0 is at a standstill on a berth track. The VSS state is “occupied”; 2. T0 is split into T1 and T2; 3. T1 remains in mode FS and reports no information about train integrity. The Confirmed Rear End of T0 stays at the last known location that was reported in the last Position Report before splitting; 4. The VSS status changes to “not available”; 5. T2 goes to SB mode after the trains split; 6. T1’s length is updated by driver (no way to update it automatically); 7. New validated train data is sent to RBC, followed by its acknowledgement; 8. A new position report is sent to RBC by T1 where integrity is confirmed; 9. RBC updates T1 train location. The VSS covered by T1 and T2 remain “not available”; 10. A Movement Authority is sent to train T1 as soon as an exit route is set&locked; 11. Train T1 starts moving supervising its MA; 12. Driver of train T2 performs the SoM procedure according UC_01_02_01_05
Postcondition	• Train T1 outside berth track; • Train T2 in OS, just after the reception of the first MA as soon as a new exit route has been set for it.
Safety relation	This use case is safety relevant.
Open topics / consideration	R_01_02_09_02_01 It shall be possible to configure some predefined areas where train splitting is allowed. R_01_02_09_02_02 In some predefined areas of the station, the system shall be able to manage the splitting of a train that has not performed End of Mission. R_01_02_09_02_01 When a train performs Start of Mission on a section marked as not available due to a previously recorded splitting, the system shall transmit a Movement Authority in OS covering at least the section occupied by the train.

7.13.3. UC_01_02_09_03 - Train Joint another one

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	09 (Joining & Splitting)
UC ID	**UC_01_02_09_03**
Use Case	**Train Joint another one**
Main actor	Train 1
Other actors	Train 2 ETCS On-board HL3/HTD Trackside
Main goal	Two trains to be joining.
Assumptions	Trains are standstill. Joining Train approaches in the same direction. The two trains have no faults. The Cab Activation, transition from NP to SB, provide the OTI-I and OTI-L reset.
Precondition	The two trains are in FS and communicating with the RBC Trackside
Flow of events	1. Train 1 has performed EoM on VSS 22; VSS 22 state becomes “unknown” and propagates on adjacent VSSs. 2. Train 2 is on VSS 12 approaching the train to be joined. 3. Train 2 is authorised according to trackside rules (e.g. OS mode or SR) and moves to VSS 21 which becomes "occupied", while VSS 12 becomes "free". 4. Train 2 moves to VSS 22, which becomes “occupied”. VSS 21 becomes "free". 5. Train 2 joins train 1 and performs EoM. VSS 22 becomes "unknown" The delay for the disconnect propagation related to VSS 22 is started. 6. Trainset 1-2 performs the Cab Activation (OTI-I/L reset) in the cabin of train 1. The train Integrity and train length information are provided to the EVC. Later on when Start of Mission procedure is performed with the validation of the data, and the session with the trackside is established, the validated train data (including updated length) are sent to the trackside which acknowledge these data. Then the ETCS on-board will send position report with integrity information and it will receive the authorisation to move; the cab of train 2 will be in SL of NL mode. Trainset 1-2 is not yet treated as integer (shadow train risk). VSS 22 becomes “ambiguous”. The established session does not stop the disconnect propagation timer of VSS 22, because it is a different train (ETCS on-board) that is connected. When the timer for the disconnect propagation related to VSS 22 expires, VSS 21 becomes "unknown" 7. Trainset 1-2 moves to VSS 23 which becomes "ambiguous". VSS 22 becomes "unknown" 8. Trainset 1-2 moves to VSS 31 which becomes "occupied" if there isn’t any risk of shadow train, and all VSS on TTD 20 become "free".
Postcondition	• The two trains are joining.

Safety relation	The Joining is safety relevant.
Open topics / consideration	The RBC could check that the new length is the sum of the two trains length.

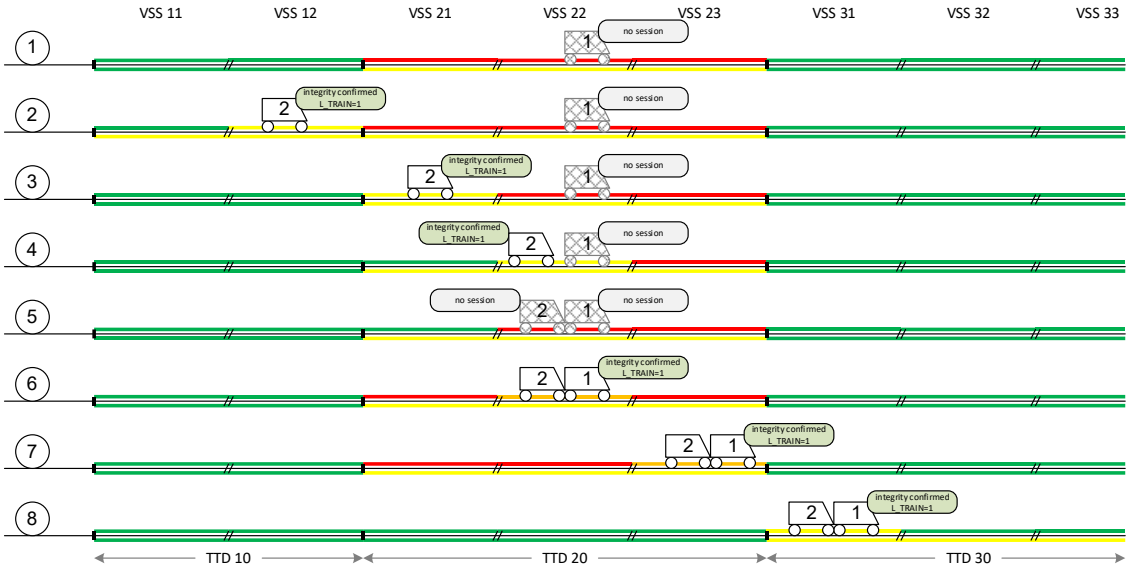


Figure 6: Joining step description

To ensure that the train integrity and train length are reported correctly a reset of the systems that evaluate train integrity and train length is required.
This can take place by closing and opening the Cabin Desk or by resetting the dedicated modules.
However, a SoM, or at least a new train data entry, is necessary because of a new train length. For this reason, the simplest solution seems to be to do an EoM and immediately after a SoM.
The scenario described above can actually be used in case the direction of the New Train does not change. The SoM will have to be done in the new cab of Train 1.
An attempt has been made to standardize the procedures as much as possible so as to have one that is always applicable.
Before starting to move the new Train, an activation of the Cabin Desk with consequent SoM must always be made. This simplifies the scenario and always has the same behaviour of the systems involved.
Any specific application where this operational scenario will be implemented is responsible to evaluate and define the maximum latency to receive the expected information and the reaction to activate in case of excessive delays:

- Confirmation of successful coupling between trains.
- Confirmation of the measurement of the new train length.
- Confirmation of Train Integrity.

Splitting.
This use case refers to splitting of a train whose integrity is confirmed on-board. The train to be split is a composition of two trainsets, each with driving cab. Two possible alternatives are described
Alternative 1
The following use case refers to the case where “train 2” resulting from splitting remains not connected to trackside.

7.13.4. UC_01_02_09_04 - Splitting of a train with integrity confirmed

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	09 (Joining & Splitting)
UC ID	**UC_01_02_09_04**
Use Case	**Splitting of a train with integrity confirmed**
Main actor	HL3/HTD Trackside
Other actors	ETCS On-board, driver, OTI-I OTI-L
Main goal	A train splits and the two resulting trains can start a new mission
Assumptions	A train to be split. Train is at standstill. The train has no faults. The Cab Activation, transition from NP a SB, provide the OTI-I and OTI-L reset.
Precondition	The train (cab of trainset 1) is in FS and communicating with the L2 + HTD Trackside - the cab of trainset 2 is in NL or SL mode
Flow of events	1. Trainset 1-2 has entered from the left side with an FS MA until end of VSS 12 and occupies VSS 12. It has stopped. 2. Train 1 and 2 are split. Train 1 remains connected with the trackside and reports train integrity lost. The cab of train 2 is closed, the mode change to SB is reported to trackside and train 2 is then disconnected and starts the train integrity evaluation by OTI-I. On the train 1 the Cab Activation is performed. FS –> NP and NP –> SB transition, the OTI-I starts the train integrity evaluation. On the train 1 the SoM is performed. Until the newly reported train data train length of train 1 is acknowledged by the trackside, train 1 can only send "no info" for the integrity status (see CR940). Due to the reported change of train data train length, train 1 is not treated as integer anymore (train1 is also in a VSS where disconnected train 2 is) and as a consequence VSS 12 becomes “ambiguous”. The moment of change of train data train length is the start of a timer for integrity loss related to VSS12. 3. Train 1 receives an MA (with optionally for VSS 12 an OS mode profile) until end of VSS 33, starts to run again, passes the TTD section border, and reports its position on VSS 21, which becomes “ambiguous”. VSS 12 becomes "unknown". 4. Train 1 moves on to VSS 22, which becomes “ambiguous”. VSS 21 becomes "unknown" 5. Train 1 moves on to VSS 23, which becomes “ambiguous”. VSS 22 becomes "unknown". At the expiration of the delay, configured according to the safety analysis for trackside, after VSS12 has been declared “ambiguous”, all VSS in TTD 10 become “unknown”

	6. Train 1 moves to VSS 31, with the physical rear still in VSS 23. VSS 31 becomes “ambiguous” and VSS 23 remains "ambiguous" 7. When Train 1 has physically left VSS 23, but (no position report received yet), after a timer configured according to the safety analysis for trackside TTD 20 becomes “free”. As a consequence, VSS 21, 22 and 23 (all VSS sections in TTD 20) go to “free” for VSS 21, 22 and for VSS 23. Because TTD 20 is free, the established rear end of the train location of train 1 is moved to the border between TTD 20 and TTD 30. Train 1 is now located on VSS 31 and, if the time elapsed between the moment the TTD has become free and the moment the trackside processes this information is sufficiently short, the trackside can consider that no vehicle may be located between TTD border and rear end of the train 1. The trackside considers therefore train 1 as integer and not followed by any ghost train. 8. Train 1 reports its position, including the confirmed rear end, inside VSS 31. This has no further effect.
Postcondition	The train is split. • Train 1 moves normally and train 2 can perform SoM
Safety relation	The splitting is safety relevant.
Open topics / consideration	

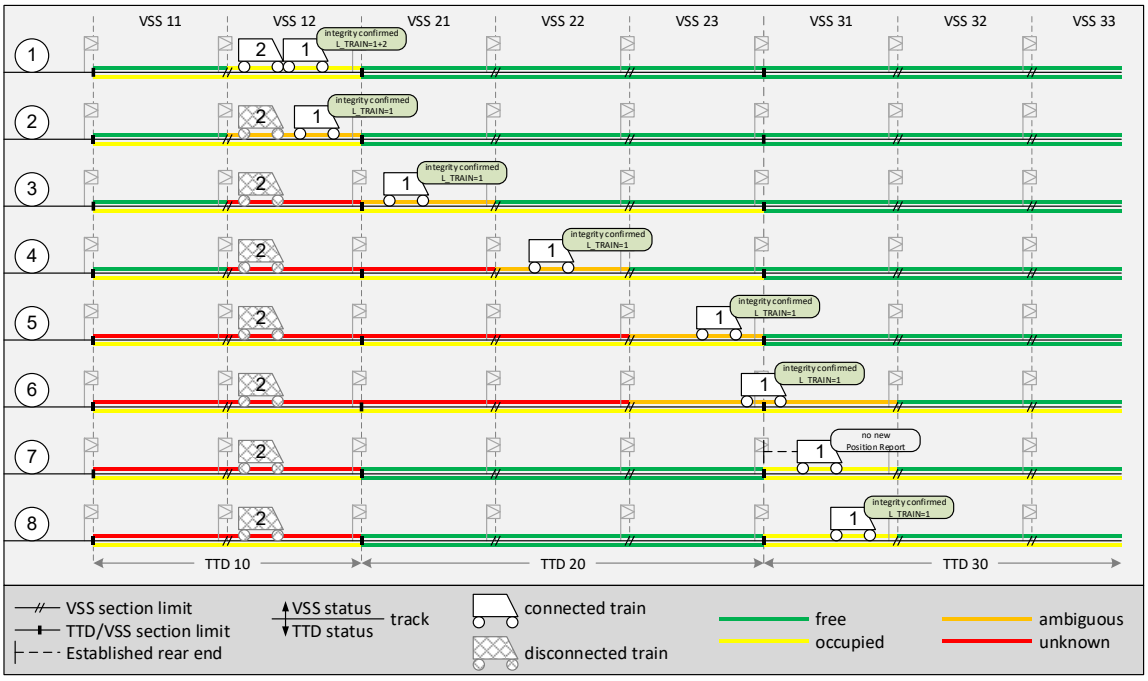


Figure 7: Splitting steps description

Alternative 2

In this use case Train 2, after splitting, performs SoM and reports its length.
The trackside waits for the SoM of trains 2 and checks that the sum of the reported lengths of train 1 and train 2 is equal to the length of the initial train. This could permit the trackside to consider train 1 integer with no possible ghost train following it.

7.13.5. UC_01_02_09_05 - Splitting of a train with integrity confirmed

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	09 (Joining & Splitting)
UC ID	**UC_01_02_09_05**
Use Case	**Splitting of a train with integrity confirmed**
Main actor	HL3/HTD Trackside
Other actors	ETCS On-board, driver, OTI-I OTI-L
Main goal	A train splits and the two resulting trains can start a new mission
Assumptions	A train to be split. Train is at standstill. The train has no faults The Cab Activation, transition from NP a SB, provide the OTI-I and OTI-L reset. After splitting the trackside waits the SoM of both trains for a defined timer. To be configured in the trackside specific application.
Precondition	The train (cab of trainset 1) is in FS and communicating with the HL3/HTD Trackside - the cab of trainset 2 is in NL or SL mode
Flow of events	1. Trainset 1-2 has entered from the left side with an FS MA until end of VSS 12 and occupies VSS 12. It has stopped. The TTD in advance to train 1 and in the rear of train 2 are free. 2. Train 1 and 2 are split. Train 1 remains connected with the trackside and reports train integrity lost. The moment of report of train integrity lost is the start of a timer for integrity loss related to VSS12. The cab of train 2 is closed, the mode change to SB is reported to trackside and train 2 remains disconnected and starts the train integrity evaluation by OTI-I. On the train 1 the Cab Activation is performed. FS –> NP and NP –> SB transition, the OTI-I starts the train integrity evaluation. On the train 1 the SoM is performed. Except for the reporting of the mode change, train 2 is not connected to the trackside. Until the newly reported train data train length of train 1 is acknowledged by the trackside, train 1 can only send "no info" for the integrity status (see CR940). Due to the reported change of train data train length, train 1 is not treated as integer anymore (train1 is also in a VSS where disconnected train 2 is) and as a consequence VSS 12 becomes “ambiguous”. 3. Train 2 performs the SB –> NP and NP –> SB transitions (is doing the Cab Activation) the OTI-I starts the train integrity evaluation. Train 2 performs SoM and reports its length this ensures that no movement inserting vehicles in the rear, in advance or in between train 1 and train 2 has occurred. Until the newly reported train data train length of train 2 is acknowledged by the trackside, train 2 can only send "no info" for the integrity status (see CR940). 4. The RBC has the train length of both trains. Can check that the sum of the two values is the same of the previous train set (Train 1 + train 2). . If the

	check is positive and the TDD in advance and in the rear do not have changed state, the trackside can consider train 1 and train 2 integer. The timer related to the delay for integrity loss may be stopped and train 1 may receive a MA according to the "normal" SoM use case.
Postcondition	The original train is split. • The two trains (Train 1 and Train 2) can move normally
Safety relation	The splitting is safety relevant.
Open topics / consideration	

7.14. Level transitions/ Handover

7.14.1. UC_01_02_10_01 - Exit from L2 area to an LNTC area

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	10 (Level transitions/ Handover)
UC ID	**UC_01_02_10_01**
Use Case	**Exit from L2 area to an LNTC area**
UC ID	UC_01_02_10_01
Main actor	Train driver Legacy IXL subsystem controlling the legacy area outside L2 area
Other actors	GSM-R network Trackside operator / dispatcher
Main goal	Description of the correct sequence of operations performed by a train during its procedure for exiting from a L2 area.
Assumptions	• OBU active in nominal conditions; • ETCS trackside subsystem working properly; • Legacy system covered by an ATP system (e.g. SCMT for Italian case); • A BG containing an immediate Level Transition to LNTC is installed at the exit boundary location;
Precondition	• Train approaching a boundary for a L2 to LNTC transition; • OBU in an supervised operating mode (FS/OS); • Track-train radio link active;
Flow of events	1. The ETCS trackside subsystem detects the train as exiting from its own L2 area; 2. The ETCS trackside subsystem detects that the exit boundary signal (it could be optical or virtual with no functional difference) is set to proceed; 3. An MA including a Level Transition order is issued to the train, with a V_EMA whose value (likely greater than 0) is set according to the information received from the legacy IXL; 4. All the virtual sections between the train front and the exit boundary are

	detected as free; 5. The status of the virtual sections upstream the train rear is calculated according to the standard rules, being not impacted by the level transition procedure; 6. As soon as the OBU detects the train front beyond the boundary location or the BG at the boundary is read, OBU level goes to NTC and the related position report is issued to the ETCS trackside subsystem; 7. OBU is supervised by the ATP system; 8. As soon as the OBU detects the train rear beyond the boundary location, it reports a position report to the ETCS trackside subsystem with train integrity confirmed; 9. The status of the last VSS close to the exit boundary is set to free; 10. ETCS trackside subsystem commands the termination of the communication session with RBC to the OBU.
Postcondition	Train running in LNTC level and SN operating mode outside the L2 area.
Safety relation	This use case is safety relevant.
Open topics / consideration	The management of level transition through the use of V_EMA has been described, but alternative solutions – e.g. the use of MA ending beyond the boundary - are deemed to be equivalent from the functional and operational point of view. This Use Case seems neither to be affected by the train integrity functions not to affect the management of the status of the virtual sections, if the assumption to have a real TTD close to the boundary is confirmed. R_01_02_10_01_01 The system shall be able to manage a level transition towards an area different from L2. R_01_02_10_01_02 The system shall send to a train approaching the boundary a Movement Authority ending at the boundary with a speed at the EoA in line with the signalling conditions beyond the border and a level transition order. R_01_02_10_01_03 The system shall command the termination of the communication to a train reporting its safe rear end beyond the boundary, if a change from L2 to a lower level was previously recorded.

7.14.2. UC_01_02_10_02 - Entering a L2 area from an LNTC area - Nominal

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	10 (Level transitions/ Handover)
UC ID	**UC_01_02_10_02**
Use Case	**Entering a L2 area from an LNTC area - Nominal**
Main actor	Train driver Legacy IXL subsystem controlling the legacy area outside L2 area

Other actors	GSM-R network Trackside operator / dispatcher
Main goal	Description of the correct sequence of operations performed by a train during its procedure for entering a L2 area.
Assumptions	• OBU active in nominal conditions; • ETCS trackside subsystem working properly; • Legacy system covered by an ATP system (e.g. SCMT for Italian case); • A BG containing an immediate Level Transition to L2 is installed at the entry boundary location;
Precondition	• Train approaching a boundary for a LNTC to L2 transition; • OBU in an LNTC and SN operating mode; • Track-train radio link not active;
Flow of events	1. OBU is commanded through a BG containing a level transition order to establish a radio communication with ETCS trackside subsystem; 2. The ETCS trackside subsystem detects the train as entering its own L2 area through the position reports based on specific preconfigured NID_BG; 3. The ETCS trackside subsystem issues to the train an MA in FS being valid starting from entry boundary, whose length depends on the conditions received from IXL; 4. If any, the optical light installed on the entry boundary is set to proceed based on a consensus raised by ETCS trackside subsystem; 5. All the virtual sections beyond the entry boundary are detected as free and are not impacted by the level transition procedure and the MA in FS; 6. As soon as the OBU detects the train front beyond the entry boundary location or the BG at the boundary is read, OBU level goes to L2 and FS operating mode; the related position report is issued to the ETCS trackside subsystem; 7. The VSS beyond the entry boundary becomes “not available” for a supervised movement of a chasing train; 8. When the VSS is cleared by the train reporting train integrity confirmed, the VSS becomes available for another supervised movement; 9. OBU is supervised by the ETCS trackside subsystem;
Postcondition	Train running in L2 level and FS operating mode inside the L2 area.
Safety relation	This use case is safety relevant.
Open topics / consideration	The management of entering train announcement through the use of position reports based on specific NID_BG has been described, but alternative solutions are deemed as acceptable from the functional and operational point of view. This Use Case seems neither to be affected by the train integrity functions not to affect the management of the status of the virtual sections. R_01_02_10_02_01 The system shall be able to accept a radio communication session coming from a train reporting in level different from L2. R_01_02_10_02_02 The system shall be able to transmit a level transition order and a Movement Authority in FS when detects a train as entering its area and all the signalling conditions beyond the entry border are met.

	R_01_02_10_02_03 The system shall send a transition order with only L2 as allowed level. R_01_02_10_02_04 The system shall inhibit the transmission of any Movement Authority if the signalling conditions downstream the boundary are not met.

7.14.3. UC_01_02_10_03 - Nominal Handover without interface for the communication of the state of the VSSs

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	10 (Level Transition / Handover)
UC ID	**UC_01_02_10_03**
Use Case	**Nominal Handover without interface for the communication of the state of the VSSs**
Main actor	Dispatcher/Traffic Management System
Other actors	Train ETCS On-board Handing Over RBC Accepting RBC
Main goal	HL3/HTD Trackside authorizes a train running in FS, reporting frequently its position with Train Integrity confirmed, to travel towards a Handover border.
Assumptions	ETCS On-board is able to handle two communication sessions. Handing Over RBC sends an MA beyond the Handover border. Handing Over RBC orders the train to terminate communication session after receiving a position report with the CRE beyond the Handover border. The Accepting and Handing Over RBC are managed by the same Dispatcher. TTD borders coincide with the Handover Border; Regarding balise engineering the Handing Over should have knowledge of balises in the Accepting RBC area to evaluate position reports to update the CRE of a train and release the VSSs in the handing over area (i.e. in rear of the border);
Precondition	A train is running in FS in the direction of the Handover border, reporting frequently with Train Integrity confirmed.
Flow of events	1. Dispatcher or Traffic Management System requests route extension for the train beyond the Handover border. Handing Over RBC sends a MA up to the border to the ETCS On-board and starts the Handover process with Accepting RBC, sending Pre-Announcement Message. The train moves towards the border. Accepting RBC receives information from Handing Over RBC that Handover process has started and receives a request for Route Related Information. Accepting RBC sends Route Related Information to Handing Over RBC. Handing Over RBC extends the MA for the ETCS On-board beyond the border location according to the Route Related Information sent by the Accepting RBC;

	2. Handing Over RBC sends to the ETCS On-board the RBC Transition Order to establish a communication session with the Accepting RBC. ETCS On-board establishes communication with Accepting RBC and starts sending position reports to the Accepting RBC; 3. As soon as the accepting RBC receives from the ETCS On-board a position report and detects that the maximum safe front end of the train has passed the border, it shall inform the Handing Over RBC that it has taken over the responsibility (req. 3.15.1.4.2 of SUBSET 026). The Handing Over RBC does not send anymore route related information to the ETCS On-board (req. 3.15.1.2.8 of SUBSET 026). The Handing Over RBC sends the Announcement Message to the Accepting RBC. 4. The train passes the border, the ETCS On-board reads the border balise group with an order to execute the RBC transition immediately and sends a position report to both the Handing Over and Accepting RBCs. Handing Over RBC receives the position report and informs the Accepting RBC that the train has reached the location corresponding to the border. Accepting RBC receives the position report. The TTD in advance of the border becomes occupied, taking into account that it is not foreseen to have a communication between the 2 RBCs about the status of the VSS sections (implementation choice because currently there is not an interoperable interface to exchange the state of the VSSs), the VSS section in advance to the border is set to ambiguous. This is consistent with the fact that some conditions to treat the train as integer (conditions 3.5.1.3 b), e) and f) will not be sent through the RBC-RBC interface) 5. The train proceeds in the accepting area, the ETCS On-board sends position reports with Train Integrity confirmed to the Handing Over RBC. When the Handing Over RBC determines that the train is completely in the accepting area, i.e. one of the following conditions happen: i) The last TTD in rear of the border becomes free; ii) ii) The train reports its CRE in the accepting area; it orders to the ETCS On-board to terminate the communication session. 6. The ETCS On-board terminates the communication session with the Handing Over RBC; *Note: The ambiguous state with the related possible shadow train will be solved in the accepting RBC area.*
Postcondition	The use case is successfully completed if it's possible to terminate the communication session with the Handing Over RBC when the train is in the accepting RBC area. The use case fails in case it's not possible to establish that the train has reached the Accepting RBC Area with its Confirmed Rear End. (There is no safety issue, only an operational one)
Safety relation	All Events are safety relevant.
Open topics / consideration	

7.14.4. UC_01_02_10_04 - Loss of Connection between Handing Over RBC and Accepting RBC

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	10 (Level Transition / Handover)
UC ID	**UC_01_02_10_04**
Use Case	**Loss of Connection between Handing Over RBC and Accepting RBC**
Main actor	Dispatcher/Traffic Management System
Other actors	Train ETCS On-board Handing Over RBC Accepting RBC
Main goal	HL3/HTD Trackside authorizes a train running in FS, reporting frequently its position with Train Integrity confirmed, to travel towards a Handover border.
Assumptions	Train is able to handle two communication sessions. Handing Over RBC sends an MA beyond the Handover border. There is a loss of connection between the 2 RBCs and there is a shortening of the movement authority to the Handover border. The Accepting and Handing Over RBC are managed by the same Dispatcher. TTD borders coincide with the Handover Border. Regarding balise engineering the Handing Over should have knowledge of balise groups in the Accepting RBC area to evaluate position reports to update the CRE of a train.
Precondition	A train is running in FS in the direction of the Handover border, reporting frequently with Train Integrity confirmed.
Flow of events	1. Dispatcher or Traffic Management System requests route extension for the train beyond the Handover border. Handing Over RBC sends a MA up to the border to the ETCS On-board and starts the Handover process with Accepting RBC, sending Pre-Announcement Message. The train moves towards the border. Accepting RBC receives information from Handing Over RBC that Handover process has started and receives a request for Route Related Information. Accepting RBC sends Route Related Information to Handing Over RBC. Handing Over RBC extends the MA for the ETCS On-board beyond the border location according to the Route Related Information sent by the Accepting RBC; 2. Handing Over RBC sends to the ETCS On-board the RBC Transition Order to establish a communication session with the Accepting RBC. ETCS On-board establishes communication with Accepting RBC and starts sending position reports to the Accepting RBC; 3. Handing Over RBC detects loss of connection with the Accepting RBC. The MA is shortened to the Handover border.

	Note: Cancellation information to the Accepting RBC is avoided in order to maintain the communication session between the ETCS On-board and the Accepting RBC; 4. According to the specific application procedures, Dispatcher/Traffic Management System authorises the driver to enter the Accepting Area, the driver selects Override to pass the Handover border, ETCS On-board changes to SR mode and informs both the Handing Over and the Accepting RBCs of the new mode. The train moves towards the border. 5. As soon as the accepting RBC receives from the ETCS On-board a position report and detects that the maximum safe front end of the train has passed the border, it shall inform the Handing Over RBC that it has taken over the responsibility (req. 3.15.1.4.2 of SUBSET 026). The Handing Over RBC does not send anymore route related information to the ETCS On-board (req. 3.15.1.2.8 of SUBSET 026). 6. The train passes the border, the ETCS On-board reads the border balise group with an order to execute the RBC transition immediately and sends a position report to both the Handing Over and Accepting RBCs. Handing Over RBC receives the position report and informs the Accepting RBC that the train has reached the location corresponding to the border. Accepting RBC receives the position report. The TTD in advance of the border becomes occupied, taking into account that it is not foreseen to have a communication between the 2 RBCs about the status of the VSS sections, the VSS section in advance to the border is set to ambiguous. This is consistent with the fact that some conditions to treat the train as integer (conditions 3.5.1.3 b), e) and f) will not be sent through the RBC-RBC interface) 7. The train proceeds in the accepting area, the ETCS On-board sends position reports with Train Integrity confirmed to the Handing Over RBC. When the Handing Over RBC determines that the train is completely in the accepting area, i.e. a. The last TTD in rear of the border becomes free; b. The train reports its CRE in the accepting area; it orders to the ETCS On-board to terminate the communication session. 8. The ETCS On-board terminates the communication session with the Handing Over RBC; *Note: The ambiguous state with the related possible shadow train will be solved in the accepting RBC area*
Postcondition	The use case is successfully completed if it's possible to terminate the communication session with the Handing Over RBC when the train is in the accepting RBC area. The use case fails in case it's not possible to establish that the train has reached the Accepting RBC Area with its Confirmed Rear End. (There is no safety issue, only an operational one)
Safety relation	All Events are safety relevant
Open topics / consideration	

7.14.5. UC_01_02_10_05 - Entering HL3/HTD Area

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	10 (Level Transition / Handover)
UC ID	**UC_01_02_10_05**
Use Case	**Entering HL3/HTD Area**
Main actor	HL3/HTD Trackside
Other actors	ETCS On-board, driver, Train OTI
Main goal	Level transition to HL3/HTD from another Level.
Assumptions	The L2 is supported by the ETCS On-board. Train fitted with TIMS. The level transition order is not conditional (i.e. P41 used for the announcement and the order). The level transition is not started by the driver. Not fallback situations: unique Level transition (only 1 level in the table of priority). No communication failures. TTD borders coincide with the Level Transition Border
Precondition	Not Start of Mission. Neither Shunting Mode nor passive shunting, nor reversing mode, nor sleeping mode, nor NL (Non Leading) Mode, nor SB (Stand By). L2 is configured in ETCS On-board and at least one Mobile Terminal is available on-board, i.e. the ETCS On-board has detected at least one Mobile Terminal in working condition, independently whether it is registered to a network or not.
Flow of events	1. An order to connect to the HL3/HTD Trackside with a given id and telephone number is given via balise group in rear of the border location and ETCS On-board establishes Communication session with the HL3/HTD Trackside if not established before. 2. Level transition announcement in the DMI. 3. When the ERTMS/ETCS communication session is open, Train Data are sent to the HL3/HTD Trackside (which acknowledges the data). 4. ETCS On-board reports integrity confirmation. 5. Level 2 MA and track description information is received from the HL3/HTD trackside before the level transition border. 6. The ETCS On-board/driver is responsible for entering the level 2 HL3/HTD area at a speed not exceeding the speed limits of the previous level (1&2/NTC/0) 7. When the level transition location is passed with the estimated front end, a position report, including the new ETCS On-board level, is sent to the HL3/HTD Trackside.

	8. The ETCS On-board equipment switches to L2. 9. The train enters the HL3/HTD area and the first TTD in the HL3/HTD area becomes occupied. 10. Mute Timer, Wait Integrity Timer and Shadow Train Timer assigned to the train and starts. The train reports position with integrity information in the HL3/HTD area and the first VSSs of the HL3/HTD area become ambiguous.
Postcondition	ETCS On-board applies MA and track description for the HL3/HTD area.
Safety relation	The function Level Transition is safety relevant as part of ERTMS/ETCS system.
Open topics / consideration	What happens if the train cannot report integrity. The Infrastructure Manager shall configure the HL3/HTD Trackside options for authorizing a train without integrity confirmed to move within or enter a HL3/HTD area. The Infrastructure Manager may conclude that, at certain locations, it is acceptable for trains to proceed into a HL3/HTD area with no fitted TIMS or with a faulty TIMS, or that they must be diverted, or the service terminated. The Infrastructure Manager may provide announcement signs for HL3/HTD areas to supplement the Driver's knowledge of the route or the announcement on the DMI may be considered sufficient. When TIMS is not working or the train is not reporting train integrity confirmed and the HL3/HTD trackside is engineered not to authorise such trains to enter, the Dispatcher shall apply non-harmonised rules whether to authorise a train to enter a HL3/HTD area. In those circumstances when the system will not issue an MA into a HL3/HTD area because a train has not reported train integrity confirmed, the Dispatcher will need to authorise the Driver to use the Override procedure. Once the train enters the HL3/HTD area, it will be managed in accordance with loss of train integrity. How to allow the change of the first VSSs from ambiguous to occupied when the train is fully inside the HL3/HTD area The HL3/HTD area may not have information about the other level area. In order to change the concerned VSSs from ambiguous to occupied, the HL3/HTD trackside should have information of the last TTD in the other level area, if any, and it shall be able to define a shadow train timer for that TTD, in order to fulfil the #11A condition from the VSS state machine

7.14.6. UC_01_02_10_06 - Exiting HL3/HTD Area

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	10 (Level Transition / Handover)
Use Case	**UC_01_02_10_06**
UC ID	**Exiting HL3/HTD Area**
Main actor	HL3/HTD Trackside
Other actors	ETCS On-board, driver, Train OTI

Main goal	Level transition to LNTC, L1 or L0 from an HL3/HTD area.
Assumptions	Train fitted with TIMS. The level transition is not started by the driver. No communication failures. An MA is extended across the level transition border (an STM Max speed is supervised at the border with the LNTC) Driver drives according to the supervision limits defined at the level transition borders. TTD borders coincide with the Level Transition Border
Precondition	Not Start of Mission. Neither Shunting Mode nor passive shunting, nor reversing mode, nor sleeping mode, nor NL (Non Leading) Mode, nor SB (Stand By).
Flow of events	1. A level transition announcement is received by the ETCS on-board and the Level transition announcement in the DMI. 2. For transitions to L0 / LNTC only the driver is requested to acknowledge the transition. 3. When the level transition location is passed with the estimated front end (or the BG at the border is received) the ETCS On-board equipment switches to the new level and sends a position report to the HL3/HTD Trackside with integrity confirmed (and the CRE still in the HL3/HTD area). 4. When the train has passed the level transition border with min safe rear end the ETCS On-board sends a position report to the HL3/HTD Trackside with integrity confirmed. 5. After receiving this position report, the HL3/HTD Trackside orders the train to terminate the session and changes the status of the last VSS from Occupied to Free. 6. The ETCS on-board terminates the session.
Postcondition	ETCS On-board is running outside the HL3/HTD Trackside area.
Safety relation	The function Level Transition is safety relevant as part of ERTMS/ETCS system.
Open topics / consideration	What happens if the train cannot report integrity: when the last TTD becomes Free, the HL3/HTD trackside can change the status of the last VSS.

7.14.7. UC_01_02_10_07 - Entering a L2 area from an LNTC area of a not ETCS equipped train

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	10 (Level transitions/ Handover)
UC ID	**UC_01_02_10_07**
Use Case	**Entering a L2 area from an LNTC area of a not ETCS equipped train**
Main actor	Train driver Legacy IXL subsystem controlling the legacy area outside L2 area

Other actors	GSM-R network Trackside operator / dispatcher
Main goal	Description of the system behaviour in case a non ETCS equipped train tries to enter the L2 area, despite the probable protections adopted for preventing this scenario.
Assumptions	• Train not fitted with an ETCS subsystem; • ETCS trackside subsystem working properly; • Legacy system covered by an ATP system (e.g. SCMT for Italian case); • A BG containing an immediate Level Transition to L2 is installed at the entry boundary location;
Precondition	• Train approaching a boundary for a LNTC to L2 transition; • OBU in an LNTC; • Track-train radio link not active (no radio system installed onboard);
Flow of events	1. Train moves on BG containing a level transition order to establish a radio communication with ETCS trackside subsystem, with no reaction; 2. If any, the optical light installed on the entry boundary is set to danger as no consensus is raised by ETCS trackside subsystem; 3. All the virtual sections beyond the entry boundary are detected as free; 4. If the BG at the boundary is read, the train does not react because of the absence of the ETCS component; ATP component reacts stopping the train because the signal at the border is set to danger; 5. The virtual section beyond the boundary, covered by a train detection devices, becomes not available for supervised movements; 6. The train is stopped; 7. An operational procedure is applied for removing the rolling stock not allowed to run in L2 area.
Postcondition	Train in LNTC standstill in the L2 area.
Safety relation	This use case is safety relevant.
Open topics / consideration	R_01_02_10_07_01 The system shall prevent a train movement inside the L2 area with an operating level minor than 2.

7.15. Degraded scenarios / system faults

7.15.1. UC_01_02_11_01 - Train movement with ETCS not available

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	11 (Degraded scenarios / system faults)
UC ID	**UC_01_02_11_01**
Use Case	**Train movement with ETCS not available**

Main actor	Train driver
Other actors	GSM-R network Trackside operator / dispatcher
Main goal	Management of train movement when ETCS subsystem is not available due to a system fault
Assumptions	• OBU active in nominal conditions; • ETCS trackside subsystem in shutdown or anyway not able to perform its mission;
Precondition	• Train stopped in a station in L2; • OBU in an supervised operating mode (FS/OS); • Track-train radio link active;
Flow of events	1. ETCS trackside system becomes unavailable; 2. Track-train communication is lost; 3. After the expiration of T_NVCONTACT, the train is no more allowed to move in a supervised mode; 4. The status of all virtual sections shall be no more calculated and reported to IXL; 5. IXL shows them as being not available for supervised movements; 6. Train driver contacts trackside operator; 7. Dispatcher gives permission to the driver to move the train in SR up to the next station; 8. Driver perform Override EoA; 9. Train goes in Staff Responsible; 10. Train moves up to the authorized destination; 11. Even if a virtual section is covered by a track detection system, its status goes is not updated even if the TDS reports as cleared; 12. The train stops inside the next station;
Postcondition	Train stopped with onboard subsystem in SR operating mode.
Safety relation	This use case is safety relevant.
Open topics / consideration	R_01_02_11_01_01 In case of unavailability of the trackside system, train movements shall be authorized only through operational procedures (Written Order). R_01_02_11_01_02 Train allowed to move with a Written Order shall move only in Staff Responsible.

7.15.2. UC_01_02_11_02 - Radio network registration and transition

Note:
This Use Case will not be exploded as it is supposed to be not relevant for the scopes of this study.
No real difference can be detected, in fact, between a pure L2 and a L3 ETCS system associated with the management of the radio network registration. Managing the virtual sections, when present, is something becoming relevant after the radio communication train-track is active, so after the conclusion of the network registration process.

7.15.3. UC_01_02_11_03 - Recovery after RBC shut down

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	11 (Degraded scenarios / system faults)
UC ID	**UC_01_02_11_03**
Use Case	**Recovery after RBC shut down**
Main actor	Trackside operator / dispatcher
Other actors	GSM-R network Maintenance staff
Main goal	Description of the procedure to be executed when the track side subsystem is switched-on for recovering after a former shutdown.
Assumptions	• Trains possibly located anywhere inside the area, with OBU active in nominal conditions; • Radio communication system working properly; • No impact to the non volatile memories of the ETCS subsystem due to the shutdown; • Train integrity device active and working onboard.
Precondition	• ETCS trackside subsystem active and properly working; • One or more trains running inside the area in a supervised operating mode (FS/OS); • Track-train radio link active;
Flow of events	1. Before the shutdown, ETCS subsystem is able to store any relevant information inside its non volatile memory about trains and track (e.g. train identifier and location, status of virtual sections, which virtual section is covered by an MA, etc.) [1]; 2. ETCS trackside system becomes unavailable due to a sudden shutdown; 3. The communication between track and all the trains is lost; 4. After the expiration of T_NVCONTACT, the trains apply the reaction (usually Service Break) and, after their stops, they are no more allowed to move in a supervised mode; 5. The train drivers are informed by the trackside operator not to move; 6. ETCS trackside subsystem is able to restart after the shutdown with no functional and operational limitation; 7. As soon as the ETCS trackside subsystem goes online (if this happens within a predefined timer) the status of each virtual section is set to the stored status, except for the ones covered by MA which are marked as not available for full supervised movements; 8. Trackside operator contacts the train drivers and gives the permission to execute a EoM/SoM procedure; 9. As soon as a train establishes a new communication session and reports a valid position inside the area, the virtual section underneath is declared as

	occupied; 10. After the MA request, the train is allowed to move according with the status of the virtual section in front of it; 11. The status of the virtual section is updated based on the train integrity information and the position reports transmitted by the OBU; 12. In case a train is not allowed to enter a supervised operating mode due to the status of the virtual section ahead, the driver gets the authorization from the signaller to enter SR mode after Override EoA; the train movement will anyway allow the update of the virtual sections status;
Postcondition	Trains moving in supervised or not supervised operating mode.
Safety relation	This use case is safety relevant.
Open topics / consideration	[1] no assumption is done about the architecture and the technology of the non volatile memory inside the ETCS trackside subsystem; The recovery of the shutdown is supposed to happen within a short time after the shutdown (possible time: few minutes). R_01_02_11_03_01 The system shall be able to store the status of each virtual sections and eventually access it after a shutdown. R_01_02_11_03_02 After a shutdown, the system shall be able to recover the previous status of all virtual sections apart from the ones previously covered by Movement Authorities which instead shall be marked as not available.

7.15.4. UC_01_02_11_04 - Trackside subsystem initialization (first start-up)

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	11 (Degraded scenarios / system faults)
UC ID	**UC_01_02_11_04**
Use Case	**Trackside subsystem initialization**
Main actor	Trackside operator / dispatcher
Other actors	GSM-R network Maintenance staff Train driver
Main goal	Description of the procedure to be executed when the ETCS trackside subsystem is switched-on for the first time (or after a very long time or heavy reconfiguration) for operation.
Assumptions	• ETCS trackside subsystem switched-off; • Trains somewhere located inside the stations; • Sweeping train with TIMS active onboard;
Precondition	• ETCS trackside subsystem configured for operating the line;

	• Any possible kind of its non volatile memories with no relevant information or empty;
Flow of events	1. The maintenance staff switches on the ETCS trackside subsystem components; 2. The components become active and ready for operating; 3. All the virtual sections are initially declared as not available for full supervised movements, excepting the ones covered by a TTD than can be declared as free it the TTD is free; 4. After the mandatory checks, the trackside operator executes the reset command; 5. The command will set to FREE the VSS not available for supervised movements, except for the ones where a connected train is localized by ETCS trackside subsystem;
Postcondition	Most of the virtual sections set to FREE and ready for operation.
Safety relation	This use case is safety relevant.
Open topics / consideration	The recovery to the default value of the VSSs can be realized also by using the sweeping train. The sweeping train procedure is for sure operationally suitable within the plain line and the main tracks of the stations, but it could be operationally heavy within the stations. After these first passages, the line can be supposed to be ready for operation and the first service can start. If and how sidings and lateral tracks could be passed by a sweeping train or by a first commercial train (but still in OS mode) is under the responsibility of the trackside operator. R_01_02_11_04_01 The system shall consider all the sections as not available at the startup.

7.15.5. UC_01_02_11_05 - Working area handover to operation

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	11 (Degraded scenarios / system faults)
UC ID	**UC_01_02_11_05**
Use Case	**Working area handover to operation**
Main actor	Trackside operator / dispatcher
Other actors	GSM-R network Maintenance staff Train driver
Main goal	Description of the procedure to be executed when a working area has to be hand-over to operations after the completion of any kind of work with no impact on the configuration of the ETCS trackside subsystem.
Assumptions	• ETCS and IXL trackside subsystems active and properly working;

	• As soon as a working area has been established, all the virtual sections covered by it have been declared by ETCS trackside subsystem as not available any kind of supervised movements; • The works executed by maintenance staff within the working area shall not have impact on the configuration of the ETCS trackside subsystem (e.g. no modification on track circuits, if any, no displacement of marker boards, balises or points, no change in the altimetric curve, etc);
Precondition	• All the works inside the working area have been declared as completed and no working staff is still inside it; • The status of the virtual sections didn't change during the working period;
Flow of events	1. The trackside operator removes the working area; 2. The trackside operator set and locks the routes, if the working area is inside a station; 3. A train is commanded to enter the working area in OS mode, acting as sweeping train [1]; 4. The sweeping train moves along the working area and every virtual section is set to FREE by the ETCS trackside subsystem as soon as a position report is received reporting the safe rear end of the train beyond the virtual section; See UC 7.16.3 – UC_01_02_12_03 – Sweeping Train for details
Postcondition	All the virtual sections within the working area are FREE and ready for operation.
Safety relation	This use case is safety relevant.
Open topics / consideration	It is out of scope the procedure for activating and de-activating a working area. But what has to be ensured is that such procedures have the right level of safety and protection vs working staff and materials. [1] if the train acting as sweeping if a first train in commercial service or a dedicated sweeping train is not part of the analysis and can be left to the decision of the trackside operator. R_01_02_11_05_01 The system shall allow the temporary activation of a working area to perform maintenance activities, inhibiting any supervised movement inside or crossing that area. R_01_02_11_05_02 Upon the activation of a working area, the system shall update the status of all the virtual sections included inside the working area as not available for supervised movements.

7.16. Miscellaneous

7.16.1. UC_01_02_12_01 – Shunting movements

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	12 (Miscellaneous)
UC ID	**UC_01_02_12_01**
Use Case	**Shunting movements**
Main actor	Train driver
Other actors	GSM-R network Trackside operator / dispatcher Shunting manager
Main goal	Description of the correct sequence of events and operations performed by a train for executing shunting movements inside a (temporary) Shunting Area.
Assumptions	• OBU active in nominal conditions; • ETCS trackside subsystem working properly;
Precondition	• Train located inside the area to be used for shunting movements; • OBU is in a supervised operating mode (FS/OS); • Track-train radio link active;
Flow of events	1. The trackside operator activates a temporary shunting area; 2. The shunting area status is reported by IXL to ETCS trackside subsystem; 3. The ETCS trackside subsystem set all the virtual sections covered by the shunting area as not available for supervised movements and it prevents any train outside the shunting area to enter with a supervised movement (all the marker boards protecting the SH area are set to danger); 4. The trackside operator allows the driver to request transition to SH; 5. The driver pushes the button; 6. The ETCS trackside subsystem grants the SH request through the proper message; 7. The OBU goes to SH mode and it is disconnected by RBC, terminating the radio link; 8. The train performs all the manouvres as needed; 9. At the end of the movements the driver performs the desk closure and the OBU goes to SB mode;
Postcondition	Train in L2/SB level/mode ready to manage a new SoM in L2.
Safety relation	This use case is safety relevant.
Open topics / consideration	*NOTE:* ▪ *It is out of scope the procedure for activating and de-activating a shunting area. But what has to be ensured is that such procedures have the right level of safety and protection vs shunters and materials.* ▪ *For the recovery to the nominal operation after the completion of the shunting movement, refer to UC_01_02_12_09 – Shunting area handover to operation.*

	R_01_02_12_01_01 The system shall allow the temporary activation of a shunting area inhibiting any supervised movement inside or crossing that area, apart from Shunting movements. R_01_02_12_01_02 Upon the activation of a shunting area, the system shall update the status of all the virtual sections included inside the shunting area as not available for supervised movements. R_01_02_12_01_03 The system shall be able to grant the SH request of a train localized inside an activated shunting area.

7.16.2. UC_01_02_12_02 – Hot Temperature Alarms on wheels

Note:

This Use Case will not be exploded as it is supposed to be not relevant for the scopes of this study.
No real difference can be detected, in fact, between a pure L2 and a L3 ETCS system associated with the management of the hot box detector alarms. Due to the alarm detection, some dedicated marker boards will be set to danger inside a station, with no significant logical dependency on the status of any virtual section between the hot box detector location and the signal.

Remark: the evaluation of the relevance of this Use Case is based on the functional and constructional characteristics of the trackside devices generating the hot box alarms used in the Italian railway applications.

7.16.3. UC_01_02_12_03 – Sweeping Train

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	12 (Miscellaneous)
UC ID	**UC_01_02_12_03**
Use Case	**Sweeping Train**
Main actor	Trackside operator / dispatcher
Other actors	GSM-R network Train driver
Main goal	Description of the procedure to be executed when one or more virtual sections are marked as not available for full supervised movement, in order to set them to free using a sweeping train moving through them.
Assumptions	• ETCS and IXL trackside subsystems active and properly working; • The sweeping train has a train integrity monitoring device working and active;
Precondition	• One or more virtual sections (adjacent or not) are marked as not available for full supervised movement;

	• The trackside operator has no chance to update their status through alternative solutions;
Flow of events	1. The trackside operator set and locks the route covering the virtual sections not free, if they are inside a station; 2. The trackside operator contacts the driver of the sweeping train and request to enter the route in OS mode, acting as sweeping train [1] and running at limited speed imposed by the operating mode; 3. As soon as the sweeping train reports a position report to be inside a virtual section with its front, ETCS trackside subsystem set its status to occupied; 4. As soon as the sweeping train reports a position report to be beyond a virtual section with its safe rear end, ETCS trackside subsystem set its status to free; 5. At the end of the journey (all the relevant virtual sections have been updated to free), the sweeping train is parked in the parking slot.
Postcondition	All the virtual sections previously not free are FREE and ready for operation. Sweeping train parked in the parking slot.
Safety relation	This use case is safety relevant.
Open topics / consideration	[1] in this scenario the sweeping train is supposed to be a train (likely a loco) dedicated to such scope. The strong assumption is of course that the sweeping train (whatever it is) shall guarantee a reliable and continuous information of its integrity. R_01_02_12_03_01 The system shall be able to grant an MA in OS to trains dedicated to sweeping activity on virtual sections marked as not available for full supervised movements. R_01_02_12_03_02 The system shall be able to upgrade the status of a virtual section to FREE once a sweeping train, after having crossed it with train integrity confirmed, reports with its safe rear end beyond the virtual section.

7.16.4. UC_01_02_12_04 – Chasing trains

Note:

This Use Case will not be exploded as it is supposed not to put relevant added value to the scopes of this study.
How the movement of a chasing train will be managed is implicitly covered by all the operational scenarios described inside this document.

7.16.5. UC_01_02_12_05 – Entering a Shunting Yard

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	12 (Miscellaneous)

UC ID	**UC_01_02_12_05**
Use Case	**Entering a Shunting Yard**
Main actor	Train driver
Other actors	GSM-R network Trackside operator / dispatcher Shunting Yard manager
Main goal	Description of the correct sequence of events and operations performed by a train during the procedure for entering a permanent Shunting Yard.
Assumptions	• OBU active in nominal conditions; • ETCS trackside subsystem working properly; • Permanent Shunting Yard not included in the ETCS trackside subsystem supervised area; • Virtual section adjacent to the shunting yard entrance covered by a real track detection device; • A specific marker board is installed at the entrance of the shunting yard, supporting the driver to stop the train at the right place; • A BG containing a immediate Level Transition to LNTC or L0 is installed at the marker board position;
Precondition	• Train approaching a shunting yard entry location; • OBU is in a supervised operating mode (FS/OS); • Track-train radio link active;
Flow of events	1. The ETCS trackside subsystem set & locks all the shunting route up to the entry location to the shunting yards and allows the transition to SH mode to the OBU; 2. The train is moved in SH mode towards the Shunting Yard and enters the Shunting Yard; 3. As soon the OBU reads the BG installed at the marker board, the OBU goes to SH/NTC operating mode/level.
Postcondition	Train running in LNTC level and SH operating mode inside the Shunting Yard.
Safety relation	This use case is safety relevant.
Open topics / consideration	This Use Case seems not to be really affected by the train integrity functions. The absence of a radio communication between a train in SH mode and the trackside subsystem imposes the engineering constraint to install a real track detection device adjacent to the shunting yard entry location. R_01_02_12_05_01 It shall be possible to configure some predefined permanent Shunting Yards where no supervised movement shall be granted. R_01_02_12_05_02 The system shall be able to detect a train inside the section adjacent to the Shunting Yard entrance. R_01_02_12_05_03 The system shall be able to grant a SH request to a train reporting a position in front of a shunting yard and having the direction towards the entrance. R_01_02_12_05_04 The system shall manage a transition to NTC level inside the Shunting Yard.

7.16.6. UC_01_02_12_06 – Exiting from Shunting Yards

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	12 (Miscellaneous)
UC ID	**UC_01_02_12_06**
Use Case	**Exiting from Shunting Yards**
Main actor	Train driver
Other actors	GSM-R network Trackside operator / dispatcher Shunting Yard manager
Main goal	Description of the correct sequence of events and operations performed by a train during the procedure for exiting from a permanent Shunting Yard.
Assumptions	• OBU active in nominal conditions; • ETCS trackside subsystem working properly; • Permanent Shunting Yard not included in the ETCS trackside subsystem supervised area, except for the first section upstream the exit border; • A specific marker board is installed at the exit of the shunting yard, supporting the driver to stop the train at the right place, before executing the exit procedure; • A BG containing a immediate Level Transition to L2 is installed at the marker board position;
Precondition	• Train approaching a shunting yard exit location; • OBU is in a LNTC/SH operating level/mode; • Track-train radio link not active;
Flow of events	1. The ETCS trackside subsystem set & locks the shunting route from the exit location to enter the L2 supervised area; 2. The driver stops the train in front of the exit marker board; 3. The driver moves the train up to entering the L2 supervised area; 4. As soon the OBU reads the BG installed at the marker board, the OBU goes to SH/L2 operating mode/level; 5. The train moves in Shunting mode up to the end of the shunting route; 6. The train moves always in SH/L2 up to the berth track; 7. The driver exit from shunting; 8. OBU goes to SB mode.
Postcondition	Train standstill on the berth track in SB mode inside the L2 supervised area.
Safety relation	This use case is safety relevant.
Open topics / consideration	If any, the status of the section upstream the exit marker board is not relevant, as it is not used by ETCS subsystem for its logic. R_01_02_12_06_01 The system shall be able to accept a train performing the Start of Mission inside a Shunting Yard.

	R_01_02_12_06_02 The system shall grant a Movement Authority OS up to the marker board and in FS thereafter, if all the signalling conditions beyond the limit of the shunting yard are met.

7.16.7. UC_01_02_12_07 – Movement in Reversing mode

Note:

This Use Case will not be detailed as it is supposed to have a lower priority compared with the others.

Moreover, the movement of a train in Reversing mode should be carefully analysed in order to check that no potential impact exists on the nominal operations and the correct management of the VSS status.

7.16.8. UC_01_02_12_08 – Manual reset of Virtual Sections

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	12 (Miscellaneous)
UC ID	**UC_01_02_12_08**
Use Case	**Manual reset of Virtual Sections**
Main actor	Trackside operator / dispatcher
Other actors	None
Main goal	Description of the procedure to be executed when one or more virtual sections are marked as not available for full supervised movement, in order to set them to free using a manual command executed by the signaller under proper conditions.
Assumptions	• ETCS and IXL trackside subsystems active and properly working;
Precondition	• One or more virtual sections (adjacent or not) are marked as not available for full supervised movements in one or more stations; • The trackside operator has no chance to update their status through alternative solutions (included a sweeping train);
Flow of events	1. The trackside operator contacts the maintenance team or the driver of the sweeping train and request, through a specific operational procedure, confirmation that all the virtual sections of the station are free (not occupied by any physical vehicle); 2. As soon as the signaller gets this confirmation, he executes a specific manual command that makes FREE all the virtual sections of the station;
Postcondition	All the virtual sections previously not free are FREE and ready for operation.
Safety relation	This use case is safety relevant
Open topics / consideration	[1] in this scenario the sweeping train is supposed to run only on a running tracks inside the station. The driver will be able to check the freedom of al the

	parallel tracks and will be able to report the absence of any vehicle to the signaller who will be allowed to execute the manual command. R_01_02_12_08_01 The system shall be able to set to free all the virtual sections included inside a station through a manual command executed by the signaller after the conclusion of the proper operational procedure.

7.16.9. UC_01_02_12_09 – Shunting area handover to operation

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	12 (Miscellaneous)
UC ID	**UC_01_02_12_09**
Use Case	**Shunting area handover to operation**
Main actor	Trackside operator / dispatcher
Other actors	GSM-R network Maintenance staff Train driver
Main goal	Description of the procedure to be executed when a shunting area has to be handed-over to operations after the completion of any kind of shunting movement.
Assumptions	• ETCS and IXL trackside subsystems active and properly working; • As soon as a shunting area has been established, all the virtual sections included inside it have been declared by ETCS trackside subsystem as not available for any kind of supervised movements; moreover all the marker boards protecting the SH area are set to danger, preventing any train outside the shunting area to enter in a supervised movement;
Precondition	• The initial conditions are the ending conditions of scenario UC_01_02_12_01 – Shunting movements; ○ All the shunting movements have been declared as completed; ○ The train having performed the shunting movements is parked on a berth track or on a siding; ○ The driver has performed the exit from shunting procedure; ○ The status of each virtual section inside the shunting area is marked as not available for supervised movements;
Flow of events	Two possible sequence of events are possible: **<u>Use of sweeping train</u>** 1. The trackside operator de-activates the shunting area; 2. The marker boards protecting the Shunting area are now ready again for operations; 3. A train outside the area of shunting is commanded to enter the working area (containing the virtual sections not available) in OS mode, acting as

	sweeping train; 4. The sweeping train moves along the working area and every virtual section is set to FREE by the ETCS trackside subsystem as soon as a position report is received reporting the safe rear end of the train beyond the virtual section; 5. The only virtual section occupied by rolling stock performing the shunting movement remain as not available for supervised movements; 6. The sweeping train is parked outside the station or in an area not used for operations; See UC 7.16.3 – UC_01_02_12_03 – Sweeping Train for details. **Use of command by the signaller** 1. The trackside operator contacts the maintenance team or the driver of the rolling stock at the end of the shunting movement for getting confirmation, through a specific operational procedure, of the actual location of the rolling stock; 2. As soon as the trackside operator gets this confirmation, he executes a specific manual command that sets each single virtual section belonging to the shunting area as FREE; 3. This command must not be executed by the trackside operator on the virtual section where the train is actually reported to be located; 4. The trackside operator de-activates the shunting area; 5. The marker boards protecting the Shunting area are now ready again for operations;
Postcondition	All the virtual sections within the de-activated shunting area are FREE and ready for operation, with the exception of the virtual section where the train is actually reported to be located.
Safety relation	This use case is safety relevant.
Open topics / consideration	*NOTE:* ▪ *It is out of scope the procedure for activating and de-activating a shunting area. But what has to be ensured is that such procedures have the right level of safety and protection vs shunters and materials.* ▪ *The need of a sweeping train or of a reset command is mainly due to the possible absence of TTD inside the shunting area. In such case, the status of the VSS, at the end of the manouvres, could not be ready for a new supervised movement.* R_01_02_12_09_01 The system shall be able to set to free each virtual sections included inside an activated shunting area through a manual command executed by the signaller after the positive conclusion of the proper operational procedure.

7.16.10. UC_01_02_12_10 – Management of Permitted Braking Distance profile

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	12 (Miscellaneous)
UC ID	**UC_01_02_12_10**
Use Case	**Management of Permitted Braking Distance profile**
Main actor	Train driver
Other actors	GSM-R network
Main goal	Description of the operational behaviour of the system in case a Permitted Braking Distance profile is configured on a piece of the track. It is also meant to show that PBD management is not affected by HTD principles and that the function can be fully applied to Regional Lines with no effective functional limitations.
Assumptions	• OBU active in nominal conditions; • ETCS and IXL trackside subsystems active and in nominal conditions;
Precondition	• Valid position known by the OBU; • Input received from IXL good for MA transmission (e.g. line block properly oriented, physical or virtual sections free [1] in front of the train); • Train registered to the radio network; • Non continuous profile configured inside RBC DP related to Permitted Braking Distance functionality;
Flow of events	1. Train driver performs a Start of Mission; 2. Train driver pushes “Start” button; 3. RBC checks with success the right conditions to issue an MA; 4. RBC issues an OS MA covering the first virtual section where the train is located and an FS MA on any free virtual section beyond the first, as long as possible based on the line condition and engineering rules adopted; 5. The MA includes the optional packet 52 “Permitted Braking Distance Information”; 6. Train starts moving supervising the MA received; 7. ETCS onboard subsystem calculates the speed restriction based on the data included inside packet 52.
Postcondition	Train in FS beyond the speed restricted area.
Safety relation	This use case is safety relevant.
Open topics / consideration	High Level Requirements: R_01_02_12_10_01 The system shall be able to manage a Permitted Braking Distance profile, transmitting it to the ETCS onboard subsystem when needed.

7.16.11. UC_01_02_12_11 – Management of Non Stopping Area

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	12 (Miscellaneous)
UC ID	**UC_01_02_12_11**
Use Case	**Management of Non Stopping Area**
Main actor	Train driver
Other actors	GSM-R network
Main goal	Description of the operational behaviour of the system in case a "Non Stopping Area" type track condition is configured on a section of the track. It is also meant to show that Non Stopping Area management (and, in general, all the track conditions) is not affected by HTD principles and that the function can be fully applied to Regional Lines with no effective functional limitations.
Assumptions	• OBU active in nominal conditions; • ETCS and IXL trackside subsystems active and in nominal conditions;
Precondition	• Train connected with RBC and running in FS mode along the line; • All inputs received from IXL good for MA transmission; • Non Stopping Area track condition configured on a section of the track;
Flow of events	1. The MA is extended by ETCS trackside subsystem to cover the section where the track condition is configured; 2. The track condition is issued to the ETCS onboard subsystem; 3. The presence of the track condition is shown to the driver on DMI according with the specifications; 4. The train goes through the area covered by the Non Stopping Area.
Postcondition	Train in FS beyond the track condition.
Safety relation	This use case is safety relevant.
Open topics / consideration	High Level Requirements: R_01_02_12_11_01 The system shall be able to manage a Non Stopping Area type track condition, transmitting it to the ETCS onboard subsystem when needed.

7.16.12. UC_01_02_12_12 – Management of Route Suitabilities – Positive Case

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	12 (Miscellaneous)
UC ID	**UC_01_02_12_12**
Use Case	**Management of Route Suitabilities – Positive Case**

Main actor	Train driver ETCS onboard subsystem
Other actors	GSM-R network
Main goal	Description of the operational behaviour of the system in case a Route Suitability is configured on a section of the track for preventing incompatible train to enters such area. It is also meant to show that Route Suitability management is not affected by HTD principles and that the function can be fully applied to Regional Lines with no effective functional limitations.
Assumptions	• OBU active in nominal conditions; • ETCS and IXL trackside subsystems active and in nominal conditions.
Precondition	• Train connected with RBC and running in FS mode along the line; • All inputs received from IXL good for MA transmission; • Local Route Suitability affecting a specific section of the track is configured inside RBC DP.
Flow of events	1. The MA is extended by ETCS trackside subsystem to cover the location where starting from the Route Suitability applies; 2. The Route Suitability packet is issued to the ETCS onboard subsystem as soon as the MA beyond this location is extended; 3. ETCS onboard subsystem evaluates (positively) the Route Suitabilities versus the corresponding Train data and verifies that they are compatible; 4. The train proceeds supervising the MA received and entering the area affected by the Route Suitability;
Postcondition	Train in FS moving inside the area affected by the Route Suitability.
Safety relation	This use case is safety relevant.
Open topics / consideration	*Note:* *Any of the following route suitabilities (or a combination of them) can be used for testing this Use Case:* ▪ *loading gauge* ▪ *traction system* ▪ *axle load category* *These are the checks to be performed by ETCS onboard subsystem:* *a) The loading gauge profile of the train is included in the list of loading gauges accepted by trackside;* *b) The list of traction systems accepted by the engine includes the one received from trackside;* *c) The axle load category of the train is not higher than the permitted one received from trackside.* High Level Requirements: R_01_02_12_12_01 The system shall be able to manage Route Suitabilities data, transmitting them to the ETCS onboard subsystem when needed.

7.16.13. UC_01_02_12_13 – Management of Route Suitabilities – Negative Case

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	12 (Miscellaneous)
UC ID	**UC_01_02_12_13**
Use Case	**Management of Route Suitabilities – Negative Case**
Main actor	Train driver ETCS onboard subsystem
Other actors	GSM-R network
Main goal	Description of the operational behaviour of the system in case a Route Suitability is configured on a section of the track for preventing incompatible train to enters such area. It is also meant to show that Route Suitability management is not affected by HTD principles and that the function can be fully applied to Regional Lines with no effective functional limitations.
Assumptions	• OBU active in nominal conditions; • ETCS and IXL trackside subsystems active and in nominal conditions.
Precondition	• Train connected with RBC and running in FS mode along the line; • All inputs received from IXL good for MA transmission; • Local Route Suitability affecting a specific section of the track is configured inside RBC DP.
Flow of events	1. The MA is extended by ETCS trackside subsystem to cover the location where starting from the Route Suitability applies; 2. The Route Suitability packet is issued to the ETCS onboard subsystem as soon as the MA beyond this location is extended; 3. ETCS onboard subsystem evaluates (negatively) the Route Suitabilities versus the corresponding Train data and verifies that there is at least one unsuitability; 4. The train is stopped at the closest stopping point corresponding to the unsuitabilities, that shall be considered as both the EOA and SvL, with no Release Speed; 5. The driver is informed about all the unsuitabilities.
Postcondition	Train in FS is standstill in front to the marker board in front of the area affected by the Route Suitability.
Safety relation	This use case is safety relevant.
Open topics / consideration	*Note:* *Any of the following route suitabilities (or a combination of them) can be used for testing this Use Case:* ▪ *loading gauge* ▪ *traction system*

	▪ *axle load category* *These are the checks to be performed by ETCS onboard subsystem:* *d) The loading gauge profile of the train is included in the list of loading gauges accepted by trackside;* *e) The list of traction systems accepted by the engine includes the one received from trackside;* *f) The axle load category of the train is not higher than the permitted one received from trackside.* High Level Requirements: Same as UC_01_02_12_12

7.17. Movement Authority management

7.17.1. UC_01_02_13_01 – Movement Authority management process when train integrity is confirmed

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	Movement Authority management
UC ID	**UC_01_02_13_01**
Use Case	**Movement Authority management process when train integrity is confirmed**
Main actor	MBS
Other actors	▪ External Source ▪ Train 1 (Followed Train) ▪ Train 2 (Following Train)
Main goal	To describe the Movement Authority management process when a given train reports “Train Integrity Confirmed by External Source”.
Assumptions	▪ There is a Communication Session established between Train 1 and MBS ▪ There is a Communication Session established between Train 2 and MBS ▪ Train 1 precedes Train 2 ▪ There is a reduced deployment of Trackside Train Detection (TTD) devices on the track ▪ ETCS-OB reports integrity according to CR940
Precondition	▪ Train 1 is equipped with an External Source that reports Train Integrity information.
Flow of events	0. Train 1 is running in FS mode 1. Train 1 sends Train Position Report with “Train Integrity Confirmed by External Source” to MBS 2. MBS updates Train 1’s Train Location 3. MBS sends a new Movement Authority to Train 2.

Postcondition	Train 1 continues running under the supervision of MBS and Train 2's MA is updated accordingly.
Safety relation	This use case is safety relevant
Open topics / consideration	Reference: FP2-R2DATO D13.1 – Moving Block Specifications applying a train-centric approach Part 2 - System Specification (Release 3)

7.17.2. UC_01_02_13_02 – Movement Authority management process when train integrity is not confirmed

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	Movement Authority management
UC ID	**UC_01_02_13_02**
Use Case	**Movement Authority management process when train integrity is not confirmed**
Main actor	MBS
Other actors	▪ External Source ▪ Train 1 (Followed Train) ▪ Train 2 (Following Train)
Main goal	To describe the Movement Authority management process when, due to either "No Train Integrity information" or "Train Integrity lost", a given train's CRE is not updated.
Assumptions	▪ There is a Communication Session established between Train 1 and MBS ▪ There is a Communication Session established between Train 2 and MBS ▪ Train 1 precedes Train 2 ▪ There is a reduced deployment of Trackside Train Detection (TTD) devices on the track ▪ ETCS-OB reports integrity according to CR940
Precondition	▪ Train 1 is equipped with an External Source that reports Train Integrity information.
Flow of events	0. Train 1 is running in FS mode. 1. Train 1 sends a Train Position Report with either "No Train Integrity Information" or "Train Integrity Lost" to MBS.
Postcondition	MBS maintains Train 1's last reported CRE, which limits the movement of Train 2.
Safety relation	This use case is safety relevant
Open topics / consideration	Reference: FP2-R2DATO D13.1 – Moving Block Specifications applying a train-centric approach Part 2 - System Specification (Release 3)

7.18. Train Integrity Loss

7.18.1. UC_01_02_14_01 – Train Integrity is confirmed after Train Integrity information is not available

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	Train Integrity Loss
UC ID	**UC_01_02_14_01**
Use Case	**Train Integrity is confirmed after Train Integrity information is not available**
Main actor	MBS
Other actors	▪ External Source ▪ Train 1 (Followed Train) ▪ Train 2 (Following Train)
Main goal	To describe the Train Location management process when Train Integrity is confirmed after "No Train Integrity Information" has been reported.
Assumptions	▪ There is a Communication Session established between Train 1 and MBS ▪ There is a Communication Session established between Train 2 and MBS ▪ Train 1 precedes Train 2 ▪ There is a reduced deployment of Trackside Train Detection (TTD) devices on the track ▪ ETCS-OB reports integrity according to CR940
Precondition	▪ Train 1 is equipped with an External Source that reports Train Integrity information ▪ When "No Train Integrity Information" is reported by the train, the train's last reported CRE remains at the same location while, in contrast, the front end is updated by MBS ▪ If Train Integrity is confirmed before the Integrity Wait Timer expires, the latter is reset, and the Train Location is updated.
Flow of events	0. Train 1 is running in FS mode 1. Train 1 sends a Train Position Report with "Train Integrity Confirmed by External Source" to MBS before the Integrity Wait Timer expires. 2. Train 1 sends Train Position Report with "No Train Integrity Information" to MBS. The Integrity Wait Timer is still running. 3. Train 1 reports "Train Integrity Confirmed by External Source" before the Integrity Wait Timer expires, which is reset.
Postcondition	The train integrity confirmation leads to Train 1's Train Location being updated. Train 1's newly updated CRE leads to the MBS sending a new MA to Train 2.
Safety relation	This use case is safety relevant
Open topics / consideration	Reference: FP2-R2DATO D13.1 – Moving Block Specifications applying a train-centric approach Part 2 - System Specification (Release 3)

7.18.2. UC_01_02_14_02 – Train Integrity is confirmed after Train Integrity loss is reported

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	Train Integrity Loss
UC ID	**UC_01_02_14_02**
Use Case	**Train integrity is confirmed after train integrity loss is reported**
Main actor	MBS
Other actors	▪ External Source ▪ Train 1 (Followed Train) ▪ Train 2 (Following Train)
Main goal	To describe the Train Location management process when Train Integrity is confirmed after "Train Integrity Lost" is reported
Assumptions	▪ There is a Communication Session established between Train 1 and MBS ▪ There is a Communication Session established between Train 2 and MBS ▪ Train 1 precedes Train 2 ▪ There is a reduced deployment of Trackside Train Detection (TTD) devices on the track ▪ ETCS-OB reports integrity according to CR940
Precondition	▪ Train 1 is equipped with an External Source that reports Train Integrity information. ▪ When "Train Integrity Lost" is reported by the train, the train's last reported CRE remains at the same location while, in contrast, its front end is updated by MBS.
Flow of events	0. Train 1 is running in FS mode 1. Train 1 sends Train Position Report with "Train Integrity Lost" to MBS 2. MBS maintains Train 1's CRE at the same location and updates its front end. 3. Train 1 reports "Train Integrity Confirmed by External Source" to MBS.
Postcondition	The train integrity confirmation leads to Train 1's Train Location being updated. Train 1's newly updated CRE leads to the MBS sending a new MA to Train 2.
Safety relation	This use case is safety relevant
Open topics / consideration	Reference: FP2-R2DATO D13.1 – Moving Block Specifications applying a train-centric approach Part 2 - System Specification (Release 3)

7.18.3. UC_01_02_14_03 – Train Integrity is confirmed after the Integrity Wait Timer expires

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	Train Integrity Loss
UC ID	**UC_01_02_14_03**
Use Case	**Train integrity is confirmed after the Integrity Wait Timer expires**
Main actor	MBS
Other actors	▪ External Source ▪ Train 1 (Followed Train)

	▪ Train 2 (Following Train)
Main goal	To describe the Train Location management process when Train Integrity loss occurs due to the Integrity Wait Timer expiring.
Assumptions	▪ There is a Communication Session established between Train 1 and MBS ▪ There is a Communication Session established between Train 2 and MBS ▪ Train 1 precedes Train 2 ▪ There is a reduced deployment of Trackside Train Detection (TTD) devices on the track ▪ ETCS-OB reports integrity according to CR940
Precondition	▪ Train 1 is equipped with an External Source that reports Train Integrity information. ▪ When "No Train Integrity Information" is reported by the train, the train's last reported CRE remains at the same location while, in contrast, its front end is updated by MBS. ▪ If Train Integrity is not confirmed before the Integrity Wait Timer expires, Train Integrity is considered as lost due to on-board related issues ▪ When Train Integrity loss occurs, the train's last reported CRE remains at the same location while, in contrast, its front end is updated by MBS.
Flow of events	0. Train 1 is running in FS mode 1. Train 1 reports "Train Integrity Confirmed by External Source" to MBS and the Integrity Wait Timer is reset. 2. Train 1 reports "No Train Integrity Information" to MBS. The Integrity Wait Timer is still running. 3. The Integrity Wait Timer expires 4. Train 1 reports "Train Integrity Confirmed by External Source" to MBS
Postcondition	The train integrity confirmation leads to Train 1's Train Location being updated. Train 1's newly updated CRE leads to the MBS sending a new MA to Train 2.
Safety relation	This use case is safety relevant
Open topics / consideration	Reference: FP2-R2DATO D13.1 – Moving Block Specifications applying a train-centric approach Part 2 - System Specification (Release 3)

7.18.4. UC_01_02_14_04 – End of Mission is performed after Train Integrity is lost

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	Train Integrity Loss
UC ID	**UC_01_02_14_04**
Use Case	**End of Mission is performed after train integrity is lost**
Main actor	MBS
Other actors	▪ Train 1 ▪ Train Driver

Main goal	To describe the Train Location management process when End of Mission (EoM) is performed after train integrity is lost
Assumptions	▪ There is a Communication Session established between Train 1 and MBS ▪ There is a reduced deployment of Trackside Train Detection (TTD) devices on the track ▪ ETCS-OB reports integrity according to CR940
Precondition	▪ Train 1 is equipped with an External Source that reports Train Integrity information. ▪ When "Train Integrity Lost" is reported by the train, the train's last reported CRE remains at the same location while, in contrast, its front end is updated by MBS.
Flow of events	0. Train 1 is running in FS mode 1. Train 1 reports "Train Integrity Lost" to MBS 2. Train 1 approaches and stops at its EoA. 3. EoM is performed by the Train Driver. The Communication Session between Train 1 and MBS is terminated.
Postcondition	MBS considers that Train 1 is no longer in communication and hence creates an Unresolved Trackbound Object.
Safety relation	This use case is safety relevant
Open topics / consideration	Reference: FP2-R2DATO D13.1 – Moving Block Specifications applying a train-centric approach Part 2 - System Specification (Release 3)

7.18.5. UC_01_02_14_05 – Train Integrity is not confirmed when entering an Area of Control

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	Train Integrity Loss
UC ID	**UC_01_02_14_05**
Use Case	**Train integrity is not confirmed when entering an Area of Control**
Main actor	MBS
Other actors	Train 1
Main goal	To describe the Train Location management process when entering an Area of Control and integrity is not confirmed
Assumptions	▪ There is a Communication Session established between Train 1 and MBS ▪ There is a reduced deployment of Trackside Train Detection (TTD) devices on the track ▪ ETCS-OB reports integrity according to CR940
Precondition	▪ Train 1 is equipped with an External Source that reports Train Integrity information. ▪ When "No Train Integrity Information" is reported by the train, the train's last reported CRE remains at the same location while, in contrast, its front end is updated by MBS. ▪ If Train Integrity is not confirmed before the Integrity Wait Timer expires, Train Integrity is considered as lost due to onboard-related issues.

Flow of events	0. Train 1 is running in FS mode and performing an entry into an Area of Control. 1. Train 1 reports “No Train Integrity Information” to MBS. The Integrity Wait Timer is still running. 2. The Integrity Wait Timer expires. Train Integrity is considered as lost
Postcondition	Train 1’s CRE is fixed at the beginning of the Area of Control.
Safety relation	This use case is safety relevant
Open topics / consideration	Reference: FP2-R2DATO D13.1 – Moving Block Specifications applying a train-centric approach Part 2 - System Specification (Release 3)

7.19. Communication Loss

7.19.1. UC_01_02_15_01 – Nominal Communication Scenario

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	Communications
UC ID	**UC_01_02_15_01**
Use Case	**Nominal Communication Scenario**
Main actor	MBS
Other actors	Train 1
Main goal	To describe the nominal scenario where the communication between Train 1 and MBS is not considered as lost
Assumptions	▪ There is a Communication Session established between Train 1 and MBS ▪ There is a reduced deployment of Trackside Train Detection (TTD) devices on the track
Precondition	
Flow of events	0. Train 1 is running in FS mode under the supervision of MBS 1. Train 1 sends a Train Position Report to MBS within a given time period
Postcondition	▪ The communication between Train 1 and MBS is not interrupted. Therefore, Train 1 continues running under the supervision of MBS. ▪ Train 1’s Train Location is accordingly updated by MBS.
Safety relation	This use case is safety relevant
Open topics / consideration	Reference: FP2-R2DATO D13.1 – Moving Block Specifications applying a train-centric approach Part 2 - System Specification (Release 3)

7.19.2. UC_01_02_15_02 – Communication Loss Scenario (1)

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	Communications

UC ID	**UC_01_02_15_02**
Use Case	**Communication Loss Scenario (1)**
Main actor	MBS
Other actors	Train 1
Main goal	To describe the scenario where the communication between Train 1 and MBS is considered as lost without the Communication Session being terminated.
Assumptions	▪ There is a Communication Session established between Train 1 and MBS ▪ There is a reduced deployment of Trackside Train Detection (TTD) devices on the track
Precondition	
Flow of events	0. Train 1 is running in FS mode 1. Train 1 does not send a Train Position Report to MBS within a given time period 2. MBS declares that the communication with Train 1 is lost.
Postcondition	MBS replaces Train 1's Train Location with an Unresolved Trackbound Object. The Communication Session between Train 1 and MBS is not terminated.
Safety relation	This use case is safety relevant
Open topics / consideration	Reference: FP2-R2DATO D13.1 – Moving Block Specifications applying a train-centric approach Part 2 - System Specification (Release 3)

7.19.3. UC_01_02_15_03 – Communication Loss Scenario (2)

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	Communications
UC ID	**UC_01_02_15_03**
Use Case	**Communication Loss Scenario (2)**
Main actor	MBS
Other actors	Train 1
Main goal	To describe the scenario where the communication between Train 1 and MBS is considered as lost, without the Communication Session being terminated, and then reestablished after which Train 1 reports "No Train Integrity Information".
Assumptions	▪ There is a Communication Session established between Train 1 and MBS ▪ ETCS-OB reports integrity according to CR940 ▪ There is a reduced deployment of Trackside Train Detection (TTD) devices on the track
Precondition	▪ Train 1 is equipped with an External Source that reports Train Integrity information.
Flow of events	0. UC_01_02_15_02 1. The communication between Train 1 and MBS is reestablished 2. Train 1 sends a Train Position Report to MBS with "No Train Integrity Information" 3. MBS checks that the received report corresponds with the same train

	4. MBS replaces Train 1's Unresolved Trackbound Object with Train 1's Train Location
Postcondition	Train 1's last reported CRE is not updated as Train Integrity is not confirmed
Safety relation	This use case is safety relevant
Open topics / consideration	Reference: FP2-R2DATO D13.1 – Moving Block Specifications applying a train-centric approach Part 2 - System Specification (Release 3)

7.19.4. UC_01_02_15_04 – Communication Loss Scenario (3)

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	Communications
UC ID	**UC_01_02_15_04**
Use Case	**Communication Loss Scenario (3)**
Main actor	MBS
Other actors	▪ Train 1 ▪ External Source
Main goal	To describe the scenario where the communication between Train 1 and MBS is considered as lost, without the Communication Session being terminated, and then reestablished after which Train 1 reports "Train Integrity Confirmed by External Source".
Assumptions	▪ There is a Communication Session established between Train 1 and MBS ▪ ETCS-OB reports integrity according to CR940 ▪ There is a reduced deployment of Trackside Train Detection (TTD) devices on the track
Precondition	Train 1 is equipped with an External Source that reports Train Integrity information.
Flow of events	0. UC_01_02_15_02 1. The communication between Train 1 and MBS is reestablished 2. Train 1 sends a Train Position Report to MBS with "Train Integrity Confirmed by External Source" 3. MBS checks that the received report corresponds with the same train 4. MBS replaces Train 1's Unresolved Trackbound Object with Train 1's Train Location
Postcondition	Train 1's last reported CRE is updated by MBS
Safety relation	This use case is safety relevant
Open topics / consideration	Reference: FP2-R2DATO D13.1 – Moving Block Specifications applying a train-centric approach Part 2 - System Specification (Release 3)

7.19.5. UC_01_02_15_05 – Communication Loss Scenario (4)

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)

Use Case function	Communications
UC ID	**UC_01_02_15_05**
Use Case	**Communication Loss Scenario (4)**
Main actor	MBS
Other actors	▪ Train 1 ▪ External Source
Main goal	To describe the scenario where the Communication Session between Train 1 and MBS is terminated and then reestablished
Assumptions	▪ There is a Communication Session established between Train 1 and MB ▪ ETCS-OB reports integrity according to CR940 ▪ There is a reduced deployment of Trackside Train Detection (TTD) devices on the track
Precondition	Train 1 is equipped with an External Source that reports Train Integrity information.
Flow of events	0. UC_01_02_15_02 1. The Communication Session between Train 1 and MBS is terminated. Train 1 is no longer supervised by MBS. 2. A new Communication Session is established between Train 1 and MBS 3. Train 1 sends a Train Position Report to MBS with “Integrity Confirmed by External Source” 4. MBS checks that the received report corresponds with the same train 5. MBS updates Train 1’s Train Location
Postcondition	Train 1 resumes running under the supervision of MBS
Safety relation	This use case is safety relevant
Open topics / consideration	Reference: FP2-R2DATO D13.1 – Moving Block Specifications applying a train-centric approach Part 2 - System Specification (Release 3)

7.19.6. UC_01_02_15_06 – Communication Loss Scenario (5)

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	Communication Loss
UC ID	**UC_01_02_15_06**
Use Case	**Communication Loss Scenario (5)**
Main actor	MBS
Other actors	▪ Train 1 ▪ External Source
Main goal	To describe the scenario where the communication between Train 1 and MBS is considered as lost, without the Communication Session being terminated, after SoM has been performed by Train 1.
Assumptions	▪ There is a reduced deployment of Trackside Train Detection (TTD) devices on the track ▪ ETCS-OB reports integrity according to CR940

Precondition	Train 1 is equipped with an External Source that reports Train Integrity information.
Flow of events	0. Train 1 has performed EoM and remains at standstill within the Area of Control. There is no Communication Session between Train 1 and MBS. An Unresolved Trackbound Object is allocated to Train 1 by MBS. 1. The Communication Session between Train 1 and MBS is reestablished. 2. Train 1 performs SoM 3. Train 1 sends a Train Position Report with "Train Integrity Confirmed by External Source" to MBS in SB mode 4. MBS checks that the received report corresponds with the same train 5. MBS replaces Train 1's Unresolved Trackbound Object with its Train Location 6. Train 1 does not send a Train Position Report to MBS within a given time period 7. MBS declares that the communication with Train 1 is lost and replaces Train 1's Train Location with an Unresolved Trackbound Object. 8. Before the Communication Session terminating, the communication between Train 1 and MBS is reestablished. 9. Train 1 sends a Train Position Report with "Train Integrity Confirmed by External Source" to MBS 10. MBS checks that the received report corresponds with the same train 11. MBS replaces Train 1's Unresolved Trackbound Object with its Train Location
Postcondition	Train 1 is ready to receive a Movement Authority from MBS and to transition to FS mode
Safety relation	This use case is safety relevant
Open topics / consideration	Reference: FP2-R2DATO D13.1 – Moving Block Specifications applying a train-centric approach Part 2 - System Specification (Release 3)

7.19.7. UC_01_02_15_07 – Communication Loss Scenario (6)

Use Case Group	01 (WP3)
Use Case family	02 (Task 3.2)
Use Case function	Communication Loss
UC ID	**UC_01_02_15_07**
Use Case	**Communication Loss Scenario (6)**
Main actor	MBS
Other actors	▪ Train 1 ▪ External Source
Main goal	To describe the scenario where the Communication Session between Train 1 and MBS is terminated after SoM has been performed by Train 1.
Assumptions	▪ There is a reduced deployment of Trackside Train Detection (TTD) devices on the track ▪ ETCS-OB reports integrity according to CR940

Precondition	Train 1 is equipped with an External Source that reports Train Integrity information.
Flow of events	0. UC_01_02_15_06 (events 0 – 7) 1. The Communication Session between Train 1 and MBS is terminated. Train 1 is no longer supervised by MBS. 2. A new Communication Session is established between Train 1 and MBS. 3. Train 1's Desk is closed and opened. 4. Train 1 performs SoM 5. Train 1 sends a Train Position Report with "Train Integrity Confirmed by External Source" to MBS in SB mode 6. MBS checks that the received report corresponds with the same train 7. MBS replaces Train 1's Unresolved Trackbound Object with its Train Location
Postcondition	Train 1 is ready to receive a Movement Authority from MBS and to transition to FS mode
Safety relation	This use case is safety relevant
Open topics / consideration	Reference: FP2-R2DATO D13.1 – Moving Block Specifications applying a train-centric approach Part 2 - System Specification (Release 3)

8. Conclusion

The following considerations apply and are relevant to the present version of this document, as delivered following 3 intermediate steps up to this one:

[A]. M12 – first delivery

[B]. M18 – second delivery

[C]. M22 – third and official delivery

[D]. M22 update for integrating comments from SP and R2DATO.

As already clarified inside section § 2 of this document, the aim of this work is the identification and description of the Use Cases mostly relevant from the operational point of view that can be used on a later demonstrator for showing that the technical solutions adopted are suitable for achieving the goals set up by GA on G1 regional lines.

The process of selection of such Operational Scenarios has taken into account the available inputs coming from other Work Packages within FP6 or even from other Flagship Projects. When not available, the Operational Scenarios have been identified thanks to the deep experience of the experts member of the team.

The following guidelines have been adopted during the process of selection and development of the UCs:

- operational procedures simplified as much as possible;
- full coverage of the most critical degraded conditions;
- automation of the procedure whenever possible, reducing the contribution requested to signaller and train driver;

- considering at the best possible the characteristics of the G1 regional lines (e.g. low density traffic, track layout not complex, etc);

Here following the main figures :

Families of Use Cases:	15
Total number of Use Cases:	98
Use Cases defined as not relevant:	5
Use Cases detailed:	93
Safety relevant Use Cases:	93

9. Requirements

Temporary Note: In this section the list of requirements defined in every Use Case is collected. The requirement's tag is just symbolic and it serves to uniquely identify them.

Identifier	Statement
R_01_02_01_01_01	The system shall check the validity of the Train Data versus the track characteristics and shall accept the train only in case of positive check.
R_01_02_01_02_01	The system shall inform the train driver through a text message about the train data which is detected as not compatible with the trackside.
R_01_02_01_02_02	The system shall order the radio disconnection of a train whose characteristics reported during the SoM procedure are not compatible with the track characteristics.
R_01_02_01_03_01	The system shall be able to accept a train performing the Start of Mission in plain line, assuming that the train data are compatible with the line itself.
R_01_02_01_03_02	When the signalling conditions for issuing the first MA after a SoM are met, the system shall transmit an MA in OS covering at least the section occupied by the train.
R_01_02_01_04_01	The system shall accept a train performing the Start of Mission also when its position is invalid or unknown.
R_01_02_01_04_02	The system shall be able to localize the train on the right track in plain line, in case of single track line, taking in account the contribution of satellite positioning system.
R_01_02_01_06_01	In case the train position is not known, the system shall send an SR_Authorization to the train when OBU requests for an MA after driver's selection on START button.

Identifier	Statement
R_01_02_01_07_01	The system shall mark as OCCUPIED a virtual section within a berth/siding track as soon as a train is localized inside it, assuming that it shall be operationally excluded that more than one rolling stock will be placed on such tracks apart from some predefined sections configured to allow joining/splitting.
R_01_02_01_07_02	The system shall mark as FREE a virtual section within a berth/siding track as soon as a train reports to have safely left it with its confirmed rear end.
R_01_02_02_01_01	The system shall be able to locate unambiguously the train through the periodical position reported by the train.
R_01_02_02_01_02	The system shall update the train front end and the train rear end when an updated position is received from the train.
R_01_02_02_02_01	The ETCS subsystem shall forward the status of all virtual sections to IXL.
R_01_02_02_02_02	The IXL subsystem shall use the status of virtual sections for implementing its functionalities requiring the knowledge of the freedom of the track.
R_01_02_02_03_01	The system shall be able to calculate the status of the virtual sections through the periodical position reported by the train and using the train integrity information contained within the position report.
R_01_02_03_02_01	The system shall be able to set a route even if it ends on the berth track occupied by a stationary train.
R_01_02_03_02_02	In case of a route ending on a occupied berth track, the system shall be able to issue an MA in FS up to occupied virtual section, if all other signalling conditions are verified.
R_01_02_03_07_01	The system shall be able to detect a possible violation of the virtual section of the berth track after a train performs an EoM in FS on it.
R_01_02_03_07_02	The system shall be able to grant again an MA in FS for a train performing a SoM on a berth track within a predefined timer from the EoM in FS, if the berth track has not been detected as violated in the meantime.
R_01_02_03_08_01	The system shall issue an MA in OS for a train performing a SoM on a berth track, if the berth track has been detected as violated in the time elapsed between EoM and SoM.
R_01_02_02_04_01	The system shall be able to calculate the status of the virtual sections through the status of the physical train detection device, when available.

Identifier	Statement
R_01_02_02_06_01	The system shall be able to locate the train using the relative distance from the LRBG (Last Relevant Balise Group).
R_01_02_03_01_01	The system shall issue MA ending on a buffer stop (including terminal stations) so that the train is allowed to stop close to the Marker Board at the buffer stop.
R_01_02_03_03_01	The system shall issue MA ending on a Marker Board at the end of an entry route so that the train is allowed to stop close to this Marker Board.
R_01_02_03_04_01	The system shall be able to manage the train stopping in plain line, due to operational needs, even if the marker board is set to proceed.
R_01_02_03_05_01	The system shall consider as not available for a full supervised movement any virtual section where a train performs an EoM.
R_01_02_04_01_01	The system shall inhibit the setting of a route in station if at least one virtual section required by the signalling condition is set to OCCUPIED.
R_01_02_04_02_01	The system shall be able to grant an MA in OS on a line virtual section whose state is neither FREE nor OCCUPIED.
R_01_02_04_02_02	The system shall be able to upgrade the status of a virtual section in line to FREE once a train, after having crossed it with train integrity confirmed, reports with its safe rear end beyond the virtual section.
R_01_02_04_04_01	The SR authorisation to cross a Marker Board must be authorised by trackside personnel with dedicated operational procedures.
R_01_02_04_05_01	When the release of a route included in a Movement Authority is commanded, the system shall issue a Cooperative MA shortening request followed by an updated Shortened MA to the train.
R_01_02_04_05_02	The grant of the Cooperative MA shortening request shall allow the complete route release.
R_01_02_05_01_01	The system shall be able to manage temporary train-track radio disconnection with no impact on the signalling functionalities.
R_01_02_05_02_01	The system shall declare the train as MUTE if it does not receive any message for a preconfigured time.
R_01_02_05_02_02	The system shall update the status of the virtual sections occupied by the train as soon as it is declared as MUTE.
R_01_02_05_02_03	The system shall update the status of the virtual sections occupied by the train as soon as the radio communication is re-established again after a temporary loss.

Identifier	Statement
R_01_02_05_02_04	The system shall consider as not available for a following train a virtual section on which a communication lost with a previous train has been recorded.
R_01_02_05_02_05	After the radio communication is re-established again after a temporary loss and the train leaves the virtual section with its safe rear end, the virtual section shall be declared as free for a supervised movement.
R_01_02_05_03_01	The train shall be able to manage Radio Hole track conditions.
R_01_02_06_01_01	The system shall activate a LX in time to avoid any impact of the train movement due to the LX status.
R_01_02_06_02_01	The system shall limit/shorten the MA for a train at the Marker Board protecting a LX detected in unprotected status.
R_01_02_06_02_02	If the Virtual Section covering the LX area is detected as free, the system shall include within the MA ending on the Marker Board protecting the LX an overlap covering the Virtual Section and having a release speed calculated onboard based.
R_01_02_06_02_03	If the Virtual Section covering the LX area is detected as not free, the system shall not include within the MA ending on the Marker Board protecting the LX any overlap.
R_01_02_06_03_01	When the system detects a LX as unprotected, but its barriers are detected to be lowered, the system shall transmit to the train the information of the unprotected status with a LX speed restriction and a Movement Authority in OS covering the LX area.
R_01_02_06_04_01	The system shall be able to detect that the safe rear end of a train has overpassed the Level Crossing area.
R_01_02_06_04_02	When the system detects that the train has safely overpassed the Level Crossing with its rear end, it shall provide to IXL its consensus to de-activated it.
R_01_02_06_05_01	The system shall be able to manage a command by trackside operator for the manual de-activation of a Level Crossing.
R_01_02_07_01_01	The system shall be able to activates Temporary Speed Restriction on the user interface to be reported to the train.
R_01_02_07_02_01	The system shall be able to revoke immediately the Temporary Speed Restriction to the train as soon as the operator set the proper commend on

Identifier	Statement
	the user interface.
R_01_02_08_01_01	The system shall issue an Emergency Stop Request to the train as soon as the command is set by the trackside operator on the user interface.
R_01_02_08_02_01	The system shall issue an Emergency Stop Request revocation to the train as soon as the command is set by the trackside operator on the user interface.
R_01_02_08_02_02	The system shall be able to issue an updated Movement Authority after the revocation of an Emergency Stop Request and the reception of an MA Request.
R_01_02_09_01_01	It shall be possible to configure some predefined areas where trains coupling is allowed.
R_01_02_09_01_02	In some predefined areas of the station occupied by a stationary train, the system shall be able to manage the joining of a second train.
R_01_02_09_01_03	During the joining phase, the system shall transmit to the approaching train a Movement Authority in OS on the virtual section already occupied by a stationary train.
R_01_02_09_02_01	It shall be possible to configure some predefined areas where train splitting is allowed.
R_01_02_09_02_02	In some predefined areas of the station, the system shall be able to manage the splitting of a train that has not performed End of Mission.
R_01_02_09_02_01	When a train performs Start of Mission on a section marked as not available due to a previously recorded splitting, the system shall transmit a Movement Authority in OS covering at least the section occupied by the train.
R_01_02_10_01_01	The system shall be able to manage a level transition towards an area different from L2.
R_01_02_10_01_02	The system shall send to a train approaching the boundary a Movement Authority ending at the boundary with a speed at the EoA in line with the signalling conditions beyond the border and a level transition order.
R_01_02_10_01_03	The system shall command the termination of the communication to a train reporting its safe rear end beyond the boundary, if a change from L2 to a lower level was previously recorded.
R_01_02_10_02_01	The system shall be able to accept a radio communication session coming from a train reporting in level different from L2.

Identifier	Statement
R_01_02_10_02_02	The system shall be able to transmit a level transition order and a Movement Authority in FS when detects a train as entering its area and all the signalling conditions beyond the entry border are met.
R_01_02_10_02_03	The system shall send a transition order with only L2 as allowed level.
R_01_02_10_02_04	The system shall inhibit the transmission of any Movement Authority if the signalling conditions downstream the boundary are not met.
R_01_02_10_07_01	The system shall prevent a train movement inside the L2 area with an operating level minor than 2.
R_01_02_11_01_01	In case of unavailability of the trackside system, train movements shall be authorized only through operational procedures (Written Order).
R_01_02_11_01_02	Train allowed to move with a Written Order shall move only in Staff Responsible.
R_01_02_11_03_01	The system shall be able to store the status of each virtual sections and eventually access it after a shutdown.
R_01_02_11_03_02	After a shutdown, the system shall be able to recover the previous status of all virtual sections apart from the ones previously covered by Movement Authorities which instead shall be marked as not available.
R_01_02_11_04_01	The system shall consider all the sections as not available at the startup.
R_01_02_11_05_01	The system shall allow the temporary activation of a working area to perform maintenance activities, inhibiting any supervised movement inside or crossing that area.
R_01_02_11_05_02	Upon the activation of a working area, the system shall update the status of all the virtual sections included inside the working area as not available for supervised movements.
R_01_02_12_01_01	The system shall allow the temporary activation of a shunting area inhibiting any supervised movement inside or crossing that area, apart from Shunting movements.
R_01_02_12_01_02	Upon the activation of a shunting area, the system shall update the status of all the virtual sections included inside the shunting area as not available for supervised movements.
R_01_02_12_01_03	The system shall be able to grant the SH request of a train localized inside an activated shunting area.

Identifier	Statement
R_01_02_12_03_01	The system shall be able to grant an MA in OS to trains dedicated to sweeping activity on virtual sections marked as not available for full supervised movements.
R_01_02_12_03_02	The system shall be able to upgrade the status of a virtual section to FREE once a sweeping train, after having crossed it with train integrity confirmed, reports with its safe rear end beyond the virtual section.
R_01_02_12_05_01	It shall be possible to configure some predefined permanent Shunting Yards where no supervised movement shall be granted.
R_01_02_12_05_02	The system shall be able to detect a train inside the section adjacent to the Shunting Yard entrance.
R_01_02_12_05_03	The system shall be able to grant a SH request to a train reporting a position in front of a shunting yard and having the direction towards the entrance.
R_01_02_12_05_04	The system shall manage a transition to NTC level inside the Shunting Yard.
R_01_02_12_06_01	The system shall be able to accept a train performing the Start of Mission inside a Shunting Yard.
R_01_02_12_06_02	The system shall grant a Movement Authority OS up to the marker board and in FS thereafter, if all the signalling conditions beyond the limit of the shunting yard are met.
R_01_02_12_08_01	The system shall be able to set to free all the virtual sections included inside a station through a manual command executed by the signaller after the conclusion of the proper operational procedure.
R_01_02_12_09_01	The system shall be able to set to free each virtual sections included inside an activated shunting area through a manual command executed by the signaller after the positive conclusion of the proper operational procedure.
R_01_02_12_10_01	The system shall be able to manage a Permitted Braking Distance profile, transmitting it to the ETCS onboard subsystem when needed.
R_01_02_12_11_01	The system shall be able to manage a Non Stopping Area type track condition, transmitting it to the ETCS onboard subsystem when needed.
R_01_02_12_12_01	The system shall be able to manage Route Suitabilities data, transmitting them to the ETCS onboard subsystem when needed.

10. References

[REF 1] Grant Agreement Project 101101962 – FP6 – FutuRe
[REF 2] ERTMS/ETCS Hybrid Train Detection cod. 16E042 Rev.1F
[REF 3] Unisig Subset 026 v.3.6.0
[REF 4] FP2-R2DATO D13.1 – Moving Block Specifications applying a train-centric approach Part 2 - System Specification (Release 3)

11. Annexes

None.